

University of New Hampshire (UNH) Cyberinfrastructure (CI) Plan

Executive Summary

UNH implemented its first 10-year CI Plan in 2008. Inspired in part by the 2007 NSF EPSCoR Cyberinfrastructure Workshop, which highlighted northern New England as the “black hole of connectivity”, and informed by and integrated with the vision and plans of the NH Governor’s Telecommunications Advisory Board (TAB), the State Director of Broadband Technology (NH Division of Economic Development), and the UNH Technology plan supporting our research, education, and business operations, the UNH CI plan embodies the goals and strategies needed to advance technological development at UNH and across New Hampshire (NH).

UNH 2008-2018 CI Plan Overarching Goals

- Connect UNH to the world-wide research community.
- Enhance campus connectivity to support research within UNH boundaries.
- Offer high speed connectivity for science and research to other NH institutions, including all University System of New Hampshire (USNH) campuses (UNH, UNH at Manchester, Keene State College, Plymouth State College, and Granite State College headquartered in Concord with educational facilities throughout NH).
- Develop the personnel at UNH needed to design, build, implement and maintain the latest technologies and tools to help researchers translate their needs efficiently and effectively.

UNH CI Plan Progress to Date

- 2008: USNH and the University of Maine System completed a fiber network construction project from Portland, ME to Cambridge, MA, upgrading a shared backhaul link to 10Gbps.
- 2010: UNH led the effort to construct 10Gbps fiber optic networks in all 10 NH counties, linking USNH and the Community College System of NH (CCSNH) on one network.
- 2011: With an Indefensible Right to Use (IRU) lease, UNH implemented a 12 fiber network from Manchester to Keene, NH, connecting Keene State College to UNH at 10Gbps.
- 2011: UNH Director of Strategic Technology Scott Valcourt was named an Extreme Science and Engineering Discovery Environment (XSEDE) Campus Champion for UNH.
- 2012: UNH Information Technology (IT) and Research Computing & Instrumentation (RCI) staff were trained to develop next-generation CI for database and network expansion.
- 2012: UNH IT established a parallel test IPv6 network to begin migrating the campus LAN.
- 2012: UNH IT students developed the first Shibboleth implementation to test federated authentication across UNH domains and those beyond the UNH boundary.

Goals/Strategies Remaining for 2013-2018

- 2013: IRU lease of 12 fibers from Manchester to Plymouth to Hanover, NH, linking Plymouth State University and Dartmouth College to UNH by August.
- 2013: Dark fiber paths with highly scalable networks for research and education, connecting resources and people across the Northeast by December.
- 2015: Emerging wireless network connectivity to all airspace in Durham.
- 2015: Enhanced campus connectivity to support large data transfer needs.
- 2016: Science DMZ and wireless network expansion across all communities in the USNH footprint.

Our CI Plan was created with the expectation that ten years might not be enough time to realize our goals. With opportunities seized and accomplishments realized in the first five years, we

significantly advanced our objectives. Our focus for the next five years is on advancing network connection expansion and network-connected research instruments to fully realize our vision.

Background

Technology is a key enabler of UNH's mission, goals, and operations. Rapid technology changes provide numerous options for technology and technology services. Increased use of mobile devices and technology, the rapid growth of digital content and the need to access new student markets and increase collaborations in teaching, research and sustainability motivated us. While barriers to technology adoption have been lowered, the complexities of integrating, securing and supporting technology have increased – all occurring in an environment of finite resources and increasing sensitivity to the impact of technology operations on budgets, human resources and energy consumption. In this environment, UNH recognized that investments in CI would yield great value to our campus, NH, and the region.

In 2007 in preparation for a UNH CI Plan, UNH began a focused investment in CI assets required to advance next-generation computing to support the UNH research/ education/ outreach/ engagement mission. We were inspired by the NSF report “Cyberinfrastructure Vision for 21st Century Discovery” goal to broaden access to state-of-the-art computing resources, focusing especially on institutions with less capability and communities where computational science is an emerging activity; and driven by the 2007 NSF EPSCoR Cyberinfrastructure Workshop, which highlighted northern New England as the “black hole of connectivity”, lacking advanced networking connectivity and other basic CI, putting NH researchers at a significant disadvantage by hindering access to national resources such as TeraGrid, large data sets, and data visualization tools.

After conducting an environmental scan and literature review, and consulting with the UNH community and state and regional leaders, UNH developed and implemented our first ten-year CI Plan in 2008. The UNH CI Plan is integrated with the NH CI plan, developed by the Governor's Telecommunications Advisory Board (TAB) and the State Director of Broadband Technology, whose goal is to assemble and construct fiber optic networks across the state for municipal and state government, transportation, public safety, healthcare, and education at all levels. The UNH CI Plan also integrates with “Atlantica 2015”, developed by Northeast CI Consortium (NECC) leaders who envisioned a regional investment that makes high speed fiber connectivity and CI resource sharing across NECC simple for non-technologists to access.

Prior to 2008, UNH was conducting its mission without access to scientific and technical resources that other EPSCoR jurisdictions had developed decades before. Our investments to date in CI have elevated UNH to be at the table with computational science institutions previously out of reach, positioning UNH as a participant in the next generation of scientific discovery. Today, through careful investment, thoughtful planning, and collaborative diligence, NH boasts dark fiber paths that offer highly scalable networks for research and education, connecting resources and people to advance future scholarship. CI is a key factor that propels our EPSCoR jurisdiction forward.

Initial Work

In 2008, USNH and the University of Maine System completed a fiber network construction project from Portland, ME to Cambridge, MA to upgrade the backhaul link shared by the two Systems to 10Gbps. By September 2013, existing funding from the NSF NH EPSCoR RII Track 2 grant (#EPS-0918033) will provide a 12-fiber IRU lease over the Big Green Panther segment

from Manchester to Plymouth to Hanover, NH, linking Plymouth State University and Dartmouth College to UNH. NIH COBRE funding (#3P20RR0187787-07S1) to NH provided a 12-fiber IRU lease from Manchester to Keene, connecting Keene State College to UNH at 10Gbps, and soon to connect to Dartmouth College for continuing NH NIH COBRE and INBRE work. The most recent major step to further the goal of statewide, next generation CI is a \$44.5m NTIA BTOP grant (#NT10BIX5570082) to UNH to assemble or construct high speed fiber optic networks in all 10 NH counties, linking CCSNH and USNH on one network called I-BEAM (Infrastructure to Broaden Educational Access and Mindshare). This network investment will establish dark fiber pathways and lit fiber solutions across the NH landscape at 10Gbps rates starting in July 2013. These projects, along with other strategic investments in backhaul networks in NH, will provide for the initial CI outlined by the TAB and the state Science and Technology plan developed by the NH EPSCoR Committee.

Leveraging

We envision that the UNH CI Plan will encompass as many of NH's research programs as possible, for all disciplines and institutional types. In 2011, Scott Valcourt, UNH Director of Strategic Technology, was named XSEDE Campus Champion for UNH. His involvement with the NH High Performance Computing (HPC) community helps UNH to achieve the contact points necessary to support new research program opportunities in HPC. E.g., while preparing the proposal for an NSF EPSCoR RII Track 1 award (#EPS-1101245) to NH in 2011, we recognized that Saint Anselm College (a private, Liberal Arts College in Manchester and grant participant) was unable to connect their science devices and data with research colleagues in NH or with NASA in Greenbelt, MD. Thus, we proposed and constructed a 24 strand fiber optic link across 3 miles from Goffstown to Manchester, using existing pathways, to increase Saint Anselm College's connection from 100Mbps to 10Gbps and possibly beyond for the next 20-year period. By leveraging existing funding and CI efforts from other grants, UNH's CI Plan is able to positively impact the work of all NH researchers, scientists, and educators.

Desktop CI Vision

We expect to significantly improve scientific engagement by capitalizing on the CI proposed to provide higher speed network access directly to more end-node users (at scientist's desktop). In 2009 the NTIA Public Telecommunications Facilities Program (#33-04-N10151) awarded funds for the Granite State Distance Learning Network (now CONNECT NH) to support high definition video conferencing connectivity to six sites in the northern and western areas of NH. The core infrastructure connecting NH's research and education community is mostly in place (or soon will be), and the campuses of the USNH and CCSNH are already engaged in leveraging CI upgrades of I-BEAM. In 2011, UNH received a USDA Rural Utilities Service (RUS) grant (#NH0712-A17) to launch a pilot program in telehealth services, enabling psychologists to reach patients north of Concord in rural communities using videoconferencing tools. Additional work in the NSF RII Track 1 grant is linking environmental sensors to data collection points at UNH and giving researchers access to real-time data that can be combined into multiple streams for unique correlation. Ultimately, UNH is seeking to provide researchers with the ability to access and control all of their required research instruments, whether they are in the laboratory on the other side of the wall or at an international research facility on the other side of the world.

Infrastructure

Data Centers

UNH has two primary data centers—the UNH-IT Data Center and the Research Computing & Instrumentation (RCI) Lenharth Data Center. Combined, these two facilities supply the majority

of computing services for the enterprise and research community, offering over 500 CPUs in native and virtual operation. Both data centers underwent an extensive study and redesign to offer hot and cold aisle configurations, reducing the need for extensive cooling and power consumption. The UNH-IT Data Center provides all financial services for all USNH campuses.

Network Capacity and Regional Connectivity

Several research centers and institutes at UNH, as well as a number research, education and outreach projects, require real-time, rapid access to large data sets, some local to UNH and some remote. USNH, though UNH, is connected to the Internet2 ION network via a 10Gbps dense wave-division multiplexing (DWDM) wave. UNH access to that ION connection is available via the Northern Crossroads (NoX), a peering point for all New England higher education institutions. NoX maintains three 10Gbps connections to Internet2 which are shared by the nearly 40 institutions linked at the NoX. With the upgrade of transport services from the NoX to UNH to 10Gbps, the amount of bandwidth is still limited to 2.5Gbps and prevents a number of projects from being competitively developed and proposed without addressing how this limit will not adversely impact those projects.

Internet2, through the NTIA BTOP grant to US UCAN, is upgrading its core network from 10Gbps to 100Gbps. The NoX is expected to take advantage of that upgrade. If this occurs, UNH will be positioned to consider upgrading the transport from one 10Gbps wave to multiple waves to capture more transport for specific research projects using our DYNES instrument. Rather than waiting for the WAN pathways to continue to grow, UNH is planning a LAN upgrade to allow larger science data transfers to move over existing network pathways.

Compute and Storage Capacity

Storage of large research data sets is becoming common in most research projects as the need for data verification and duplication of results is required. Hardware and systems necessary to support these project needs are in demand. Individual and groups of researchers are not equipped to maintain this complex and growing collection of systems, especially with the power, cooling and CI expertise required. These needs make it more effective for UNH to invest in professional staff to manage such systems for researchers and their collaborators.

UNH will sustain and grow the compute, storage and network capacity to meet the demand from research projects. Storage needs are expected to continue to grow as more data points are required to advance multiple research disciplines. This growth is supported with basic UNH funding augmented by grant funds for individual projects. In part, management of this storage is by the UNH Library institutional repository, making data available on and off the UNH campus.

Implementation of IPv6 and InCommon Federation

The infrastructure to support IPv6 protocols at UNH has been in place since the IPng Working Group was proposed in the Internet Engineering Task Force. The UNH-IOL (InterOperability Laboratory) established a collaborative project in 2003, called Moonv6, in conjunction with the North American IPv6 Task Force and the Joint Interoperability Test Command. The UNH-IOL had overall responsibility for organizing the Moonv6 event, the largest permanently deployed multi-vendor, native IPv6 network in the world from 2003-08. All of the major players developing IPv6 products and services to be rolled out across industries come to the UNH-IOL first. UNH-IOL's initial involvement resulted in their leading the U.S. Government's deployment of IPv6 natively across the country in government installations. Involvement by UNH students has enabled the UNH IT community to garner extensive, real world, IPv6 deployment experience.

In addition to the UNH-IOL USGv6 IPv6 native network, the UNH campus network has a working native IPv6 network for production systems. Critical services (e.g. routing and name - DNS), are resident on our IPv6 test network. A current IT project is tasked with migrating some electronic mailing services and web services to a native IPv6 stack. The core campus network is capable of running IPv6, and in Summer 2013, UNH IT will target selected UNH research and operations units to consider the transition from native IPv4 to IPv6. The recent developments of moving more services and servers to our core Data Center and the deployment of more private IP networks has brought some relief in the pressure on public IP addresses. However, as a result of UNH's intimate involvement in the IPv6 community, not only are we preparing for the near-term day when our entire network operates a native IPv6 network, our key staff members leading the migration efforts are presenting to other institutions, both public and private, on the process and merits of making the transition to native IPv6 sooner rather than later.

UNH maintains a custom-built identity management system with LDAP backend, serving UNH and Granite State College students. This system provides a single sign-on solution for many campus-based systems for UNH students, faculty, staff, alumni and various "associated" users. The NECC research work in the NSF EPSCoR RII Track 2 grant made evident the need to authenticate across institution domains. (Many researchers needing to access devices outside the UNH campus network needed to maintain independent login and password combinations to accomplish their research.) In 2012, UNH IT started a project to deploy Shibboleth between research devices on the UNH campus. This project continues in 2013, with the added assignment to implement the InCommon Federation configurations. UNH is an InCommon Federation member, and will be fully deployed by the summer of 2013, with the goal of advancing certification to make remote resources access seamless for researchers, as well as to make accessing UNH resources easier for off-campus researchers.

Long Range CI Goals

Additional CI investments over the next five-year period include preparations necessary to sustain and transition conceptual tools into regular production and use by educators and students across NH. UNH Research Computing and Instrumentation (RCI), along with the UNH IT Department and the UNH Library, are making CI investments in storage technology that will both preserve data as well as make data resources available for synthesis and learning. The Library will be involved in efforts to manage and share data sets produced by UNH researchers. It will serve as a site for registering datasets in the institutional repository, which includes providing a deposit mechanism for data that will be stored and secured in a central location at UNH and backed-up off-site. This service will include providing metadata records and access information for all datasets and download links for data that has been freely shared by researchers. A critical requirement for effective e-science, NH's CI investment is focused on building the tools, infrastructure, personnel and experience necessary to remain competitive in pursuing scientific research critically needed in our world.