

WHITE PAPER

# Upgrading R&E Networks to Bolster Bandwidth, Operational Efficiency, and Information Security

Research and Education (R&E) organizations are looking for new and better ways to provide network services to campus communities. They need bandwidth—and lots of it—to transmit large data files for researchers, facilitate streaming video and collaboration applications for the student population, and support immersive teaching and productivity applications for faculty and staff.

Big data and cloud services are driving many of these trends. Current networks for many institutions were designed for email and Web browsing, and cannot support today's more sophisticated use cases with steadily increasing traffic demands. R&E organizations' network design updates must promise robust performance while ensuring capability for growth and offering conveniences that make operating the network simple and efficient. The network must also keep all information secure.

This paper discusses the challenges facing R&E networks today and key factors organizations can consider when planning modernization projects. It describes a simplified, high-performing, intelligent architecture that can deliver more bandwidth, more efficiently, to all users on campus while reducing the operational burden on IT organizations.

## Serving multiple user communities in R&E ecosystems

R&E networks must support a comprehensive set of services to meet the connectivity needs of their end-user communities—including researchers, students, faculty, and staff. Each user group is equally important to an institution, but each segment's usage characteristics and network demands can vary.

**Research community:** Thanks to open data initiatives, high-performance computing, and National Research and Education Networks (NRENs) that interconnect institutions around the world, researchers are collaborating with dispersed colleagues and sharing data generated by on-campus or external projects. Participation in organizations such as the Human Genome Project or the NASA Center for Climate Simulation (NCCS), for example, adds prestige to a campus and can influence an institution's eligibility for research funding and partnership opportunities. To participate, institutions are required to have very high-capacity, high-bandwidth connections to transmit gigabytes, terabytes, and even petabytes of information to and from collaborating organizations.

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**Students:** In her USA Today article, "See you in September: Green Bay college sends acceptance letters via Snapchat," Samantha Hernandez notes that today's student population, known as Generation Z, dominates campus network traffic. These students are constantly connected. About half are online for 10 hours per day: the vast majority watches streaming video on YouTube for two hours per day, and they engage constantly with their communities on social media.<sup>1</sup> Gen Z students prefer collaborative learning and expect easy access to e-learning tools anywhere, anytime: "For them, technology has always been a fully integrated experience into every part of their lives. And they don't think education should be any different."<sup>2</sup>

<sup>1</sup> "Gen Z Media Consumption: It's A Lifestyle, Not Just Entertainment," by Nelson Granados, in Forbes, June 20, 2017. <https://www.forbes.com/sites/nelsongranados/2017/06/20/gen-z-media-consumption-its-a-lifestyle-not-just-entertainment/#7f9e00d18c94n>

<sup>2</sup> "How Generation Z Is Shaping The Change In Education," by Sieva Kozinsky, in Forbes, July 24, 2017. <https://www.forbes.com/sites/sievakozinsky/2017/07/24/how-generation-z-is-shaping-the-change-in-education/#6fbcd79d6520>

To attract and retain Gen Z students, institutions must satisfy this group's expectations for constant access to applications requiring flexible, high-performance, high-bandwidth connectivity.

**Faculty and staff:** Faculty and administrators use a broad variety of cloud services and applications—using cloud-based learning management systems, teaching Massive Open Online Courses (MOOCs), and collaborating via video. The approaches continue to gain sophistication, driving up campus capacity and bandwidth requirements. The immersive experiences enabled by virtual reality will further transform teaching and create new forms of collaboration, and networks will need to support these capabilities.

Faculty and staff also need a strong presence on social media to keep Gen Z students engaged. Many colleges are using Snapchat, for example, to provide virtual tours of campuses and facilities, host question and answer sessions, and recruit students.<sup>3</sup> These and other social media applications can place new demands on a network. Institutions will need flexibility to scale capacity and bandwidth to accommodate these services.

### Strategic considerations for R&E network evolution

According to Educause, evolving from “historical services to emerging platforms is a major IT strategy” at nearly two-thirds (61 percent) of colleges and universities.<sup>4</sup> Recognizing the need for modernization is a first step. Every organization planning a network evolution must craft a strategy addressing its short- and long-term needs.

Based on its experience deploying networks in the R&E community, Ciena recommends considering the following factors when planning network upgrades or modernization projects.

**Scalability:** R&E network traffic will increase steadily as higher education user communities continue to ramp up their use of cloud services for research, teaching, learning, social, and administrative activities. To support the expected volumes of data traversing their networks, institutions will need high-capacity infrastructure that can scale quickly to deploy more bandwidth wherever and whenever it is needed. Depending on the system, a network should be able to facilitate capacity increases from 10 Gb/s to 100 Gb/s, 200 Gb/s, 400 Gb/s, or even higher capacities. Capacity should be easy to upgrade

so the institution can respond conveniently and on demand to sudden surges in traffic.

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**High performance:** R&E networks must ensure network reliability, availability, and performance requirements to support a wide range of use cases. At any given university, the network must provide access to high-performance computing facilities and enable researchers to share massive data sets with remote colleagues. The network must also support high-volume usage of real-time video streaming and collaboration tools among faculty and students and ensure ultra-low latency and very low jitter for applications such as virtual reality. To deliver the best quality of experience for all end-users, organizations must have robust networks as well as the capability to monitor performance, pinpoint areas in need of improvement, and adapt the network to changing conditions.

**Flexibility:** Network operators need the flexibility to implement new network functionalities when and where necessary to enable new services and applications. Rather than deploying functions in hardware, institutions can now virtualize network functions and use software to orchestrate services. This approach revolutionizes network control and service provisioning, giving R&E operators the flexibility to evolve their services in pace with user demands.

**Operational efficiency:** Campus and network operators want to deliver new services and upgrades as quickly as possible, but it can take months to complete projects when services run on hardware-based legacy architectures. IT staffing constraints can add further delays. Next-generation networks that offer software orchestration capabilities make it possible to provision services remotely and automate many deployment and operations tasks. This makes it possible to turn up new services in minutes, not months, reducing the burden on IT staff or the need to bring in professional services.

**Information security:** R&E institutions are prime targets of cyberattacks because their networks contain many types of information—from proprietary research data to information about users' personal lives, financial records, and health.

<sup>3</sup> “See you in September: Green Bay college sends acceptance letters via Snapchat,” by Samantha Hernandez, in USA Today, July 19, 2017. <https://www.usatoday.com/story/news/nation-now/2017/07/19/college-acceptance-letters-snapchat/493314001/>

<sup>4</sup> “Top 10 IT Issues, 2016: Divest, Reinvest, and Differentiate,” by Susan Grajek, in Educause Review, July 11, 2016. <https://er.educause.edu/articles/2016/1/top-10-it-issues-2016>

Institutions employ multiple security standards to safeguard their networks and must comply with federal security regulations or risk losing eligibility for federal research funding and financial aid programs.<sup>5</sup> Encrypting data communications and stored data are among the required security features.<sup>6</sup>

**Programmability:** The more opportunities a campus or operator has to automate the programming of the network, the faster new capabilities and services can be deployed. Programmable features can be implemented with Network Functions Virtualization (NFV) and software orchestration tools. Associated technologies can also monitor network behavior and application performance and automate adjustments to the system. These capabilities can be installed in the core network and/or networking equipment deployed on campus. Because programmable features expedite service delivery, the features reduce operating costs as well.

**Total cost of ownership:** Many R&E network operators are finding that next-generation network technologies offer performance and operational advantages that can reduce the overall total cost of ownership compared to legacy approaches. For example, a streamlined architectural foundation integrating Ethernet capability into the packet optical network and virtualizing routers and other functions can reduce hardware needs and system complexity. High-density, energy-efficient network components can dramatically reduce facility space requirements as well as energy costs. Organizations can further reduce operating costs by using remote provisioning and automation features enabled by virtualization and orchestration technologies.

### **A convenient architecture: One network for all R&E user communities**

A single architecture can serve the many demanding needs of the user communities in an R&E ecosystem. The key ingredients include virtualization and orchestration technologies that make it possible to program and automate service delivery, a programmable network foundation that can scale as needed to deliver bandwidth whenever and wherever it is needed, and analytics that help optimize and control the network. Encryption deployed at the network level will keep information secure.

Virtualization and orchestration: NFV and associated orchestration features make it possible to use software to deploy essential network capabilities previously deployed in hardware. Virtualization and orchestration can future-proof a network because the software-based functions are programmable and adaptable to future conditions. Campuses and network operators can add features or upgrade capabilities as often as needed. New services can be provisioned quickly to accelerate service delivery while reducing IT costs.

Ciena's Blue Planet® streamlines the definition and creation of NFV-based services, allowing the automation and connectivity of virtual compute, storage, and connectivity infrastructure and virtualized functions including routers, firewalls, encryption, and others. The technology can be hosted in a centralized location, such as a data center, and/or distributed locations, such as campus facilities at the edge of the network.

Hosting Virtualized Network Functions (VNFs) at network edge locations is an important benefit for campuses because it brings compute processes, data, applications, and services closer to the users to bolster application performance. The virtual functions are also highly practical. Virtual encryption, for example, makes it possible to encrypt data before it leaves a building—a feature required by some security regulations.

**A scalable, programmable, high-performance network foundation:** R&E organizations can simplify their networks dramatically by converging Ethernet services on packet-optical connections that extend from the core to the edge of the network.

Ciena's 8700 Packetwave® Platform, a high-capacity packet-optical switch integrated with Ethernet capabilities, can be used to establish the backbone of an R&E network. The 8700 offers 800 Gb/s capacity, with potential to increase to 6.8 Tb/s. It can support connections of all sizes between data centers, distribute large quantities of data between collaborating research organizations, and handle the aggregated bandwidth demands of researchers, students, faculty, and staff who access the network from their respective campus locations. Network operators can integrate the technology themselves on their own fiber connections and/or use the technology on connections provided by managed services providers.

<sup>5</sup> "NIST Special Publication 800-171 for Higher Education: A Guide to Helping Colleges and Universities Comply with new Federal Regulations," by Tiffany Dovey Fishman, Richard Rudnicki, and Joanna Lynn Grama, in Deloitte Insights, Oct. 30, 2017. <https://dupress.deloitte.com/dup-us-en/industry/public-sector/protecting-classified-uncontrolled-information-higher-education.htm?d=us:2el:3pr:dup4321:awa:dup:103117>

<sup>6</sup> "Schools Must Adhere to Cybersecurity Regulations or Risk Losing Title IV Eligibility," by Duane Morris LLP, in Lexology, Sept. 4, 2017. <https://www.lexology.com/library/detail.aspx?g=3745d3af-b34c-4737-895a-120c9bbe4518>

## Advanced R&E Network

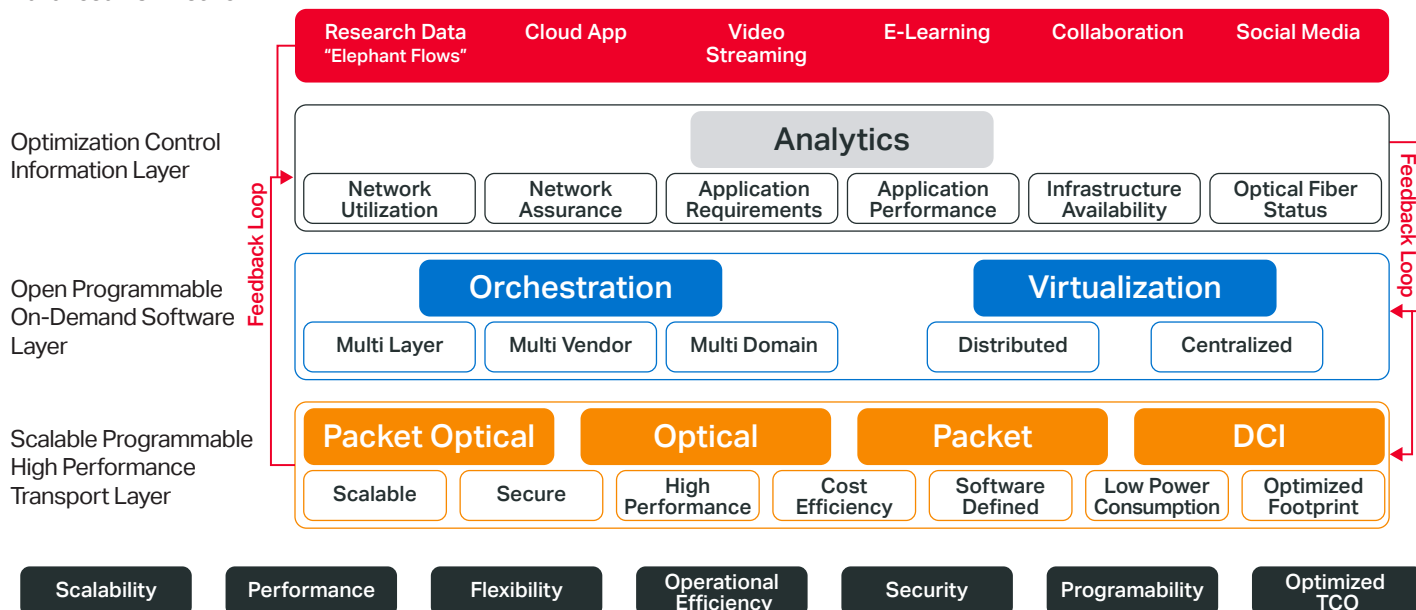


Figure 1. Example R&E network

Encryption deployed at the network level can ensure data center interconnections, stored content, and in-flight transmissions are secure at all times.

The 8700 is an efficient, compact solution, now with 70 percent more 1/10GbE, 300 percent more 40GbE, and 200 percent more 100GbE Ethernet connections, while requiring only half the energy of standard units—offering the power to protect an institution's bottom-line and the environment. It integrates seamlessly with Ciena's Blue Planet Software-Defined Networking (SDN) solution and offers zero-touch provisioning to expedite deployments.

Ciena's 3906mvi Service Virtualization Switch is designed to establish GbE connectivity at campuses and other locations at the edge of an R&E network. The solution is optimized for between one and six GbE deployments. It includes a pluggable x86 server module that hosts VNF applications, enabling institutions to implement VNF within building premises. The approach eliminates the need to buy hardware for each function at a location. VNF applications can include virtual routers, encryption, firewalls, optimization tools, and service monitoring, among others.

**Analytics to optimize and control the network:** Analytics enable R&E campus and network operators to understand whether their network topology is working effectively and how their network resources and applications are performing

across their systems. End-to-end analytics provided by Ciena's Blue Planet can be used to visualize and interpret trends to optimize traffic management and capacity planning. Forthcoming features include the capability to sense and predict conditions affecting service performance and respond automatically by deploying capacity or needed network functionalities. The analytics engine also provides feedback into the network to help build and strengthen network intelligence needed for programmable features and service automation.

### How to begin the network evolution

Think holistically, with a view of the future, when developing an R&E network evolution strategy:

- If the organization is a NREN, the technology roadmap likely defines the performance requirements needed to support its various user communities in the coming years. Make sure all upgrade projects from this point forward support that vision.
- If the organization is a college or university, consider the performance requirements needed to participate in collaborative research projects, facilitate access to big data sets, or support student, faculty, and staff access to cloud services and content delivery platforms. Determine the types of data that will be transmitted in the coming years and the network capabilities needed to support these combined needs.

- Create an upgrade path enabling the network to evolve gradually, at a pace aligning with the institution's strategic needs and budget.
- Rather than simply adding more routers to bolster capacity, which can add complexity to the network and lock the institution in with legacy approaches, consider a scalable, high-capacity packet-optical network with built-in Ethernet connectivity.
- Take advantage of virtualization and orchestration tools to reduce reliance on legacy hardware and provide opportunities to program and automate service provisioning and activation.
- Make sure the network protects stored and transmitted data in compliance with security regulations.
- Check to see what types of funding and cost-sharing opportunities are available from networking partners and state and federal organizations.
- Take strategic advantage of solutions to reduce power consumption. Sometimes it can be easier to find institutional funding for new solutions if the technology supports the organization's green objectives while also reducing operating costs.
- If the institution is looking at the latest technologies, make sure the solution is commercially available and proven in very demanding R&E network environments.

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