Level 3 COMMUNICATIONS

Connecting and Protecting the Networked World℠

WHITE PAPER

RESEARCH & EDUCATION'S GLOBAL EXPANSION
NETWORKS SUPPORTING DISCOVERY AROUND THE WORLD

Executive Summary

Can technology help people chase dreams? Can universities meet the needs of a growing number of students who view college as an essential step in achieving life goals? Empower researchers to explore ideas individually and in consortia, around the globe? Operate economically while simultaneously helping the institution's vision for its future become reality?

From sharing massive volumes of data between teams around the globe, to making it easy for a student to register for a course using their smartphone, CIOs and IT teams in universities are tasked with making sure the networks they use today are reliable, highly secure, super high capacity and designed to anticipate future demands.

Economic realities can impose difficult problems for IT teams. Funding for IT is up modestly in 2013, after years of reductions. These increases are largely due to expansions in operating funding and are reflective of overall institutional budget growth. However, at institutions where there was a decline in the total central IT budget, 57 percent experienced a decrease in operating funding.[1] By and large, and especially among community colleges, IT staff is being reduced in response to budget constrictions. These are compelled by reductions in government funding as well as the needs to control costs and stem increasing tuition hikes. Updating IT staff skills to keep pace with new communications technologies further complicates the situation.

One solution to budget issues is to grow the addressable market by expanding internationally. A number of universities are establishing satellite institutions in regions of the world where higher education is becoming a high priority, for example Asia and the Middle East. Distance learning and Massive Open Online Courses (MOOCs) represent a new education paradigm. Millions of students now take advantage of online courses, either as their only source for education or as part of the mix of classes they attend each semester. The model for MOOCs, a free online learning system, is evolving, but it is apparent that demand exists; one company, Coursera, claimed to have more than 1.3 million students as of October 2012.

Research and education (R&E) institutions enjoy a population that embraces challenges. That attitude has traditionally included taking on networking among research groups. However, university CIOs today need to solve for the telecommunications needs of the entire campus. They have recognized the need to engage communications services providers to supplement their in-house staff. They are moving increasingly to providers that offer complete, flexible solutions, which encompass everything from physical network construction to a suite of managed professional services.

Level 3 Communications has a rich history of successful R&E support. In addition to a global fiber optic network reaching 45 countries and deep metro penetration, Level 3® Managed and Professional services offer expertise and commitment to the customer experience that builds a foundation for a lasting relationship.

Introduction

Research and education (R&E) organizations operate with two somewhat different yet dependent philosophies. On the one hand, their purpose is to educate and enable discovery. On the other hand, they need to take in enough revenue to support their existence, and beyond that they need to grow to better fulfill the first objective. Another issue, the fact that costs are rising annually while budgets have been shrinking, further complicates the picture.

Expanding R&E institutions need local networks that satisfy the communications needs of the home campus and the satellite campus, both for collaboration services and in response to shifting user behavior.

One approach to increasing revenue is to expand globally by establishing satellite campuses. In essence, students and researchers in other regions of the world represent a new market and R&Es seek to grab part of that market. However, such expansion also calls for global communications networks that can transport huge amounts of research data among teams. It also necessitates local networks that satisfy the communications needs of the home campus and the satellite campus, both for collaboration services and in response to shifting user behavior, the most obvious example being the BYOD phenomenon.

Consequently, much like in private enterprise, the role of the IT team is changing. More than ever, university IT teams are being asked to drive efficiencies and revenue. Recognizing both the challenges and opportunities, university CTOs are engaging network service providers for help.

Private network and public Internet connectivity is the foundation for all this, as well as changes in how professors teach, students learn, researchers team up and IT teams align their network strategy with the institutional strategy. While this is a somewhat obvious observation, keep in mind that it is subsea and global terrestrial networks that are enabling R&E organizations to now establish satellite campuses in regions awakening to the advantages large-scale higher education can bring to societies and economies.

Big Data and Big Traffic in R&E

The confirmation of Peter Higgs' theory that a particle consistent with what has become known as the Higgs Boson helps prove that technology can help people chase — and catch — dreams. As part of that work, over the past three years experiments using the Large Haldron Collider (LHC) created more than 100 petabytes of data, roughly equivalent to 700 years of full HD-quality movies.[3]

Although Higgs' work was the primary project under way at CERN, not all this data was generated by his team's quest for the Higgs Boson. More than 1,000 scientists, engineers and students, working on several different projects and from multiple countries, have collected and shared data produced by the LHC. Data analysis will continue at full speed over the next two years, and that will call for more data transfer over global networks.

Research efforts in many parts of the world are under way and more are planned, requiring more Big Data networking and collaboration technologies. KEK, for example, is an organization also smashing particles at near light speed, work that complements the research at CERN. In February 2013, KEK announced a new partnership between "the two most mature future particle physics projects, the International Linear Collider (ILC) and the Compact Linear Collider study."[4] The result is the Linear Collider Collaboration, a group that will continue exploring subatomic physics and, like LHC, provide a source for research data to the larger scientific community. Another project of note, and one that will lean heavily on Big Data, collaboration and an extensive network, is the Square Kilometer Array. Square Kilometer Array (SKA) South Africa, a business unit of the country's National Research Foundation, is joining ASTRON (the Netherlands Institute for Radio Astronomy) and IBM in a four-year collaboration to research extremely fast but low-power exascale computer systems. These systems are aimed at developing advanced technologies for handling the massive amount of data that will be produced by the SKA, which is one of the most ambitious science projects ever undertaken. The vision of this project is to build the world's largest and most sensitive radio telescope. The array will be located in Southern Africa and Australia and the project constitutes what, for now, is considered the ultimate Big Data challenge.[5]

MOOCs are a new illustration of how online learning platforms can help satisfy the thirst for education and training. In addition to the millions of people taking courses through companies such as Coursera, online education provided at a fee has skyrocketed in the last decade. Eduventures estimated that in fall 2010, 2.78 million students had enrolled in a fully online program, which at that time represented 14 percent of all higher education enrollments.[6] For universities, online learning presents an opportunity to teach at very low cost, since the capital and operational costs of brick and mortar facilities is obviated. It also creates increased traffic in the network, a burden that affects user experience and influences network design.

What's Inspiring Global Expansion

Universities are extending their presence into Asia and the Middle East as part of a larger globalization trend. Columbia University has opened two new research centers, one in Amman and the other in Beijing. Rather than following the traditional university model – with students attending classes in pursuit of a degree – these facilities are focused strictly on research. Professors and students in Jordan and China can collaborate in real time as they work on issues in law, political science and journalism. Cornell Medical College has opened a new school in Qatar, and New York University is building a campus on an island off the coast of Abu Dahbi.[7]

Why reach into these regions? The answer to that question is multifaceted and spans from the ideal to the practical. Considering ideals, R&E institutions recognize the need to enable access to high level education to more people in emerging nations as part of their mission. Increasing the number of well-educated, highly skilled people tends to have positive effects in regard to quality of life. Furthermore, collaborative research offers the opportunity to advance both discovery and overcome cultural differences, making the world a better place to live.

Practically speaking, people in these nations and other parts of the world represent a new revenue stream, a welcome opportunity in light of budget pressures as well as the need to reign in tuition increases by broadening the revenue base. Another angle is that the possibility for technology transfer is increased. Researchers with an entrepreneurial agenda can look to venture funding from a bigger group of investors when it's time for academically incubated technologies (initially supported by the R&E organization and government grants) to take the make-or-break journey through the "valley of death" en route to commercialization. High-profile researchers draw funding and are recruited based on their reputation, and so represent another source of income. R&E institutions need to provide the networks and technological infrastructures that support (and help retain) celebrity researchers; their work can raise the reputation of the institution, improve potential for endowments, and attract other researchers.

Sometimes it comes down to cold, hard economics. Real estate prices and construction costs in Boston, for example, are much higher than in many other cities in the world. The business case for building a new facility or campus abroad, and deploying the connectivity to and within that campus, could show that it's cheaper to grow into new regions than to expand in cities where space is at a premium.

Furthermore, the rise in distance learning in the U.S. and elsewhere is showing that exchange of thoughts and information in virtual environments can be engaging, inspiring and worthy of accreditation. An interesting consequence of broadband connectivity is that it has led to shift in how teachers teach and students learn called "flipping." Instead of a professor standing in front of a class delivering a non-interactive lecture, students watch videotaped lectures as homework and dig into the details of the subject during class time. What this shows is that the value of in-person conversation can never be replaced, it's just that now lectures can also occur in virtual classrooms connected by broadband networks.

Internet2: A Successful Model

We can look to success stories to understand the advantages building and operating a global R&E communications network can bring. Turned up in 1996, Internet2 is a global network dedicated to R&E among "international leaders in research, academia, industry and government who create and collaborate via innovative technologies."[8] R&E organizations can engage Internet2 for network services spanning transport to design and engineering and security, taking advantage of global connectivity that has been architected specifically for Big Data and reliability.

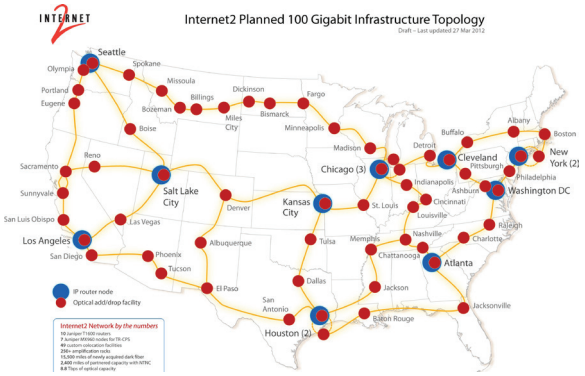

Figure 1. Planned Internet2 Topology

The type of collaboration that has occurred through Internet2's network is just as diverse as the spectrum of R&E itself: video broadcast of live dance performance between institutions in Michigan and Beijing; healthcare networks linking area hospitals in northwestern Wisconsin; data sharing between biomedical researchers; and application development for industries.

The next step in Internet2's evolution will bring 100GE broadband communications to the entire United States. The upgraded network uses brand new 100 Gigabit Ethernet technology and will have an unprecedented 8.8 Terabits of capacity. [9]

Challenges & Solutions

College presidents and researchers dream big — often on a global scale. Their ambitions necessitate equally as lofty network solutions that enable access to Big Data for groups of international researchers and consortiums. To make that happen, IT teams have to solve a mix of inherent problems. Complicating matters is the fact that budgets are decreasing and IT's role is shifting. Just like in enterprises, R&E IT teams are being directed to do more with less capital and smaller staffs, and to validate their role by showing they can help increase revenue while also supporting the R&E core mission. Whereas, in the past, IT essentially operated independently, now "it is very important that IT funding is not viewed as unrelated to other academic and operational decision making about funding."[10]

Security

Data breaches were recorded in many universities last year, and the most damaging was at the University of Nebraska, which had a breach of 654,000 records on May 25, 2012. According to the Ponemon Institute, the average cost per compromised record in an education environment is $142, which puts the cost of the Nebraska data breach at about $92 million.[11]

The need to protect sensitive records, research data and personal information calls for a unified threat mitigation strategy that encompasses the entire "cybersecurity ecosystem." That ecosystem is comprised of the place where the data is generated (in this case, the university), the private and public networks, and the place where data is shared, the satellite university or global research centers and any data centers that are part of the network.

Each area of the cybersecurity ecosystem faces different types of security threats. Increased dependence on public networks, Cloud services and transition to housing data in data centers multiplies the points of vulnerability that hackers can exploit. Viruses, bots and advanced persistent threats (in which malware unobtrusively relays information to the hacker) commonly reside inside the institution's firewall. Networks are prone to attack using phishing and sniffing techniques. External systems, including Cloud deployments, are subjected to SQL injection and many of the same threats one would see inside R&E's or data center service provider's firewalls.

This is where a network provider can be of great help to organizations that lack the capabilities and in-house resources with the special, constantly evolving, requisite security skills. Tier 1 network providers have visibility into network traffic that entities on either end of the network simply don't have. What this capability allows is observation of traffic and comparison of that activity with known, normal activity. Distributed Denial of Service (DDoS) attacks are a prime example of why this matters. DDoS attacks, one of the most frequently used tactics, employ bots to create a spike in demand that overwhelms a server(s). The network provider's technicians monitoring networks in security operations centers or network operations centers can see that activity, take steps to mitigate it, and notify the victim.

The constantly shifting threat landscape, shaped by hackers who spend every day working to find and take advantage of weaknesses, is a battlefield in which hackers have the advantage and organizations in the public and private sector are, for the most part, on the defensive.

DIY Culture & Networks

Most R&E IT professionals seem to be do-it-yourself type people. Scientists, engineers and students in general are, by nature, problems solvers. While that's great for discovery, it has led to haphazard network construction, network scaling without a holistic view, and sub-optimal design. For example, it's not uncommon for multiple 10 gigabyte paths, owned by multiple individual consortiums of researchers, to be operating on a network. Converging that infrastructure could result in economies of scale that create cost savings, simplified management of the network and network service providers, and increased performance essential to coping with the network demand associated with research and daily administrative operations. Adding to the demand is the sharp increase in "dorm traffic," driven by smartphones, tablets and other devices designed to stream content. And on top of that are and more and more wireless devices such as set-top boxes and printers students bring with them when they move into campus residences.

Security is influenced by a DIY culture. Understanding the threats and counter measures is challenging for companies that specialize in cybersecurity. It is virtually impossible for IT teams supporting R&E institutions. The constantly shifting threat landscape, shaped by hackers who spend every day working to find and take advantage of weaknesses, is a battlefield in which hackers have the advantage and organizations in the public and private sector are, for the most part, on the defensive. As wireless, mobile solutions, and self-provided mobile devices owned by students and educators (i.e., bring-your-own-device — BYOD) enter the school, security will also become more complex, requiring the school to monitor potentially thousands of variably secured mobile access points to protect the institution's resources.[12]

After weighing the complexity and capital expenditure, the level of effort and resources required, and budget restrictions, a total of 61 percent of educational institutions chose to use service providers to partially or fully manage communications (as shown in Figure 2).

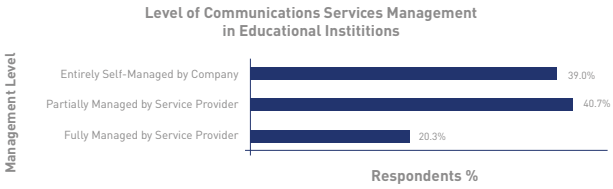

Figure 2. Source: Frost & Sullivan, Education Communications: Evolving Opportunities for CSPs, Charles Carr, March 2013.

The answer to effective network design, global deployment, operation, optimization, and security begins with a partnership in which each party acknowledges its limitations and applies its area of expertise. Working in complement, global network providers and R&E organizations can develop

communications solutions that meet today's needs and anticipate tomorrow's demands.

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Big Data, Big Traffic & Collaboration

Big Data is simply a fact of R&E life, evidenced by LHC and KEK experimentation as well as developing projects such as the SKA. In many network architectures in use today, when the data flow exceeds as-built capacity, a solution for dividing and sending it must be devised. In legacy, sub-optimal network architectures, "Big Traffic" data sets that exceed the broadband capacity are broken up and transported via several paths.

Cloud deployments, particularly Infrastructure as a Service (IaaS), offer a possible solution to handling Big Traffic. IaaS puts the burden of building, operating and maintaining the network on the provider. It also offers the flexibility and scalability necessary to support research missions as they mature and morph. Software defined networking and other virtual network management technologies enable "smart networks" that optimize class of service, for example, and server virtualization can help control costs and improve uptime.

How collaboration can be utilized is impacted by networks, which need to accommodate increasing mobility. Skype, Instant Messaging, Web meetings and Web conferences can unify teams working across campus, in the next state or on the other side of the world, but only if the network can enable such unified communications and collaboration (UCC) services. On the plus side, by utilizing an appropriate blend of collaboration services, virtual teams can increase efficiencies and become more productive. In many instances, the ability to go to one provider for both network and collaboration services not only simplifies management and helps cut operational costs (web meetings in lieu of travel, cost advantages relevant to IP vs. old-fashioned telecommunications, etc.), it helps ensure that the collaboration can occur. Highly reliable networks are the foundation for effective virtual teams.

These high-level challenges are representative of the many issues that R&E CIOs face. Of course, there are more. A list of the Top 10 issues faced is shown in Figure 3.

Top-Ten IT Issues, 2012

1. Updating IT professionals' skills and roles to accomodate emerging technologies and changing IT management and service delivery models
2. Supporting the trends toward IT consumerization and bring-your-own device
3. Developing and institution-wide cloud strategy
4. Improving the institution's operational efficiency through information technology
5. Integrating information technology into institutional decision-making
6. Using analytics to support critical institutional outcomes
7. Funding information technology strategically
8. Transforming the institution's business with information technology
9. Supporting the research mission through high-performance computing, large data, and analytics
10. Establishing and implementing IT governance throughout the institution

Figure 3. Source: Top-Ten Issues 2012, Educause, May/June 2012

Services & Their Advantages

R&E institutions are figuratively and literally breaking new ground by expanding globally. In addition to optimal network infrastructure at the home campus and the satellite campus, trans-Atlantic and trans-Pacific subsea connectivity obviously is mission critical. But, that's just the fiber network itself. All the peripheral equipment — routers, servers, switches, etc. — and the associated network operation tasks round out the long list of items R&E IT teams need to address. As discussed, the majority of these teams work with network service providers to cope with the challenge. When it comes to managed services, what do they choose to outsource? Figure 4, shows that managed Internet services are far and away most frequent. The other most called upon services are

directed at managing local and wide area network performance. It's interesting to note that 25 percent outsource security management. In light of the escalating frequency of cyberattacks on educational institutions and cyber-espionage aimed at pirating intellectual property, there's a very good chance that R&E organizations will increase engagement of these security services. For many reasons, it's simply too difficult to go it alone.

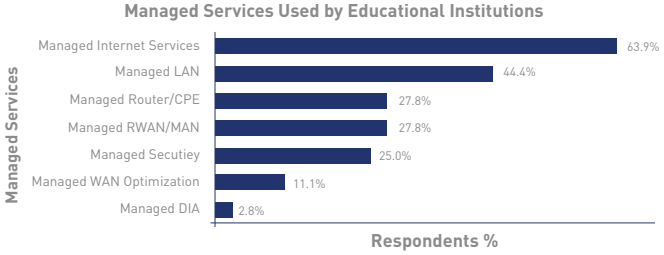

Figure 4. Source: Frost & Sullivan, Education Communications: Evolving Opportunities for CSPs, Charles Carr, March 2013.

In an ideal world, service providers would be able to offer "remote campus in a box" implementations that make the entire process a standardized set of steps. Instead, what's true is each network deployment, whether campus-wide or international, presents a unique set of requirements. These are ambitious, difficult situations that call for collaborative effort. A close relationship between the R&E organization and the provider is essential to knowing which network technologies best meet requirements in each location, and even to augment staff.

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And when that effort succeeds, a number of advantages result, including:

- The addressable market grows, spurred by network connectivity
- Online enrollment/learning increases, providing a high ROI for the university and the student
- Cost are controlled for network operation and, overall, for the institution
- Collaboration services are fully utilized, helping virtual teams to be more productive
- Sensitive data for researchers, students, faculty and administrators is secure
- A positive Web experience is delivered to current and prospective students
- Leading researchers and the funding that accompanies them is attracted and retained
- R&E missions are achieved

Level 3's Position

Level 3 has many years of experience building, operating and protecting their own and their customers' networks. The company can draw on deep institutional knowledge to optimize the performance of the complex, multi-continental networks which are used today and will be turned up in the future. Furthermore, they can assemble teams that can deliver a broad suite of managed services aligned to the R&E organization's IT skillset gaps. Level 3 is one of a select group of Tier 1 network providers that are able to augment networking expertise with Professional and Managed services as well as collaboration, security and data center offerings.

Level 3 also has a proven track record of success working with R&E organizations. The company's long-standing involvement with Internet2, along with numerous university network deployments of voice, video and data communications on a global scale, are testament to the company's position as a reliable, trusted provider for research and educational institutions anywhere in the world.

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Conclusion

R&E organizations are implementing a wide spectrum of projects that challenge themselves and the technologies central to discovery. The institutions where these teams work serve these researchers, and need to also enable faculty, students and administration to work effectively — it's an all-encompassing mission.

Complicating matters is the never-ending pressure of controlling costs. CIOs in R&E are being tasked with transforming IT services to drive revenue and cut operational costs. Meanwhile, evolving, increasingly complex communication technologies and security scenarios call for specialized skills. Keeping pace on both those fronts, while also maintaining operational continuity is becoming more difficult, especially in the face of funding decreases.

One solution to the economic pressure, and to help fulfill their charter – to cultivate education across the largest group of people practically feasible – is to expand into regions of the world where education is lacking and desired. Many major universities are doing just that, and they require global networking solutions to link the home institution with the satellite. These are complex, sophisticated networks that need to be reliable, extremely high capacity, scalable and highly secure.

Network service providers such as Level 3 offer R&E organizations the global, economic solutions that allow IT teams a viable path to aligning their activities with the overall R&E mission.

References

1. 2012 CDS Executive Summary Report, http://net.educause.edu/ir/library/pdf/PUB8009.pdf
2. http://chronicle.com/article/Massive-Excitement-About/134666/
3. http://press.web.cern.ch/press-releases/2013/02/first-three-year-lhc-running-period-reaches-conclusion
4. http://legacy.kek.jp/intra-e/topics/2013/022814/
5. www.skatelescope.org/news/big-bang-meets-big-data/
6. http://www.learninghouse.com/resources/whitepapers/research-study, referencing Silber & Condra, 2011.
7. www.csmonitor.com/tags/topic/Cornell+Medical+College
8. www.internet2.edu/
9. www.internet2.edu/network/
10. Top 10 IT Issues 2012, Educause, Susan Grajek, the 2011–2012 EDUCAUSE IT Issues Panel, and Judith A. Pirani, educause Review May/June 2012
11. http://campustechnology.com/articles/2013/03/21/higher-ed-data-breaches-at-near-record-high-in-2012.aspx
12. Education Communications: Evolving Opportunities for CSPs, Frost & Sullivan, Charles Carr, BCS 7-3, March 2013
13. http://www.emarketer.com/newsroom/index.php/college-students-adopt-mobile-board/

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