Research Cyberinfrastructure Resources
An Overview of MU’s Research Facilities and Assets

Digital Humanities

The Digital Humanities Commons @ The Allen Institute and the Proposed Graduate Certificate in Digital Humanities
The Digital Humanities Commons @ The Allen Institute (DHC) is located in London Hall, on the corner of E. Stewart Road and Fifth Street. The DHC offers a dedicated space and technical support for a unique laboratory that assists MU arts and humanities faculty members and senior graduate students with digital research projects. The DHC is a partnership between MU’s School of Information Science & Learning Technologies and Mizzou Advantage. Learn more about the new Graduate Certificate in Digital Humanities, or join the DH Listserv at https://po.missouri.edu/cgi-bin/wa?A0=DIGHUMANITIES-L. For more information, contact Director, Twyla Gibson (gibsontg@missouri.edu) or Associate Director, Anne Barker (barkera@missouri.edu).

Digitization Services at MU Libraries

Digitization Services at MU Libraries
MU Library offers digitization services for faculty who would like material to be digitized for use in courses or research. Services include scanning books, maps, and images up to 23 x 33 inches and transparencies and negatives. Digital facsimiles will be added to the MU Digital Library Collection. Some restrictions apply. For more information, contact mulibrariesdig@missouri.edu.

Usability

Adaptive Computing Technology (ACT) Center
The ACT Center, a department within the Division of Information Technology, provides assistance to MU faculty, staff, and students with innovative technologies that may be needed during a career or education. The ACT Center strives to assist the MU community in creating universally designed environments. Services include adaptive assessments, adaptive technology training, electronic text, web accessibility, and workstation analysis. For more information call (573) 884-2828 or visit actcenter.missouri.edu.

Information Experience (IE) Lab
Located in MU’s School of Information Science & Learning Technologies, the IE Lab conducts research and evaluates technologies for ease of use. The IE Lab is a university-based usability lab that provides services to companies and organizations. Since the IE Lab is used as a teaching and research facility, the pricing is very competitive, and research guides the delivery of services. IE Lab services are available on the MU campus or at any client-selected location. Services include: expert evaluation by IE Lab staff to assess compliance of a website or software application with accepted usability standards; user interviews with current or potential users in focus group or individual settings; and user observations collecting computer interface data. Learn more at ielab.missouri.edu.
Visualization

iLab – Immersive Visualization Lab
The iLab is a virtual reality facility that supports stereoscopic 3-dimensional (3-D) visualization. The iLab is a lower-cost alternative to virtual reality systems like CAVE using readily available hardware components, familiar desktop computing environment, and affordably priced virtual reality authoring tools. Software resources in the iLab include:

- Advanced CAD and animation tools (Rhino3D, Autodesk 3D Studio Max, Maya, Softimage, Mudbox, Motion Builder)
- Game development tools like Unity
- Virtual reality authoring tools (EON Professional and iCatcher)
- 3-D video editing and post-production (Sony Vegas Pro, PFDepth, PFTrack, Nuke, Ocula & Mari) software
- Behavioral simulation (MassivePrime) software

The iLab also has an 18-camera Optitrack system and a pair of 5DT data gloves for motion capture. The lab also has a variety of 3-D displays ranging from 18 ft. by 6 ft. rear-projected display, zSpace display, 3-D TV monitors, Oculus Rift, and augmented reality glasses. In addition to 3-D simulations, the lab has capability for capturing and analyzing human-computer interaction and user-experience/usability data. The iLab offers an immersive virtual reality environment for teaching and fosters innovative research across disciplines. Learn more at arch.missouri.edu/ilab/index.html.

Survey and Collaboration Tools

ORCID
ORCID provides a persistent digital identifier that distinguishes you from every other researcher. Integration is key in research workflows, such as manuscript and grant submission. ORCID supports automated linkages between you and your professional activities - ensuring that your work is recognized. Your ORCID ID allows you to easily and uniquely attach your identity to research objects such as datasets, equipment, articles, media stories, citations, experiments, patents, etc.

Qualtrics
Qualtrics is a web-based tool for building surveys. MU has a campus site license that allows faculty, staff, and students to use it for surveys by simply logging in with a MU username and password. Currently there is no charge for using Qualtrics (although there may be in the future). Qualtrics meets the security requirements associated with gathering data classified as Restricted (DC Level 3) (infosec.missouri.edu/classification/dcl3.html). Request an account by emailing mudoits falsehoods@missouri.edu. Training and support is available from Qualtrics at qualtrics.com/university/researchsuite and qualtrics.com/research-suite/building-surveys.

Mobile Videoconferencing
MOREnet’s Mobile Videoconferencing service is an HD-quality personal telepresence system that can link room systems, desktops, and mobile endpoints over ordinary IP networks. It is a software-based solution powered by Vidyo that provides a telepresence experience on desktops, laptops, and personal devices, transforming almost any device into an HD-quality videoconferencing endpoint and providing a personal, customizable experience to each user. Learn more at more.net/services/mobile-videoconferencing.

Lync 2013
Closely integrated with the Microsoft Office system, Lync 2013 offers streamlined and persistent communications across platforms and mobile devices. The tight integration provides presence awareness, indicating a person’s availability based on computer activity and Outlook calendar data. Lync 2013 features software-powered voice capabilities, enterprise-class instant messaging (IM), and peer-to-peer audio- and videoconferencing. Users can connect and collaborate from any location using an Internet connection. Learn more at doit.missouri.edu/services/conferencing/lync.
Information Security, Authorization, and Access

Information Security
By University policy, the MU CIO has overall responsibility for information security across MU, including the MU health care system. Existing policies, such as the data classification system and security standards, define how information and data are to be protected - regardless of who manages or controls the data. However, it is important to note that valuable research data, often representing years of effort, can have a low security classification. Protecting these data is vitally important to supporting high-quality research at MU. The Division of IT has a number of technology resources and security experts to ensure that research and other data are adequately secured, whether access is local or remote. IT staff are trained and certified to use a variety of tools to secure and validate the status of the network, servers, databases, and applications. Through our participation in federated identity management, standard authentication and authorization mechanisms can be implemented and supported. Learn more at doit.missouri.edu/services/infosec.

Shibboleth
Shibboleth allows single sign-on access to other data systems within their established networking federation, while protecting each institution and user’s privacy and security. Federated identity allows for information about users in one security domain to be provided to other trusted organizations within a federation. MU’s involvement in the Great Plains Network (GPN) has resulted in our use of Shibboleth to provide authentication services that enable single sign-on capability. Learn more at shibboleth.net.

InCommon
The InCommon Federation administers and enables federated identity management servers throughout the higher-education community. This federation is sponsored by Internet2 and facilitates the ability to provide identity management authentication to more than 6 million individuals throughout the nation’s educational institutions. InCommon serves as the cornerstone for joint projects collaborative efforts, and provides access to resources such as the NSF’s Fastlane, NASA’s Nspires, and Grants.gov without the enormous overhead of maintaining separate identity management systems. Learn more at www.incommon.org.

eduroam
eduroam (education roaming) is the secure, world-wide roaming access service developed for the international research and education community. As part of the eduroam community, MU faculty, staff, and students can use their MU credentials while traveling to get Wi-Fi access on eduroam-affiliated campuses (eduroam includes many U.S. and international institutions); visitors from affiliated campuses may use the wireless eduroam network while visiting MU. Note: access must be set up prior to travel - call Tech Support at 573.882.5000 to get set up prior to your trip. Tech Support can also assist if help is needed while travelling. Learn more at www.eduroam.org or doit.missouri.edu/services/internet-network/eduroam.

Digital Repositories, Data Storage, and Data Transfer

MOspace
MOspace is the institutional repository for the four-campus University System. MOspace is a permanent digital storehouse of research and knowledge, focusing on works created by those connected with the University of Missouri. It is a place where faculty, staff, and students can store their intellectual output that requires a permanent URL. MOspace uses DSpace, an open source application developed at MIT, providing permanent URLs for documents and research data sets deposited through it to the MOspace server. MOspace is a joint initiative of MU Libraries, the Division of Information Technology, and the University of Missouri Library Systems. Learn more at libraryguides.missouri.edu/MOspace.

Kaltura
Kaltura is a video/audio streaming, recording, and encoding service which is accessible through courses on Blackboard Learn. Learn more at courses.missouri.edu.
Data Storage
Two options exist for centrally administered data storage as well as departmental file servers, cloud storage, etc. Basic File Storage (BFS) provides a highly-scalable, secure, and backed-up data storage solution for file shares and directories. BFS costs ten cents per gigabyte (GB) per month with additional storage provisioned in one GB increments. Learn more at doit.missouri.edu/services/data-docs-files/basic-file-storage.

UMBC Data Storage – The UM Bioinformatics Consortium (UMBC) currently manages more than one petabyte (PB) of storage. Faculty conducting research unrelated to bioinformatics may use storage on a case-by-case basis. Currently there is no charge for storage. Learn more at umbc.RNet.missouri.edu/resources.

DropOff
DropOff enables users to exchange large files at no charge. Authenticating with your MU user name and password, you locate the file and address it to an email recipient. You'll obtain a one-time voucher containing a unique token to send to the recipient. The recipient can then enter their credentials, log in, and enter the token to retrieve the file locally. Learn more at dropoff.RNet.missouri.edu or www.greatplains.net.

Secure TransmIT
Secure TransmIT is a no-charge method for transferring sensitive information in an encrypted “package.” The recipient is alerted via email that a package with log-in instructions is waiting. When s/he successfully opens the package, the file can be transferred from the storage location to the recipient’s computer. Users may transmit up to 100 GB every 30 days. Learn more at doit.missouri.edu/services/data-docs-files/secure-file-transmission.

Networking

Internet2
Internet2 is an advanced networking consortium led by the research and education community spanning US and international institutions who are leaders in the worlds of research, academia, industry, and government. The Internet2 community is developing breakthrough network technologies that support the most exacting applications of today—and spark the most essential innovations of tomorrow. MU has belonged to Internet2 since its inception in 2000. Learn more at http://www.internet2.edu/.

Internet2 Innovation Campus
MU is one of a select few universities designated as an Internet2 Innovation Campus. These campuses form the building blocks of a nationwide Research & Education (R&E) innovation platform, helping to create an environment for innovation at leading research universities. Leveraging the Internet2 Network and enabling services like InCommon federated identity management; Internet2 recently began offering a portfolio of services and discounts to Internet2 members, including cloud services and video services. Learn more at www.internet2.edu/network.

High-Speed Ethernet
MU’s high-speed Ethernet network provides gigabit Ethernet to the desktop and provides connection to the Internet. Service is available in most on-campus offices, classrooms, conference rooms, computing sites, residence halls, and some fraternities and sororities. Gigabit Ethernet network access is available to departments for $13.75/port/month. Learn more at doit.missouri.edu/services/internet-network/wired-network-internet.

MizzouWireless
The MizzouWireless network provides 54 megabits per second throughput for University faculty, staff, and students who authenticate with their username and password. Guest access is available with a University department’s sponsorship. MizzouWireless offers secure information transmission via advanced encryption methods and the ability to print to network printers without using Virtual Private Networks (VPN). Researchers should understand that the wired network is faster and more reliable than wireless for working with or transferring large data sets. Learn more at doit.missouri.edu/services/internet-network/wireless-internet.
RNet – Research Network

MU was among the first in the US to create a separate research network (RNet). Serving MU’s research community since 1999, RNet exists and is administered separately from, but is interconnected with, MU’s high-speed network. RNet has an autonomous set of virtual local area networks (VLANs) that co-reside within the internet address space of the University, but are on a separate high-speed routing and switch infrastructure. There is no charge for using RNet. Major research labs and scientific instruments at MU campus are connected to RNet with 1 – 10 gigabits per second interfaces, which can be configured and have researcher-friendly firewall policies. IPv6 routing capabilities are supported within RNet through a dual-stack mode setup and a separate IPv6 address space. Learn more at doit.missouri.edu/research/research-network.

RNet External Network

RNet enables accessibility to high performance computing (HPC) resources throughout the four-campus University of Missouri System through a core fiber-optic network and 10 Gigabit (GB) optics operated by the Missouri Research and Education Network (MOREnet). This network enables MU researchers to connect via high-speed networks and collaboration services such as videoconferencing with Missouri’s 900 node research and education network for higher education, K-12 education, telehealth sites, and public libraries as well as state government and their affiliates. Connectivity to Internet2 is available through MOREnet and the Great Plains Network (GPN) consortium, and directly from RNet, if needed. The direct connection between RNet and Internet2 is being upgraded to 100 Gbps connectivity, with MOREnet providing built-in redundancy for route protection to avert network disruption due to faults. Learn more at doit.missouri.edu/research/research-network.

RNet Science DMZ (Demilitarized Zone) Protection Environment

A Science DMZ environment is being developed (through 2013-14 NSF CC-NIE, and 2014-2015 NSF CC*IEF funds) with minimal firewall restrictions to enable "friction-free" RNet data flows internally within the campus, and externally to other regional and national network locations. Currently, Science DMZ capabilities include: 100 Gbps connectivity to Internet2 Innovation Platform, experimental testbeds with MU’s supercomputer (partly supported by 2014-2015 NSF MRI funds), perfSONAR multi-domain measurement points to troubleshoot network bottlenecks, Bro-based intrusion-detection monitoring of RNet flows, Data Transfer Nodes with RoCE/iWARP capabilities for fast data transfers over wide-area networks, and an OpenFlow switch infrastructure. Several software-defined networking research collaborations with leading industry vendors such as Cisco, Brocade as well as with remote campuses such as Ohio State University, University of Arizona (iPlant), and Clemson University (NSF ACI-REFs Initiative) are aiding in the maturation of the OpenFlow support for domain science researcher use cases on the MU campus. Shibboleth-based authentication and authorization services also enable secure access to Science DMZ resources and enforcement of researcher-friendly policies for cyberinfrastructure access.

Missouri Research and Education Network (MOREnet)

MOREnet provides high-speed Internet access with bandwidth capacity up to 100Gbps to K-12 schools, colleges, universities, public libraries, state government, healthcare, and other affiliates in Missouri. MOREnet also provides access to online reference resources, technical expertise, security education, videoconferencing, and more. MOREnet designed and built one of the first state advanced, high-bandwidth research networks in the country, laying the groundwork for Internet availability to thousands of rural Missourians. MOREnet is currently the only state research and education network that carries network traffic on its backbone for Internet2. Learn more at www.more.net/.

Great Plains Network (GPN)

Administratively housed at the University of Missouri, the Great Plains Network (GPN) was founded in 1997 to address the needs of the research and education community resulting from increasingly overwhelming use of the public Internet. GPN members include over 20 leading universities in eight states. GPN was the first regional connector to Internet2, and GPN continues to lead in support of research collaboration, education, and advanced networking for member institutions. MU and the GPN have been instrumental in developing and proving scalability of Shibboleth as a security model for fine-grained authorization needs across multiple institutions and in large high-speed networks. Learn more at www.greatplains.net.
Research Support Computing

For available services, service rates, how to apply for services, and additional information see doit.missouri.edu/research/research-network.

High Performance Computing (HPC)

High Performance Computing (HPC)

MU’s HPC system (Lewis) is in the process of being upgraded. The first phase of the upgrade is currently in place and consists of 20 Advanced Clustering Technology nodes with 128 GiB RAM and 24 Haswell cores for a total of 480 cores and 2560 GiB RAM, which will replace the aging Dell 1850/1950 dual processor nodes. This system has both QDR Infiniband networking for parallel computation (MPI) and 10 Gigabit Ethernet network connections for storage, including access to the new General Purpose Research Storage system that has over 1 petabyte of new storage for researchers. This system also houses 12 additional compute nodes as a part of the recently announced MRI award from the NSF [1]. In addition, in 2014 the SGI “Clark” system was upgraded to four Dell C8000 systems with 24 cores, 256 GiB of RAM, and 12 TB of local disk scratch.

The hardware and software refresh will form the bases for future expansions and will integrate existing systems. These systems include 32 nodes (384 CPU cores) of HP and Advanced Clustering Technologies (ACT) Xeon servers for general purpose computing services and eight nodes of IBM 3850M2 quad-core compute nodes (64 cores) with 24-48 GiB RAM. In addition there are two IBM 3850X5 compute nodes each with 512 GiB RAM and an IBM 3850M3 node containing two Tesla M2070 GPU’s.

HPC-Connected Disk Storage

Research computing is the process of deploying one Petabyte of EMC/Isilon for General Purpose Research Storage to facilitate researcher collaboration, data collection (instruments), and data storage across campus for Windows and Linux machines and to facilitate the analysis of the data utilizing the Lewis HPC cluster. This storage will be available to all researchers on campus with 20 GiB of private and project storage being made available at no cost and additional storage available for a fee. Research computing also maintains an additional one Petabyte of storage that is connected to the HPC environment. For HPC network scratch there is a 110 TB EMC storage array managed by the IBRIX distributed file system.


Health Care IT

MU Institute for Clinical and Translational Science (MU-ICATS)

MU-ICATS encompasses a rich array of resources which are easily accessible to investigators. By organizing these resources into integrated clusters and cores, MU-ICATS has created a highly productive, efficient and collaborative environment for clinical and translational science. MU-ICATS has implemented three systems: REDCap, i2b2 and PowerTrials. The REDCap (Research Electronic Data Capture), created by Vanderbilt University, is a web-based application for building and managing online surveys and research databases. The i2b2 (Informatics for Integrating Biology and the Bedside) is a data warehousing system that enables researchers to use existing clinical data for discovery research. PowerTrials is a complete solution for clinical trial studies including the candidate identification during the patient care process and the management of protocol information, clinical trial initiation and enrollment activities. Learn more at icats.missouri.edu.
**Informatics at the University of Missouri**

**MU Informatics Institute (MUII)**
MU Informatics Institute is a joint research and education program supported by 16 departments in MU's Colleges of Agriculture, Food & Natural Resources, Arts & Science, Engineering, Education, and Veterinary Medicine plus the Schools of Medicine, Nursing, and Health Professions. The Institute offers a PhD program in two emphasis areas: bioinformatics and health informatics, as well as a concentration area in geoinformatics. Each area stresses the skill sets and research appropriate for the subfield within the broad area of informatics. MUII's mission has three components: education, research, and outreach. To have a global impact in advancing computational research in biology, medicine, and geospatial science, the stakeholders across the UM System believed it was critical to the University's missions to offer a doctoral program in informatics, build an international-level research program, and provide service to scientific communities for informatics needs. In addition, MUII continues to innovate, fostering a Big Data ecosystem environment in order to develop state-of-the-art biomedical informatics software. Learn more at muii.missouri.edu.

**Informatics Research Core Facility (IRCF)**
The mission of the IRCF is to facilitate research and education through the development of computational resources. Computational resource development ranges from software creation to database design to hardware configuration consulting. IRCF staff members are skilled in these activities and are available for a range of services. The IRCF is committed to serving the informatics needs of the research community. Additionally, the IRCF is dedicated to providing educational and instructional opportunities for MU students, staff and faculty. These opportunities are often offered as either workshops or individual training activities. Learn more at ircf.RNet.missouri.edu.

**Digital Biology Laboratory**
The research focus of Digital Biology Laboratory (DBL) is Bioinformatics and Computational Biology. We are interested in various topics including protein structure prediction, high-throughput biological data analyses, primer and probe design, protein phosphorylation analysis, simulation studies of plants, cancers, viruses, and many more. The lab is interested in working with MU faculty in funded research collaborations. Learn more at http://digbio.missouri.edu.

**The University of Missouri Bioinformatics Consortium**
The University of Missouri Bioinformatics Consortium (UMBC) maintains a high performance computing, networking and storage infrastructure to support research across the four campus UM-System. Established in 2001, the UMBC provides centralized, high capacity data storage and analytical tools that can be used over high-speed Internet2 connections in support of research. The UMBC coordinates the provision of high-performance computational systems to analyze massive sets of data, very large storage devices to house major data collections, high speed networking services to facilitate location independent access and collaboration among investigators, software applications supporting system-wide computation research, and technical support staff. Through collaborations with IBM, HP, and EMC/Isilon scalable high capacity storage is available to house many widely used and specialized genomic databases and analysis tools and packages to support the analysis needs of the research community. Learn more at umbc.RNet.missouri.edu.
### A-Z Index

<table>
<thead>
<tr>
<th>Resource</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Computing Technology (ACT) Center</td>
<td>1</td>
</tr>
<tr>
<td>Data Storage</td>
<td>1</td>
</tr>
<tr>
<td>Digital Biology Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>Digital Humanities Commons @ The Allen Institute</td>
<td>1</td>
</tr>
<tr>
<td>Digital Humanities Initiative</td>
<td>1</td>
</tr>
<tr>
<td>Digitization Services at MU Libraries</td>
<td>1</td>
</tr>
<tr>
<td>DropOff</td>
<td>1</td>
</tr>
<tr>
<td>eduroam</td>
<td>1</td>
</tr>
<tr>
<td>Great Plains Network (GPN)</td>
<td>1</td>
</tr>
<tr>
<td>High Performance Computing</td>
<td>1</td>
</tr>
<tr>
<td>High-Speed Ethernet</td>
<td>1</td>
</tr>
<tr>
<td>HPC-Connected Disk Storage</td>
<td>1</td>
</tr>
<tr>
<td>iLab – Immersive Visualization Lab</td>
<td>1</td>
</tr>
<tr>
<td>InCommon</td>
<td>1</td>
</tr>
<tr>
<td>Informatics Research Core Facility (IRCF)</td>
<td>1</td>
</tr>
<tr>
<td>Information Experience (IE) Lab</td>
<td>1</td>
</tr>
<tr>
<td>Information Security</td>
<td>1</td>
</tr>
<tr>
<td>Internet2</td>
<td>1</td>
</tr>
<tr>
<td>Internet2 Innovation Campus</td>
<td>1</td>
</tr>
<tr>
<td>Kaltura</td>
<td>1</td>
</tr>
<tr>
<td>Lync 2013</td>
<td>1</td>
</tr>
<tr>
<td>Missouri Research and Education Network (MOREnet)</td>
<td>1</td>
</tr>
<tr>
<td>MizzouWireless</td>
<td>1</td>
</tr>
<tr>
<td>Mobile Videoconferencing</td>
<td>1</td>
</tr>
<tr>
<td>MOspace</td>
<td>1</td>
</tr>
<tr>
<td>MU Informatics Institute (MUII)</td>
<td>1</td>
</tr>
<tr>
<td>MU Institute for Clinical and Translational Science (MU-ICATS)</td>
<td>1</td>
</tr>
<tr>
<td>ORCID</td>
<td>1</td>
</tr>
<tr>
<td>Qualtrics</td>
<td>1</td>
</tr>
<tr>
<td>RNet – Research Network</td>
<td>1</td>
</tr>
<tr>
<td>RNet External Network</td>
<td>1</td>
</tr>
<tr>
<td>RNet Science DMZ (Demilitarized zone) Protection Environment</td>
<td>1</td>
</tr>
<tr>
<td>Secure TransmiIT</td>
<td>1</td>
</tr>
<tr>
<td>Shibboleth</td>
<td>1</td>
</tr>
<tr>
<td>The University of Missouri Bioinformatics Consortium</td>
<td>1</td>
</tr>
</tbody>
</table>