ACUTA Journal of Telecommunications in Higher Education

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IPv6—What You Don’t Know CAN Hurt You
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Quotes of Note

Coping with rapid change means prioritizing, focusing on goals, and building—then empowering—diverse and capable teams that you can trust. No one can ever know it all.

Cathy O'Bryan
Director of Client Support
Indiana University

I believe the only way to cope effectively with the rapid pace of change in our work environment is to begin by accepting that it is the norm for us. Being flexible and constantly adjusting priorities based on institutional requirements allows me to find solutions and meet objectives as they arise.

Tony Mordosky
Associate Provost
Info Resources/CIO
Rowan University

The Year Ahead

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<th>Event</th>
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<tr>
<td>43rd Annual Conference</td>
<td>March 30 – April 2, 2014</td>
<td>Hyatt Regency Hotel, Dallas, Texas</td>
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<td>Fall Seminar</td>
<td>October 26 – 29, 2014</td>
<td>Park Plaza Hotel, Boston, Massachusetts</td>
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<td>Winter Seminar</td>
<td>January 25 – 28, 2015</td>
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ACUTA's mission is to advance the capabilities of higher education communications and collaboration technology leaders.

ACUTA’s core values are to:
- encourage and facilitate networking and sharing of resources
- exhibit respect for the expression of individual opinions and solutions
- fulfill a commitment to professional development and growth
- advocate the strategic value of communications and collaboration technologies in higher education
- encourage volunteerism and contributions by individual members
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This is what I call the Fourth Network Revolution.... History has shown that new networks catalyze innovation, investment, ideas, and ingenuity. Their spillover effects can transform society...

Tom Wheeler, FCC

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I think everyone agrees that urgency is arriving soon for many, but each institution is wrestling with whether they are already late or can wait a little longer.

Jonathan Young

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As the new year got underway, I took a moment to reflect on the year we left behind, before I really knuckled down and committed to the resolutions that quickly became old as we advance into spring. One resolution that should be near the top for everyone, especially higher education, is to consider the movement to IPv6.

After being in the information and communication technology field for over 20 years, I have many fond memories. I remember very well the work and training that I did with IPv4. That was rough! IP did not come easy at first, but then all of a sudden the light came on.

I remember one instructor commenting back in 1990 that we would probably run out of space in IPv4 relatively soon. Absurd, we all said. The address space of IPv4 was more than adequate to fit our needs. (And I suppose those who developed the telephone numbering system thought the same.)

Well, his comment did become reality and, as we all know, the IPv4 numbers were all allocated and used as of summer 2011. Interesting… The Internet is still working and numbers are still being allocated. One reason for this is just that the regional Internet registries (RIRs) can no longer get any new IPv4 address space from the Internet Assigned Numbers Authority (IANA), but there were great tools developed (NAT, CIDR, VLSM) to make more efficient use of the currently available IPv4 numbers.

These developments did not stop the movement toward a new and improved Internet protocol. What was once called IPNG we now know as IPv6. This is the new routing protocol for the Internet, and eventually—who knows when—the entire Internet will be routed with this protocol.

So, Where Are We Now?
A year ago there was an IPv6 launch day. This day, promoted by the Internet Society, was the day we were encouraged to turn on IPv6 and leave it on. 2014 does not see an IPv6 launch day event, but that does not mean the job of moving the world into IPv6 is done. Google is currently reporting that 1.27 percent of the traffic comes in over IPv6. Interestingly, the leaders in IPv6 deployment were Russia, France, Ukraine, Norway, and the United States. Of all networks in the global BGP routing table, only 12 percent had IPv6 protocol support.

Cisco is currently forecasting that for 2014, 3.1 percent of total IP traffic will be IPv6. By the end of 2017, 23.9 percent of IP traffic will be IPv6.

Increasingly, governments require support for IPv6 in new equipment. For the United States, it was specified in 2005 that all network backbones of all federal agencies had to be upgraded to IPv6 by June 2008. This was completed before the deadline. (See, the government can work effectively and efficiently.)

As we know, all major operating systems on personal computers and server systems also had IPv6 implementations on them. Major providers of Internet services—both ISPs and content providers—also have implemented IPv6 into their products.

So, why are we not running IPv6 globally? The new Internet protocol provides us with an infinite (actually 340,282,366,920,938,463,463,463,374,607,431,768,211,456) amount of address space (welcome, hexadecimal), increased security, and a host of routing features that will make our lives far easier. I remember a conference in 1999 hosted by Doug Comer (one of the originators of IPv4) who noted that we would be fully IPv6 by 2005. I suppose the answer to that question—Why are we not running IPv6 globally?—is the same as why we have not switched from the QWERTY keyboard. Too much training, too much work, and not enough time.

Clearly, we are moving in the right direction. Clearly, the tools are in place. Clearly, we are hesitating to do it. Moving along at our current rate, we will eventually get to full IPv6 deployment, but not soon. It has been noted by some pundits that with the current growth rate, we will hit full implementation on May 10, 2048. Unless, of course, there is a catastrophic event that causes the current Internet to become disabled (to be read as a security-related item) and forces us to jump to IPv6. This, unfortunately, is a plausible scenario that
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Whatever happened to the IPv4 address crisis?

Excerpted from an article by Lee Schlesinger, Network World, Feb. 17, 2014

In February 2011, the global Internet Assigned Numbers Authority (IANA) allocated the last blocks of IPv4 address space to the five regional Internet registries. At the time, experts warned that within months all available IPv4 addresses in the world would be distributed to ISPs. Soon after that, unless everyone upgraded to IPv6, the world would be facing a crisis that would hamper Internet connectivity for everyone...

So, here we are three years later and the American Registry for Internet Numbers (ARIN) is still doling out IPv4 addresses in the United States and Canada. Whatever happened to the IPv4 address crisis?

The day of reckoning still looms—it’s just been pushed out as the major Internet players have developed ingenious ways to stretch those available numbers. But these conservation efforts can only work for so long.

[The American Registry for Internet Numbers (ARIN)] currently has “approximately 24 million IPv4 addresses in the available pool for the region,” according to President and CEO John Curran. They’re available to ISPs large and small, but Curran predicts they will all likely be handed out by “sometime in 2014.”

Even then, addresses will still be available to be assigned to the operators’ clients for a while longer. And not all operators are likely to experience shortages at the same time. “It’s more of a problem for networks that are growing. For networks that are stable, they can reuse addresses” as some customers drop their service and new ones sign up.

Could really change the date from 2048 to 2015.

An interesting note here is that hackers are starting to use IPv6. Cloud-Flare experienced an IPv6 3GB/second DDoS attack in 2013. It appears that a lot of legacy security products assume an IPv4 world and were not designed for IPv6. These products don’t know what to do with IPv6 traffic and just pass the traffic on. In essence, IPv6 becomes a way of bypassing legacy security products. Historically only a tiny fraction of hacking attacks originated from IPv6 vectors, but that has taken a sharp uptick lately.

Interestingly, as higher-education leaders, we usually explore and move to new technology before the masses. Are we doing this now? I speculate that most of you already have a sandbox with IPv6 deployed and are experimenting and becoming familiar with it. I wonder how many of us have full deployed IPv6. I speculate that few, if any, have.

When Do I Upgrade My Network?

So the question we all are asking is, When should I upgrade my network? That, my colleagues, is the $2^38$ (yes, million dollar) question. If this is not a push from the top (due to a major security breach... as mentioned before and as pushed by the Feds), then it will be a pull from the bottom. With AT&T, Comcast, and Time Warner bringing on new households via IPv6, it would make all the sense in the world for colleges, businesses, and banking to provide them the fast, secure service that they will expect. This, of course, would better be done before the complaining starts.

Where do we start? Probably with training of staff in the differences of v6 vs. v4, hexadecimal, and (of course) the new equipment. What new equipment? Expect this transition to touch every part of your network, and unless you have brought edge routers and security devices up to snuff in the last three or four years, expect to buy new equipment. Being IPv6 capable does not mean that it necessarily has all the features you would expect in an IPv6 world.

So, after our stall is ready, after our equipment has been refreshed (either with new hardware or software upgrades), what comes next? Well, we just flick the switch, right?

One would be naive to think that this will happen with a flick of the switch. We will be operating dual-stack devices for years. With the dual-stack logic, those who are bilingual know that transitioning is easier but requires a lot of monitoring technologies to ensure that communication is not lost. This monitoring is a whole new world for most of us. To preserve the integrity and security of our network and computing infrastructure, we must monitor behaviors of applications, network, hardware, and other elements to ensure users have the reliability of communication that they demand (five nines, to say the least).

In Conclusion, a Challenge

This is where I would like to see ACUTA help out in dissemination of information: leading the charge toward IPv6 and advocating any adjustments that higher education needs. If any of you have experimented heavily or have implemented a partial deployment, please share this information with others via ACUTA seminars, the eNews, or the Journal. I truly hope you enjoy this issue of the Journal, and I hope you learn a lot about what others are doing with IPv6. And I really hope that you share your experiences, ask questions on the listserv, pull together focus groups to share knowledge, and generally lead the charge to move your campus to IPv6.

Reach Ron at rkovac@bsu.edu.
As the Publications/Media Committee pointed out in its initial solicitation for content for the spring Journal, "Technological sophistication is one key to success in education today as well as in today’s business environment. But staying anywhere near the cutting edge requires constant upgrades as improvements happen increasingly often." I turned to Aaron Fuehrer, ACUTA CTO, to share how he is meeting the demands of the organization with his cost-effective strategies. We recently upgraded our Internet access and LAN in our Lexington, Kentucky, office, as well as implemented VoIP and Microsoft 365. I think our recent journey is a great story to tell.

His planning for the Internet, LAN, VoIP, and Microsoft Office 365 projects really began much earlier, but gained visibility and momentum when the 2012 strategic planning retreat created a task force to review existing technology used by ACUTA and to suggest ways to provide leading-edge services to both the membership at large and internal support staff. To help focus future task force conversations and to provide background to the task force members, Aaron created a summary that provided an overview of our current technology and how it is used. In the review he identified the task of the technology and the primary users and included an explanation of how the technology works currently, as well as the life cycle, if it were applicable.

As Aaron pointed out, some technology will be used strictly by internal employees (staff), some is for the benefit of external customers, and other technology has a blended use. To fit within the Journal theme, we’ll limit our highlights to those below.

In December 2012, ACUTA removed its T1 Internet access line and replaced it with a 5x5 Mbps wireless Ethernet connection. In addition to this needed speed upgrade, we also switched to using a hosted VoIP solution from QX.Net and eliminated the outdated Meridian landline phone system. We now save approximately 50 percent of the monthly cost of the old T1 and local/long distance landline costs combined.

As part of the new Internet connection project, the ACUTA internal LAN was also upgraded. Each staff office has separate Ethernet connections for both the Polycom 450 VoIP phone and Windows 7 PC. Separate VLANs then connect back to a new Cisco 2960 PoE 48 port switch and Cisco ASA 5505 firewall/edge device.

Both the VoIP phone configuration and the wireless point-to-point Ethernet connection to our new ISP have exceeded expectations. We are under contract with QX.Net for a minimum of two years (through December 2014). The in-house LAN upgrade with the Cisco 2960 and 5505 should be adequate in this configuration for at least 5 years.

After monitoring the successful Internet and LAN implementation for a few months, Aaron carefully planned and orchestrated the migration of the eight Dell PC workstations in the ACUTA office and our two remote laptops, all running Windows 7 and Office 2010, to Microsoft Office 365 to give the staff a cloud-based, file-sharing and e-mail-access system that functions on traditional computers as well as mobile devices. In addition to providing instant messaging, shared calendars, and video-chat capabilities, this migration resulted in cost savings, since we no longer need to maintain the Exchange 2007 server or Barracuda spam appliance.

A critical key to a successful upgrade is to build customer satisfaction into your project plan, which Aaron did at every step of the way during these recent ACUTA office upgrades. For example, he predicted that the difficult part of the Microsoft transition would be how to address the large amount of email that each staff member has collected in Outlook over the years. He then met with
each one and developed an individual migration plan for e-mail to determine how much actually needed to be transmitted to the cloud, accessible anywhere and anytime, and how much could be archived on the individual user’s PC.

And just as the Internet and VoIP implementations were scheduled between the fall and winter ACUTA seminars, so was the transition to Office 365 scheduled after the annual conference and before the fall seminar. There are many parallels between the administration of IT on a college campus and that in an organization. No matter how large or small, the processes remain the same.

As a dues-paying member of ACUTA, you can rest assured that Aaron (and everyone on staff) is committed to the good of the organization and works diligently to bring about efficiencies that are in the best interest of ACUTA. In this case, he anticipated our needs, adhered to his scheduled dates, and exceeded all of our expectations. The most amazing thing of all is that Aaron is an IT staff of one.

Contact Corinne at choch@acuta.org.

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How do recent upgrades help ACUTA staff members?

Lisa Thornton, Chief Strategy Officer:
The two biggest impacts on me would be the phone system and Office 365.

The upgraded phone system makes sending calls to my remote office easy and seamless. It’s also great to get an e-mail informing me I have a message, and I can even listen to it on my laptop.

With Office 365 I can easily access my work e-mail from my phone or tablet, and that has been a game changer! It is so easy to check and respond to e-mails when I am traveling for ACUTA or just when I’m away from my laptop. My response times have been greatly reduced, and I can choose to always be in touch!

Amy Burton, Director of Strategic Relationships: The two biggest improvements I’ve seen are being able to receive voicemail over e-mail (phone upgrade) and being able to access e-mail and files on SkyDrive from anywhere (Office 365 upgrade). It makes staying connected so much easier.

Lori Dodson, Finance and Accounting Specialist: Since returning to ACUTA after a three-year absence, I can really see how technology upgrades have dramatically improved our processes. For example, I used to answer all incoming telephone calls and transfer them to the appropriate person. With the installation of the new VoIP telephone system, all staff members now have direct lines. I answer a fraction of the calls I used to, giving me more time to focus on my duties.

The upgrades in IMIS, our database, have been huge! Not so long ago, all registrations that were paid with credit cards were processed manually; now people can register for events and pay online. We used to mail invoices to those who needed one; now, we e-mail them. We’re not only saving time and effort, but we’re also saving a lot of paper, which helps ACUTA financially and is much more ecologically sound.

Joanie Profitt, Registration and Database Coordinator: I have benefitted from the recent technology upgrades in several aspects of my job. The biggest one was the upgrade of our database in coordination with the online ordering system. This has streamlined a large part of the registration process. In the past, orders were received from the website and then had to be manually entered. Now they flow in automatically and only a few need special attention. With this tedious task out of the way, I am able to spend more time focusing on other projects, such as improvements in the appearance of all our mass e-mail correspondence and data entry of prospects for marketing purposes. These are the types of tasks that it was once hard to find time for, and they have now become a large part of what I accomplish for ACUTA.

Pat Scott, Communications Director:
To create ACUTA’s publications, the program I use most often is Adobe’s page layout program, InDesign. I rely heavily on Outlook for e-mail to communicate with members, writers, printers, and others. Most articles are submitted in Microsoft Word. Doing my job today is dramatically different from when I first started doing this kind of work. It’s been a long time since I sent photographs with crop marks and resizing instructions with printed projects. Our recent upgrades have given me better access to e-mails and higher levels of sophistication with InDesign.

Upgrading always brings improvements, but there is frequently a transition during which we adjust to new ways to do routine tasks and learn how to use new capabilities. Upgrading is like crossing a river. You just have to swim really hard for a short time to get to greener pastures on the other side.
RIP for TDM
FCC SAYS LEGACY TECHNOLOGY MUST GO

After assuming office, FCC Chairman Tom Wheeler lost no time in issuing a challenge to the telecom world when he called for "a diverse set of experiments" to move just about everything from TDM to an IP-style network. Wheeler, who took on the job as FCC chair on November 4, 2013, issued his statement barely two weeks later.

Some observers of the proposal see such a change less as a technology advance than an attempt to duck government regulation.

Most colleges already have embraced—many would justifiably say spearheaded—the move to IP. Still, there are enormous chunks of both telco-based and campus-based services that use legacy TDM systems. If there is TDM technology tied anywhere to your campus, yours is one of the operations that the FCC’s proposal will affect. The idea is to move everything—everything—in the nation’s telephone system from its century-old network of circuits, switches, and copper wires to IP. While the upgrade will cost money, the FCC would argue that, in the long run, trying to maintain physical switches and a POTS-style network will be even more expensive. Simply keeping software current for old switches already is a challenge for many schools.

“The FCC is serious about this,” says J.G. Harrington, attorney with Cooley, LLP, Washington, D.C., the firm that represents ACUTA on regulatory matters. “The FCC is serious because the whole carrier network is serious about this.”

“The FCC is recognizing the reality that the telephone network is converting to IP,” says Charles McKee, vice president of government affairs with Sprint. Located in Washington, D.C., McKee handles legislative, regulatory, and spectrum issues for the company.

While most carriers already have made the transition to IP in their networks, McKee notes that much of the traffic is converted to TDM when it is handed off. “The FCC has not set a date by which we are going to shut down the TDM network,” he emphasizes. However, he adds, they have taken steps to start eliminating the Universal Service Fund subsidy for TDM networks.

At most campuses and for the big carriers, TDM is gradually on its way out. Talk to telecom managers and they would say that advanced IP-based services are in. Any FCC program likely will speed up the transition and might not do much to help schools finance the changeover.

AT&T has suggested that the FCC set up a hard cutoff date for TDM, and telecom managers need to be sure they appreciate the difference between the FCC’s current position and AT&T’s stand. “AT&T and Verizon would like to transition to all-IP” Harrington says. AT&T already has its U-verse service in place, and Verizon offers FiOS. Vonage and Skype also offer services that would make the FCC chair happy. But others fear the transition will not stop there.

McKee says Sprint and others are concerned that AT&T and Verizon—two of the biggest boosters of the move away from TDM—will use the transition as an excuse to get out from under regulatory oversight. The FCC might not see it that way.

A Bit of Background
“This is what I call the Fourth Network Revolution,” Wheeler said. “History has shown that new networks catalyze innovation, investment, ideas and ingenuity. Their spillover effects can transform society—think of the creation of industrial organizations and the standardized time zones that followed in the wake of the railroad and telegraph.”

Is IP the answer to everything in the network? Even a college that has embraced IP with a Cisco VoIP PBX sees its output come as TDM. What will happen when TDM becomes a dirty word in networking?

What the FCC Wants
Wheeler went for an Order from the Technology Transitions Policy Task Force that would include recommendations to the Commission on how best to:
1. Obtain comment on and begin a diverse set of experiments that will allow the Commission and the public to observe the impact on consumers and businesses of such transitions (including consideration of AT&T’s proposed trials);
2. Collect data that will supplement the lessons learned from the experiments;
3. Initiate a process for the Commission’s consideration of legal, policy, and technical issues that would not neatly fit within the experiments, with a game plan for efficiently managing the various adjudications and rulemakings that, together, will constitute our IP transition agenda.
The Next Revolution?

Given that TDM is phased out and IP rules, this surely won’t be the last technology revolution. Everyone knows technology changes faster and faster. Are we going to have to do this all over again in another 20 years?

 FCC Chairman Wheeler admits that the future of networks can be hard to see, especially in moments of great change. He offers the following historical note: “When Alexander Graham Bell offered Western Union all rights to his telephone patents in 1876, the response was a curt dismissal. A Western Union memorandum concluded that “[t]his ‘telephone’ has too many shortcomings to be seriously considered as a means of communication.”

The way forward is to encourage technological change while preserving the attributes of network services that customers have come to expect, Wheeler said in a blog post.

Harrington is a bit more optimistic about the lifespan of IP, noting that the TDM world lasted 80 years. “That’s not too bad,” he says, adding that upgrades like IPv6 are backward-compatible with IPv4. Any future massive changes probably are well beyond our lifetimes.

The draft Order should include recommendations to FCC, Wheeler said, on how best to speed the initiation of experiments and assess, monitor, measure, and analyze their outcomes. “How consumers are informed and protected should be a major component,” he added.

In addition, the order should explain how the Commission can best obtain accurate and useful information about the technology transition from multiple resources that could include collaboration with other federal, state, and tribal agencies; public input through crowd-sourcing; and leveraging outside expertise and advisers.

Wheeler stumped for policy that would set forth the best process that the FCC can initiate so that, in parallel, it may decide the legal and policy questions raised by this network revolution.

Harrington says that this initiative, along with an incentive auction for broadcast spectrum, is one of the two major projects that have drawn Wheeler’s focus. “The other commissioners are pretty clear that it is important,” Harrington continues. “It will happen.”

All of that may sound great to many customers, but what about those charged with providing the services?

Telcos Respond

The big names in telecommunications services are not singing the same song. The former Baby Bells are all in favor of dumping TDM and, with it, the regulatory oversight that the FCC has exercised on price controls. CLECs and others are worried that they—and their customers—will be priced out of the market in a nonregulated environment.

“Our current infrastructure has served us well for almost a century, but it no longer meets the needs of America’s consumers,” said Jim Cicconi, AT&T’s senior executive vice president of external and legislative affairs, in a prepared statement. “The transition to broadband and IP services that has already begun is driven by consumers who are moving to the Internet and choosing to connect in ways not imagined just a decade ago.”

“On the carrier side, incumbents argue that this is an IP universe,” Harrington says. “They say that the Internet works so well that they don’t even see any need for regulations under an IP-based network plan.”

Here, then, might be the reason—behind-the-reason for the major players’ strong desire to see the world go to IP: an opportunity to free themselves of pesky regulation.

“Sprint has certainly been supportive of an IP transition,” McKee says. The company sees colleges and universities as part of their overall enterprise customer base.

“We fear a monopoly or duopoly without price controls,” McKee says. He points out that AT&T and Verizon—basically the old Bell operating companies—today control 80 percent of the telecom revenue in the United States and that even the competitive carriers must purchase lines from the LECs. “One of our concerns is that those carriers will have an incentive to use market power to increase costs to the enterprise customer,” McKee says. He says he fears that the LECs will use a transition to IP as an excuse to duck existing regulations that cover TDM-based services, especially pricing rules.

Sprint’s McKee is also concerned. “There is a need for the FCC to continue to provide for interconnection to the ILECs at a reasonable and affordable rate.”

“AT&T is using the IP transition as cover to eliminate regulatory oversight,” McKee continues. “They are effectively using removal of copper to remove any obligation to the last-mile connections,” he says. He fears that AT&T will argue that the old regulations covered TDM and copper. If the network is no longer copper, then is there no need for FCC jurisdiction? “It will take a long time before anyone eliminates all that copper. That will be the case for a long time to come,” McKee says.

Still, there is an FCC proceeding on copper retirement.
"We share the concerns of the CLECs around what will happen to this plant," McKee says. The answer, he continues, is for providers to offer "interesting products" on existing copper infrastructure.

The issue will be of special concern to enterprise customers—those businesses and colleges that are not part of the broader consumer market. Consumers have moved from landline-style services in droves, and about a third of the consumer market now is on wireless phones.

"Most carriers want the amount of regulation at the retail level reduced," Harrington continues. There has been some success in transitioning some market sectors—online retail is a prime example—to the IP world. "Others like guaranteed quality of service and are not so thrilled with best-effort service," Harrington notes.

Much of the FCC's broad plan is aimed at underserved geographic areas. This will require substantial capital investment by telcos in many cases. "Like any change, it requires planning," Cicconi said. "The geographic trials directed by Chairman Wheeler will provide the real-world answers needed to ensure a seamless transition."

Wheeler's idea is not original, nor is he the first to voice it at the FCC. In fact, the odds of action being taken are bolstered by the number of senior commissioners who have already pushed for IP. Commissioner Ajit Pai, for example, is on record as having said the FCC should "embrace the future by expediting the IP transition." He started at the FCC in mid-2012 and will serve through 2016 at least.

Commissioner Mignon Clyburn, who served her first FCC term in 2009–12 and is in her second term, called on the FCC "to carefully examine and collect data on the impact of technology transitions on consumers, public safety, and competition."

"She is right," Wheeler says, adding that he proposes to do just that. "With the Commission now at full force, it is time to act with dispatch," Wheeler urged his fellow FCC members.

Commissioner Pai quoted Albert Einstein, saying that a "pretty experiment is in itself often more valuable than 20 formulae extracted from our minds." Wheeler said Pai is right. "Those principles will guide us in our work as we ensure the continuation of the Network Compact."

Harrington says the FCC sees its role as making sure that the transition goes as smoothly as possible.

**Small and Rural Schools**

Smooth might not be the word network managers at small colleges are thinking right now. And they are right.

"It will be a complicated, difficult transition," Harrington says. "The big question is, How do you ease that transition?"

The financial hit is likely to come all at once. There is no good way to upgrade the college's network a few lines or a few departments this week and a few more next month. That will be
a serious, all-at-once bite in the budget. “At any small school, there will be a big impact,” Harrington predicts.

At the moment, there are no proposals to help with funding the transition as there were with the transition to digital television, where a program was rolled out to underwrite the cost of converter boxes. Keep in mind, however, that the move to digital TV was mandated by an act of Congress, and the lawmakers have the power to allocate funds to support laws. The FCC has no such power to use tax dollars.

If your campus is a cable phone customer, the transition might be a non-event. After all, the transition is provided by the EMTA modem that converts the signal. “At some point, everyone will need an IP phone,” Harrington says. “If you are a regular Verizon customer with an RJ-11 that works fine, will Verizon pay for that upgrade?” He says he expects the transition to be a big boost to cable providers.

Rural schools, flinching when they first heard the FCC’s proposals, might be in better shape to negotiate than are some of the small schools in big urban markets. In some cases, a rural or small-town college might be one of the two or three largest customers that a telco serves. That gives the school some bargaining leverage when the time comes for the change.

That does not mean it will be totally smooth sailing for rural colleges. For instance, there are concerns that there could possibly be just four or five major points of interconnection for this new, proposed network. If those points are Chicago, New York, Los Angeles, and Houston (as would be logical and likely), what does that mean to the rural college in Montana or Tennessee?

“Keep in touch with your telco,” Harrington advises. “Talk to your representative. Understand what your carrier is likely to do.” He points out that the local contact might not be on top of the plans being made back in the telco’s headquarters but, if enough colleges are asking questions, the university community should be able to get a feel for the pulse of the decision-making bodies.

“Make it an issue,” Harrington urges. He says he figures the transition will come to the networks sometime in the next three to four years. “Then they will force their customers to switch over.”

This is an issue that needs to be in front of the university president and the school’s financial teams. It is not something to ignore or postpone. “It is going to happen,” Harrington emphasizes.

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Track 1. Trends in Service and Technology Delivery
Explore how the “as a service” trend is offering new avenues for service delivery; how virtualization in the data center, network, and at the desktop is opening new opportunities for service delivery; how delivery of services doesn’t depend on physical assets; and how these delivery options are changing hiring practices within technology service departments.

Topics we would like to cover include:
1. Case studies from universities that have moved to or adopted a shared-services structure that includes Information Technology
2. Campus experiences leveraging the cloud for official university-sanctioned services
3. Success stories related to the adoption of Internet2 Net+ services
4. Case studies from universities that have partnered with regional or state consortiums/groups to provide technology services/products for faculty, staff, and students
5. Campus experiences with server, desktop, and/or network virtualization that have affected technology services
6. Case studies about virtual desktops (VDI) and its impact on computer labs, remote access requirements, software licensing, and/or application provisioning
7. Success stories concerning the pursuit of technology services that are “better, faster, and cheaper”
8. Case studies on central versus de-centralized IT and how this affects service and technology delivery
9. Campus experiences with the challenge to keep technologists current with technology changes and meet the increasing end-user expectations of technology solutions
10. Success stories from IT organizations that are changing the responsibilities and duties of technicians, administrators, and engineers when the lines are blurred between communications, systems, and networks
11. Case studies on policy and governance changes in the wake of technology services that aren’t dependent upon university-owned or -managed resources
12. Campus experiences with endpoint management services/technologies

Track 2. Securing our Connected Environments
Explore methods institutions are utilizing to educate their faculty, staff, and students about securing their devices; technology solutions to monitor perimeters and borders for inappropriate activities; policy and procedural initiatives to govern appropriate access and use of technology or data; and best practices employed to enable ease of access without compromising security.

Topics we would like to cover include:
1. Campus experiences with deploying a “defense in depth” approach to information security
2. Success stories on educating faculty, students, and staff on secure computing practices.
3. Case studies related to incident handling/response in the wake of a suspected hack, compromise, and/or breach
4. Campus experiences securing mobile devices not owned by the university
5. Success stories on balancing security and ease of access for faculty, students, and staff
6. Case studies concerning writing or revising policies and agreements that protect the university as well as those who access university resources
7. Campus experiences with including university marketing and/or public relations in security conversations and responses
8. Case studies on responding to and combating sophisticated phishing attacks
9. Campus experiences with cyber-insurance and reputation-management initiatives
10. Success stories on using monitoring solutions and/or services to identify and respond to security threats
11. Case studies on deploying services such as network access control, host integrity checking, mobile device management, group policy object, virtual private network, encryption, 802.1x, and/or multi-factor authentication to secure endpoint and user access
12. Campus experiences with the latest PCI-DSS guidelines and efforts to manage the “in scope” designation.

www.acuta.org
IPTV: The Future of Cable TV
A proposed Internet2 service changes the way IPTV is delivered

On October 29, 1969, the world changed forever with the connection of the first two nodes on the Internet. Forty-five years later almost every form of communications has migrated to using the Internet protocols, otherwise known as IP. Beginning with e-mail and file sharing, the migration to IP soon included videoconference systems, then voice communications (VoIP), and now even security and energy-management systems have been transitioned. The next-to-last system to transition is the voice cellular network, but the carriers’ 4G networks will migrate to voice over LTE, or VoLTE, based on IP, over the next two or three years. The last system to migrate will be linear television programming.

Linear entertainment is scheduled programming and content, as opposed to pay-per-view and streaming video such as Netflix or Hulu. Linear programming in most campus environments is run over a coaxial or coaxial-fiber hybrid network dedicated to the cable television plant. Support of this network can be expensive, especially for aging cable plants or cable plants in harsh environments that involve high heat, UV sun damage, or corrosive environments, such as the salt and humidity present on coastal campuses.

The ultimate solution in the elimination of broadband cable plants is a transition to linear television over IP, often referred to as IPTV. While migrating to IPTV has been in the works for the past 10 years, there have been hurdles that, until recently, we have not been able to overcome. These obstacles were partially technical, partially financial, but mostly based on requirements placed on the distribution systems by the content owners. The issues and their solutions are described in this article.

To fully understand the issues, you first have to understand the full television distribution ecosystem. The primary players are the content owners. These are firms such as NBC Universal, Turner Networks, HBO, and ESPN (although much of the ESPN content is actually owned by the sports leagues themselves). Next there are the firms that accept the content from the owners and place it on satellites for distribution. This group includes companies such as EchoStar and Vubiquity (formerly Avail TV). Then there are the companies that collect the content from the satellites and redistribute it to the end users.

Some of these companies use direct satellite reception such as DirecTV and Dish. Other firms, such as Time Warner, Comcast, and Suddenlink, take the programming from the satellite feed and modulate the channels over the cable TV plant. Most campus cable TV networks are included in this last group.

Typically what is allowed in terms of delivery methods is dictated by the content owners. The bottom line is that the content owners set the rules, and you must comply if you want their content. There are legal consequences of not playing by their rules.

The Technology Side of the Equation
With this understanding of the distribution rights issues, we can now discuss the technology side of the equation. Building a broadband cable TV plant in the past involved installing a series of set-top boxes, one for each channel in the cable lineup, and connecting the output of each box to a modulator that puts the content on the appropriate channel, for example, channel 2 or channel 3. These set-top boxes were available in residential and commercial models, and the model installed depended on the installation budget, costing, at most, a few hundred dollars per channel.

Similarly, installing an IPTV system on a campus involved installing an encoder for each TV channel that encoded the video stream into a standard format, such as MPEG2 or MPEG4, or into a proprietary format, such as Haivison. In either case, the cost of encoding each channel is several thousand dollars. To the encoding costs you must also add the encryption costs, if you are going to use IP distribution. Because IP traffic is so easy to share, the content owners have demanded proven methods of digital rights management, or DRM.

The bottom line is that building an IPTV distribution plant is too expensive unless your campus supports tens of thousands of students in its residence halls. Telephone companies that provide cable television services get around this...
issue by transporting the content across their high-speed data networks and sharing the services across many communities. Examples of this are AT&T’s U-verse and Verizon’s FiOS. Several universities have spent the past eight years working on such a plan by using the high-speed Internet2 network that connects them. The idea was that we would centrally encode the content and then use multicast to share it.

Success eluded us because not only is multicast support still not pervasive on most campuses, and, more important, the content owners would not allow this sort of sharing on the Internet2 backbone. The fear was that the Internet2 network is a shared architecture with a single backbone, about 40 regional optical networks connecting to thousands of campus networks. In spite of the DRM deployed, there is a perception that controlling the entire intranet equates to more security. Carriers are allowed this sort of sharing since they own, control, and manage a single network.

**A New Delivery Method**

After several failed attempts, a new method of delivery is being deployed. Five universities are currently trying a proposed Internet2 NET+ service that changes the way IPTV services are delivered. The changes include:

1. The use of satellite receivers that extract MPEG4 streams for several channels from one box. By using the already-encoded video from the satellite, the encoding costs are eliminated. This brings the costs down to less than $1,000 per channel.
2. The distribution to the student is done over unicast-encrypted HTTPS. This provides the DRM required by the content owners, and removes the complexities of supporting multicast.
3. The downside of not using multicast is an increase of video traffic on the network. This new solution supports content servers that can be distributed across the campus network cost effectively. A single feed is sent from the encoders to the distribution servers, and these servers are placed close to the dorm rooms on the network. (See Figure 1.)

After authentication, the content available over this service can be viewed either on a standard browser or by using a Roku set-top box. The system also supports a software-based DVR service, allowing students to watch their favorite programs at their convenience. The universities that are involved in this trial program include Harvard, Yale, the University of Utah, the University of Wisconsin, and Texas A&M University.

I have often been asked why we even need linear programming anymore. My answer is there is still a social aspect to watching your favorite program live with friends that is not the same with pay-per-view. Much like online shopping has taken a significant market share of the shopping experience, the malls are not yet shutting down. Another factor to consider is that campuses that have shut down their cable television plant have found a significant increase in Internet bandwidth costs as students shift to net-based streaming services, such as Netflix. As we go forward with this service, our intention is to continue to work with the content owners in an attempt to get their blessing to share content between campuses. They are starting to warm up to the idea as they become more comfortable with over-the-top content delivery by some of their largest partners, such as Comcast.

The innovation provided in this new IPTV service comes from a relatively new company out of Cambridge, Massachusetts, called Philo (www.philo.com), which had its origin in a Harvard incubator. Texas A&M University has been working with Philo on a trial basis for the past year, and it is our intent to go forward with an IPTV service in the fall of 2014.

*Walt Magnussen, Ph.D., is director of telecommunications at Texas A&M University. Reach Walt at w.magnussen@mail.telecom.tamu.edu. Jason McConnell is lead network engineer at A&M.*
We hear and read a lot about SIP trunking these days. It is cost effective, offers new services, and fits very nicely into the transition to IP-based networks. But not all SIP trunking implementations are problem free. Whether you are an educational institution or enterprise, the SIP trunking problems are vertical-market independent. SIP trunks connect the institution to the PSTN. SIP trunking can also be used to connect multiple remote campuses together, avoiding the PSTN entirely.

SIP Trunking Problems Persist

Every year The SIP School™ performs international surveys of SIP implementations. The SIP Survey 2013 (www.thesipschool.com/survey2013.html) presents the status and problems relating to SIP trunking. This year’s survey, the third year it has been conducted, includes more than 850 responses, including 50 percent U.S., 7 percent Canadian, and the rest international. Figure 1 compares three problem areas in 2013 to the results obtained in the 2012 survey. They are very much the same, with no appreciable improvement by the providers or equipment vendors. Two new options were added for 2013 for those who have no SIP trunks or who never had a problem. One hopeful note is that a few enterprises had no problems at all, but they are in the minority. With providers’ and vendors’ experiences, problems should have declined.

Unsatisfactory SIP trunk implementations will not only cost the institution in labor and extra communications charges, it will also affect the confidence the campus faculty, staff, and students have in their use of communications. Some students may even try to bypass the wired telephone network and attempt to contact who they are calling by the use of mobile phone exclusively.

IP PBX Problems

There are five areas of concern with the IP PBX vendors that SIP trunks support. Most have improved or remained the same since 2012. These are compared in Figure 2, which asks the question, “If the problems were found to be with your SIP/ VoIP-based PBX, what were they?”

PBX firmware upgrades, at the bottom of the chart, has become less of a problem but remain the biggest problem. Check with the vendor to determine if there are updates that may affect SIP trunk deployment and operation.
Codec issues has increased since the 2012 survey. This is most likely a mismatch configuration problem. Check the settings carefully.

As Figure 2 illustrates, SIP trunks keep "dropping" has declined slightly as a problem.

SIP registration failures to the ITSP has remained the same as the 2012 survey. This is probably improper configuration on the part of the enterprise staff or more likely the value-added reseller (VAR). The questions are the effectiveness of enterprise and VAR training, as well as vendor documentation. Is it just poor typing skills and unverified data entry?

No SIP license is, frankly, hard to believe. This begs the question, How much knowledge do enterprises have of the software they have implemented? This should be a no-brainer; it should not occur at all. Check first with the vendor before deploying SIP trunks. The SIP license may not be included in the procurements.

**Edge-Device Problems**

Let’s look at Figure 3 to see what has improved since the 2012 survey. Both No audio and Calls to the PSTN blocked have diminished as problems. In six other categories, the problems have increased, not decreased, from the 2012 survey levels.

The biggest problem, One-way audio, remains the primary headache with the session border controller (SBC). This was the worst problem in 2012 and remains the worst problem in 2013. The rise in this number is significant. When one-way audio occurs, the call is rapidly terminated and the caller tries again or gives up. Imagine this condition during class registration or emergency situations. This issue strongly highlights the importance of testing the components together before deploying and initializing the SIP trunking service. The results of the testing could influence the purchasing decisions regarding edge devices.

One-way audio is most often the result of the network address translator (NAT) breaking SIP, which means that since SIP operates at the application layer and NAT is created at the transport layer of the network, media often cannot reach the SIP device being used in the network because its private IP address is not routable outside the local area network. One of the beneficial functions of the SBC is to resolve that NAT traversal (pass through) issue and to rewrite the header information so that SIP can reach those devices.

Codec issues is the next most common problem. This should not be on the rise, as those working with this "specialized" equipment should have a good understanding of codecs. The enterprise staff and VARs that are able to work with others involved in an implementation should ensure that codecs are configured correctly and tested thoroughly (the big issue).

SIP registration failures, which is next on the list, is most likely a configuration problem. This means that the SIP trunk cannot be initialized.

**QoS issues** is another problem that probably results from misconfiguration. This leads to poor-quality calls, speaker frustration, and misunderstood conversations.

Firmware updates required to fix issues grew considerably worse. This appears to be negligence on the part of the VAR or IT department. It is also possible that the SIP vendor is not being diligent in its downloads.

SBC failures, such as a crash or lock-up, have increased but remain a minor problem (unless it’s your problem). This problem is solvable during the testing phase and should not have increased.

**SIP Trunk Provider Problems**

The survey question relating to the providers was, “If you’ve had problems that were found to be on the SIP trunk provider side, what were they?” The 2012 results are shown as a percentage of the 2013 results in Figure 4.

Compared to 2012, Trunk registration failures improved. ITSP SIP server failures remained about the same, as did Call conferencing with "external" caller fails. Incoming call transfer failure problems and the other five areas of concern were all somewhat worse in the 2013 results, something that would not be expected since SIP trunk implementations are not new to the providers.

The worst problem in the 2012 survey, Trunks “dropping” intermittently, is still the top problem in the 2013 survey. In fact, it is even more common than ever. This problem should be
addressed during testing/trials as losing a call during a conversation is one of the most frustrating events to occur. This wastes time, and the call may be difficult to re-establish. The caller may have to resort to a mobile call which defeats the purpose of the SIP trunk.

One-way audio is far worse in 2013 than in 2012 and is the second most common problem. This is very likely a provider configuration issue, or it could be attributed to improper configuration of the SBC.

Codec mismatch should not really happen, as configuration settings should ensure a match. This can be fixed on the SBC to conform to the settings of the provider.

Poor quality is an old problem with known established corrections. It is difficult to understand how this problem is increasing in frequency when delay, jitter, and packet loss have been discussed for years. Is poor quality due to poor documentation or negligent configuration practices in the network infrastructure?

Trunk registration failures is a little worse in 2013 than 2012 and should not be happening. This could be the fault of improper configuration or a symptom of a provider software problem.

No audio also increased slightly. This is probably also a provider configuration issue or an SBC-generated problem.

All of the issues in Figure 4 have been around since the beginning of SIP trunk implementation. It is disappointing that the industry still has not reduced the problem frequency. These basic implementation issues should be eliminated during the initialization of the SIP trunks.

It begs the question of whether the implementation teams are overworked, undertrained, or both. Or could it be that the providers have not made these problems high priority on their list of improvements? It would seem that the cost to the provider for resolving these problems could be avoided by further investment in the implementation team, along with the necessary testing when SIP trunks are installed.

A Successful SIP Trunk Project

There are best practices that should be followed to deliver a smooth and problem-free SIP trunk implementation. SIP trunking implementations are maturing but not mature. These eight best practices will help ensure a smooth implementation.

1. Be clear about your objectives and the key indicators that will demonstrate you have met the objectives.
2. Ask, ask, ask questions. If you make assumptions, you are responsible for them, not the vendors and providers.
3. Coordinate with the vendor(s) and provider(s). Have them all meet with the enterprise staff tasked with the implementation.
4. The problems discussed in The SIP Survey are the common challenges that will be encountered. Anticipate them. Do not be surprised if they occur during the implementation.
5. Have a good test plan. Assume your implementation is unique, no matter what the vendors and providers state. There can be differences in SIP protocol headers, error codes, and DTMF signaling requirements. Verify the software releases to be used. Fax works differently with nearly every SIP trunk provider. Plan extra time for interoperability testing.
6. Ensure that you have current and adequate documentation and configuration guides from all parties involved in the implementation.
7. Look for management tools from the vendors and providers that support reporting for capacity planning, voice quality, service levels, and security.
8. Do not expect the time allocated to be enough. Add some time for unanticipated issues.

This article is adapted from a white paper, "Success with SIP" (http://info.necam.com/success-with-sip?&hssc=_hstc&hsCtaTracking=319c5739-d50f-4179-b79f-c77f3afef81a%7C6060bc2-429e-4e78-a02e-49be33218a0b) written by Gary Audin and published by NEC.
The only thing constant is change. Just about the time you get the bugs worked out of a system or an application, someone announces an upgrade. When you finally get familiar with that process, they change the rules again.

Yet, we don’t deny the necessity of progress, any more would, even if they could, wish away the tremendous advantages we have achieved because of technology. Maybe we have to think of change as a learning tool that will keep us sharp.

For this issue of the Journal, we asked five ACUTA members a few questions about some big changes currently happening or surely coming soon to every campus. Their replies are very interesting.

First, let’s introduce our panelists and look at a brief overview of each campus to help give their responses context.

Joanne Kossuth has been at Franklin Olin College of Engineering in Needham, Massachusetts, for 14 years. The college, which will graduate its ninth class this May, is a four-year undergraduate engineering institution with 353 students and approximately 50/50 gender balance across the classes—unusual for an engineering college. Olin has a partnership with Wellesley and Babson Colleges that allows for cross-registration, cross-dining, and student participation in a large number of clubs, projects, and teams.

Dave O’Neill, former ACUTA president, has been CIO at Community Colleges of Spokane (CCS) for just four months now, but he’s an IT/telecom veteran with many years of experience. CCS enrollment is more than 26,000 students and the school has an IT staff of 51. CCS serves the six eastern counties of Washington and provides two-year liberal arts and science transfer degrees, career technical degrees and certificates, adult basic education, worker retraining, customized business training, and continuing education. CCS is geographically the largest community college district in the state of Washington and the second largest in enrollment. The areas served range from the metropolitan environment of Spokane and the surrounding area to the rural rolling hills farm communities of the Palouse in the southwest corner of the state to the mountainous forest communities of northeast Washington.

Justin Ragsdale is director of network operations at Wentworth Institute of Technology in Boston since 2004. Wentworth has 3,380 full-time students and an FTE of approximately 600, with an IT staff of 33. The school offers career-focused undergraduate and graduate degrees in engineering, computer science, architecture, design, and management. The urban campus is part of a consortium of six colleges, collectively known as the Colleges of the Fenway.

Mark Reynolds, RCDD, has been at the University of New Mexico since 2002 and at New Mexico Tech since 1983, with 31 years in higher education and 40 plus years in telecommunications, IT data, infrastructure, and IT and physical security. He has been a member of ACUTA since 1990. UNM central IT includes 143 FTEs: the CIO, deputy CIO, security officer, customer service, networks (voice, data, infrastructure, and physical security), classroom technologies, computing platforms, and applications. The University of New Mexico was founded in 1989 and occupies 800 acres along old Route 66 in Albuquerque, a metropolitan area of more than 900,000 people. There are 27,278 students attending main campus with another 7,933 students at branch campuses. UNM employs 21,595 people statewide, including employees of University Hospital, and has nearly 157,000 alumni, with Lobos in every state and 92 foreign countries. We are truly a city within a city.

Jonathan Young is a senior consultant with Vantage Technology Consulting Group. He has worked in higher ed
for most of his 19 years in IT. His focus for the last 15 years has been on running an effective IT group that cost-effectively enables and supports the institution.

Q. Has your campus migrated to IPv6 or are you considering that? If so, what stumbling blocks did you experience or do you anticipate? What impact did/will this have?

Kossuth: We have not yet migrated to IPv6. We do anticipate a project to migrate to IPv6 in the future but have not assigned a time line to the project as we have not bumped up against the limits yet and do not expect to for a while. We anticipate that quite a bit of time will be required for planning and mapping of the strategy and the roll out. Once the planning and mapping are complete, finding an appropriate service window to work in (to have the least impact on the community) will be important.

O'Neill: CCS has not migrated to IPv6. The primary reason is time and available resources. Many current projects revolving around the consolidation of IT resources, along with major updates, have placed the migration to IPv6 at a lesser priority. However, we are planning to fully deploy IPv6.

Ragsdale: We have not migrated to IPv6, nor have we started to consider it. There have been discussions with the Colleges of the Fenway and the six schools' ISP toward planning for IPv6, but nothing active in the current plan.

Reynolds: UNM has an IPv6 feed from its ISPs but has no production service. We have not migrated to v6 yet due to lack of interest and lack of on-campus v6 services available. This is in the research and engineering stages.

Young: Most campuses still seem be in the investigations phase of IPv6. We have a number of clients that have moved forward with IPv6 at the core but only a few that have deployed organization-wide. Many of the large research universities with distributed IT departments seem to support IPv6 on the portion of the network controlled by central IT with the departmental support still generally in its infancy.

Q. If IPv6 is not in your master plan, how did you make that decision?

Ragsdale: There is nothing technically or academically driving us for the need to move to IPv6. We currently have a very large amount of IPv4 addresses available to us. I anticipate that within four or five years we will start to migrate or be planning migration.

Young: For many, IPv6 has been on the table as something they would like to invest in for many years. The fact is the urgency hasn’t been there for such a long period makes it easy to continue (justifiably) to ask the questions "Can’t it wait another year or two, we have more higher priority issues to deal with than our resources allow, can’t we just defer this a bit longer?" In these lean times (the last year or two things seem to be improving a bit in higher ed, but the "new normal" is a shadow of its former self), it continues to be difficult to justify the IPv6 investment for most. I think everyone agrees that urgency is arriving soon for many, but each institution is wrestling with whether it is already late or can wait a little more.

Q. The college is historically an incubator for electronic mischief and malware. How do you address IPsec, built-in security, and related issues?

Kossuth: Olin College focuses on educating our faculty, staff, and students with regard to the inherent security risks. All community members receive a VPN client with which to accomplish remote access. We push out anti-virus and malware updates on a regular basis. Our IT staff shares security concerns with the Student IT Working Group, which then helps get the message to other students. Our Information Security Committee meets quarterly to discuss any incident and issues as well as to provide updates on current issues and to work on strategies to mitigate them in our community. The college also uses Secure Human as a training requirement for community members.

O’Neill: Security has been designed around isolating these threats. That is the predominant factor to keep malware and mischief at a minimum. Physical separation of student-owned BYOD systems, and heavily used “built-in” security, like firewalls and ACLs, are core strategies. As the Windows XP platform is retired from service, the expansion of IPsec within the organization will continue to progress.

Ragsdale: This is an ever-moving target. We recently created an ISO position to spearhead security and information assurance standards and policies. Increasing awareness for the campus is a primary goal as, historically, security breaches have been attributed primarily to human error. On the network level, we take a multi-level approach having several systems protecting and viewing network data. Over the years, we will be filling in the gaps by adding more of these services and enhancing the automation, integration, and reporting capabilities. In January, we replaced our fire wall with a next-generation fire wall with additional application-level awareness and intrusion-prevention system integrated. This will allow us to provide better detection and blocking of malware and other suspicious traffic as it enters and
leaves our network. Internally, we will be implementing network access control to control what devices come onto the network and what access is given to them.

**Jon Young:** IPv6 has tremendous potential to enhance security over the long term; however, in these early days, many of the traditional security tools (firewalls, IDS/IPS, SIEM, etc.) have weak or no IPv6 support. Additionally, the relative scarcity of resources and eyes on the various IPv6 stacks and implementations has many greatly concerned that the pain we experienced in the late 1990s and early 2000s may be repeated. I don’t want to suggest that institutions should avoid IPv6; on the contrary, I believe IPv6 planning and implementation are absolutely required. In addition to the standard list of worries about address depletion and the developing world’s use of IPv6, one need only look at your IPv4-only network to realize that IPv6 is already there in major ways, with the vast majority of end-user devices supporting IPv6 out of the box and just waiting for something to start (hopefully that something is legitimate) advertising IPv6.

**Q.** What does IPv6 offer you in terms of quality of service (QoS)?

**Kossuth:** We currently have a fully converged network and utilize QoS tagging for services. We expect that IPv6 will enhance those capabilities.

**O’Neill:** Although CCS has not yet deployed IPv6, we do not anticipate IPv6 having a huge effect on how QoS is currently deployed within the organization. Packet shaping on our Internet connection and internal bandwidth is not noticeably constrained. Some of the basic QoS in place for voice is administered on the LAN switches, and some video QoS will be added in the future, but the QoS for IPv4 is setup very similar to the Traffic Class value used in IPv6.

**Reynolds:** We will take advantage of existing IETF RFC or level of QoS when we put this into production.

**Q.** Where does SIP fit into your master plan?

**Kossuth:** SIP is currently deployed in some portions of the campus, and unified communications plans will require additional SIP capabilities.

**O’Neill:** SIP virtual trunking is currently deployed for the PBX system and for use with Microsoft Lync. SIP is going to be an important building block in our transition to VoIP once a major platform update is completed within the current calendar year. Upon successful implementation of the new platform, further project goals involving the migration to IPv6 for SIP will be planned.

**Ragsdale:** Wentworth currently has a SIP connection into our campus. Within our master plan, we are looking to research the feasibility of adding an additional SIP connection, creating a highly available and fully redundant connection to the PSTN network. Our SIP connection is connected to our Microsoft Lync environment. We will also be looking at the size of our SIP connection and evaluating if we can reduce the amount of bandwidth allocated to it. Conference calling and webinars with call-in features are increasing in use, and the SIP connection will continue to support this service offering.

**Reynolds:** We have a legacy NEC voice system that was upgraded to a hybrid in 2006 with more than 20,000 extensions, 3,100 of which are now on NEC VoIP. We are working on a roadmap to embrace the Microsoft Lync 2013 stack with O365 and premises design to be an adjunct to the voice system, providing unified communications to our customer base.

**Young:** I have yet to see SIP (on campus) rise to the level of the major strategic item in an IT master plan. SIP trunking often comes up as a tactical decision primarily related to anticipated cost savings. Replacement or upgrading of a legacy PBX is a frequent driver of SIP, but the phone system upgrade is the strategic item, and SIP is an implementation detail. From Vantage’s perspective, we have seen a significant uptick over the past year or so in the planning and procurement for the replacement of legacy Nortel phone systems including for those campuses being driven off of their Nortel-based Centrex solution.

**Q.** Has your campus employed some cloud strategies? What do you conclude are advantages and disadvantages?

**Kossuth:** Olin considers cloud options in the conversations about all projects. Depending on the project and the requirements, we have found that the costs of cloud strategies can be more than the cost of on-premises strategies. Cloud options can increase or decrease control, require different skill sets on the part of IT staff to manage the services, provide a challenge in terms of the readiness of your campus to continually upgrade software and interfaces, change training parameters, increase or reduce staffing requirements, increase or reduce costs, and more. From our experience, cloud strategies need to be seriously considered in the context of the campus and the college requirements, but they are not always the appropriate answer for the challenge.

In the next few weeks, we will roll out our first externally hosted main website, so our learning experience continues. We also still have a full backup on premises that can be switched over on short notice.

**O’Neill:** CCS has adopted a general cloud philosophy for major enterprise application systems deploying ERP, Learning Management System (LMS), and e-mail for faculty, staff, and students to the cloud. Additionally, systems backup data are routed to the cloud beyond the onsite and local storage. Further strategies will include disaster recovery capabilities from within the cloud.

Advantages include access to and reliance on facilities and skills beyond
those the district could afford to create and maintain in-house; security and remote-access control beyond that which would be possible relying on CCS enterprise resources; the ability for academic programs to provide broader access and opportunities beyond on-campus classroom/lab environments; and the ability to focus the relatively expensive CCS staff resources on tasks and systems unique to the district. Basic advantage is a greater efficiency. Disadvantages include loss of technical control; possible increased operating costs (assuming stagnant staffing); change in vendor vision, priority, or product; and dependence on a contractual agreement between the enterprise and a vendor.

Ragsdale: Yes, we absolutely have employed cloud strategies. In all new projects we typically take the cloud-first approach and evaluate to make sure it meets our needs. Some products that we have running in the cloud are student e-mail, learning management system, CRM, document image storage, on-campus housing resource planning, and career-services support services. The advantages are that upgrades for the systems are typically handled completely by the vendor with little to no involvement from us needed, and they typically employ anywhere/anytime-access methodology, which supports our mission and increases use. In addition, uptime is often higher then we can typically achieve, and on-campus changes are less likely to affect the service in the cloud.

But there are some disadvantages, too. You need to ensure that your Internet connection can support the additional services, in both capacity and quality of delivery. Although many SaaS solutions require small amounts of bandwidth, as mission critical they can easily get pushed down by other Internet applications often found on campus networks, requiring you to employ appropriate shaping/caching/prioritization technologies.

Authentication and data integration often become a little more challenging. It is very important that user authentication and authorization be part of your strategy, otherwise users can easily get a disjointed experience.

Reynolds: We have deployed MS Exchange in the cloud (O365) as well as premises-based exchange. As part of the roadmap, we will utilize this design for the client-based and OWA (Web Application) versions of Lync as part of this stack. The advantage is having these services hosted and relying on the provider to assure current state of the product. The disadvantage is the continual analysis of the bandwidth required—dedicated or shared from the university to the cloud. Security is key for these types of installations to assure that the university protects the assets of our customers, which we take very seriously.

Q. Do you have a set policy on upgrades in general? If so, what are your guidelines? If not, who has the responsibility to make the decision to upgrade or not to upgrade a technology that has an impact on the whole campus, and how is that process handled? Do departments and staff make decisions independent of IT/Telecom? How are staff/faculty requests evaluated?

Kossuth: Olin College does not have any academic departments or tenure. The college’s focus is on interdisciplinary activities. Technology purchases are required to be vetted by central IT. We do not have any strict policies on upgrades. The IT Planning Committee meets quarterly to discuss projects and emerging technologies. The Enterprise Resource Planning Group also meets quarterly to help prioritize the technology projects.

Any technology expenditures above $100,000 require approval of the Finance and Facilities Committee of the board as well as the board in general.

O’Neill: The current replacement policy for desktop equipment revolves around a four-year service life, five years for server-based equipment, and seven years for network devices/appiances. Desktop equipment trickle-down practices create circumstances for some users to experience five-year-old equipment or older. Large variations exist between organizations throughout the enterprise. Recent operational budget reductions have eroded predictable upgrade schedules. The CIO has the responsibility for decisions regarding enterprise-wide upgrades but funding authority resides with the chancellor. Broad enterprise-wide upgrades outside scheduled operationally-funded upgrades occur only on the decision and funding by the chancellor. Department heads, deans, and executive administrators with available funds may choose to upgrade desktop equipment within their own departments. All purchases for equipment pass through the Office of Information Technology by work order, which also includes equipment delivery and set up.

Departments make decisions if their budgets allow, but standards and standard configurations must prevail. Recent restructuring and chartering of a single enterprise IT organization under the direction of a CIO will have an impact. A newly formed IT governance structure will also impact this historical trend. All staff/faculty requests are now being reviewed by the Office of Information Technology Customer Support Services staff.

Ragsdale: Recently we started to work on a 4/5 year network/infrastructure refresh cycle. Since we are early in this process we are still working out our process and the priority of items. Initially we are working on items that are out of support or soon to be out of support and critical areas on campus. All items technology related are supposed to go through technology services to be reviewed with the individual departments. The project management office assists in vetting and coordinating the activities.
Reynolds: The CIO and deputy CIO are instrumental in assuring that we stay in tune with the needs of the academic environment, health care, health sciences, non-university, statewide, and across the United States for services and the technologies required to provide that expectation. There are many governance structures that allow this exchange of ideas to occur at the executive level and then brought to the management and “boots on the ground” level. UNM IT has made strides in building the partnerships necessary to eliminate the “silo” approach to IT with the central IT (common-good IT services approach) to assure we spend the IT budget funds as efficiently as possible.

Q. Looking back with an eye to the future, what should we be doing differently now, based on our experience of the past 10 years with IPv6? Are there ways that technology advances have created more problems than they have solved? Have there been pleasant surprises?

Kossuth: Given the “Internet of Things” vision of the future, it makes sense for us to think about an unlimited supply of IP addresses. We also need to consider how all of these addresses will be able to communicate, the bandwidth needs, and the ability to use data from all of these sources in a way that we can actually make business intelligence from the data—a large challenge.

O’Neill: The percent of IPv6 adoption is still in the single digits. Technology advances often create desire for changes to new technology, e.g., innovative change for the purpose of being innovative or technical solutions looking for applicable problems. A pleasant surprise is the not-so-near impending IPv4 “cliff” prognosticated as the demanding force for IPv6.

Ragsdale: I can’t speak to the specifics of what IPv6 will require us to do differently on the network, but in general, with technology we need to be more business focused and attaching business requirements directly to the technology we are implementing or upgrading. Bringing and demonstrating value-add to the business objectives and requirements is increasingly paramount. The advances in technology have increased the demand for services and time-to-deliver expectations, outpacing what we typically are staffed to provide. This increases the need for engaging with outside consultants and companies to augment our staff numbers and skills. The switch to using more SaaS solutions also changes the skill sets that staff need, requiring us to rethink our internal resource toolkits and support options. It has been pleasant to see more end users wanting to engage with us at different levels of their process, and that satisfaction is growing as we progress toward the goal of having IT at the table.

Reynolds: We have not implemented IPv6 yet, but we see the value it brings due to the continued increase in IP connections, addresses for the five to eight devices that students, staff, faculty, and visitors bring to the campus. Over the years, we have seen the wireless connections grow exponentially and cause “appeared outages” due to lack of available IP addresses. These appeared outages tell us that the customer’s device could not connect to the Internet, but the signal strength bars were perfect. The real issue was that the system could not generate an IP address to authenticate that user, so it appeared to be a downed system. The trouble ticket comes in as a P1 (priority 1), meaning services are down. To fix this, we had to open more IP addresses to address the situation, and then it resolved itself. It doesn’t mean that there are not enough wireless access points to boot but, at least in this case, it was IP space.

As this situation continues, most of our resources are spent on triaging and the hours to provide the experience the customers expect for ubiquitous mobility.

Young: We should have had a louder and more consistent voice in dealing with all of our various vendors regarding general information security as well as IPv6 related implementations. We are in this bind of being so late to the IPv6 table largely because we (as an industry) have not demanded it from our vendors much earlier. If we don’t insist on features and either ignore them or allow the vendors to leave them as vaporware, those vendors won’t see the business case in implementing those features and won’t choose to invest the resources. We must vote with our $$$.

Thanks to Joanne, Dave, Justin, Mark, and Jon for their insights on these topics. ACUTA is strong because our professional network includes so many competent professionals who are always willing to share their experiences. In case you have additional questions for these contributors, here are their e-mail addresses:

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Wentworth Hall at Wentworth Institute of Technology
IPv6—What You Don’t Know CAN Hurt You

There are things you should do now to prepare for what is certain to come

Back in 2011 the Internet Assigned Numbers Association (IANA) released the last two "/8" blocks of IPv4 IP addresses, depleting the pool of available addresses. The upshot for colleges, universities, and educational institutions? Time to prepare for the transition from an IPv4 world to an IPv6 world. Fortunately, the transition does not need to happen overnight; yet it cannot be ignored. Transition methods that are being implemented today include tunneling, dual-stack, network address translation (NAT), and renumbering. None is perfect, but there is no perfect strategy. The best solution is to deploy a mix of strategies.

The Issue

The pool of available new IPv4 addresses is rapidly diminishing, and in some cases is already depleted. In Asia-Pacific regions, the pool became exhausted in April 2011, and in Europe in September 2012. Estimated depletion dates are in January 2015 in Latin America, February 2015 in the U.S. and Canada, and February 2022 in Africa.

Universities and other educational institutions—particularly those with operations in far-flung geographies—need to put in place a strategy and roadmap to address the imminent future of IP. The key point to understand is that the current version of IP, IPv4, and its next-generation edition, IPv6, are not interoperable. This becomes a huge problem for any university, which must continue supporting legacy IPv4 services while ensuring availability via IPv6.

For most universities, the right approach isn’t a sudden cutover. Instead, it’s implementing various integration strategies in an appropriate sequence, neither too quickly nor too slowly. Fail to move outward-facing servers IPv6-reachable, and risk becoming inaccessible to clients and business partners from AsiaPac and other regions in which IPv6 predominates. But move to an all-IPv6 infrastructure, and discover that critical management and security applications no longer work. Understanding these strategies, and implementing them in an appropriate sequence, is key to avoiding unnecessary pain from the advent of IPv6.

IPv6: A Brief History

In order to understand where IPv6 came from, it’s helpful to understand some history. (See Figure 1.) IPv4 was first introduced in 1981 as Internet Engineering Request for Comment (RFC) 791 and expanded address space to 32 bits, supporting a theoretical maximum of approximately 4.2 billion addresses. It had a classful architecture that went under the assumption that each IP address was, by necessity, globally unique. (Note: In a "classful" architecture, routing protocols do not send subnet mask information together with their routing updates.) The expectation was that this global uniqueness would continue.

Unfortunately, this put massive amounts of stress on the Internet. The classful network scheme was creating exponential growth in routing tables, which could potentially outstrip the ability for the Internet to route transmissions. The classful scheme also led to the extremely inefficient distribution of IP addresses, where a great number of addresses were given out but never used.

Quickly realizing that IP address exhaustion was imminent, the Internet Engineering Task Force (IETF) launched a working group called "IP next generation," whose task was to combat the growth. By 1996 the group had emerged with its solution, IPv6. It did not change the IP architecture, but rather expanded on IPv4, extending address space from the initial 32-bit length to 128-bit length, creating a theoretical upper limit of 2128, or roughly 340 Undecillion usable addresses. Along with expansion of address space, it did include other small upgrades including built-in dynamic allocation and VPN capabilities.

Unfortunately, IPv6 did not address all problems of IPv4, the most pressing being the exponential growth of routing tables. It also created a problem. Even though IPv4 and IPv6 are architecturally similar, they are not interoperable. In hindsight, this is a glaring issue, but at the time, the general assumption was a “flash-cut” transition. It was later realized that a transition that abrupt would not be a very desirable one.

In the meantime, steps were taken in an attempt to slow the depletion, starting with the development of Classless Inter-Domain Routing (CIDR) in 1993. CIDR allows the allocation of network addresses based on a bit-address boundary, as opposed to using one or more 8-bit groups as done with classful design.
This created a more efficient process for allocating addresses, helping to slow down the depletion as well as shrink routing tables.

The second major advancement came in 1999 with the introduction of Network Address Translation (NAT). The development of NAT greatly slowed down the depletion of addresses by “hiding” multiple devices behind one IP address, creating a private network. Every device behind the NAT would have its own unique address within the private network, but NAT eliminated the need for each device to have its own IP address to the “big Internet.”

**Today’s Transition Alternatives**

The existence of CIDR and NAT significantly slowed down the exhaustion of IP addresses, staving off complete depletion by an estimated decade, but we’ve arrived at a point where all new addresses are IPv6. The move to V6 already happened in Asia, where some Internet service providers are IPv6-only. If an enterprise has any public-facing servers that are not IPv6 compatible, anything on that server, including websites the enterprise operates, are invisible to anyone using IPv6.

Lacking the ability to receive any incoming IPv6 packets can also create issues with mobility. Imagine an employee is travelling to Asia on business and needs to connect to the enterprise’s network. Since the public Internet the employee is using is on IPv6, that employee could not gain access to the network if it is not compatible, creating very real business issues. (VPN technology is one solution.)

Some aspects, like public-facing servers, require more immediate attention than others. Not every aspect needs to be changed at once. Deploying strategies such as tunneling, dual-stack, NAT, and renumbering can make a smoother transition to IPv6. See Figure 2.

- **Tunneling:** Tunneling involves encapsulating IPv4 conversations in IPv6, sending them through over the Internet, and then pulling out the IPv4 at the other end. (Alternatively, as high-

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**Figure 1. IPv6: A Brief History**

|------|------|------|------|------|------|------|------|------|

**Figure 2. IPv4 to IPv6 Transition Strategies**

- **Tunneling**
  - Transport one protocol “within” another (RFC 2473, used to tunnel IPv4 to IPv6; RFC 4214 designed to tunnel IPv6 in IPv4)

- **Dual-Stack**
  - Each device supports both IPv4 and IPv6, and responds to sender based on sender’s preferred addressing scheme

- **NAT**
  - Addresses translated

- **Renumbering**
  - Re-assign all devices in IPv4 network with IPv6 addresses
lighted above, IPv6 can be encapsulated in v4). While this may seem simple, it has its challenges. It greatly increases processing overhead on both ends, it requires adjusting management and security tools and applications, and every device that the message travels through must support this process. All of this greatly increases the complexity of the network. Because of the increased complexity, a drop in performance is also seen. Tunneling solutions are typically implemented in software at the client end and either software or hardware at the other end, architecturally similar to legacy remote access (RAS) or v4-to-v4 VPN solutions.

- **Dual-Stack:** A dual-stack strategy can be thought of as the "bilingual approach" and seems to be one of the more promising strategies. The basic premise is that every device in the network—from routers to desktops—supports both IPv4 and IPv6. (See Figure 3.)

While this solves the issues involved in interoperability, it still has its downsides. First, it puts incredible strain on the network. Since each device must run two different addressing schemes, it is very resource intensive. Everything that the device does, it must essentially do twice.

Second, it creates numerous security and management headaches. The real issue here is that there isn’t feature equivalence between v4 and v6—meaning that existing management and security software can’t provide the same level of control and protection to the part of the network that’s IPv6. That is, the v6 traffic is significantly less manageable, and more open to attacks, than its v4 counterpart. Worse, most desktop and laptop operating systems default to IPv6 if it’s available—meaning that network managers have to take proactive steps to shut down these defaults if they want to control, manage, and protect their networks.

- Network Address Translation (NAT): Another strategy for dealing with IPv6 is employing network address translation (NAT), which literally translates from v6 to v4 (and vice versa). NAT capabilities are embedded in an increasing range of devices, from routers and firewalls to load balancers and application delivery controllers (ADCs). The big challenge with NAT is scalability. Not only is translation inherently expensive to process, but also NAT interferes with many applications that assume end-to-end transparency. The translation mechanism interferes with this transparency and drives workarounds, which are labor-intensive.

This issue increases when NAT is deployed inside large networks (i.e., carrier-grade NAT). Just as with enterprise NAT, carrier-grade NAT is relatively simple to get started, it can cover a large part of the network, and it holds some security benefits, but at the same time, it introduces translation delay into the network, and can conflict with such services as VPNs. It also creates a barrier that some applications cannot cross, causing them to not function. Finally, NAT can be expensive and further exacerbate routing issues.

- Renumbering: Some companies ask why all of this is necessary. Why not just renumber every device and be done with it? Two big reasons. First is that renumbering doesn’t solve the backwards-compatibility issue—it just inverts it. An organization that renumbers may be able to connect with all future IPv6 networks, devices, and services, but it needs some way to communicate with legacy solutions.

The second issue is the one highlighted above: Moving to IPv6 actually means taking a step backwards when it comes to management and security applications. At some future date when IPv6 security and management applications are superior to IPv4 ones, this won’t be an issue—but it’s unclear when this date will be.
Transition Challenges
While there are methods to deal with IPv6, none of them is perfect; each has its own weaknesses. See Figure 4.

Since none of the solutions is perfect, the recommended way of going about a transition would be to use a mixed approach. Every part of the enterprise network is different and thus has different needs. Likewise, no two enterprises are the same, and each enterprise may end up with multiple different strategies.

So what are most companies doing today? The most common strategy, by far, is to move to a dual-stack approach. The next-most common approach is NAT, followed by tunneling and readdressing. See Figure 5.

Practical Techniques
If you're one of the majority of organizations that haven't yet taken action with respect to IPv6, there are a handful of issues you should focus on. First is to ensure you have an available IPv6 allocation to work and experiment with. If you haven't already, it's past time to contact ARIN (in the U.S. or Canada), or the geographically appropriate numbering authority, to obtain an address allocation.

Next, you should make sure all your public-facing websites (such as AcmeUniversity.edu) and services like DNS are reachable via IPv6. Depending on the state of your infrastructure, that may—in fact, likely will—require outsourcing these, hosting on a provider's infrastructure.

After that, the next area to focus on is ensuring that remote users have a viable means to connect back to the corporate network. That means, in turn, adopting a solution like tunneling and/or NAT and making sure you clearly articulate the circumstances under which it will be used.

Finally, once these issues are resolved, you can begin thinking about a longer-term migration strategy. Assess your management and security platforms, and make sure that they're capable of delivering functional parity to your IP infrastructure. The degree to which they can do that dictates the degree of your internal migration.

Conclusions and Recommendations
- Resist the urge to make a "flag day" cutover. Plan for an incremental transition.
- Request and receive your company's IPv6 address allocation.
- Move your critical servers to IPv6-reachable infrastructure.
- Solve the problem of remote or travelling employees coming in from countries that have already migrated to IPv6. Consider tunneling or other solutions.

With respect to the other transition solutions:
- NAT what you can.
- Dual-stack if you must.
- Renumber as a last resort.

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Moving from the Old to the New

Replacing analog voice lines with SIP trunks enables universities to support a range of new applications

by Paul Korzeniowski

The writing is on the wall: Universities that depend on antiquated network infrastructures are facing big decisions with dramatic implications.

The Problem

Time division multiplexers (TDMs) cannot support the applications expected of campus technology today—not just voice and data, but also videoconferencing, unified communications (UC), multimedia, and more. Deploying modern applications on analog voice lines is expensive, inefficient, and ineffective. When network changes are closely tied to manual processes, schools spend lots of time and money on routine maintenance such as system moves, adds, and changes. These lines do not easily support multimedia applications, so multiple connections often are needed when only one line would be more economical.

The Solution

To meet today’s communication needs, universities must revamp their network infrastructures. They need to move from old connections (TDM) to new links (session initiation protocol). SIP operates anywhere an IP connection is available, and today—because of the widespread use of wireless communications—that literally means just about anywhere. SIP was built to support multimedia applications, and it carries data, voice, and video transmissions over one line. SIP also delivers a solid foundation for modern collaborative applications, such as UC and videoconferencing. To support today’s complex, dispersed, bandwidth-intensive communication needs, universities need SIP connections.

Obviously, this is not an easy fix. Infonetics Research, Inc., estimates that 88 percent of the telecommunications lines now running in North America are TDM lines.

The Challenges

The main reasons universities move down the SIP path center on limitations with TDM trunks, which are not very intelligent, generally work with only one end point, and usually are hard wired. Because the central controller typically holds all the intelligence and the telephones are dumb devices, troubleshooting is time consuming and tedious. TDM networks lack automated maintenance and troubleshooting functionality. Typically, technicians physically reconfigure the line if an employee moves from one office to another, and, as a result, even simple system upgrades represent long, tedious processes.

This means that academic institutions spend a lot of time and money deploying, maintaining, and upgrading TDM links. Often, the systems are so complicated that the institution is 100 percent reliant on its service provider to troubleshoot and maintain the system. For instance, in the middle of 2009, Minot State University looked at adding modular messaging to its existing Avaya TDM PBX telephone system.

“We were challenged by an aging analog infrastructure that had high annual maintenance costs,” stated Cathy Horvath, director of IT at Minot State University. The upgrade project would have run close to $400,000. With the PBX maintenance contract renewal approaching, the university decided to redirect its effort away from an old Avaya upgrade and instead migrate to a Microsoft and ShoreTel SIP solution.

TDM connections do not work well with today’s applications, such as messaging, conferencing, or collaboration. One problem is that TDM links require separate channels for each type of transmission. So if an employee wants to show PowerPoint slides during a video presentation, two separate communications lines are needed. In addition, TDM links do not adequately handle the network fluctuations that arise when, for example, a user downloads a complex PowerPoint presentation or conducts a videoconference. If there are any blips during an exchange, the transmission may appear garbled, and information may be lost.

There are other application limitations. TDM systems typically rely on proprietary, vendor-specific application programming interfaces. Developing add-on products and applications for these networks is also time consuming and expensive. Consequently, few third parties have taken on the work, and schools find themselves with a limited number of possible collaboration solutions.

Moving from TDM to SIP typically requires a significant upfront investment, and the process can be sidetracked by personnel challenges. It’s fair to say that moving from TDM to SIP offers universi-
ties significant potential benefits but is not for the faint of heart.

The Payoff
Persistence pays off in the end. Once they make a change, schools find that network troubleshooting becomes easier. A SIP trunk is a broadband Internet link that connects a company's IP-based PBX to an Internet telephone service provider (ITSP). With SIP, technicians do not have to manually alter each system. Changes often require only a few clicks of a mouse. Because less manual intervention is required, support teams troubleshoot and remedy problems by themselves and more quickly than third parties can—often within a few minutes.

SIP also delivers more network monitoring flexibility. Rather than being onsite, communications staff can test the network remotely from home, so they do not have to drive to campus to address a situation that arises in the middle of the night. In addition, SIP vendors often deliver self-service functions, so users can make their own network changes. The bottom line is that communications maintenance requirements drop significantly once a school deploys SIP connections.

Perhaps an even bigger value comes from the applications that run on top of a SIP infrastructure. With SIP, schools can more effectively support multimedia exchanges. These lines carry data, voice, and video content on one connection. Bandwidth is allocated on an as-needed basis, so the chances of fluctuations disrupting exchanges diminish significantly.

Unlike the TDM world, SIP devices conform to industry standards. Because SIP is a generic protocol for establishing multimedia communications sessions on IP networks, universities can deploy advanced functionality, such as VoIP, videoconferencing, unified messaging, and contact center solutions. In addition, the SIP Forum ensures interoperability among vendors' applications, so universities can freely mix and match different application components.

A Productivity Boost
Unified communications is one of the first places where schools start to exploit SIP's application capabilities. It integrates multiple forms of human and device communications in both real and nonreal time. From a single point, users can access messages from multiple devices and media types. For example, they receive a voicemail message and respond via e-mail. UC also integrates "presence," or the ability to detect whether the intended recipient of a message is online and available to text, chat, or conduct a video call. Minot State University deployed Microsoft's UC solution because the university relied on Microsoft's Active Directory for identity management and Microsoft Exchange for e-mail and calendaring. With UC, schools integrate communications functions, calendaring, and workflow into one environment and support cohesive voice, video, instant messaging, and collaboration functions.

UC's biggest benefit often is increased productivity. "Faculty and staff comfortable with their Microsoft Outlook client saw voicemail messages appearing in the e-mail inbox on any exchange support device," explained Minot's Horvath. "It was a hit. In addition, faculty and staff could call into voicemail, enter a PIN number, and get voicemails, e-mails, and calendar information." In such cases, employees and faculty no longer are tied to their office phones. They access their work e-mail and voicemail via smartphone, so they can contact individuals more quickly.

With presence, tracking down individuals becomes simpler. For instance, a receptionist can pinpoint where a faculty member is in the school and route infor-

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✓ Administrative cost savings
✓ Wireless Services available under contract

Watch for new contracts this Spring

MiCTA represents all non profit entities including educational, government, libraries, healthcare, religious, charitable and public sector with members in all 50 states. MiCTA produces and publishes collaborative RFP's generating agreements that are made available to all MiCTA members in good standing
mation to the nearest IP-enabled device. From a student perspective, UC means teachers are easier to contact. When school campuses can span multiple locations, employees and faculty can use just four-digit dialing instead of nine-digit long-distance connections.

UC opens up new learning opportunities. Classroom collaboration expands as faculty have more options for delivering course materials. With faculty and students no longer tied to classrooms, distance-learning applications become easier to deploy and support. Videoconferencing offers other possibilities: faculty may bring in virtual speakers via Web or videoconferencing. An added bonus is the ability for staff and faculty to participate in videoconferencing from their desktop PCs and phones in addition to special videoconference rooms.

Schools have often struggled developing campuswide notification systems, needed in case of emergencies. They may want to let folks know that the campus is shutting down because of inclement weather or to be on alert in case of a police matter. With UC, they now have a common communications mechanism that can quickly and easily notify students, staff, and faculty of any emergency situations.

Obstacles to Overcome

But movement to these new applications creates challenges.

- Money, money, money. The top concern centers on capital costs. Schools must make significant investments (often seven figures) in network infrastructure and buy items such as VoIP media gateway (AudioCodes), more network bandwidth, storage arrays, upgraded servers, and additional software. Cost-justifying the investment can be challenging.

- Network security. In addition, new network-security issues emerge. TDM networks are closed and not open to intruders. IP links further expose schools to all of the malware traveling on the Internet. As universities move to SIP, they need to make sure that their network infrastructure is able to protect sensitive school and student information.

- Personnel issues. The shift to SIP also creates personnel issues. Each school needs to know its users before moving to these new applications. Getting rid of a desk phone can be anxiety provoking for certain employees. They sometimes rail against the process and try to overtly or subtly undermine the transition. Training is crucial because it helps to address the fear of change often seen with such migrations. A school should provide an initial round of training when it rolls out the new system and then follow-up training a couple of months later to take users to the next level.

- Training. There are also changes in the telecommunications department. The staff needs to understand how to operate the new network and handle a different set of issues. Employees may have been working with traditional telecommunications systems for decades, so the change moves them out of their comfort zones. Data center personnel also need training. The infrastructure is the same, the packet routing is the same, but the quality of service and the requirements are different.

One Day at a Time

Rather than face all the changes at once, many schools choose to make the move in phases that may even span a few years. Conducting a test run of the new capabilities is recommended, and in some cases, it may be best for the communications department to pilot the new system. By following that course, they will know firsthand how the process unfolds and can work the kinks out before helping users.

Moving from a TDM to an IP network provides schools with plenty of benefits, such as streamlined productivity, reduced costs, and support for a wider range of applications. However, the process presents them with new challenges as well. In order to reap the potential rewards, everyone needs to be ready to take on the extra work.

Paul Korzeniowski is a freelance writer who specializes in communications issues and is based in Sudbury, Massachusetts. He has been writing about these issues for more than two decades and can be reached at paulkorzen@aol.com.
Thanks to Our Exhibitors and Sponsors!

Thanks to these companies that exhibited or sponsored at one, two, or all three of our events in 2013. ACUTA members are their potential customers, but representatives from many of these companies have also become our partners in success as well as our friends. As they determine whose events they will attend each year, ACUTA is glad they have chosen ours!

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2013 Award Winners

At the Annual Conference each year, ACUTA is proud to recognize some members who have contributed their time and talents in very special ways. Here are three people who were honored in 2013 for giving their best efforts to strengthen ACUTA and make the association more valuable for everyone.

Bill D. Morris Award
Riny Ledgerwood
University of San Diego

The Bill D. Morris Award represents ACUTA's highest level of recognition. The recipient, in the estimation of the president, exemplifies the dedication, vision, professionalism, and leadership that Bill brought to this organization many years ago.

The recipient for 2013, Riny Ledgerwood, continues to serve ACUTA and prove her dedication. She has served on ACUTA committees, including multiple years as the chair of the Program Committee, and on the ACUTA Board since 1997—a record-breaking total of 16 years. Even before this, she consistently volunteered to be a user group leader at the annual conferences.

Riny has been a presenter, moderator, and monitor at many ACUTA events. This record is a testament to her support and commitment to the association and her willingness to continue to share her time and expertise with ACUTA members.

Ever gracious, Riny had this to say about her involvement with ACUTA: "Throughout my career as a communications professional, I owe it to ACUTA for much of my learning through sessions and vendor networking. I also gained invaluable experience and friendship by volunteering to serve on the Board and committees. It is absolutely worth it."

Presenting the award at the Annual Conference in 2013, President Jennifer Van Horn said, "I first remember talking to [Riny] at the Winter Seminar in 2003 in Phoenix. She was very friendly and outgoing, and she encouraged me to join the Program Committee, which I did the next year. This started my leadership career with ACUTA, so I guess I owe it all to her."

ACUTA is pleased to recognize the winner of the Bill D. Morris Award, ACUTA Secretary/Treasurer, Riny Ledgerwood. Her dedication to ACUTA is an inspiration to all of us.

Grab the mobile app and head for Texas!
Join us for the 43rd Annual Conference & Exhibition
March 30-April 2
Hyatt Regency • Dallas, Texas
www.acuta.org/app
Matthew K. Arthur
Washington University at St. Louis

Since 2001 this award has recognized outstanding leadership among the ACUTA membership. The award honors the memory of ACUTA Past President Ruth A. Michalecki of the University of Nebraska Lincoln for her leadership of ACUTA and the communications technology profession.

The person selected for this award:

- Motivates and fosters collaboration to accomplish the goals, objectives, and mission of his or her institution or company
- Actively participates in the education, professional development, and mentoring of other professionals
- Demonstrates initiative in creating programs, projects, or activities that impact the community, and
- Engages in activities that directly benefit ACUTA or the broader higher education community.

A member of ACUTA for 14 years, Matt represents Washington University in St. Louis. He has served in numerous leadership positions with ACUTA, including his service as president of the association in 2010-2011. Even following his years on the Board of Directors, Matt has continued to participate actively in ACUTA as a willing contributor to our educational programs, serving as a speaker on many occasions. He is always willing to lend a hand to fellow members, and he supports the active participation of other IT professionals from his campus in ACUTA activities.

In addition to his leadership and service with ACUTA, Matt is an active leader within many other higher education and IT organizations. Matt personifies the values and characteristics of a leader in every way.

Jeri Semer Volunteer Recognition Award
Mona Brennan-Coles
Western University

In its second year, this award is granted to a subcommittee chair, committee or subcommittee member, institutional or corporate affiliate member, associate or emeritus member who has provided extraordinary service during the year. The award is named after the late Jeri Semer, ACUTA Executive Director 1994–2011, who saw the future of the organization reflected in its active members, and who did much to foster the growth of our extensive volunteer program.

Mona Brennan-Coles from Western University in Ontario, Canada, was selected for this award in 2013. An active participant on the ACUTA Community listserv, Mona has contributed to the eNews and the Journal, presented at events, promoted ACUTA to colleagues, and encouraged other volunteers to participate more actively. She has provided advice and written various articles that were helpful for our colleagues in the United States and for our other Canadian members. She is a true international asset.

Mona is currently a member of the Publications Committee and the Social Media Subcommittee. She is one of our most involved international members in ACUTA.
Institutional Excellence Award 2013
Honorable Mention
Abilene Christian University: Virtual Lab Project

Abilene Christian University’s Information Technology Departments of Enterprise Infrastructure and Technology Support teamed with the College of Business Administration to launch the initial pilot phase of a Virtual Lab Project. The pilot consisted of two professors from the College of Business Administration who taught a combination of a business statistics course and two business operations courses. The combined student count for all three sections totaled 80. The pilot group selection stemmed from ongoing conversations between Technology Support and the College of Business Administration, which had begun in May of 2010 when the College of Business Administration expressed interest in virtual desktops. Historically, the business operations course was taught in the College of Business Administration computer lab. The selection of this course for the pilot offered the opportunity to assess the effectiveness of the virtual lab when the course was taught in a traditional classroom. The business statistics course was selected because homework assignments required specific applications that were only available on the computers in this particular computer lab. This required students to complete homework assignments during specific times when the lab was available throughout the week.

From an infrastructure perspective, the pilot consisted of 50 virtual desktops that could be accessed from personal computers (Windows or Macintosh), as well as mobile devices (such as Android tablets or iPads). An additional element of the pilot was the availability of these virtual desktops from both on and off campus. The 50 virtual desktops were provisioned with software applications that mirrored those loaded on the computers located in the College of Business Administration computer lab.

At the start of the fall 2012 semester, technology support staff were invited to each of the three course sections to provide an overview of the pilot to the students who would be participating. These visits also included guided instructions regarding how to access the virtual lab as well as instructions on how to receive assistance in the event they encountered trouble accessing or using the virtual lab. Throughout the semester, log-in metrics were collected by Enterprise Infrastructure to understand when and how often the virtual desktops were accessed. As the semester drew to a close in December, a student questionnaire was sent to participating students to gauge their experience with the virtual lab pilot. In addition to the questionnaire, Enterprise Infrastructure and Technology Support met with the professors who leveraged the virtual lab to collect their observations and feedback on the success of the initial pilot.

Planning, Leadership, and Management Support
Planning for the Virtual Lab Project followed two parallel streams beginning in 2010. The first stream was initiated by the College of Business Administration, which was consciously aware of the adoption and benefits of virtual desktops from companies they interacted with through graduate placement programs, distinguished speaker series, and internship programs. Curious about the technology and interested in ensuring that students in their program were prepared for the business environments they’d enter upon graduation, the College of Business Administration engaged ACU’s Technology Support group to better understand the feasibility of deploying virtual desktops for their students.

The second stream was initiated by ACU’s enterprise infrastructure team, which was interested in expanding virtualization technology, which had been successfully deployed in the server environment, into the client environment. Working in concert with Technology Support, three pressure points were identified that virtual desktops could address.

The first pressure was the problematic dual-boot environment of Macin-
toshiba computers. Almost a third of the computers deployed to faculty and staff were Macintosh, and yet there were a fair number of business-specific applications that required a Windows environment to operate. Rather than users opting for a Windows computer, they referenced marketing literature that touted Macintosh’s capability to run both Windows and Macintosh operating systems, unaware that configuring a Macintosh computer with the functionality to run both systems was expensive and time-consuming. Furthermore, there was an unpredictability of installation. What might take an hour for one computer could end up taking several hours for another. This resulted in a highly manual process and greatly impacted the time-to-deliver for new computers.

The second pressure resulted from the fact that the Windows terminal server for remote workers was becoming an increasingly unwieldy go-to solution for a vast number of users who performed institutional work away from the office. Initially, the Windows terminal server was set up for one specific application for the admissions and enrollment management offices. At first, it was easy to leverage this resource, but over time it became the answer to all issues associated with staff who had difficulty with access to applications away from the office. As a result, the number of applications residing on this Windows terminal server, and the number of users allowed to access this server, had grown exponentially.

The third pressure concerned academic discipline labs and the tension felt by some department chairs and college deans that the physical space of a computer lab could be better used for other purposes. To reconcile this tension, several academic departments investigated requiring specific laptops and software applications for their students to participate in the degree program, but often the increase in cost to the student was seen as a greater barrier than having a computer lab.

Armed with these three pressures, ACU’s IT groups began reviewing the products and services that comprised the virtual desktop market. During this review period, VMware, with whom ACU partners for server virtualization, launched its virtual desktop client for the Apple iPad. With this announcement, ACU concluded that any success for a virtual desktop deployment hinged on the convergence of a relationship with an existing vendor (in this case, VMware) and the ability to integrate virtual desktops with ACU’s successful mobile-learning initiative, where students had the option of choosing an iPad as their mobile device.

In the fall of 2011, ACU moved quickly to begin a technical evaluation of VMware’s virtual desktop product, called VMware View. VMware set up a 60-day evaluation instance of the VMware View product comprising a couple of Cisco servers and 20 virtual desktop licenses. This evaluation enabled ACU’s IT groups to gain a better understanding of the complexities associated with offering virtual desktops and allowing hands-on experience with the user interfaces from both management and end-user experiences. Thanks to the 60-day evaluation period, many questions were identified by all IT departments, and it was determined that accurately defining the intended scope and usefulness of a virtual desktop deployment was required to guide any efforts of implementation. In the evaluation, IT learned about desktop virtualization, as well as application virtualization. Both were offered via the VMware View portfolio; nevertheless, each took different resources and configurations to become a reality. IT refined the focus of what virtual desktops would address at ACU.

Building on the VMware evaluation and the lessons learned from this process, IT chose to establish a virtual lab as its first pilot project to leverage virtual desktops. This decision marked a convergence of the separate, but parallel, virtual desktop streams that were occurring on the campus. ACU’s College of Business Administration was eager to participate in the pilot, and since they had specific applications that were only supported within a Microsoft Windows desktop environment, this made them a natural choice to be the inaugural pilot participants. To build out the virtual desktop pilot, IT chose to begin with a solution that equaled the aforementioned 60-day evaluation pilot conducted by VMware.

In late spring 2012, ACU purchased 50 VMware View licenses and the server hardware to support these licenses for $35,000, totaling $700 per license. Funding for this project was secured using IT operation savings as a result of contract negotiations and staff vacancies. Using these savings allowed IT to seed the pilot and manage its initial use. The pilot process was essentially a proof-of-concept to be used in an effort to secure additional funding through ACU’s Educational Technology LINK (Leadership, Infrastructure, Networking, and Knowledge) team. LINK administers the technology portion of the Academic Enrichment and Technology fee and works to further the vision of technology integration into the teaching and learning environment at ACU. In an effort to quantify the virtual labs position, IT quickly determined that virtual desktops weren’t necessarily a cost-saving mechanism, but rather a cost-transfer proposition. Instead of funding lab replacements, the LINK team could fund virtual labs at the same level, providing more hours of lab accessibility and convenience for student use.

As the College of Business Administration’s virtual lab was being compiled during summer 2012, IT determined that success of the pilot would be based on comparing the performance and responsiveness of the virtual lab to a computer located in the physical lab. A metric of two minutes was identified as a key measure of the performance and responsiveness. If a user could log in to the virtual desktop and be able to interact with it (quantified by launching the “start”
menu) within two minutes, then this was comparable to the delay associated with logging into a physical computer located in the computer lab. In order to meet this metric, IT spent days optimizing the virtual desktop, increasing the amount of memory to which each desktop had access, and ensuring that the number of disks set up for the virtual desktops had sufficient input/output pathways to handle boot storms without a measurable lag. On multiple occasions, IT conducted stress tests where the staff converged in a classroom and, in unison, launched the virtual desktop application and connected to the virtual desktops. During these stress tests, system administrators monitored utilization indicators, and stress proctors monitored stopwatches to confirm all testers were able to interact with the “start” menu within the virtual desktop within the desired timeframe.

Promotion of Technology and Maturity of Effort
ACU has a rich history of investing in technology enriching the education of students. Recent milestones that illustrate this history include a campuswide network build-out to provide network connections in all administrative and academic buildings (1995); network connections per pillow in the residence halls (1999); migration of all student, finance, and administration systems to SunGard Banner (2000); a multyear project to provide wireless network connectivity to all buildings across the campus (2006); transformation of the main floor of the library into a learning commons (2007); a mobile-learning initiative to integrate mobile devices into the curriculum (2008); and most recently the building of a digital-learning studio where students can create media-rich audio and video products (2010). Each milestone is built on the success of the previous ones and lays the foundation for future milestones. An example of this effect can be seen with a decision in 2007 to move all campus e-mail to Google Apps for Education. This decision freed up an e-mail administrator position, which was repurposed to an application developer position. With this application developer position, ACU was able to develop a suite of Web applications that fueled the success of ACU’s mobile-learning initiative.

ACU’s virtual lab pilot is built on the successes experienced by several different areas. With ACU’s decision and focus to be a leader in mobile learning, ACU has spent considerable effort to construct and optimize a robust and resilient wireless network that sees an average of 300,000 connections a day by 16,000 unique devices. ACU’s effort to effectively manage the space, power, and cooling resources has resulted in 52 percent of the servers housed in ACU’s data center being virtual servers. ACU’s interest in electronic textbooks and evaluating the educational efficacy of these tablet devices has resulted in a 145 percent increase in the number of iPads registered on the wireless network between the fall 2011 and fall 2012 semesters. The wireless network, server virtualization, and the number of iPads on campus all have a role in laying the foundation for the ACU virtual lab product.

Client or desktop virtualization is not unique within higher education; however, each case seems to be a little different. For instance, in 2010, the University of North Texas at Dallas launched virtual desktops as a replacement option for faculty and staff computers by swapping out the traditional computer with a peripheral connector box, also known as a “thin client.” Indiana University has been piloting an application-virtualization project since 2010, where applications can be used without the need to install them on a user’s computer.

What differentiates ACU’s virtual-lab project from other virtualization projects is how it’s built on the technology successes that have come before and the collaboration between administrative and academic departments to make the project a reality. Administratively, this project is dependent upon the constant collaboration that takes place between system administrators, who manage the server infrastructure, and the technical support analysts, who manage software installations and provision the desktop images. Together, these two IT departments couldn’t produce a pilot without the support and assistance of the College
of Business Administration professors, who are willing to take the risk of using an unproven solution, and students who are willing to participate in the pilot.

Quality, Performance, and Productivity Measurements

During the first semester (fall 2012), two sources of data were collected to determine how the pilot performed. The first data source was the virtual desktop log-in events. The second data source was student responses to a questionnaire sent out at the end of the semester. The log-in events provided insight to usage such as frequency, time of day, load distribution among virtual desktops, and course sections. The results of the student questionnaire gave information regarding the experience of using the virtual desktop.

During fall 2012, the virtual desktops had a total of 1,277 log-ins by 90 unique users (this included IT staff, faculty, and students). See Figure 1.

As Figure 2 illustrates, use of the virtual-lab pilot occurred most often between 8 a.m. and 12 p.m. This was an expected result, as two of the three course sections in the pilot were accessing the virtual lab during class time (Monday, Wednesday, Friday from 9 to 11 a.m.). Another notable metric was the number of simultaneous connections by hour (Figure 3). With the exception of the first day, the virtual lab pilot was released to the students, the number of logged-in users never exceeded 50 percent of the available licenses.

The data collected from the student questionnaire revealed that students felt the virtual lab was easy to access (Figure 4) and the performance was good (Figure 5). In fact when asked whether the virtual lab was more beneficial than the traditional lab, 70 percent responded they thought it was more beneficial.

The student questionnaire did reveal that only 26 percent of the respondents "knew whom to call if they encountered trouble with the virtual desktops." Since this was a pilot project, the decision was made not to utilize the normal student technology support mechanism, and students were instructed the first day whom to call. With these data, future pilots and participants will be pointed to the regular student technology support mechanism. However, when students were asked about trouble encountered while using the virtual desktops, only 15 percent responded with a description of a problem and 27 percent responded that they didn't have problems (the remaining 42 percent didn't provide an answer).

The results from the first semester of the pilot are encouraging. The performance data from the student questionnaire suggested that the work to optimize the pilot during the summer of 2012 was successful. The usage data suggested that even more students could utilize the virtual lab without requiring an addi—
tional investment in servers or licenses. As ACU looks to the second semester of the pilot, additional metrics are sought to determine how long the virtual desktops are used per log-in and what applications students are using. In addition to these measures, ACU’s system administrators want to measure memory usage and SAN connections to determine if the solution could be better optimized to increase the number of virtual desktop licenses without requiring additional server hardware.

Cost, Benefit, and Risk Analysis

When ACU began evaluating the feasibility of a virtual desktop deployment, it was quickly concluded that a virtual desktop initiative wouldn’t necessarily be a cost-saving mechanism. The cost of $700 per virtual desktop is equivalent to the cost of deploying a computer in one of the academic discipline labs. With virtual desktops, academic-specific software applications would be equal as well, whether purchasing software licenses per machine (whether physical or virtual) or purchasing a site license (a campuswide license). For cost reduction, ACU looked briefly into application virtualization; however, this option required additional services, such as a separate license server to manage a limited number of available licenses that could be “checked out” while a user was utilizing a specific software application. ACU felt that this complexity, currently infeasible, could possibly be part of a separate, future evaluation process.

To this end, ACU was convinced that the benefit of a virtual lab was more accurately felt in both its ready availability and its potential to recapture physical space previously dedicated to housing academic-specific computer labs. The benefit of availability can be quantified in both hours of operation and locations from which the virtual lab could be accessed. Under the traditional computer lab model, specifically within ACU’s College of Business Administration, the hours students could enter the computer lab were limited by the times when professors hadn’t scheduled the lab for classroom use and when the building was open.

By contrast, the virtual lab model was available 24 hours a day, seven days a week. The trade-off then becomes licensed-instance availability. As observed during the pilot, only once during the semester were all 50 licenses in use. During the majority of the time, only half of the licenses were in use; this offered opportunity for more users to access the virtual lab, even while a class in session actively employed the virtual lab. As for availability of access, ACU set up the virtual lab so that it could be accessed both on and off campus. Based on student response at the end-of-semester assessment, 82 percent of the students who indicated they utilized the virtual lab outside of class had accessed the virtual lab from off campus. Under the previous class model, students would have had to physically enter the computer lab to utilize the academic-specific software.

The long-term benefit accompanying a broader deployment of virtual labs is the opportunity to recapture physical space, which could be leveraged for more classroom space. This could potentially mean more courses being offered during a semester or courses being offered for a greater variety of degree plans. Another long-term benefit is a more effective use of ACU Technology Support’s physical resources, as well as a greater scalability of labs across all departments. While these possibilities have not been completely affirmed with this test, it is planned to capture and record more diverse information in future implementations.

Despite the conclusion that a virtual lab isn’t a cost savings, ACU has positioned virtual labs as what translates to a cost transfer. Rather than investing in the replacement of computer-lab computers every three years, these funds could be leveraged to expand and increase the virtual lab environment. After three years, the university wouldn’t lose its initial investment; rather it would continue the operation’s number of virtual lab machines and increase the number of virtual desktops with each renewed investment.

The largest risk associated with a virtual lab environment is that it should operate identically to a computer sitting in the computer lab in order to maintain ease of utilization for the users. Despite its nature as a completely virtual environment and the possibility of multiple variables impacting access and use of the virtual desktop, it was recognized that the average student user would compare his or her experiences to the desktop machine. To this end, ACU system administrators worked with desktop support technicians to fully optimize the virtual desktop experience. This included ensuring each virtual desktop had 2 gigabytes of memory with which to work; reducing the number of applications on each virtual desktop, including removing antivirus software (a known resource hog); and paring the profiles on each virtual desktop to bare essentials.

In addition, to work on each virtual desktop, system administrators searched for best practices in industry literature, ensuring that each virtual host had sufficient use of input-output processes so that accessing the SAN wouldn’t hinder its speed. ACU’s IT engineers and technicians worked under the assumption that it should take less than two minutes for a student to connect to the virtual desktop and be able to interact with the virtual desktop’s start menu. To support this effort, prior to the start of the fall 2012 semester, ACU conducted a series of stress tests where ACU’s Information Technology employees would gather in various classrooms and simultaneously attempt to access the virtual desktop, in an effort to simulate a worst-case load scenario on the virtual labs solution. Early stress tests confirmed that it could take up to eight minutes before a virtual desktop
was loaded and ready for use. This eight-minute mark was unacceptable, and ACU system administrators worked to better optimize the virtual desktops and quantify where the bottlenecks resided in resource constraints.

Further stress tests included multiple-device access options, including Windows laptops, Macintosh laptops, iPad tablets, and Android tablets. In the final stress test, days before the first day of the fall 2012 term, success was reached when 40 devices were able to connect and load the virtual desktop in under two minutes.

These efforts, and initial feedback of acceptable behavior, paid off when 83 percent of the students responded that accessing the virtual lab was “not difficult” and 88 percent responded that the performance of the virtual lab was either “excellent” or “good.”

Other risks associated with virtual desktops include a lack of some key metrics, due to an inefficient method of recording information. Improved methods of gathering specific data points are currently being developed. Individual users’ computers and their Internet connections off campus are additional risks associated with this project. In order to connect to the virtual desktops, there are a few minimum requirements related to hardware, as well as to the data connection utilized. If these requirements are not met, users could experience a drop in performance or loss of connectivity. While in most cases the minimums are readily achievable (especially with recent increases in consumers’ technology capabilities and Internet bandwidth minimums on the rise throughout the United States), there still exists the possibility that student computers could fall below these minimum standards. Nonetheless, this constitutes an acceptable risk, as there is little that can be done to impact the results in these few cases. Initial reviews indicate that the concern exists but is not widespread enough to hinder the project’s overall success.

**Customer Satisfaction/Results to Date**

To conclude the initial semester of the Virtual Lab Project, members of ACU’s Information Technology, Education Technology, and College of Business Administration who had been involved in the project met to review the pilot’s progress and assess how to proceed for the following semester (spring 2013). Critical for this review process were the opinions and observations of the two College of Business Administration professors who participated in the pilot. Both professors were complimentary of performance and accessibility of virtual desktops, echoing the responses received through the student questionnaire. More telling was their eagerness to continue with the pilot through the following spring 2013 semester. Both professors offered anecdotal stories of how students had gone beyond the initial scope of the pilot and were using their access to the virtual desktops for other course work. When the group reviewed the student comments related to problems encountered while using the virtual desktops, the professor who was using the virtual lab during the class period offered that when she was aware a student was having a problem, they took the opportunity as a teachable moment to diagnose the problem and identify potential resolutions.

All parties recognized that the initial pilot was engineered to be successful. The student participants didn’t outnumber the available licenses, so there wasn’t a concern that the solution was oversubscribed. The applications being leveraged by the students were relatively small, with reference to the memory and processing requirements, to ensure the virtual desktops wouldn’t be bogged down and result in appearing to be unresponsive. The number of applications available to student participants were identical, and only a single desktop image was available for use, reducing any potential confusion experienced by student participants. To this end, the parties recognized that changes to these acutely managed variables could have the potential of resulting in different experiences on the part of the students.

In preparing for the second semester (spring 2013) of the Virtual Lab Project, despite the number of course sections staying constant, the actual number of student participants doubled. Other changes sought for the second semester included more metrics, such as virtual desktop session duration and resource monitoring. In addition to these, ACU’s Technology Support department is interested in limiting the face-to-face instructions on how to access and use the virtual desktop in favor of simply distributing written instructions and pointing students to the normal student technology support mechanisms to provide greater assistance to those students who encounter trouble.

Looking beyond the pilot, ACU is evaluating funding options to scale the number of available licenses from 50 to 100 and engaging additional academic departments and colleges to assess the result of having multiple virtual labs operating concurrently, as well as having additional applications accessible. ACU is also interested in increasing the types of mobile clients that access the virtual desktops, to evaluate the performance differences associated them.

Without question the initial semester of the virtual lab pilot was successful. Thus far, all parties engaged with this pilot have been pleased with the initial results and the promises the solution holds for continued growth. Determining an acceptable rate of growth and identifying the sustainability of this growth are two of the challenges that will continue to be vetted in the coming months and phases of the virtual lab pilot.

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