

# Toward a Coordinated Cyberinfrastructure for the University of Illinois at Urbana–Champaign (Illinois) 2022

## Introduction

Illinois is working to further develop an innovative and coordinated cyberinfrastructure (CI) to enhance the productivity of faculty and staff, increase learning opportunities for students, and provide all members of the institution with new capabilities that facilitate discovery and enable transformational science, engineering and innovative educational programs. These advanced digital services must also evolve so as to integrate with the emerging global CI ecosystem. Illinois continues to develop and update an extensible CI *architecture* that facilitates integration and supports the continuous addition of new capabilities. The environment is complemented by operations, support, and education activities co-designed to ensure usability, reliability, capability, performance, and security leading to enhanced productivity and research impact. These efforts *accelerate the advancement of knowledge discovery across a broad range of research domains by reducing barriers to the use of cyberinfrastructure, enabling diverse collaborations, and expanding access to a wide range of resources and services.*

In 2018, the University finalized “The Next 150”, its 2018-2023 Strategic Plan<sup>1</sup>. This document set forth a vision—*to be the pre-eminent public research university with a land-grant mission and global impact.* The need for campus cyberinfrastructure to support our vision is featured prominently in this strategic plan. In response to the articulated technology needs of campus faculty and researchers, a Deputy CIO of Research position was created and charged with establishing a continually evolving collection of services and resources through collaborations and partnerships. These documents and actions demonstrate not only the recognized importance of campus cyberinfrastructure, but the University’s commitment to develop and support that cyberinfrastructure.

## Creating a Research Technology Environment to Enable Cutting Edge Research

The DCIO for Research is bringing cohesion to a variety of efforts that have been underway on the Illinois campus over the past several years and, at their core, have the intent of satisfying the needs of researchers by addressing some aspect or aspects of the overall cyberinfrastructure. Significant local investments to provide resources and services to support the academic mission of our campus have already been made or are in the process of being made.

## Facilities

Data Center Shared Services (DCSS)<sup>2</sup> is a campus initiative to consolidate campus server rooms and data centers. DCSS provides standard hosting services in three different data centers (one off-campus), at no charge to campus users. For large-scale research systems, the National Center for Supercomputing Application’s (NCSA)<sup>3</sup> National Petascale Computing Facility<sup>4</sup>, an 88,000-square-foot facility, is available.

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<sup>1</sup> <http://strategicplan.illinois.edu/>

<sup>2</sup> <http://datacenter.illinois.edu/>

<sup>3</sup> <http://www.ncsa.illinois.edu/>

<sup>4</sup> <http://www.ncsa.illinois.edu/expertise/facilities/national-petascale-computing-facility/>

## Networking

The Campus Advanced Research Network Environment (CARNE)<sup>5</sup> was established as a section of the campus network designed to provide unrestricted high-speed access to off-campus locations for specific research purposes—a Science DMZ<sup>6</sup>. Additional information about CARNE is below.

The campus is also launching a Next Generation Infrastructure (NGI) initiative to integrate and automate actions to manage the user experience more fully. Native capabilities integrated into the infrastructure ecosystem will enable and enrich the faculty, researcher, student, and staff experience. A future where focus shifts from reactive operations to preemptive infrastructure operations is envisioned with data used to continuously optimize academic and research outcomes.

## Data Support

Illinois has launched a Research Data Service (RDS)<sup>7</sup> to provide full data life cycle support resources and services. RDS provides researchers, colleges, and institutes with access to the expertise, tools, and infrastructure necessary to manage their research data for access and to provide strong, long-term stewardship for research data. Headquartered in the University Library, the Research Data Service is a partnership between the Office of the Vice Chancellor for Research, the Library, Technology Services (the central campus IT service provider)<sup>8</sup> and NCSA.

## Computation

Substantial investments have been made in providing computing resources, including co-investment with faculty in the Illinois Campus Cluster Program (ICCP)<sup>9</sup> to meet the needs for research computing. Individuals, groups, and campus units can invest in compute and storage resources on the campuswide research computing resource.

In 2022, Illinois launched the Delta system<sup>10</sup>, operated by NCSA and funded through the National Science Foundation's Innovative High-performance Computing program. Delta will be the most performant GPU computing resource in NSF's portfolio and will be an essential computing resource nationally and among Illinois researchers.

## Storage

The ICCP file system offers scalable storage from 1 terabyte up to many petabytes available in dedicated project file sets available across a wide variety of protocols. The ICCP also offers a Disaster Recovery (DR) service that allows users to purchase the capability of daily data backups to an off-site/off-campus location.

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<sup>5</sup> <https://answers.uillinois.edu/illinois/page.php?id=72823>

<sup>6</sup> <http://fasterdata.es.net/science-dmz/>

<sup>7</sup> <http://researchdataservice.illinois.edu/>

<sup>8</sup> <http://www.techservices.illinois.edu/>

<sup>9</sup> <https://campuscluster.illinois.edu/>

<sup>10</sup> <https://www.ncsa.illinois.edu/research/project-highlights/delta/>

## Identity and Access Management

The Urbana campus has a dedicated Identity and Access Management team that is focused on providing contemporary solutions for identity management, authentication, authorization, and federation to campus customers. The campus has integrated password management with the university system, meaning campus affiliates can use credentials across the system where appropriate. The campus fully supports Shibboleth as its central authentication service, including an option for integrated multifactor authentication. The campus releases the Research and Scholarship attributes to all service providers in InCommon and EduGAIN to support ease of use and rapid onboarding for external Service Providers. Finally, the campus Shibboleth Identity Provider is published to InCommon and EduGAIN to allow for a broad range of national and international research collaborations.

## Training

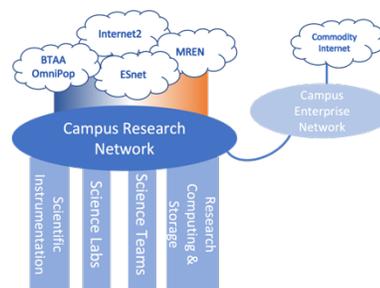
Computational Science and Engineering (CSE) is contributing to the research technology ecosystem by offering hands-on, interactive tutorials<sup>11</sup> on a range of topics including use of specific software packages (e.g. COMSOL, Fluent, MATLAB) to general topic introductions (e.g. Big Data), to how to use campus resources such as the Illinois Campus Cluster. Software Carpentry<sup>12</sup> is another core competency within the research technology ecosystem and Illinois has certified trainers across many disciplines and domains.

## Campus Advanced Research Network Environment (CARNE)

CARNE is a Science DMZ strategy to enable high-performance, data-intensive research with a friction-free network gateway to both local and wide area research resources. It is a cooperative effort between Technology Services and NCSA in support of campus research.

All campus buildings are redundantly connected (2x1Gbps or 2x10Gbps) to the campus enterprise network. When possible, the enterprise network is leveraged for CARNE connections through traffic segregation via Virtual Routing and Forwarding (VRF) instances. For campus locations with high-bandwidth demand, a physically separate CARNE path is provisioned.

All campus research connections aggregate to CARNE border routers and traverse a passive, non-invasive security perimeter. Wide area research collaborations are accessible via connections to Internet2 Advanced Layer2 Services<sup>13</sup>, Big10 Academic Alliance (BTAA) OmniPoP,<sup>14</sup> ESnet,<sup>15</sup> and MREN.<sup>16</sup>



<sup>11</sup> <https://cse.illinois.edu/cse-training/>

<sup>12</sup> <https://software-carpentry.org/>

<sup>13</sup> <http://noc.net.internet2.edu/i2network/advanced-layer-2-service.html>

<sup>14</sup> <http://www.btaa.org/projects/technology/omnipop/introduction>

<sup>15</sup> <https://www.es.net/>

<sup>16</sup> <http://mren.org/>

## Access with IPv6

Since 2009, the University networks have been fully IPv6 enabled. Since becoming fully IPv6 compliant, the engineering emphasis has shifted from network configuration to service adoption.

## Wide Area Integration Strategy

CARNE enables research collaborations through multiple 10Gbps and a 100Gbps connections to the wide area research network fabric, including regional connectors such as the BTAA OmniPOP and MREN, and to national fabrics such as ESnet and Internet2.

Network connector consortiums provide a forum to develop and deploy tools, such as PerfSonar, for network path evaluation. End-to-end path optimization is essential for research collaborations to fully benefit from the underlying cyberinfrastructure.

## Wide Area Security Strategy

A “security in layers” approach has been adopted for both the enterprise and CARNE networks. On the University-operated wide area network, BCP38 best practices for ingress filtering of malicious traffic, such as bogons and IP source address spoofing, eliminates unnecessary network traffic from ever reaching campus networks. At the CARNE border, optical taps are used to feed a Zeek Network Security Monitor<sup>17</sup> cluster. Malicious traffic is dropped via non-latency inducing network control mechanisms.

## InCommon Participation

The University of Illinois at Urbana-Champaign is a member in good standing of the InCommon Federation, and participates as an InCommon Identity Provider, releasing the R&S attribute bundle to all R&S service providers. This allows other InCommon participants to use Illinois identities, authentications, and attribute sharing when providing services across institutions. Illinois cyberinfrastructure components can similarly provide services to federated identities from other InCommon participants.

The University of Illinois at Urbana-Champaign is also an investing member of the Trust and Identity in Education and Research (TIER) initiative within Internet2. The university system project is aligned with the architecture, interoperability, and goals of the TIER initiative for the Urbana campus.

## Governance of a Comprehensive Cyberinfrastructure

The Research IT team (RIT), instantiated in 2015, served as the impetus for a campuswide research technology ecosystem, comprised of numerous partners from across campus, that is accountable to the Office of the CIO and to the Office of the Vice Chancellor for Research & Innovation. On behalf of the ecosystem, RIT will be the proponent of both projects that it will lead and of projects that it coordinates on behalf of other campus units. Further, RIT will provide a means of effectively and proactively coordinating efforts to tap into state and federal sources of funds to move our campus forward in providing a unified and coherent digital research ecosystem. RIT will build upon the efforts of the past several years in establishing campus-wide services such as the CARNE Science

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<sup>17</sup> <https://zeek.org/>

DMZ, the Illinois Campus Cluster Program, and the Research Data Service as initial steps in creating a research support environment encompassing the much broader needs of our campus research community providing the resources and services along with the critical support necessary to enable our researchers to excel. RIT, along with all the research technology ecosystem partners, works with faculty, researchers, and technology professionals to support the research needs and technology development efforts across the campus through leadership, oversight and collaboration as appropriate. These efforts are complemented by the IT Council, a group of high-level IT directors representing all areas of campus, which coordinates activities between the operators of the various research CI services and resources.

### **A New Cyberinfrastructure Master Plan for Illinois**

As described in this plan, substantial effort and funds are being expended by Illinois to provide the CI needed by its research community. All activities planned within the research technology ecosystem have been informed by data collected during the Year of Cyberinfrastructure<sup>18</sup>, an effort to highlight through faculty focus groups the use of CI in support of research and education across all disciplines and to develop a master plan (analogous to a facilities master plan) to guide the continued development and evolution of our CI environment. This effort was jointly sponsored by the Vice Chancellor for Research and Chief Information Officer.

The new CI Master Plan, once completed, will provide more cohesive guidance for the campus CI investments. It will become a living document fostered by a governance process that campus has already established, one used to guide the already substantial and still growing recurring investment that campus makes in CI infrastructure.

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<sup>18</sup> <http://hdl.handle.net/2142/88444>