

Internet2

Implications for Libraries



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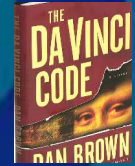
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*Technology for the Rest of Us:
What Every Librarian Should Understand
About the Technologies that Affect Us*

The Blackwell, Ohio State University, Columbus OH
May 25, 2004



Outline



- ▶ **Context: environment today, 2009, 2019, 2029, 2049**
 - Libraries of the “near” future
- ▶ **Internet History**
 - Problems with the “commodity” internet
 - Advanced networking landscape
- ▶ **I2 capabilities, applications, WPI Goddard GigaPoP**
 - K-20 role: SEGP, Sponsored Participants
 - Connections and projects
- ▶ **Goddard Collaborative**
 - Solving the last mile and costs issues
 - Sharing infrastructure
- ▶ **Educational technology and the library**
- ▶ **Digital libraries and the future**
 - Is it worth the trip?
 - Do we have a choice?



What's going on? ... Waves of Power

▶ Mid 1800's Electric Power

- Key enabling technology
- 1st Industrial Rev => Physical Abilities

▶ Mainframe "System" Era

- Limited users; focus on scientific and business computation

▶ Personal Computers

- Computers for the masses; focus on personal productivity, entertainment
- Merging computing & communications

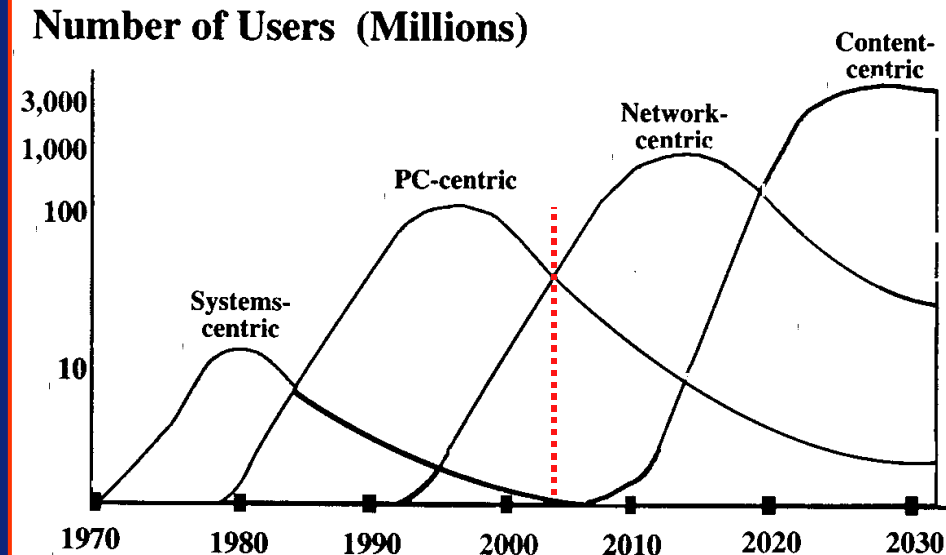
▶ Networking

- Mission: connect the world
- Focus on collaborative workgroups

▶ The Next Thing: media-rich "CONTENT" for the "information society"

- **Requires a new generation of software/hardware applications**
- **2nd Industrial Revolution—about knowledge, value, mental abilities**
- **Universities—knowledge creation, dissemination, learning businesses**
- **Libraries—knowledge repository, dissemination, learning**

Figure 6-1. Stages of industry growth.

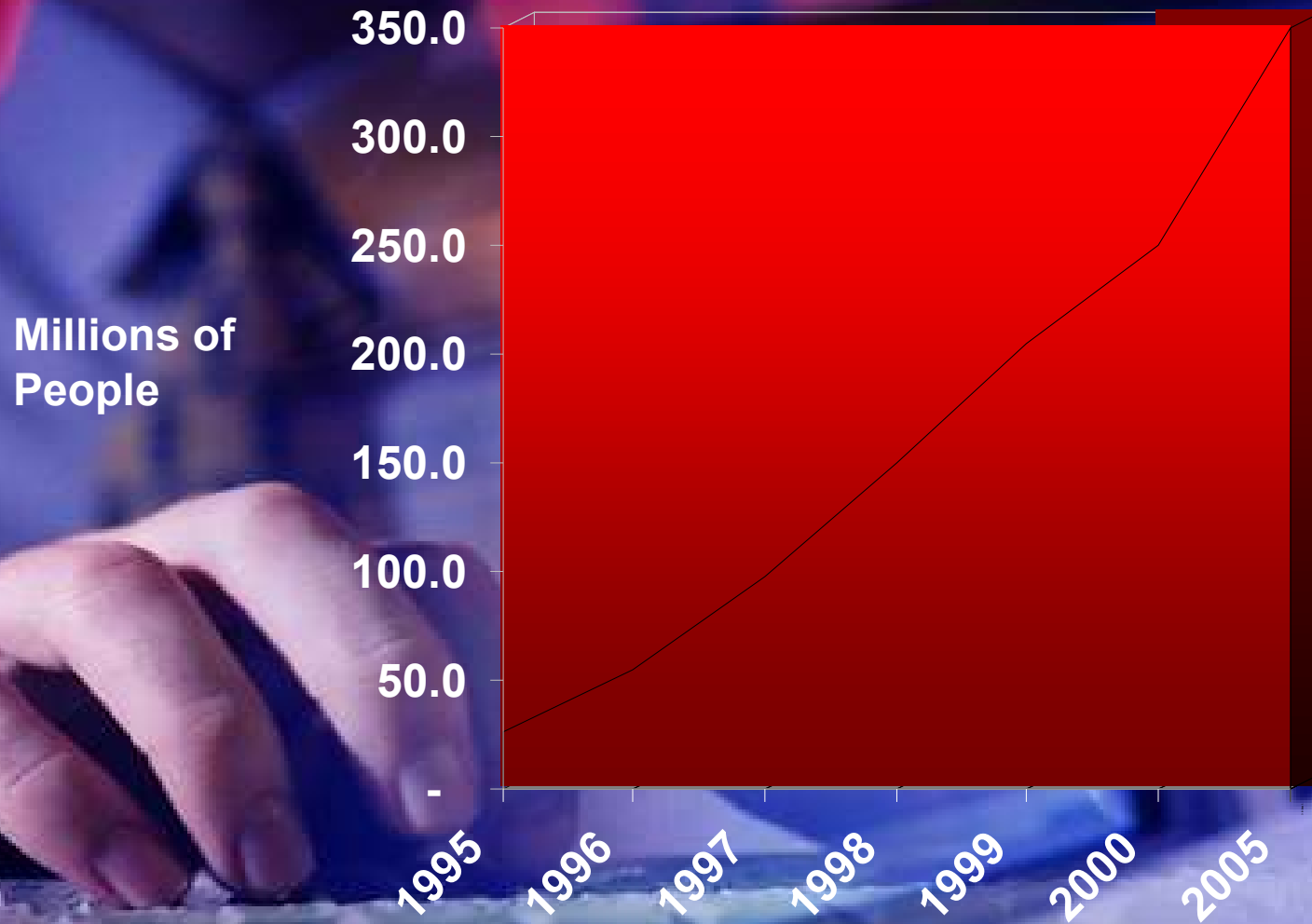


Source: *Waves of Power*, David Moschella, AMACOM American Management Association, NY, NY, 1997, pg. 98.

Source: *The Age of Intelligent Machines*, Ray Kurzweil, MIT Press, Cambridge MA.



People on the Internet



The Day the Computers Died ...

- ▶ **1960: A few scientists don't get printouts from their last submission of data on punch cards; Some business reports are held up.**
- ▶ **1999: Society grinds to a halt ...**
 - All electric power distribution fails
 - Most motorized vehicles fail – car, truck, bus, train, plane, subway
 - No electronic communication: TV/radio, phone, fax, pager, email
 - No paychecks; no banking
 - What about full data loss?
- ▶ **In 40 years we have gone from manual methods of controlling our lives and civilization to being highly dependent on the continued operation of our computers (machines)**

The next 40 years leaves us where?



Future Considerations?

2099: goal of education, and of intelligent beings, is discovering new knowledge to learn!

▶ 2009

- Education trend: Just-in-Case -> Just in Time -> “Just for Me”
- Intelligent courseware
- Translating phones + ww network => few communication barriers

▶ 2019

- Invisible, ubiquitous, embedded computers—in walls, clothing, bodies ...
- 3D VR interfaces (e.g., glasses) used routinely to communicate with people, computers, www, VR
- \$1,000 computing device is approximately equal to the computational ability of the human brain

▶ 2029: \$1,000 unit of computation has the computing capacity of ~ 1000 human brains

▶ 2049: Nanobot swarms project physical/virtual presence in remote locations

▶ Law of accelerating returns

- Next 20,000 years of progress (at today’s rate) occurs in the next 100 years
- ✂ → Our “long term” future is not so far away!

Source: The Age of Spiritual Machines, Ray Kurzweil, Viking Penguin Group, NY, NY, 1999.



Infinite Memory & Bandwidth

- ▶ Don't worry about super intelligent machines taking over
- ▶ More likely scenario: people who can think and act 1000 times faster, using personal intelligent agents.
- ▶ Advances of the next 50 years will undoubtedly be as dramatic as the last 50
 - Capabilities such as accident-avoiding cars,
 - Universal access to information and knowledge,
 - Entertainment on demand,
 - Learning on demand,
 - Telemedicine and geriatric robotics will clearly come to pass.
- ▶ More esoteric capabilities such as teleportation, time travel and immortality will also become possible, raising a number of social and ethical questions.
- ▶ As we find ways to transform *atoms to bits*, that is, substitute information for space, time and matter, many of the constants of our universe will assume a new meaning and will change the way we live, work and govern ourselves.
- ▶ Some of us will have superhuman capabilities, like getting a month's worth of work done in a day. Such capabilities can be used to further increase the gap between the haves and have-nots, or to help the poor, the sick, and the illiterate.

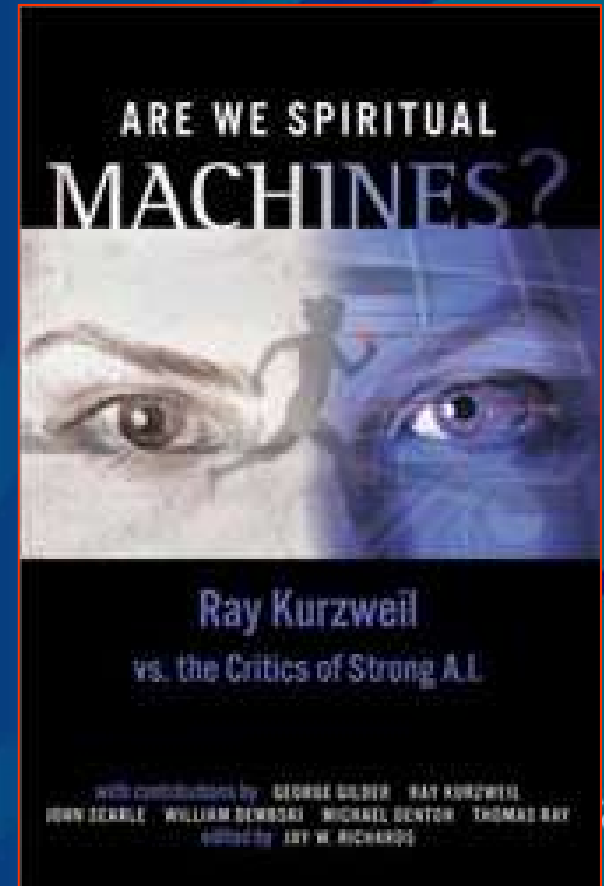
Are we spiritual machines?

Can machines become spiritual (i.e., conscious)?

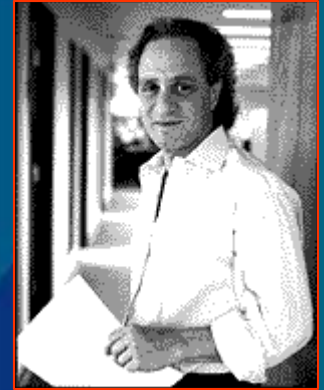
Technology is evolution by other means!

- ▶ Computers are becoming more powerful at an accelerating rate, but will they ever become conscious?
- ▶ Kurzweil says that nonbiological intelligence will soon become indistinguishable from conscious entities such as humans. He explains how we will "reverse engineer" our software (our minds) and "upgrade" our hardware (our bodies) to *indefinitely extend human life*—before the dawn of the 22nd century.
- ▶ Kurzweil argues that accelerating growth of computer power will result in machine intelligence exceeding human intelligence early in this century. Nanobots will scan and enable the reverse engineering of our brains, provide 3D immersive virtual realities, and free the human mind from its severe physical limitations as the next step in evolution. ***Ultimately, humankind will "merge with its computational technology."***

<http://www.kurzweilai.net/articles>



Kurzweil's 2099



Ray Kurzweil

▶ If these postulations become reality ...

- How will society react and make choices?
- Our children will be around to witness 2099+
- How does the library evolve and fit in?
 - Is it a repository and search engine? Is it more?
 - How do we help one another—*Reference Librarian Superhero?*
 - What is its relative importance in the grand scheme of things?
- Does higher education have a role or is most information downloaded into our “new brains?”
 - Lectures for knowledge transfer aren't needed
 - You can download other's experiences, memories, skills, etc. (e.g., Matrix)
 - How does learning occur?
 - Machines can quickly and easily share knowledge with billions of others
- Role of intelligent beings is to discover new knowledge and to learn



History of the Internet

▶ Yesterday's Internet

- Started with government (DARPA), then research universities
- Commercialization led to thousands of users, remote login, FTP, interconnections to mainframe computers

▶ Today's Internet—the “Commodity” Internet

- Growing at 10 to 15% per month
- Capabilities: standards, GUI interface (Mosaic) led to WWW, millions of users, e-mail, low quality audio and video, interconnections between PCs and servers, unpredictable performance
- Network not designed for all this → “World Wide Wait”

Applications adapt to the underlying technology



Yesterday's Internet

- ▶ Thousands of users
- ▶ Remote login, file transfer
- ▶ Interconnect mainframe computers
- ▶ Applications capitalize on underlying technology

Today's Internet

- ▶ Millions of users
- ▶ Web, e-mail, low-quality audio and video
- ▶ Interconnect personal computers and servers
- ▶ Applications adapt to underlying technology

Today's Environment

- ▶ “More original data will be created in the next two years than in all of human history,” *Information Overload*, Adam Pertman, *Globe*, 2/2001.
- ▶ “The rate of growth of Internet use in the United States is currently two million new Internet users per month,” *A Nation Online: How Americans Are Expanding Their Use Of The Internet*, February, 2002.
- ▶ “More than 70% of the workers in developed economies are information workers,” *Turmoil in IT: A Brave New World*, 2001.
- ▶ “More than half of the nation is now online. In September 2001, 143 million Americans (about 54 percent of the population) were using the Internet — an increase of 26 million in 13 months. In September 2001, 174 million people (or 66 percent of the population) in the United States used computers,” *A Nation Online: How Americans Are Expanding Their Use Of The Internet*, February, 2002.
- ▶ **Children and teenagers use computers and the Internet more than any other age group**
 - 90% of USA children (ages 5 to 17 (~ 48 million)) use computers
 - 75% of 14-17 year olds and 65% of 10-13 year olds use the Internet.

Library Near-term Futures ...new missions/visions?

- ▶ **“Content” centric future brings libraries into more demanding roles in a rapidly changing environment**
 - Data, information, knowledge, **WISDOM**¹ base exponentially expanding
 - *Our repository, like Elvis, has left the building!*
- ▶ **New customers, services, and accelerating change management**
 - How do I find, manipulate, synthesize, and visualize information?
 - What critical thinking skills do I have or need to learn?
 - Am I information literate and have IT fluency/competencies?
- ▶ **Collaboration and global community building**
 - Who can help me? Could be anyone? (a much broader scale than before)
 - How do I fund and share “scarce” resources?
- ▶ **Intellectual pursuit ... involves more complexity**
- ▶ **Socialization, and societal impact due to technology**
 - Starbucks + Barnes and Noble → The Experience Economy²
- ▶ **Technology fluency and impact on operations**
- ▶ **Intellectual property rights, ethics**
- ▶ **Funding sources**

¹Source: Working Knowledge. Davenport and Prusak, 1998, Harvard Business School Press, Boston MA.

²Source: The Experience Economy, Pine and Gilmore, 1999, Harvard Business School Press, Boston MA.

Source: “From Automation to Transformation,” Cliff Lynch, EDUCAUSE Review, Jan/Feb 2000.



Tomorrow's Internet

- ▶ Billions of users and devices
- ▶ Interconnect personal computers, servers, and embedded computers
 - The GRID
- ▶ Convergence of today's applications with multimedia (telephony, video-conferencing, HDTV)
- ▶ New technologies enable unanticipated applications (and create new challenges)

Today's Internet Doesn't

- ▶ Provide reliable end-to-end performance
- ▶ Encourage cooperation on new capabilities
- ▶ Allow testing of new technologies
- ▶ Support development of revolutionary applications

Problems With Today's Internet

- ▶ **Not capable of supporting billions of users (and devices)**
- ▶ **Human interaction awkward—forced to adapt to technology**
 - Virtual meetings and seminars
 - Shared authoring
 - Browsing publications
- ▶ **Not capable of supporting the convergence of today's multimedia (telephony, interactive video, HDTV)**
- ▶ **Not capable of supporting the development and testing of new technologies and new applications**
 - Distributed large-scale computing and database efforts are not feasible
 - Network focused rather than integrating computing, network, storage, communications
 - Poor searching: Data structures for relationships among data/information sets not there
- ▶ **Inadequate for mission-critical applications**
 - Authentication
 - “Best Efforts” at security, etc. not good enough
- ▶ **“Last Mile” connectivity problems are still prevalent**
- ▶ **Intranet vs Extranet dynamic bandwidth matching**
 - Match capacity and demand
 - A more secure environment
- ▶ **Security/Risks—viruses, denial of service, SPAM, digital crime**

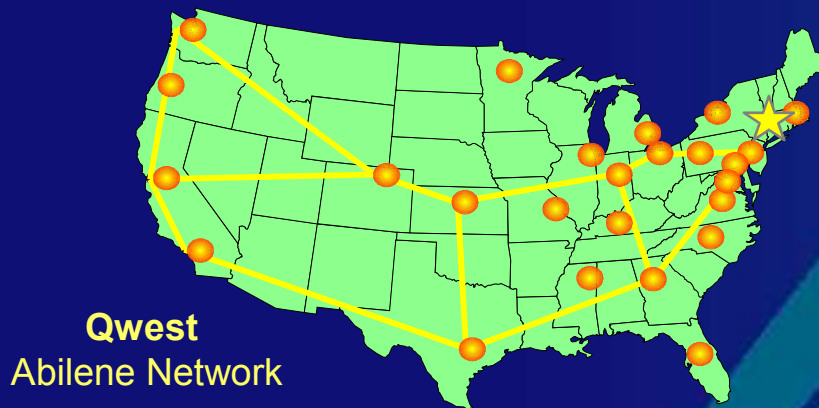
Why Internet2?

- ▶ **The internet was not designed for:**
 - Millions of users
 - Congestion
 - Multimedia
 - Real-time interaction
- ▶ **But, only the Internet can:**
 - Accommodate explosive growth
 - Enable convergence of information work, mass media, and human collaboration

Internet2 <http://www.internet2.edu>



- ▶ Networking research project
- ▶ Consortium of 206 research universities working in partnership with industry and government entities, 33 state K-20 networks
- ▶ Qwest Abilene network backbone
- ▶ 43+ international partners/networks
- ▶ **MISSION:** “Facilitate and coordinate the development, operation and technology transfer of advanced, network-based applications and network services to further U.S. leadership in research and higher education and accelerate the availability of new services and applications on the Internet.”



● gigapops

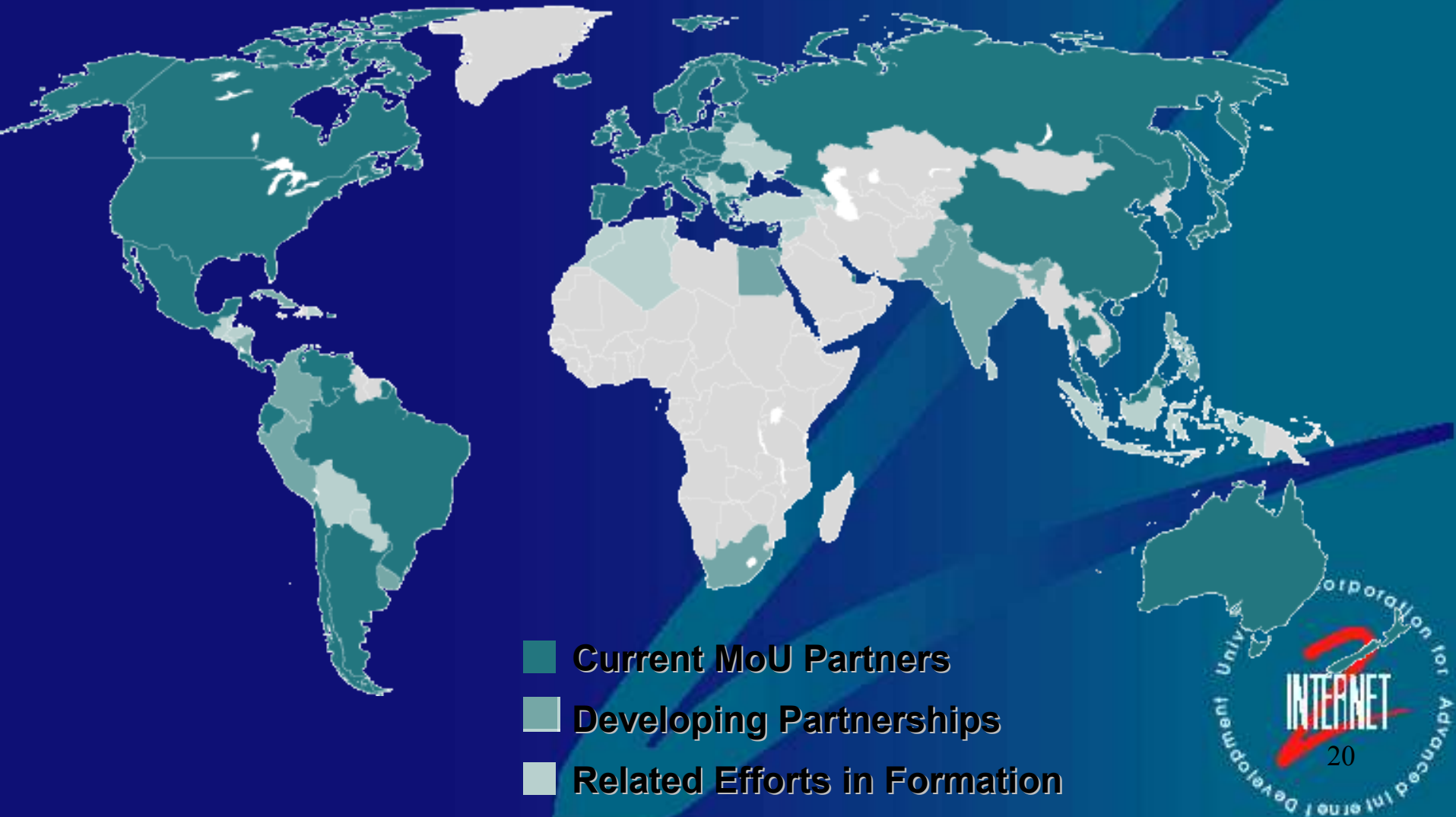
★ WPI Goddard GigaPoP
at 155 Mbit/s

- Collaboration
- Videoconferencing
- Distributed, distance learning
- Virtual reality
- Remote instrumentation
- Digital libraries
- Remote mentoring/auditioning
- Rehearsal and performance
- New IT utility



International Partnerships

Leading to global intellectual capitalism?



Internet2 Focus Areas *(April, 2004)*

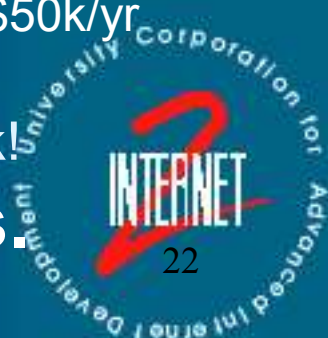
Through Internet2, 22 Working Groups are focusing on:

- Advanced network infrastructure
 - Backbone, IP optical, architecture, gigaPoPs, end-to-end performance, peer-to-peer
- Middleware
 - Authentication, identification, authorization, directories, security
 - Video conferencing, video on demand, instant messaging
- Engineering
 - IPv6, measurement, multicast, quality of service, routing, security, topology, campus bandwidth management
- Advanced applications
 - Digital video, orthopedic surgery, presence/integrated communications, Research Channel, virtual reality, distributed learning, virtual labs
- Partnerships
 - Industry, government, international networks, peering, K-20 Initiative
The Quilt, **American Library Association's Office for IT Policy**



Internet2 Membership *(April, 2004)*

- ▶ **206 Universities and colleges**
- ▶ **40 Corporations**
 - Contribution to higher education & research networking
- ▶ **41 Affiliate members (Government labs, non-profits)**
- ▶ **33 Sponsored Education Group Participants**
 - *Networked aggregates of educational institutions (typically a state education network) that connect K-20, community colleges, technical and trade schools, museums, libraries, art galleries, hospitals that require routine collaboration on instructional, clinical, and/or research projects, or services and content with other I2 participants*
 - UMASS—MITI is MA SEGP
 - Fee/yr = \$30k + \$2k * (10 Congressional Reps for MA) = \$50k/yr
 - SEGPs in 33 states; 4 in CA
 - I2 is going mainstream → production education network!
- ▶ **43 International partner networks / orgs.**
 - Americas, Asia-Pacific, EU, Middle East



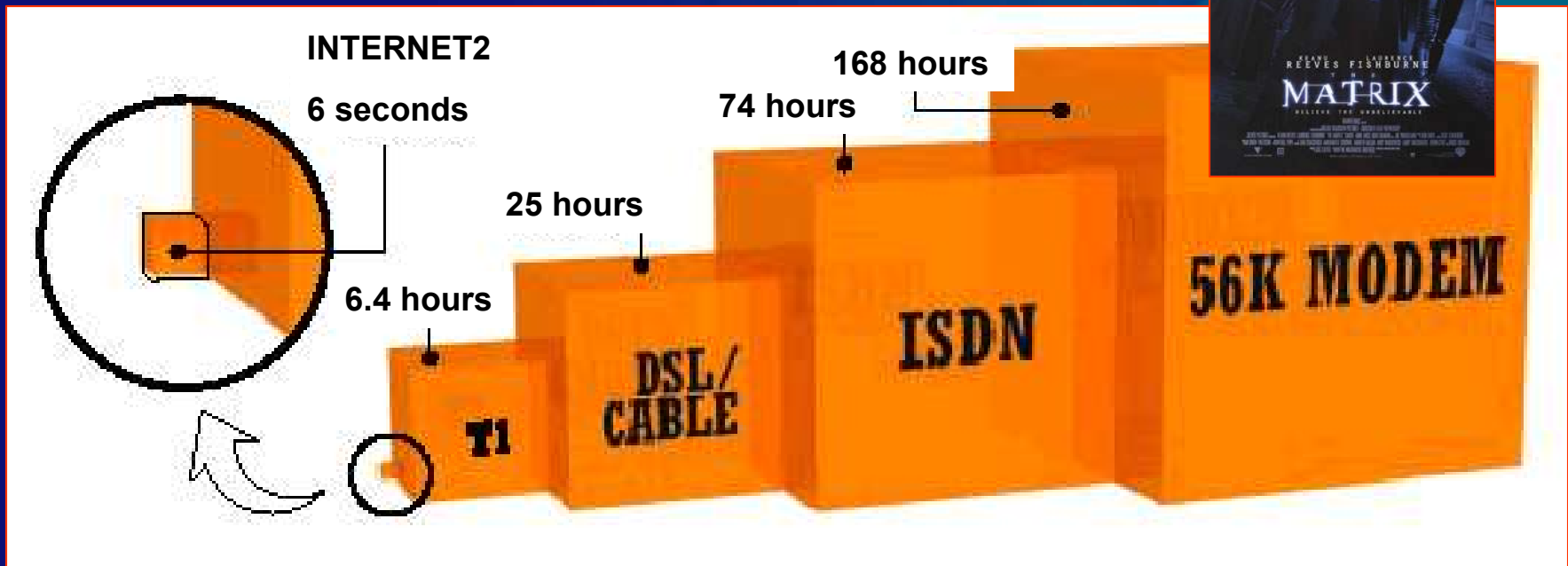
Why is I2 Important? ... *Short term 5-10 years*

- ▶ **A high-speed, high quality, high capability network**
 - 1000 times faster than the Commodity Internet
 - Today's network for universities and research institutions
 - I2 is becoming the production education network for K-20 (SEGP mechanism)
- ▶ **Integration of computing, storage, communications -> new IT utility**
- ▶ **Global communication/collaboration vehicle**
 - Power of the network is proportional to Number_of_Users^2 (Metcalfe's Law)
 - Connect to Next Generation Internet (NGI) used by many government departments
- ▶ **Potential for sharing and leveraging scarce resources**
 - Assets (weather station, excavator, electron microscope, art, ...)
 - Program content, production and distribution (e.g., Jason via VA Tech)
- ▶ **Important new technologies: VC, VR, distributed computation, teleimmersion, collaboratories; *Application innovation***
- ▶ **Transparent to the user, except for better response time and quality**
- ▶ **I2 is forerunner of the future commodity network**



Multimedia Requires High Bandwidth

“The Matrix” Download (DVD Quality, circa 2001)



The bigger the file, the more I2 will be apparent

Caltech and CERN Set *New Internet Speed Record*



- ▶ April 20, 2004—Physicists smash internet speed record
- ▶ Researchers transfer data across nearly 11,000 km at an average speed of 6.25 Gigabits/sec (Gbps).
- ▶ The new record of 6.25 gigabits per sec (Gbps), breaks previous records of 5.44 Gbps (Oct 03), and 2.38 Gbps
- ▶ Equivalent of a full-length DVD movie in about six seconds.
- ▶ *More than 20,000 times faster than a typical home broadband connection.*
- ▶ *[Matrix and Matrix Reloaded] X 2 < 26 seconds*

CBC News

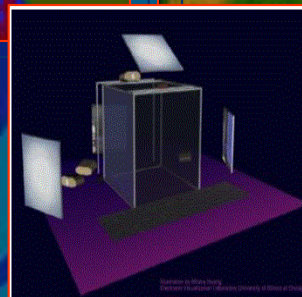
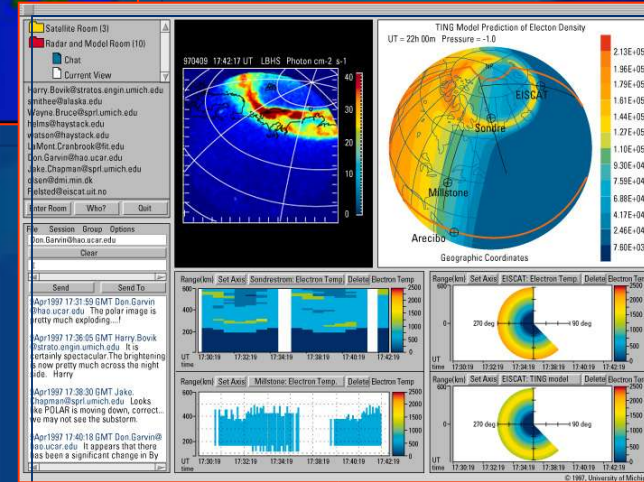
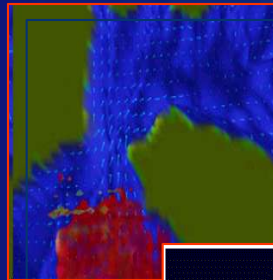
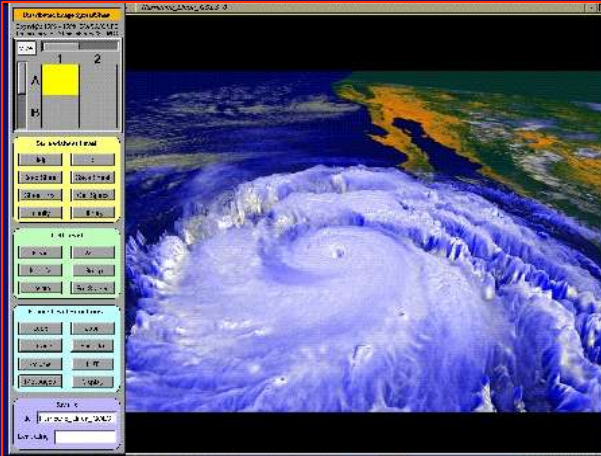
New Internet2 Speed Record



- ▶ Physicists smash internet speed record
Last Updated Fri, 17 Oct 2003 17:10:49 GENEVA -
Researchers have more than doubled the world speed record for internet data transfer.
- ▶ Scientists at the CERN particle physics laboratory in Switzerland sent the equivalent of a full-length DVD movie in about seven seconds.
- ▶ The average transfer rate was 5.44 gigabits per second (Gbps), which broke the previous record of 2.38 Gbps – *more than 20,000 times faster than a typical home broadband connection.*
- ▶ *(Matrix and Matrix Reloaded) X 2 < 30 seconds*



I2 Applications



Fuller Access Grid @WPI





The Access Grid is a collection of “resources that can be used to support human interaction.”

<http://www.accessgrid.org>

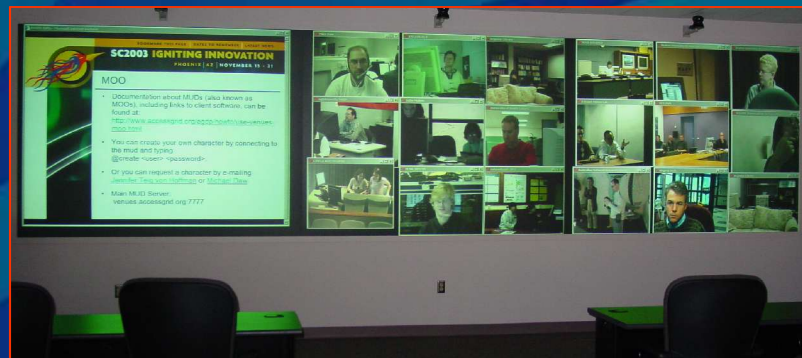


Group-to-Group Collaboration
150 sites as of 4/03. Six in New England:
WPI, BU, Dartmouth, University of Maine,
Air Force Research Lab-Hanscom AFB.

- ▶ New breed of “research facility”
- ▶ Supported with multimedia tools for meeting collaboration—video conf., shared software, data visualization
- ▶ Connected to WPI’s fast, reliable intranet and Internet2 global extranet
- ▶ Creates a global, virtual community of shared researchers, scholars, devices, and resources

▶ Sample Activities

- Super Computing Global '03
- Global Grid Forum
- NCSA Digital Library Technologies
- Virtual Genomics and Bioinformatics Conf.
- Distributed Rap Sessions
- Seminars, short courses, technical meetings
- Impromptu distributed meetings of faculty, students, staff



Advanced Internet Development

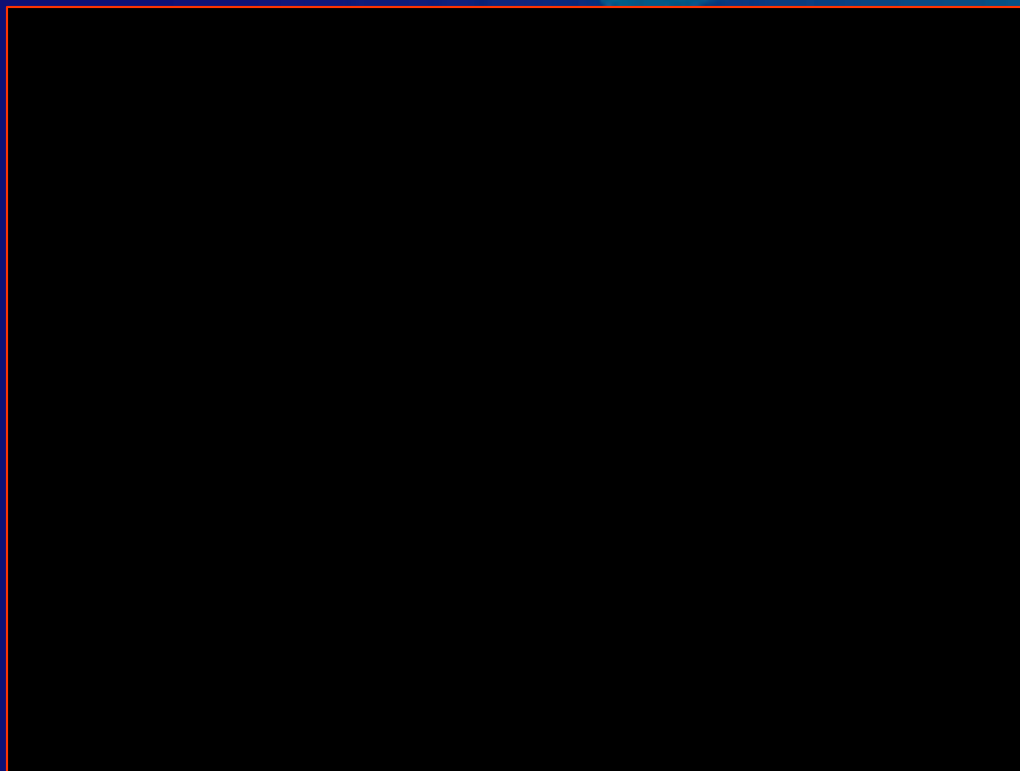
Internet2 on CNN

- ▶ **High-tech musical collaboration**
- ▶ **Application themes**
 - Collaboration at a distance (6 cities)
 - Access to remote musical experts/teachers
 - Geographically distributed production
 - Recording, research, sharing ideas
 - High-quality, real-time audio and video

What I1 did with communication, I2 may do with collaboration!

WPI Virtual Orchestra
Virtual Alden Memorial/Theater





Distributed Musical Collaboration

What do YOU need to participate?

- ▶ **Membership via K-20 SEGP or Sponsored Participant**
 - Sponsored Participant—requires a project and I2 sponsor
- ▶ **High performance internal network infrastructure**
 - Universities have 100 Mbit/s or better
 - SEGP/sponsored members can work with less
- ▶ **An external connection to Internet2—two ways**
 - Via a **SEGP** network (e.g., OH-OARnet, MA-UMASS MITI)
 - Via **direct connection** at a gigaPoP (e.g., Ohio GigaPoP, Goddard, NoX)
- ▶ **Applications—what do you want to do?**
 - I2 Technology Evaluation Center (ITEC-Ohio)
 - Video conferencing—MegaConference
 - Share computing and data storage hardware/software
 - Web conferencing software
 - Access to specialized resources, facilities, meeting rooms, applications



I2 SEGP Goal

Sponsored Education Group Participant

- ▶ Bring together I2 institutions, K-12 schools, colleges and universities, libraries, and museums to get new technologies—**advanced networking tools, applications, middleware, and content**—into the hands of innovators, across all educational sectors in the United States, as quickly and as “connectedly” as possible.
- ▶ SEGP status targeted at both developed and emerging state-based education networks



SEGP Connectivity Fundamentals

- ▶ SEGP status targeted at both developed and emerging state-based education networks
- ▶ One or more Internet2 University Members in the same state act as *sponsor(s)*
- ▶ Connectors take overall fiscal and operational responsibility for the SEGP
- ▶ Periodic SEGP progress updates to Abilene required (e.g., how are SEGPs implementing advanced applications? *i.e., what projects?*)

SEGP Connectivity Survey Fall 2002

Summary of Results

- ▶ **62% of the state education networks can access the Internet2 backbone network at >155 Mbps**
- ▶ **As of late 2002, there are 25 state K12 / K20 networks participating connecting about 9800 K20 institutions –**
 - 7173 K12 schools (73% of total)
 - 1482 public libraries (15% of total)
 - 551 community colleges (6% of total)
 - 526 four-year colleges and universities (5% of total)
 - 102 museums, zoos, aquariums, and science centers (1% of total)
- ▶ **For more information:**
 - <http://k20.internet2.edu/segp/stateconnect/segpsurvey.shtml>

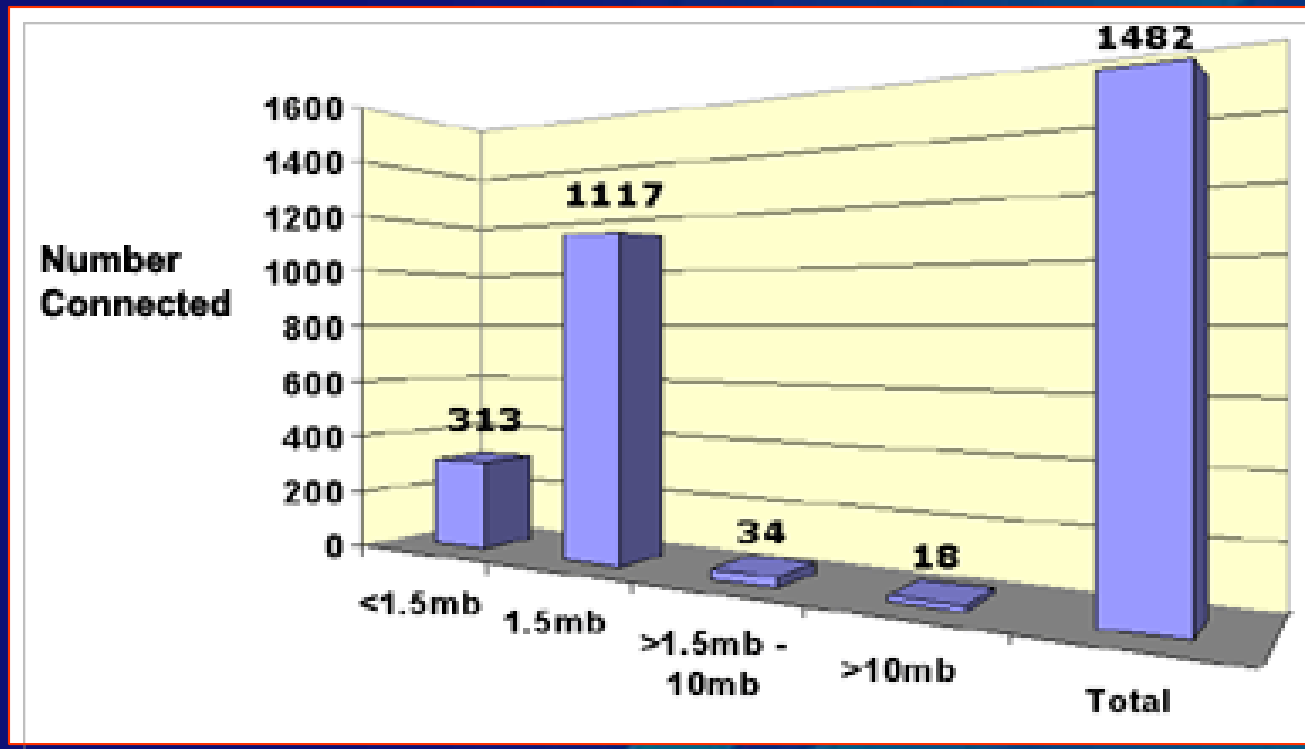


SEGP Connectivity Survey Fall 2002

	<1.5mb	1.5mb	>1.5-10mb	>10mb	Total
K12 Schools	686	4332	957	1198	7173
Community Colleges	11	198	216	126	551
Four Year Colleges and Universities	22	163	116	215	526
Public Libraries	313	1117	34	18	1482
Museums, Zoos, Aquariums, and Science Centers	27	59	10	6	102
Grand Total					3 4

Public Libraries Connected

Internet 2 SEGP Survey Fall 2002



SEGP Connectivity in Ohio Fall 2002

Sponsored Education Group Participants

- ▶ **155 Mbps connection to I2**
- ▶ **Multicast and multi-conferencing enabled**
- ▶ **OARNet Connector**
 - K-12 Connected 0
 - Community Colleges 0
 - Four Year Colleges 14
 - Public Libraries 0
 - Museums, Zoos, Aquariums, Science Centers 1

Ohio 25 SEGP Institutions June 2004

- ▶ Baldwin-Wallace College
- ▶ Cedarville University
- ▶ Central State University
- ▶ Cleveland Institute of Art
- ▶ Cleveland Institute of Music
- ▶ **Cleveland Museum of Art**
- ▶ Denison University
- ▶ Hebrew Union College
- ▶ Heidelberg College
- ▶ Hiram College
- ▶ John Carroll University
- ▶ Malone College
- ▶ Medical College of Ohio
- ▶ Miami University
- ▶ Mount Union College
- ▶ Oberlin College
- ▶ Ohio Northern University
- ▶ Otterbein College
- ▶ Southern State Community College
- ▶ University of Dayton
- ▶ University of Findlay
- ▶ University of Rio Grande
- ▶ Walsh University
- ▶ Xavier University
- ▶ Youngstown State University



Megaconference V

- 187 Institutions
- 28 Countries

SEGPs—New England March 2004

Sponsored Education Group Participants

▶ Four in New England

- State Education Networks:

- RI: Ocean State Higher Education, Economic Development and Administrative Network (OSHEAN)
- CT: Connecticut Education Network (CEN)
- MA: Massachusetts Information Turnpike Initiative (MITI)
- Maine: University of Maine System Network (UNET)

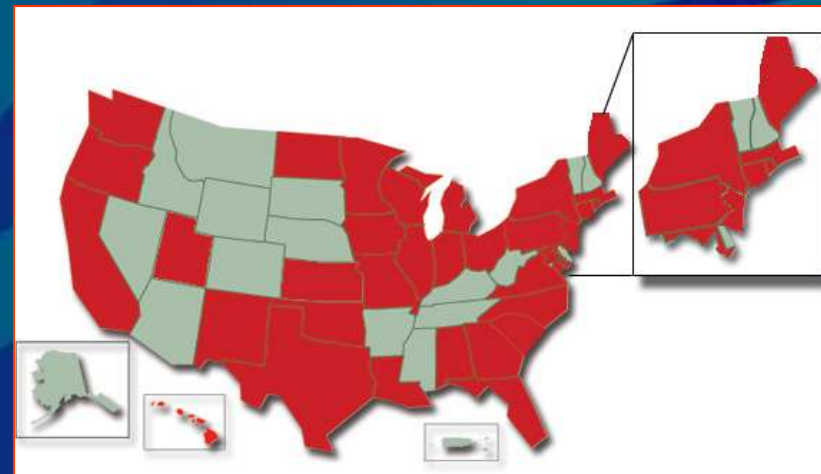
- Connector: Northern Crossroads (NoX), Boston MA

- Sponsors:

- OSHEAN: URI and Brown
- CEN: UCONN and Yale
- MITI: UMASS Amherst

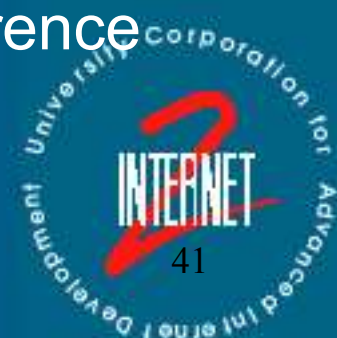
- USA Overall

- 33 SEGPs, 33 States
- 33 SEGP Projects



33 SEGP Projects (March 2004)

- ▶ "English For All" - Cyberstep Project
- ▶ Lewis and Clark Resources
- ▶ myK20 Web Application Development
- ▶ K-12 & University Musical Collaboration
- ▶ K-12 Megaconference "Megaconference Jr."
- ▶ Health Science Career Series
- ▶ Coping with Crisis Coping with Crisis: Effective Strategies for Educating During Difficult Times— an International Virtual Panel
- ▶ World Tour Language Exchange Program
- ▶ National K12 Educational Service Agency Conference
- ▶ North Dakota Lewis & Clark Resource Collection



33 SEGP Projects (March 2004) *continued ...*

- ▶ **Imagining the Future**
- ▶ **Interactive Dialogue with Educators from Across the State (IDEAS) [Wisconsin]**
- ▶ **Lewis and Clark Then and Now: Linking the Trail to America's Students**
- ▶ **Videoconferencing: Germany to UWSP**
- ▶ **Exploring the Future of Learning**
- ▶ **Pacific Lighthouse**
- ▶ **ShowMe The World**
- ▶ **JASON project**
- ▶ **Biotechnology/Bioinformatics Discovery!**
- ▶ **American Sign Language Video-Based Learning Objects**
- ▶ **Virtual Marine World Exploration**
- ▶ **Multicast Streaming from Brazil**
- ▶ **VoIP in Campus**
- ▶ **Virtual College Tour**
- ▶ **Virginia I2-K20 Mini-Conference**
- ▶ **Baltimore Research & Education Network (BERnet)**
- ▶ **TVbyGirls**
- ▶ **4th Grade Social Studies**
- ▶ **The Slide Heard 'Round the World!**

SEGP *Example Project*



- ▶ **Jason Project, Feb-2002:** Virginia 4th - 9th grade students at 6 sites watched the capstone video conference, a live I2 VC between glacial geologists at Chugach National Park, studying the history of glaciers, and wildlife biologists at the Alaska Sea Life Center investigating the Stellar sea lion's eating patterns and how its body uses fat for energy.
 - Local 2-way VC at each of the 6 state sites; local experts led further discussion at each site (e.g., mountain climbers, marine biologists, etc.)
 - 8 Collaborators: VA Tech, I2, Net.Work.Virginia, Jason Project, Science Museum of Virginia, WBRA Public TV, Virginia Community College System, Virginia Department of Education.
- ▶ **New mode for delivery of educational programming**
 - Real-time adds lots of value
- ▶ **Students** saw how classroom concepts were applied, how math is used in scientific research, how English skills are necessary in technical and scientific documentation.
- ▶ **The curriculum comes alive.**
 - This type of environment shows students how subject matters link together.
- ▶ ***You don't get the question of "Why do I need to know this?"***



Applications for Libraries

Lewis and Clark

Then and Now:

Linking the Trail to America's Students

<http://ali.apple.com/lewisandclark/>



- *Live with Lewis* are 20 minute broadcasts emphasizing the Discovery Expedition's current reenactment with comparisons to the original trail. Students will learn about events of the reenactment as well as the geography, history, and culture of the people and places along the trail then and now.
- *Distance Learning Videoconferences* are longer 60-75 minute broadcasts that link students and teachers to experts across the country, and focus on interdisciplinary curriculum related to the expedition.
- *Special Event* broadcasts will feature live coverage of special events in the reenactment.

Applications for Libraries

Biotechnology/ Bioinformatics Discovery!

Partnerships with high schools, community colleges, and biotechnology and biomedical sites to bring high-quality science education to diverse, underserved student populations.

<http://www.okccc.edu/BBDDiscovery>



Applications for Libraries

Virtual College Tour

Through the use of Internet2 K-12 schools are able to IP video conference with colleges on Internet2.

- ▶ Students can meet their potential professors and discuss the university's offerings at length
- ▶ Students gain further insight into the university of interest
- ▶ Students can experience a personal feel for the university
- ▶ Universities can gain a better understanding of what students seek in a college
- ▶ Universities can achieve enhanced outreach and awareness of programs using existing Internet2 technologies

Remote Instrumentation

Real-Time Tele-Operation of Remote Equipment

North Carolina State University

<http://CARL.ce.ncsu.edu/>

Tele-vator is a computerized excavation backhoe that can be remotely operated over Internet2 high-performance networks. Because of its size and potential criticality of operation (e.g., in hazardous rescue situations), Tele-vator requires a high-level of sophisticated two-way feedback, including adequate depth of vision provided via high-definition stereovision. Guaranteed Quality of Service (QoS)—such as network bandwidth, latency (delay) control, and jitter (variability in delay) control—are essential to ensure the quality of the 3D image, audio, and equipment control channels required by Tele-vator's remote operators.





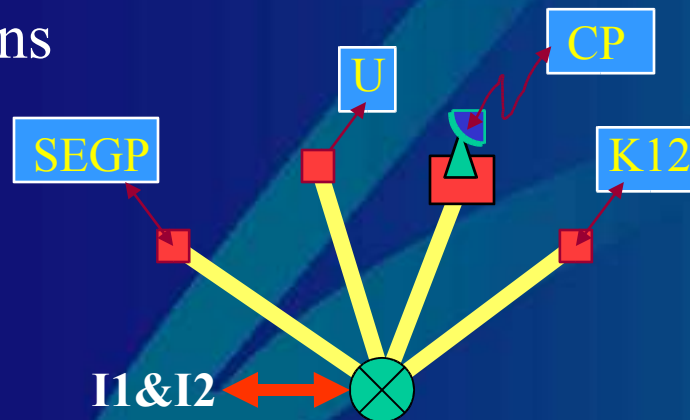
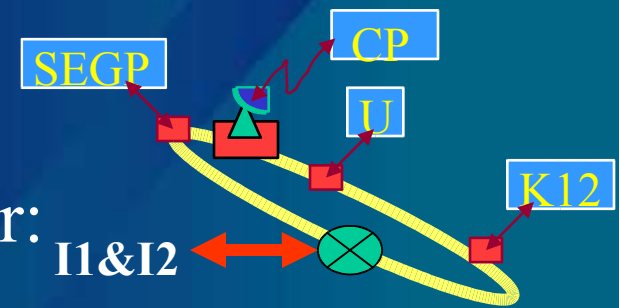
***A success story about collaboration
and network connections!***

***WPI-Internet2 Sponsored
Participants and Projects***

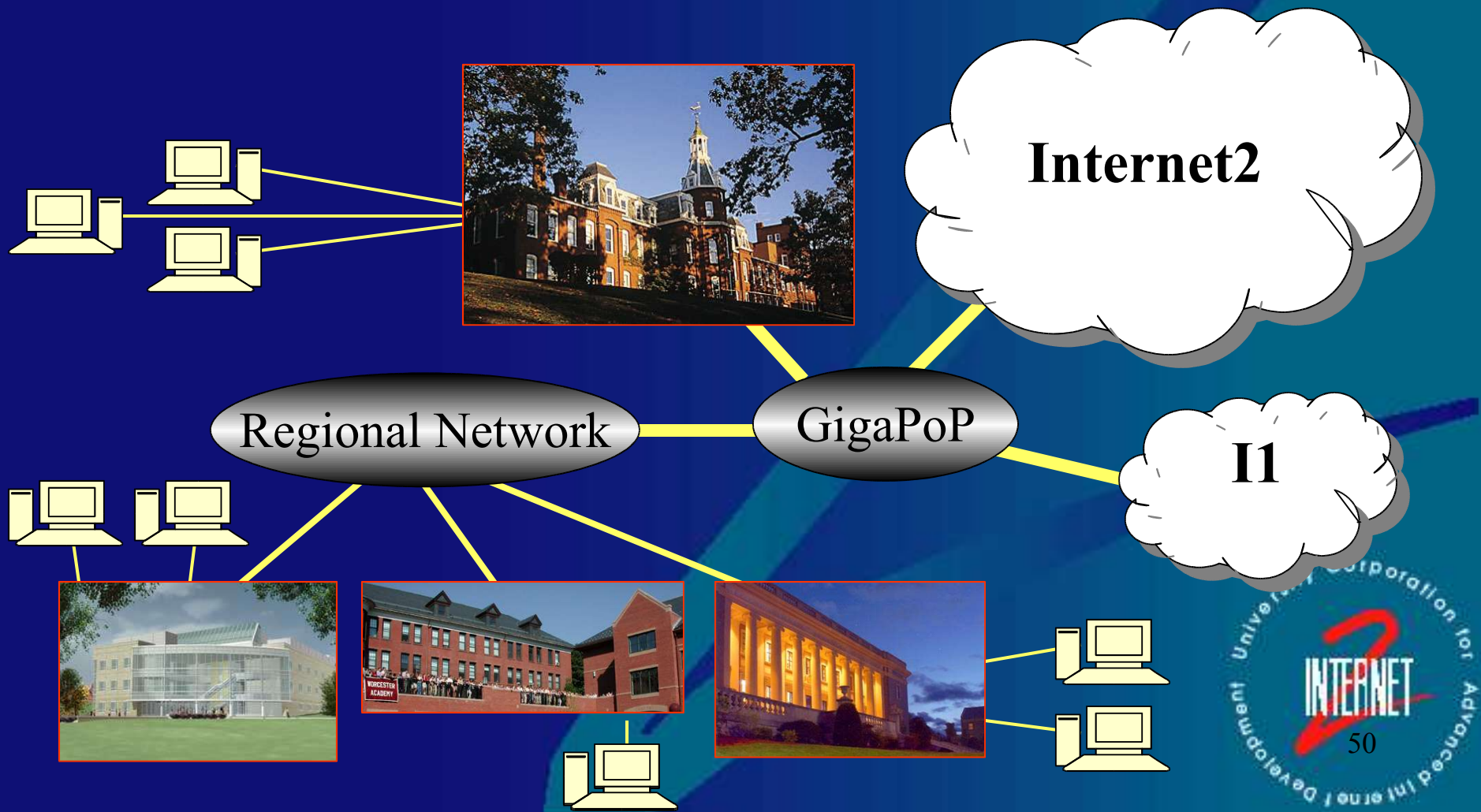


The Worcester MA Story

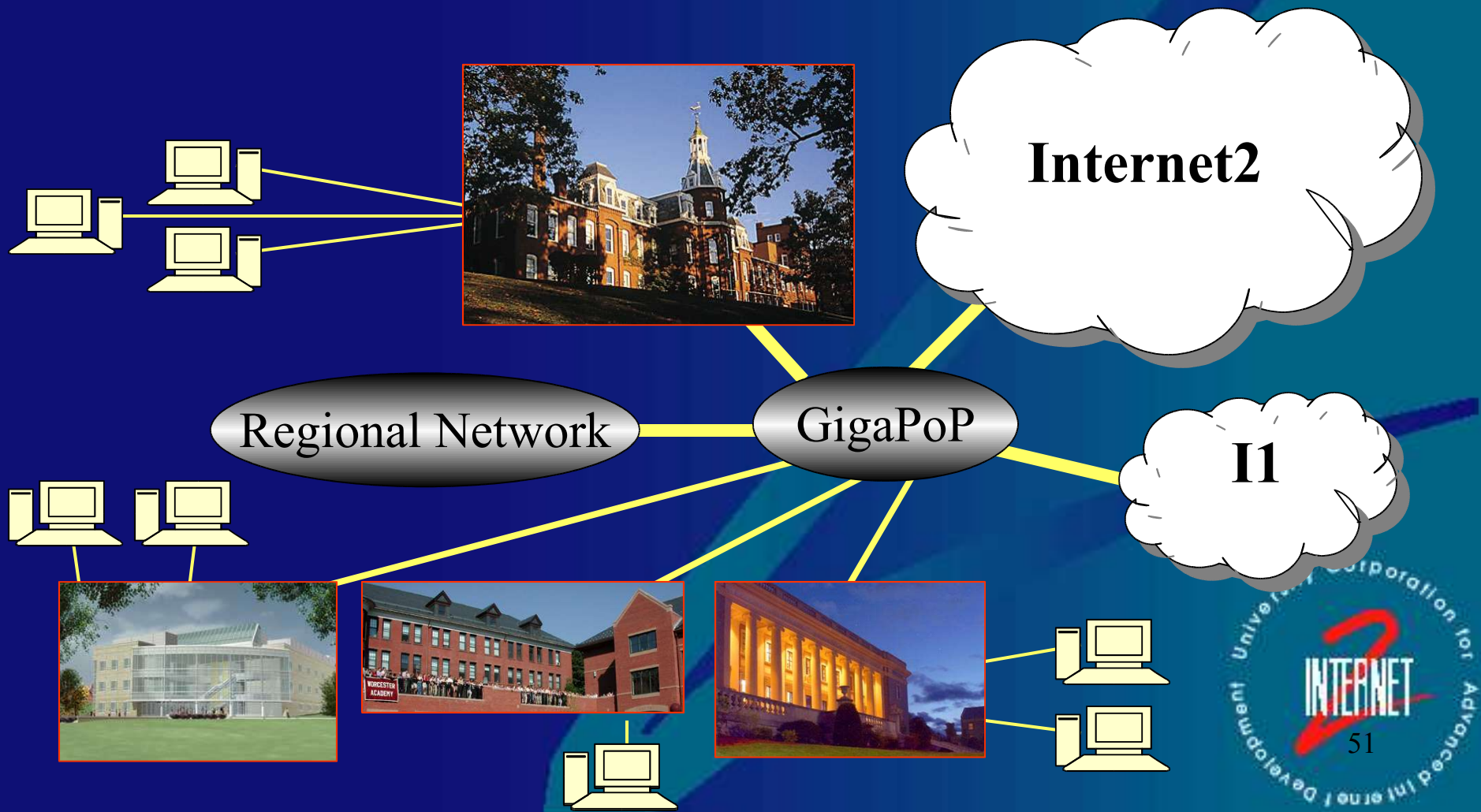
- It was clear that the “fiber-centric” network ring approach was not feasible
- A new approach was needed for:
 - Local access solutions
 - Cost savings
 - Applications



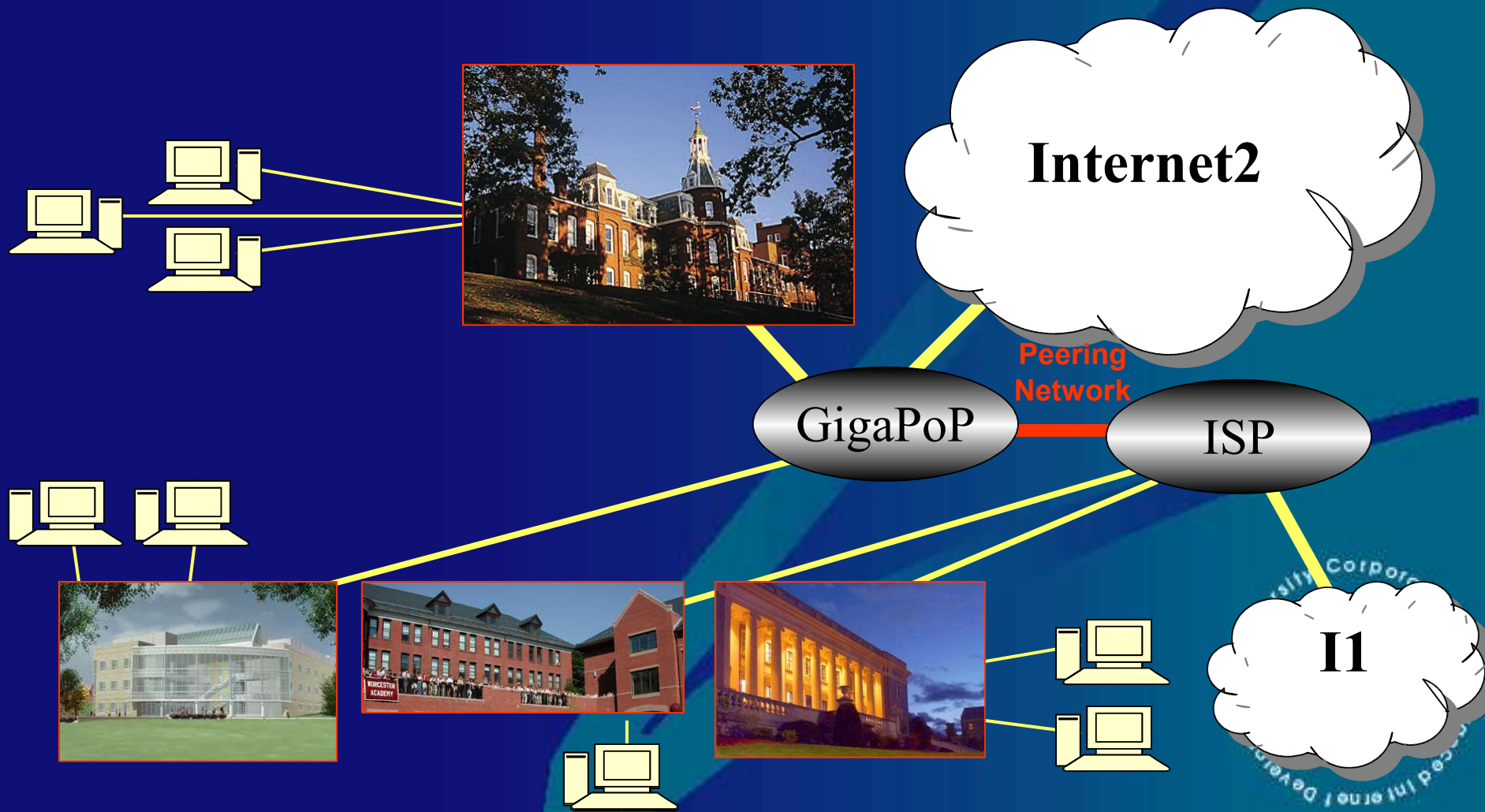
I2—Advanced Worcester Network Infrastructure—Original Plan



I2—Advanced Worcester Network Infrastructure—Actual Connections



I2—Advanced Worcester Network Infrastructure—Peering w/ ISPs



– Members –

Goddard Collaborative 2004

Colleges & Universities

- Assumption College
- Becker College
- Babson College
- Clark University
- College of the Holy Cross
- Mass College of Pharmacy and Health Sciences
- Mount Ida College
- Olin College
- University of Massachusetts Medical School
- Wheaton College
- Worcester State College
- Worcester Polytechnic Institute

Towns

- Town of Needham, MA

Educational Networks

- JASON Foundation for Education
- MEC Technology Systems (MECnet)

K-12 Schools

- Mass Academy of Mathematics and Science
- Shrewsbury Public Schools
- Worcester Academy
- Worcester Vocational High School

Museums & Other Educational Institutions

- American Antiquarian Society
- EcoTarium
- Higgins Armory Museum



Why are we working together?

To build technological infrastructure and to share knowledge and resources

- **Internet2 Connectivity**
- **Collaboration Opportunities**
 - Shared Network Infrastructure
 - Distance Learning & Content
- **Expanding Community Outreach**
 - Colleges and universities
 - K-12
 - Museums
 - Libraries
 - Municipalities
- **Administrative Cooperation**
 - Disaster Recovery
 - Storage
 - Archiving
- **Academic Cooperation**
 - Share unique resources
 - Instructional Technology Support
 - Technology Mediated Learning
- **Leveraging Purchasing Opportunities**
 - Commodity Internet Providers
 - Internet2 Group Access
 - Telecommunications Providers
- **Leverage Resources thru Partnership**
 - Research
 - Services
 - Shared Network Infrastructure
 - Purchasing Opportunities



101 Sponsored Participants

(April, 2004)

- ▶ *Individual educational institutions (non-profit and for-profit) K-20, community colleges, technical and trade schools, museums, **libraries**, art galleries, hospitals that require routine collaboration on instructional, clinical, and/or research projects, or services and content with other I2 participants.*
 - ▶ **WPI has sponsored:**
 - Boston Museum of Science
 - The College of the Holy Cross
 - Assumption College
 - American Antiquarian Society
 - Higgins Armory Museum
 - Merrimack Education Center (MEC)
- Connections via the WPI Goddard I2 GigaPop; NoX is also an option
- ▶ **Each has a set of *collaborative projects***

WPI Goddard I2 GigaPoP *Sponsored Participant Projects*

- ▶ **American Antiquarian Society**
 - Video academic seminar series, digital library, AG broadcasts, K-12 program modules sharing AAS content
- ▶ **Assumption College**
 - Access grid node, data analysis and visualization, pre-lab instrument orientations via video, neurobiology research for minority students, remote conferences with Biosphere II, physics computer simulations, collaborations with Woods Hole
- ▶ **College of the Holy Cross**
 - Genome Consortium for Active Teaching
 - Study abroad teleconferencing
 - Supercomputing with the MERCURY Computational Chemistry Consortium (gas/liquid interface)
- ▶ **Merrimack Education Center (MECnet)**
 - Math and Science distance education program developed by WPI for distribution to 12 school districts; MA-DOE funded
 - Offering Masters in Math for Educators
 - Potential: 250 school districts, 40,000 teachers in MA



WPI Goddard I2 GigaPoP

Sponsored Participant Projects

▶ **Boston Museum of Science**

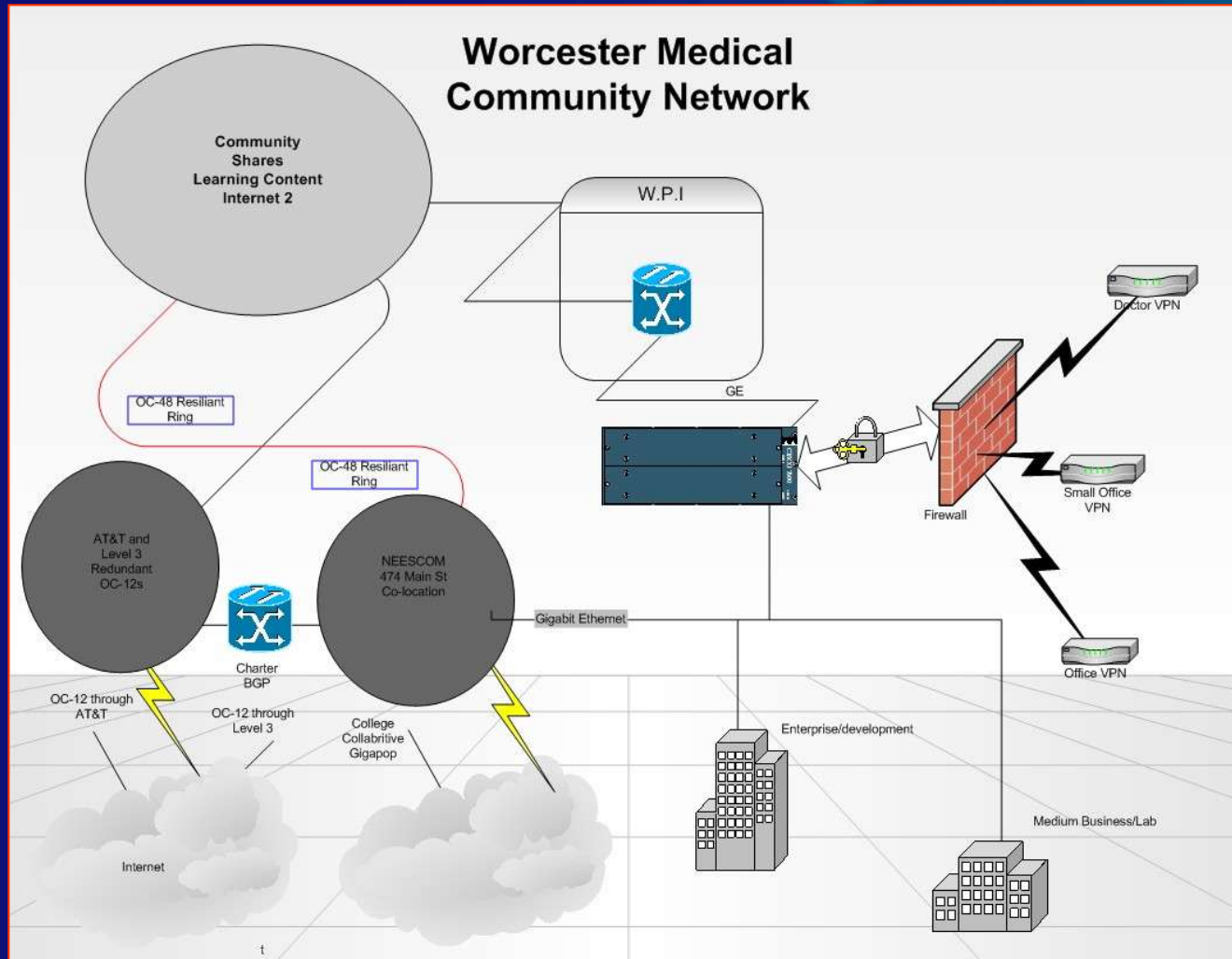
- K-12 distance education programs for science and technology literacy; K-12 teacher resource
- Curriculum design/development and collaboration for K-12 engineering programs; content repository
- Network-accessible, interactive displays and exhibits
- Cheaper, faster I1 and I2 access

▶ **Higgins Armory Museum**

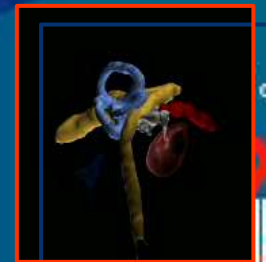
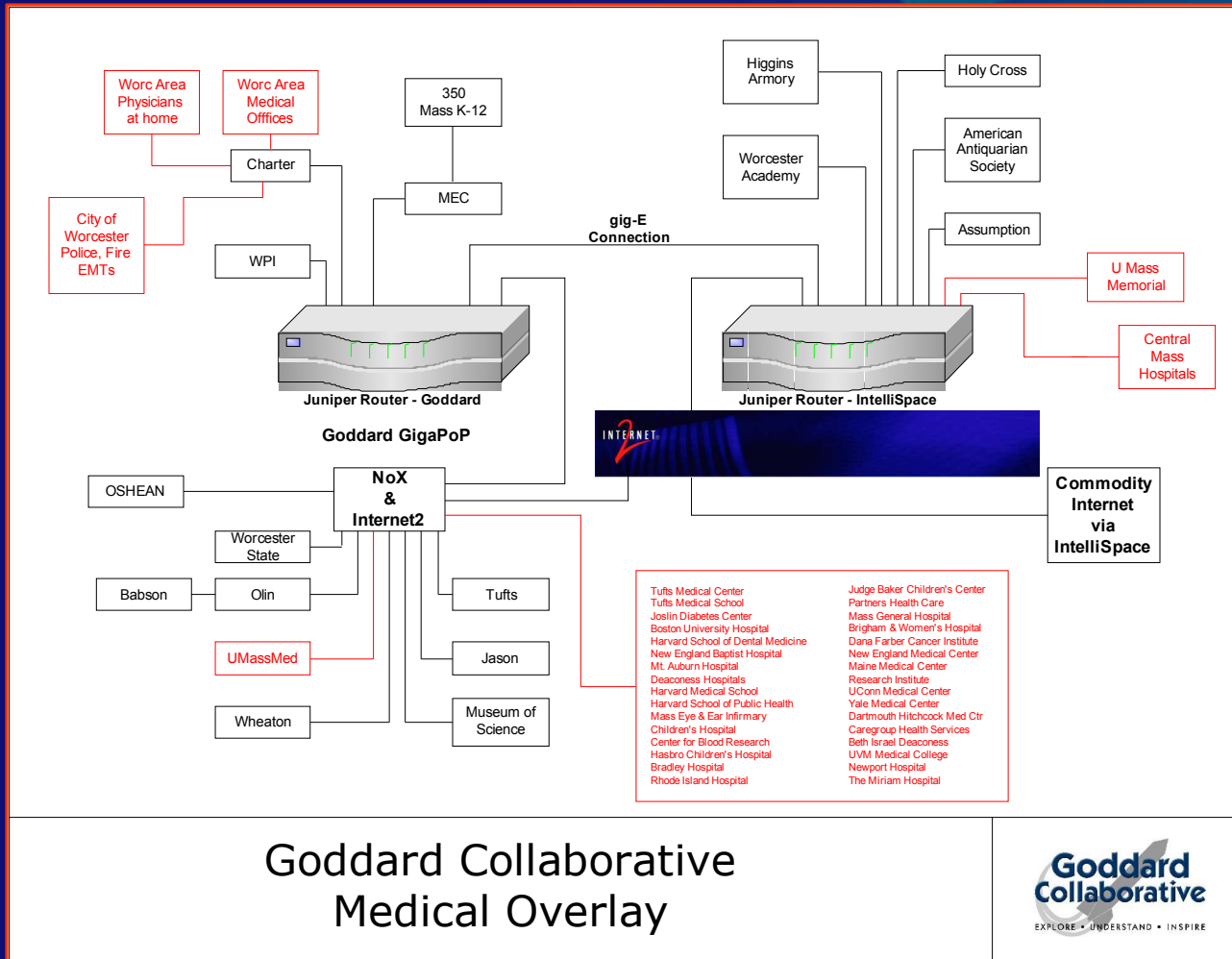
- K-12 education programs in Civics, Government, Economics, and Geography; Cortes, Roman Legionary, Joan of Arc; Virtual visits
- IMLS 3-year grant for world-wide Metals Conservation Summer Research Institute
- Facilitate collaboration with researchers in Austria, France, UK, Sweden, Italy
- Facilitate WPI student projects—virtual exhibitions
- Cheaper, faster I1 and I2 access



Potential for New Relationships



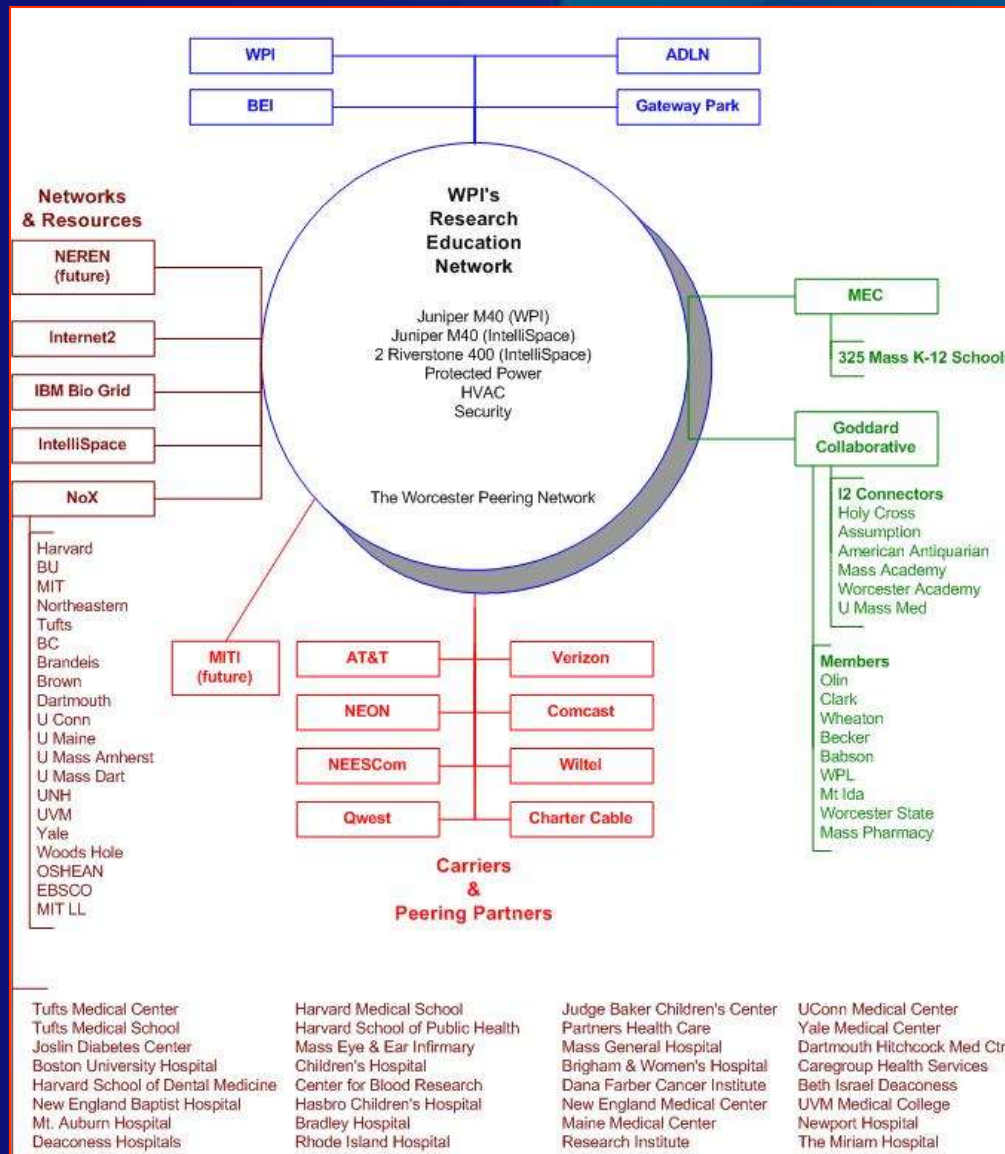
Bonding the Medical Community



Goddard Collaborative
Medical Overlay

Goddard Collaborative
EXPLORE • UNDERSTAND • INSPIRE

WPI Research & Education Network



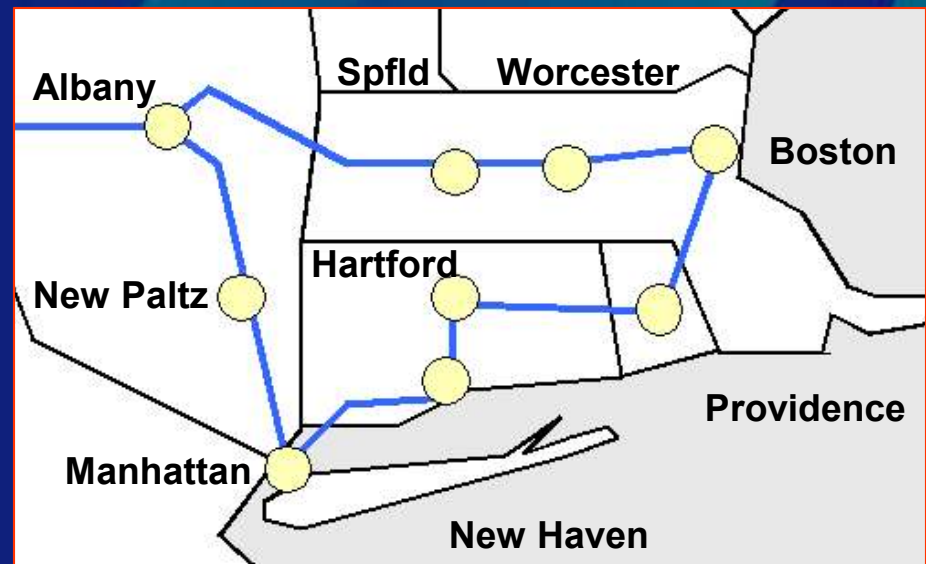
Northeast Research & Education Network (NEREN)

▶ Participants

- NoX, OSHEAN, UConn, UMass, WPI
- NYSERNet
- UCAID FiberCo

▶ Goals

- Position Northeast Region for next generation I2, national optical initiatives such as NLR, USA Waves, and research and grant opportunities
- Enhance capacity for future requirements & services
- Enhance redundancy and diversity
- Share costs & resources



I2 - Digital Libraries

Digital Music Library System

Indiana University

VARIATIONS Project

<http://www.dlib.indiana.edu/variations>

VARIATIONS



Multimedia Digital Libraries

Carnegie-Mellon University

INFORMEDIA II Project

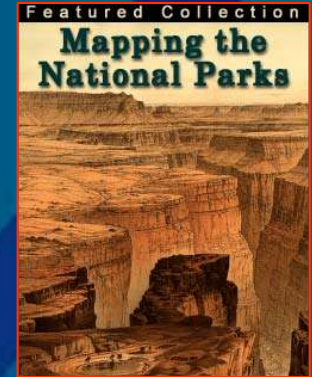
<http://www.informedia.cs.cmu.edu/dli2/>

Automatically combines speech, image and natural language understanding to create a full-content searchable digital video library.



Digital Library Initiatives

- ▶ NSF – NSDL (National Science Technology, Engineering and Math Education Digital Library)
<http://comm.nsdlib.org/>
<http://arxiv.org/ftp/cs/papers/0201/0201025.pdf>
- ▶ Library of Congress – NDLP (National Digital Library Program)
<http://lcweb2.loc.gov>
- ▶ K-12: Library of Congress's The Learning Page
<http://lcweb2.loc.gov/ammem/ndlpedu/>
- ▶ The California Digital Library (CDL) opened its public "digital doors" 1/20/1999 by making available an integrated web gateway to digital collections, services and tools <http://www.cdlib.org>.
 - CDL charge: continue the selection, building, management, and preservation of the University's shared collections of digital resources and apply new technologies to enhance sharing of the physical collections
- ▶ Tibetan and Himalayan Digital Library:
<http://iris.lib.virginia.edu/tibet/frameset.html>



Digital Library Initiatives



- ▶ MIT Research in digital form, including preprints, technical reports, working papers, conference papers, images, and more.
- ▶ As a joint project of MIT Libraries and the Hewlett-Packard Company, DSpace provides stable long-term storage needed to house the digital products of MIT faculty and researchers.
 - **For the user:** DSpace enables easy remote access and the ability to read and search DSpace items from one location: the World Wide Web.
 - **For the contributor:** DSpace offers the advantages of digital distribution and long-term preservation for a variety of formats including text, audio, video, images, datasets and more. Authors can store their digital works in collections that are maintained by MIT communities.
 - **For the institution:** DSpace offers the opportunity to provide access to all the research of the institution through one interface. The repository is organized to accommodate the varying policy and workflow issues inherent in a multi-disciplinary environment. Submission workflow and access policies can be customized to adhere closely to each community's needs.



Digital Library Initiatives



University Libraries

▶ OSU Knowledge Bank

- Diverse sources
 - Reports and presentations
 - Digital projects
 - Knowledge bank repository
 - Related websites and projects
 - MIT DSpace <http://www.dspace.org/>
 - CalTech Open Digital Archives (CODA) <http://library.caltech.edu/digital/>
 - UCal eScholarship <http://escholarship.cdlib.org/>
 - UVA/Cornell Fedora <http://www.fedora.info/>
- Unified access
- Integrated information
- Trusted archive

<http://www.lib.ohio-state.edu/KBinfo/>



Digital Libraries Today

- ▶ **Current research efforts have already demonstrated that the existing commodity Internet can be an effective environment for developing digital library systems.**
 - These efforts include the ARPA/NASA/NSF-sponsored Digital Library Programs, as well as the wide range of operational institutional library systems offering access to online catalogs, abstracting and indexing databases, and primary content, such as journals in electronic formats.
- ▶ **While today's operational systems suffer from reliability and performance problems as a result of shortcomings in the existing Internet, they do not call for substantially higher application-dedicated bandwidth or bandwidth reservation.**
 - They require only that the existing Internet function smoothly and reliably within its current design parameters.
- ▶ **Moreover, many of the hardest problems—intellectual property rights and rights management, and viable economic models for scholarly publishing in the 21st century—are far beyond the scope of any networking infrastructure program.**

Digital Libraries Tomorrow

- ▶ Internet2 offers important opportunities to move the Digital Libraries program into new areas.
- ▶ Very high bandwidth will allow currently exotic materials, such as continuous digital video and audio, to move from research use to much broader use.
- ▶ Images, audio, and video can, at least from a delivery point of view, move into the mainstream currently occupied almost exclusively by textual materials.
- ▶ This will also facilitate more extensive research in the difficult problems of organizing, indexing, and providing intellectual access to these classes of materials.
 - Semantic Web—”An extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation.¹” <http://www.w3c.org>
 - Ray Kurzweil—Language translation, artificial intelligence²

¹Tim Berners-Lee, James Hendler, Ora, Lassila, “The Semantic Web,” Scientific American, May 2001 Web of Data.

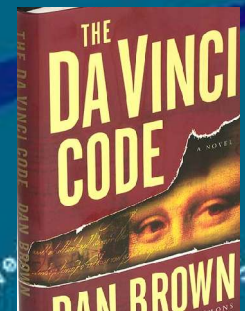
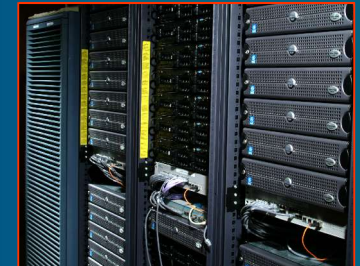
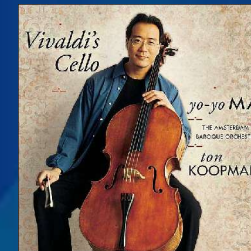
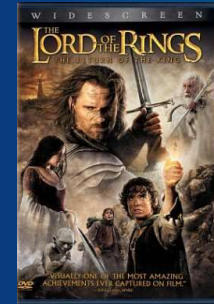
²Ray Kurzweil, The Age of Spiritual Machines, When Computers Exceed Human Intelligence, 1999, Viking, NY, NY.



Challenges for Digital Libraries

Near-term time frame

- ▶ **Technical architecture**
- ▶ **Effective access and content**
- ▶ **Building the resource**
 - Incorporating rapidly changing technologies
 - Acquiring and digitizing analog materials
 - Enhanced cataloging and search tools
- ▶ **Interoperability**
 - Protocols, standards, etc.
- ▶ **Intellectual property and ownership**
 - Rights management, permissions, restrictions, transactions, AUPs, etc.
- ▶ **Sustaining the resource**
 - Production—very costly to create/convert high quality digital content
 - Operation, maintenance and preservation—technical architecture, storage, medium, content—ARCHIVING takes on new dimensions



INTERNET

Predictions for the Future ... Academic Libraries

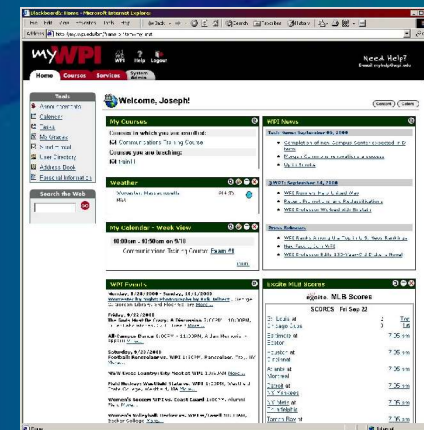
- ▶ Establishing a new definition of the 'canon' of scholarly communication and the library's relation to it re acquisition, selection, organization and management, access and preservation
- ▶ Addressing the problem of acquiring, managing, and preserving the raw materials for future scholarship as these materials become digital and as they diversify in character
- ▶ Finding a new balance between collective, centralized action and local effort
- ▶ Defining the service boundaries of the library in a world where information is dynamic and is manipulated rather than simply presented to the library users
- ▶ Resolving the systemic funding problems in an environment where costs for traditional materials are increasingly unsustainable and where libraries are simultaneously being confronted with the need to invest in the support of a range of non-traditional networked information resources
- ▶ Developing new roles for the library within the academic enterprise to meet the needs of the networked information revolution... teaching information literacy, multimedia authoring, partnerships with info-intensive research projects, support of distance education, stewardship of learning objects...



Educational Technology

Into the library we go ... defining new service boundaries?

- e-books, digital cameras, mobile equipment, etc.
- e-classrooms, computers, networks, tech support
- Videoconferencing, CATV, satellite facilities
- Streaming media / webcasting production and support
- Distance and distributed education tools
- Instructional design and technology support
- **myLibrary** portal and web design
 - **Concept:** User and supplier customizable information source (both push and pull)
 - **Content:** announcements, multimedia files (audio, video, text), course materials (syllabus, assignments, assessments), external web links, ...
 - **Collaboration tools:** threaded discussion groups, shared whiteboard, email lists, ...
 - Integration of learning environment (e.g., Blackboard) and special search tools (e.g., Encompass)
- **Graphic production services—the ARCHIVE**
 - Scanning, photo manipulation, file conversion, 3DVR
 - Creation of virtual objects, graphical images
 - Print, posters, transparencies, file conversion, ...
- **Administrative support for the multimedia resources, computing, networking, storage, ...**
 - Cataloging, indexing, searching, etc.



Information Literacy

The use of information technology will help enable all students to solve problems, improve their personal performance, and gain the critical and abstract thinking skills necessary to become lifelong learners and contributing members of their communities.

To achieve this vision, all Manitoba students will:

- ▶ **use** information technology to structure inquiries, solve problems, and gather, organize, validate, and communicate information on a local and global scale
- ▶ **manage** information technology by making creative, productive, and efficient technology choices for the tasks at hand
- ▶ **understand** information technology and reflect upon the ethics and impact of its use, synthesizing new insights and making reasoned decisions as information technology evolves

Manitoba Information literacy and IT Fluency reference:

http://www.edu.gov.mb.ca/ks4/docs/support/tfs/pdfed_tech.pdf



Why would you join I2 NOW?

- ▶ **Libraries of the future NEED to know and use technology as information growth explodes and information literacy moves to the forefront of our skill sets; It's YOUR future!**
- ▶ **Advance your institution's mission/vision**
 - Differential competitive advantages
 - Innovation is important; Be a player; Prestige; Knowledge; Survival
 - Plan NOW for upgrades, technology acquisition, etc. It takes TIME and \$!
- ▶ **Others have joined ... *the community is forming***
 - 33 SEGPs; 101 Sponsored Participants
 - Somebody else may pay part of your participation fees
- ▶ **Access to the newest, high-performance networking infrastructure and educational applications**
 - Collaboration, remote devices, distance learning, video
- ▶ **Cost containment, bandwidth, quality of service**
 - If more organizations join, the costs can decrease



WPI I2 Networking Video

Illustrate how faculty, research scientists, corporate collaborators, and university administrators are benefiting from I2.

- ▶ **Jim Dittami (remote access, collaboration)**
 - NMR, Worcester State, Med Research
- ▶ **Julie Mullen (comp grid, shared resource)**
 - High Performance Supercomputing
- ▶ **Bob Volkman, Pfizer (corp. collaboration)**
 - National UG Fellows Program
 - Corporate Research Collaboration
- ▶ **Kristin Wobbe (use I2 in classroom/teach)**
 - PET Enzyme Project
 - Web related research; Use of NIH SW programs
- ▶ **Tom Lynch (apps, DV, E2E, MW)**
 - Why I2 is mission-critical to WPI



Internet2 and WPI

Libraries Are Wonderful Places

- ▶ Quiet and contemplative places—but include the children
- ▶ Forward looking while being a repository of the past
- ▶ Collaborative—sharing, caring, friendly
 - Librarians HELP others
- ▶ Trusted agents—due to ethics and values
- ▶ Communicators—crisp and clear
- ▶ Problem solvers—outcomes focused
- ▶ Technical and analytical
- ▶ Excellent management
- ▶ Core values—you know what you stand for
- ▶ Mission—you know why you are here
- ▶ ***Vision for the future—where are you going?***



The Culture of the Future

- ▶ *Keep your current strengths!*
- ▶ *Live your core values, remember and reflect on your mission*
- ▶ **Create vision, embrace change, and BUILD—**
 - **Inspiring vision** and strong/creative leadership to meet extraordinary challenges posed by the future (keep your “common sense”)
 - Demonstrate ROI and SELL and FUND your vision
 - Lots of “WOW Factor” possible through technology—*use it!*
 - Cost control, e-content are pressing challenges
 - **Culture that embraces change**, technology, and can manage them
 - **Organizations with fluidity** in roles as service providers and “choreographers of knowledge”—be able to service a new generation and breed of “customers”
 - Design flexibility into space use; dynamic environment to keep patron interest
 - **IT infrastructure**—you will need more of it—expensive, but mission critical
 - **Collaboration capabilities to build RELATIONSHIPS**
 - Expand your personal network of contacts using new mediums/channels
 - Create proximate and distant public spaces for sharing and human interaction
 - Driving force in a GLOBAL community of knowledge workers
 - **Virtual Reality**—on-line archiving, while expensive now, may be cheaper than space; but... it creates the nasty problem of maintenance and backward compatibility



More Information

▶ **Goddard Internet2 GigaPoP contacts:**

- WPI: Allan Johannesen, GM, aej@wpi.edu (508) 831-5434
- WPI: Tom Lynch, tlynch@wpi.edu (508) 831-6075
<http://www.wpi.edu/Admin/IT>

▶ **Useful Links**

- <http://www.wpi.edu>
- <http://www.goddardcollaborative.org>
- <http://www.internet2.edu>
- <http://k20.internet2.edu/segp>
- <http://www.abilene.iu.edu>
- <http://www.qwest.net>
- <http://www.cise.nsf.gov>
- <http://www.neescom.com>
- <http://www.kurzweilAi.net>
- <http://ocw.mit.edu>

WPI

Goddard Collaborative

UCAID and Internet2 Project

Internet2 SEGP Project

Abilene Network Operations Center

Abilene Internet2 Network

NSF advanced networking grants

NEESCom, New England dark fiber provider

Ray Kurzweil's futuristic viewpoints

MIT Open Courseware Initiative



Manitoba Information literacy and IT Fluency reference:

http://www.edu.gov.mb.ca/ks4/docs/support/tfs/pdfed_tech.pdf

