

Telecommunications Hub

“Few realize that Chicago is also a major center of advanced digital communications...These capabilities form a solid foundation for the digital economy of the 21st Century, especially for world-wide commerce.”

Joel J. Mambretti, Ph.D., Director,
International Center for Advanced Internet Research (iCAIR)
Northwestern University

Chicago is the communications center of N. America & its global gateway.

Chicago and New York are the only two U.S. metropolises in which the majority of the office space is located downtown. This intense concentration develops creative synergies that are beneficial for the entire region, not just companies locating downtown.

- 12 Fortune 500 companies within walking distance of each other¹
 - And 18 more in the suburbs
- Home to 160 major corporate headquarters, 2nd only to New York²
- 1,500+ foreign firms in metropolitan Chicago³
- An intense concentration of over 460,000 workers – 50% of whom arrive to work via mass transit⁴
- One of the largest, most diverse pools of global business service expertise--including management/IT consulting, accounting, human resources, marketing, legal, engineering and advertising talent
- A non-stop gateway to 54 international and 134 domestic business centers⁵
- Two of Zagat's top 10 world hotels are in downtown Chicago
 - #2 - Peninsula Chicago, #6 - Four Seasons

¹ Data source: Fortune magazine

² Data source: Hoovers.com

³ Data source: Dun & Bradstreet

⁴ Data source: IDES, Quarterly Census of Employment & Wages

⁵ City of Chicago, Department of Aviation

Downtown is also the epicenter of one of the highest concentrations of young, educated workers in the world. Both hip and urbane, these north lakeside neighborhoods are a ready source of educated and creative workers, but also the key to attracting future talent.



- 300,000+ people live in the neighborhoods surrounding the central business district⁶
- 39% have a bachelor's degree – 2.5 times the national average
- 29% have graduate degrees – 3.3 times the national average
- 34% of the population is between 21 and 34 (19% nationally)
- Only 10% of households have children (36% nationally)
- 57% walk, bike or take public transit to work (11% nationally)

It All Connects Downtown.

No other place in the world rivals Chicago's advanced telecommunications infrastructure and the interconnection of regional, national and international networks.

- #1 U.S. commercial terrestrial telecom network⁷
 - 25.7 terabytes/second lit capacity (915 Tbps total capacity)
 - 153 lit fiber pairs (1,140 total fiber pairs)

⁶ Data source: Claritas Demographic

⁷ Data source: Telegeography

- 18 fiber providers
 - 31 bandwidth providers
- 27 of 28 U.S./Canadian NSPs have a POP (point-of-presence in the Chicago area)
- [Chicago: Most Internet-Accessible City in the U.S.](#)
- The Chicago Network Access Point (NAP)--the world's largest commercial Internet exchange point by volume--is located in the central business district
- North America's largest "carrier hotel" (server/data storage/routing hardware facility) is located in downtown Chicago--The Lakeside Technology Center

Global Glass Gateway.

The only facility in the world that provides a cooperative interconnection point among numerous international advanced networks – Science Technology and Research Transit Access Point (STAR TAP) - is located in downtown Chicago. STAR TAP is enhanced by StarLight, the leading Optical Internet Exchange (OIX) in the U.S -- i.e., twenty OC192 fiber strands connect to StarLight.



- 14 international advanced networks and/or consortia networks interconnect at STAR TAP/StarLight
 - Connecting downtown Chicago to leading edge networks in Argentina, Brazil, Chile, Venezuela, Japan, Korea, Taiwan, China, Russia, Philippines, Australia, Indonesia, Hong Kong, Singapore, Malaysia, Thailand, Sri Lanka, Vietnam, Canada, CERN, the European Union Data-Intensive Trans Atlantic Grid, Denmark, Finland, Iceland, Norway, Sweden, the Netherlands, the Czech Republic, the United Kingdom, Switzerland, Bangladesh, India, New Zealand, Pakistan and Ireland
- 7 U.S. advanced networks interconnect at STAR TAP/StarLight
- STAR TAP/StarLight enables network flow to international collaborators from over 150 U.S. leading-edge research universities and institutions, including supercomputing centers
- The research projects that STAR TAP/StarLight helps to foster are among the most computation-demanding and/or data-intensive applications in the world
- In 2004, StarLight was part of a world-wide team that set two new records in the Internet 2 Land Speed Record competition. Data streams traveled at 7.21 Gbps across a network nearly three-quarters the circumference of the Earth.

From Playing With Light To Shifting A Paradigm

The unique collaborative spirit of those within Chicago's advanced telecommunications community, and the larger Midwest advanced telecommunications community as well, has resulted in a number of highly ambitious projects that have the potential to redefine computing and telecommunications as we know it.

TeraGrid



The world's first multi-site supercomputing system is anchored in Chicago.

The Distributed Terascale Facility (DTF) was launched with \$53-million in initial funding from the National Science Foundation (NSF) in 2001, expanded with a \$35 million award in 2002, a \$10 million award in 2003, a \$9.7 million award in 2004, and is being further expanded and maintained with an additional 5-year, \$150 million NSF award in 2005. The DTF carries 11.6-trillion calculations per second and stores more than 450-trillion bytes of data, with a comprehensive infrastructure called the "TeraGrid" to link computers, visualization systems and data at nine sites through a 40-billion bits-per-second optical network.

The largest portion of the DTF computing power will be at the National Center for Supercomputing Applications (NCSA) at the University of Illinois in Urbana-Champaign. NCSA has seven additional DTF partners, called Resource Providers: the San Diego Supercomputer Center (SDSC), Argonne National Laboratory in Chicago, the Pittsburgh Supercomputer Center (PSC), Oak Ridge National Laboratory, Purdue University, Indiana University, and the Texas Advanced Computing Center.

The TeraGrid is accessible to researchers across the United States so that they can more quickly analyze, simulate and help solve some of the most complex scientific problems. Examples of research areas include molecular modeling for disease detection, cures and drug discovery; automobile crash simulations; research on alternative energy sources; seismic modeling; improving groundwater cleanup efforts; and climate and atmospheric simulations for more accurate weather predictions.

In addition, beginning in 2006, the computational resources of TeraGrid will be available to all user requests to the NSF. This integration effort brings the total TeraGrid system performance to a peak of 102 trillion calculations per second.

TeraGrid's computing power is not restricted to just researchers in the U.S. In November 2005 TeraGrid linked with the U.K. National Grid Service via transatlantic fiber to carry out research on a shared grid. By pooling their expertise and resources, TeraGrid helps solve problems that otherwise can't be solved.

OptIPuter



OptIPuter is a five-year, \$13.9 million National Science Foundation-funded project to interconnect distributed storage, computing and visualization resources using photonic networks. The main goal of the project is to exploit the trend that network capacity is increasing at a rate far exceeding processor speed, while at the same time plummeting in cost. This allows one to experiment with a new paradigm in distributed computing—where the photonic networks serve as the computer's system bus and compute clusters taken as a whole serve as the peripherals in a potentially planetary-scale computer.

NetherLight

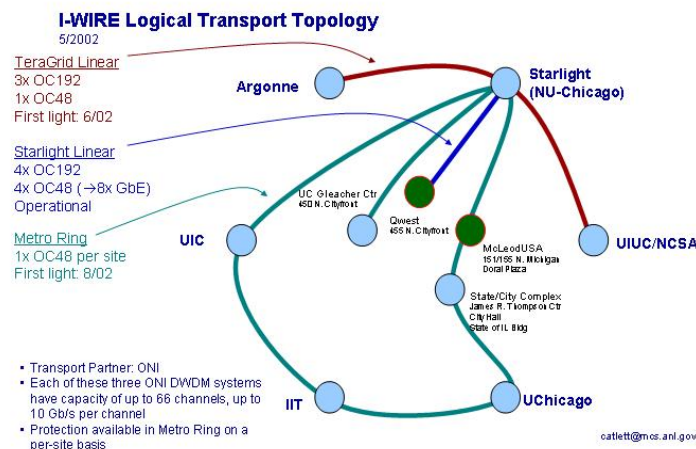
The world's first transAtlantic lambda has been realized between SURFnet (the Netherlands Advanced Research Network) and StarLight. The 2.5 Gigabit/s fiber optic connection is being used to investigate new concepts of optical bandwidth provisioning (e.g., traffic control over lambdas, peering/interconnects with lambdas, provisioning and administrating lambda networks, etc.) and to gain experience in these new techniques.

OMNInet

A research partnership has created the world's most advanced metro network testbed, based on leading-edge photonic technology (e.g. lambda switching) in Chicago. The partnership is comprised of SBC; Nortel; the International Center for Advanced Internet Research (iCAIR) at Northwestern University; the Electronics Visualization Laboratory (EVL) at the University of Illinois at Chicago; the Mathematics and Computer Science Division (MCS) at Argonne National Laboratory; GigaPort/SURFnet in the Netherlands; and the Canadian Network of the Advancement of Research, Industry and Education (CANARE). The project includes:

- Trials of highly, reliable, scalable 10 GE in metropolitan and wider area networks. 10 GE runs at 10-100 times faster than current local area network standards, and can support applications that require extremely high levels of bandwidth
- Trials of new technologies to support applications that require extremely high levels of bandwidth
- Development and trial of optical switching, ensuring maximized capabilities in the wide scale deployment of all-photonic networks
- Trial of new technologies that allow for application signaling to optical network resources bandwidth
- Experiments with new types of advanced networking middleware that make networks more intelligent.

I-WIRE



I-WIRE is a 225-mile optical fiber network linking the infrastructure of downtown Chicago with its major research institutions, universities and the National Center for Supercomputing Applications (NCSA) in Urbana/Champaign. This is another example of on-going efforts within advanced computing and networking to strategically enhance and accelerate existing information technology initiatives, in order to secure our leadership position as the dominant hub of the information economy. The final topology of the network will result in:

- A linear strand of 3x OC192 fibers and 1x OC48 fiber between Argonne, StarLight and NCSA
- A linear strand of 4x OC192 and 8x GbE between StarLight and the West Coast
- A metro fiber ring of 1x OC48 per site between StarLight, the Qwest POP downtown, the McLeodUSA POP downtown, the University of Chicago Gleacher Center downtown, the James R. Thompson Center and City Hall, the University of Chicago, the Illinois Institute of Technology, and the University of Illinois at Chicago

I-WIRE was the first connection in what became the TeraGrid network, and now comprises its in-state backbone. Without the state supported funding of this project, the National Science Foundation would have never awarded the NSCA-SDSC coalition the project (PSC joined the partnership at a later date).

I-LIGHT & I-LIGHT2

Completed in 2001 at a cost of \$6 million, I-LIGHT is an optical fiber network between Purdue University and Indiana University. This super-fast network earned the EDUCAUSE 2003 award for excellence in networking. I-LIGHT comes to Starlight, where it connects with the TeraGrid.

In 2004 the Indiana Legislature approved \$10 million to expand the I-LIGHT network to other state colleges and universities, which will be called I-LIGHT2. In November 2005, the state of Indiana will begin the process of acquiring fiber optic network leases and transferring funds to complete this initiative.

CAVEwave

A continuous 10 Gbps connection from UI-C to the University of Washington in Seattle and the University of California in San Diego provides the backbone for projects like the OptIPuter. This wavelength, along the National LambdaRail (NLR), provides researchers with a dedicated and predictable network for their projects.

This connection extends from the Electronic Visualization Laboratory at UI-C to StarLight, and from there connects to Seattle and also to San Diego. This wavelength is also available to Federal agencies international research centers and corporate research projects.

Illinois Century Network (ICN)

The ICN initiative was originally an education-only network, but is now expanding state-wide to schools, libraries, colleges, universities, public libraries, museums, and to local government and state agencies. The \$25 million per year network delivers a high-speed telecommunications backbone for data, video and audio. These dark fiber and wavelength based services are being developed in part by the State of Illinois and the International Center for Advanced Internet Research (iCAIR).

The ICN offers DNS hosting, IP addresses, monitoring, technical support and consultation services to members.

USAWaves/IEEAF

The Internet Educational Equal Access Foundation seeks to globally expand the next generation Internet, create university-corporate partnerships, and spur innovative research. Donated bandwidth is shared for a range of educational uses, while governance structures seek to promote broad access.

To date, the IEEAF has received in donations over 8,000 miles of trans-USA fiber, 7,000 km of trans-European fiber, including 10Gbps and 622 Mbps connections. Currently, the IEEAF is connecting the US and Asia-Pacific for a truly global network.

Midwest Research and Education Network (MREN)

One of the world's most advanced, innovative, high-performance regional networks utilizes the Chicago NAP as a hub and is comprised of several regional research institutions including: The University of Chicago, Argonne National Laboratory, University of Illinois at Chicago, Fermi National Accelerator Laboratory and Northwestern University.

MREN assisted in creating the first Next Generation Internet Exchange (NGIX) in Chicago. The 3 existing NGIXs act as exchange points between the Federal high-performance networks (FEDnets):

- Internet 2's Abilene
- NASA's Operational Net (NISN)
- NASA's Research and Education Network (NREN)
- DARPA's Defense Research Network (DREN)
- DOE's ESNet & vBNS

Benders of Light

Chicago is not only home to an impressive telecommunications infrastructure, but also to an incredible array of internationally recognized organizations and talent dedicated to creating the next generation of digital telecom.

International Center for Advanced Internet Research at Northwestern University

iCAIR was established to accelerate the level and pace of Internet research by focusing on key technologies that have the potential to significantly advance Internet capabilities. The Center is a central member and collaborator on a number of the on-going advanced telecommunications projects mentioned previously.

Combining the efforts of educational institutions, research centers and corporate partners, iCAIR is designed as an incubator and early-deployment facility for advanced Internet technologies in three mission areas: leading-edge applications design and development, middleware (e.g., new network services and systems, including core metasearches), and infrastructure based on emerging high performance technologies.

Electronic Visualization Laboratory (EVL) at University of Illinois at Chicago

EVL at the University of Illinois at Chicago is an interdisciplinary laboratory that combines art and computer science and which specializes in virtual reality over high-speed networks. Funded research projects include tele-immersion, collaborative software, the development of viable, scalable, deployable stereo displays, and management of next-generation advanced networking initiatives. EVL is the host organization of the National Science Foundation-funded Science, Technology, and Research Transit Access Point, STAR TAP, and also is a lead organization developing StarLight, the optical STAR TAP.

Laboratory for Advanced Computing (LAC) at University of Illinois at Chicago

LAC was established in 1988. It develops algorithms, software and systems with a focus on: data mining, distributed computing, and high performance computing and networking.

The labs' first focus is on data mining and, more generally, data intensive computing. The LAC was one of the co-founders of the Data Mining Group, which establishes standards for data mining.

Tomorrow's web will intermix the commodity internet, wireless networks and specialized high performance networks. The lab's second focus is on developing algorithms and applications for this emerging infrastructure. Project DataSpace is a current project focused on creating a web of data.

Clusters of workstation have emerged as the basic platform for high performance computing. Connecting geographically distributed clusters with high performance networks is an area of active research. The lab's third focus is developing algorithms and software for local and distributed clusters of workstations. The National Scalable Cluster Project (NSCP) 1994-1998 was a LAC project which pioneered the use of distributed clusters for data intensive mining.

Rosen Center for Advanced Computing at Purdue University (RCAC)

The Rosen Center for Advanced Computing provides access to leading-edge computational and data storage systems, as well as expertise in a broad range of high performance computing activities.

EnvisionCenter for Data Perceptualization at Purdue University

Researchers in the Envision Center explore novel computer graphics, advanced visualization, and human computer interface technologies, such as auditory, haptic, and multimodal interaction. These technologies are integrated with state-of-the-art advanced computation and networking, and high-end immersive visualization environments to assist researchers and industry in their quest for new knowledge and innovative products. The Envision Center will be a window into computational aspects of science and engineering, providing effective means to communicate complex research results to students, researchers and the general public.

The Globus Alliance

The Alliance--a research partnership between Argonne National Laboratory, the University of Chicago, the University of Edinburgh, the NCSA, Northern Illinois High Performance Computing Laboratory, The Royal Institute of Sweden, the Univa Corp., and the University of Southern California--is developing fundamental technologies needed to build computational grids. The Alliance's Globus Toolkit has been recognized by a number of notable organizations as the "de facto [software] standard for Grid computing."

The Globus Alliance was honored in 1998 with the prestigious Global Information Infrastructure "Next Generation" award and in 2002 received an R&D 100 award. The Globus Project leaders were honored by InfoWorld in 2003 as one of its "InfoWorld's Innovators." Two of these three are from Argonne. Also, the NSF awarded the Alliance \$13 million in 2005 toward the Toolkit.



Global Grid Forum (GGF)

GGF is a community-initiated forum of 5,000+ individual researchers and practitioners working on distributed computing, or “grid” technologies, which is managed and operated by members of Argonne National Laboratory. The GGF’s primary objective is to promote and support the development, deployment, and implementation of Grid technologies and applications via the creation and documentation of “best practices” – technical specifications, user experiences, and implementation guidelines (i.e., the equivalent of the Internet Engineering Task Force (IETF) for distributed computing technology).

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