

University of Cincinnati Cyberinfrastructure (CI) Plan 2017-2021

EXECUTIVE SUMMARY

The University of Cincinnati has a robust enterprise network that provides network services for greater than 45,000 faculty, staff, and students across several campuses, however, the demand for shared computing power, ever-increasing data volumes, and higher network capacities are all on exponential growth paths. To address the changing needs of the academic and research communities, this plan outlines a comprehensive cyber-infrastructure framework that has the potential to revolutionize science, engineering, and other research disciplines across the University of Cincinnati.

At the core of the plan is the expansion of a friction-free campus networking architecture that will facilitate the growth of UC's Research Ecosystem. Key goals include:

- **Expand UCScienceNet (UCSN)**, a 100Gb Science DMZ following the model of ESnet and incorporating best practices and lessons learned for monitoring and tuning network performance to provide the high throughput required to achieve STEM research goals.
- **Upgrade the university's Data Center** and implement a Data Center Infrastructure Management (DCIM) system, to provide high-speed data transfers between enterprise storage and the university's core systems and bring state-of-the-art management and monitoring to the data center.
- **Expand High-Performance Compute (HPC) resources**, leveraging the existing baseline HPC infrastructure and expand capacity to the entire campus research community by partnering with the Ohio Supercomputer Center (OSC) for cloud resources. Include a scale-out NAS system which will enhance our overall storage strategy.
- **Continue IPv6 Implementation** and transition plans in conjunction with academic sponsorship.
- **Become an InCommon "Silver Assurance" Identity Provider**, to provide federated login access to online services that require a greater confidence in identity.
- **Expand IT Resources & Services and Education for Researchers**, collaborating with computational researchers to become an integral part of the research life cycle by initially focusing on the needs of the Provost and Office of Research's interdisciplinary research clusters in data analytics, water, and cancer research.

The University of Cincinnati is committed to implementing this Cyberinfrastructure Plan to fully embrace the mission and vision of enabling transformative academic and research initiatives.

BACKGROUND

In 2013, under new leadership, the UC Office of Information Technology (UCIT) developed a new IT@UC Strategic Plan in order to better align with the goals of the university's "Creating Our Third Century" strategic plan, and position itself not only as a provider for central IT services, but as a facilitator for the ever evolving needs of the university's academic IT and research community. Supported by the university-wide IT governance structure, the IT@UC Strategic Plan establishes the core values of partnership, collaboration, and communication to drive the transformation, and focuses on three high-level strategies and priority investments for IT across the university:

- **Transformative eLearning** - Drive adoption of 21st Century learning through the discovery, development, and deployment of a standardized eLearning ecosystem.
- **Research and Knowledge Creation** – Identify and enable a base of resources to support research across all disciplines, including high performance computing and data repositories, collaboration tools and education.
- **Shared Services and Shared Architecture** - Build and develop high-performance shared services and intentional interdependence between IT units to improve efficiency and cost-effectiveness.

The focus of the IT@UC Strategic Plan not only embraces but empowers the university's Third Century goals, which makes a commitment to building the university's resource base and leveraging research.

INFRASTRUCTURE

Current Network

In 2004, the UC Office of Information Technology (UCIT) implemented a network architecture with the goal to provide a resilient, stable network to the university community. The network design consists of redundant core routers each connected via 2Gb fiber uplinks to a pair of redundant distribution layer switches at one of five distributed node rooms. The closet switches connect back to the distribution switches via dual 1Gb fiber uplinks providing redundancy to the access layer switches. End users connect via a 10/100Mb Fast Ethernet connection and share the 1Gb uplink back to the distribution layer switches. This shared uplink significantly restricts research capabilities of transferring large data sets.

Internet connectivity is provided by a Dense Wavelength Division Multiplexing (DWDM) metropolitan optical ring also known as the Cincinnati Educational Research Fiberloop (CERF) ring. This ring provides a single shared 10Gb connection to OARnet, and Internet2. The CERF ring, which is managed by UCIT, also provides Internet connectivity for Cincinnati Children's Hospital Medical Center, Xavier University, and Cincinnati State Technical and Community College on separate 1Gb interfaces. The CERF ring is optimized to prevent any loss of service in the event of a fiber cut.

As previously mentioned, UC utilizes a 10Gb network interface to connect to OARnet through the CERF ring. The 10Gb pipe is a connection shared by the university community for commodity Internet along with any research data traffic. This bottleneck is prohibitive for research data to be transferred between peer institutions.

To remove the bottleneck, UCIT increased the hardware capability of the CERF ring. The enhanced capability enables researcher access to a 100Gb pipe connecting the university's main campus to OARnet's 100Gb Internet 2 backbone.

UCScienceNet (UCSN)

UCScienceNet (UCSN), a 100Gb Science DMZ, modeled after ESnet, incorporates PerfSONAR for monitoring and tuning network performance, enables software-defined networking and OpenFlow capabilities, and provides high-throughput capacity required to achieve STEM research goals and enable multiple disparate high-speed big data transfers across a comprehensive, integrated, cyberinfrastructure.

UCSN consists of hardware deployed specifically for aggregation of high-speed networking. This hardware has characteristics of high-throughput with minimal latency to ensure rapid delivery of large scientific data sets. The hardware employs bandwidth scalable from 40Gb depending on research requirements and 100Gb delivery from the aggregation layer outward to Internet 2 and National Research and Education Networks (NREN).

UCSN, servicing five research intensive locations, provides a friction-free network, creating a true Science DMZ to address the limitations of the existing commodity network. UCIT in partnership with the Office of Research, provided funding to add additional endpoints to UCSN expanding benefits of a high-speed network to researchers not connected during the initial deployment of UCSN.

This expansion will require the deployment of Cisco Nexus 3000 switches deployed in strategic research areas. The Nexus 3000 will provide scalable 40Gb back to the research core. It will also provide 10Gb to the high performance computing equipment, which today is limited to 10/100Mb.

Expanding the friction-free campus networking architecture, and eliminating campus and building level network infrastructure constraints, will enable formation of a Research Ecosystem encouraging diverse, multidisciplinary collaboration and partnerships to address complex Grand Challenge problems.

PerfSONAR

The increased interest in quantifying high-speed bandwidth available for research and education networks has led to an initiative to deploy network monitoring tools at key points of the network. We have incorporated a perfSONAR framework, to gather throughput statistics that are relevant to the use cases of researchers on UCSN and produce usability studies from applied use of remote big data transfers.

Data Center

The UC Data Center, managed by UCIT Enterprise Shared Services, provides 6,700 square feet of space for enterprise shared services, research systems, and UC co-locators. A Data Center Infrastructure Management (DCIM) system has been added, bringing state-of-the-art management and monitoring to the data center. The data center's internal network provides high-speed data transfers between enterprise storage and the university's core systems.

In partnership with members of the UC community, UCIT is working to define an overall strategy for improved data center services. Current services include managed physical and virtual servers, data center hosting for co-locators, and hosting for applications and web services.

UC has entered into a partnership with the State of Ohio and established a secondary data center at the State of Ohio Computer Center (SOCC) in Columbus. Our SOCC data center, online since June 2015, provides real-time synchronization with data storage systems in our primary data center, replication of data backups, and both active-active and active-standby hardware for critical business continuity and disaster recovery scenarios.

Storage Capacity

The UCIT Enterprise Shared Services division offers a variety of compute and storage resources to the UC community. Compute services include managed physical and virtual servers, data center hosting for co-locators, and hosting for applications and web services.

Service administrators work with requestors to develop solutions to optimize the use of resources based on project requirements.

Enterprise storage includes 660TB of production storage online, with various performance and backup levels offered based on the needs of the individual, group, or application. To expand and enhance our overall storage strategy, UCIT recently added a scale-out NAS system. By consolidating disparate/distributed storage systems into a robust, centrally-managed service, this system will drive down the cost of online storage for the entire campus community, while also increasing reliability, availability, and fault tolerance. The system is scalable to multiple petabytes of capacity and can easily be expanded to meet increasing storage demands as they arise.

Compute Capacity

UCIT's Research and Development department leads the IT Governance's Research and Development topical committee which is charged with identifying, prioritizing and recommending computational resources for researchers. The existing HPC clusters support several engineering departments. In order to expand these resources to the entire campus the committee is evaluating the Ohio Supercomputer Center's new cloud "condo" model, whereby campus researchers will include additional capacity for the HPC cluster in their project specifications and grant requests. This approach will leverage the baseline HPC infrastructure to expand the capacity of this service, benefiting the entire campus research community.

Currently 2,390 research cores and 114TB of storage exist in four HPC clusters that are located in research centers and managed by distributed IT. These clusters will, along with the cloud services at OSC, provide compute power for all researchers.

IPv6 Implementation

The university has a /48 IPv6 assignment from ARIN and has successfully deployed a pilot IPv6 network in conjunction with academic sponsorship. Our perimeter firewall and infrastructure support services, such as DNS and DHCP, are fully capable of IPv6 support as determined from the IPv6 pilot project. The next phase of IPv6 deployment will be on strategic internet-facing web servers positioned in our data center. This IPv6 build out will be in coordination with our Business Application Services team.

BCP 38

BCP 38 or RFC2827 is an internet best practice of employing Network Ingress Filtering to defeat Distributed Denial of Service (DDoS) attacks which employ IP Source Address Spoofing. The university has been an early adopter of Network Ingress Filtering; access lists are deployed on all internal routers allowing only known-source IP addresses from local subnets. Perimeter routers are configured with access lists to deny any incoming packets with spoofed source IP addresses that mimic our class B public IP range.

The following are abbreviated web page results from running the Spoofer Project's Spoofer tool from an internal university computer:

Egress Filtering Depth: The "tracefilter" test found your host unable to spoof valid, non-adjacent source addresses through even the first IP hop.

Received (Adjacent Netblock Testing): Your host can spoof 0 neighboring addresses (within your /32 prefix). Spoofed probe packets appear to be blocked by your local NAT rather than being rewritten with a public source address. NAT is blocking spoofed traffic rather than rewriting the source address.

Sustainability

UCIT currently engages Cisco Smartnet for maintenance on all of our core, distribution, and optical equipment. We utilize Aruba maintenance for all of our wireless controllers and access points. All network operations and engineering services are provided by the Network Operations Center.

In addition, any hardware that is scheduled to reach an End of Support status will be incorporated into equipment refresh cycles outlined in our 5-year plan.

IDENTITY & ACCESS MANAGEMENT

The University of Cincinnati is already an InCommon Identity Provider, providing federated access to 77 service providers (30 organizations, 41 higher educational, 6 government). In cooperation with our Office of Information Security, the university is actively pursuing InCommon "Silver Assurance" status to provide federated login access to online services that require a greater confidence in identity.

RESOURCES & SERVICES

In June 2014, the UC Office of Information Technology created a dedicated department to proactively support the IT needs of university researchers. The UCIT Research & Development office connects researchers with technical expertise, resources, training, and state-of-the-art IT services to support individual and multidisciplinary IT-enabled research projects. As an example, the Center for Simulations & Virtual Environments Research (UCSIM) is providing technical and hardware expertise, programming, and modeling support for virtual and augmented reality research collaborations with the Cincinnati Children's Hospital Medical Center TEAM VR Lab, the Air Force Research Lab Discovery Center, and the UC Center for Cognition, Action, and Perception. Moving forward, the department will continue to grow its resource base and extend services to include expertise in data analytics, high performance computing, and data visualization, becoming completely integrated into the STEM research life cycle. The department will continue to collaborate with local, regional and national experts in order to provide the level of research computing services necessary at a large, research intensive university. The R&D department director chairs the IT Governance Research and Development committee with representatives from all major research clusters.

INTEGRATION WITH STATE, NATIONAL, & INTERNATIONAL PARTNERS

Researchers across the institution leverage many big data research partners which necessitate a need for data transfer requiring high bandwidth capabilities. Among these are the Ohio Supercomputer Center, NSF National Snow and Ice Data Center, Nasa (Goddard, Ames, JPL), Alaska SAR Facility, USGS EROS Data Center, Oak Ridge National Laboratories, NCSA, XSEDE Supercomputers, NIST, CERN, Fermilab and numerous other peer institutions.

The UC Office of Information Technology staff is closely integrated with OARnet, Internet2, industry partners and other research intensive universities staff to share best practices and resources to accelerate the national research and discovery efforts.