Internet2 and Education
at Cal Poly SLO

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Acknowledgements

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Overview Internet2 and Education

- Motivation
- Objectives
- Internet2
  - Structure and Organization
  - Network
  - International Connections
  - Important Topics
- Internet2 and Education
  - K-20 Community
  - Educational Activities
- Internet2 at Cal Poly
  - Overview
  - I2 Champions
  - Activities
- Chapter Summary
Internet2 Overview
Internet2 Mission and Goals

*Internet2 Mission*

- Develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow’s Internet.

*Internet2 Goals*

- Enable new generation of applications
- Re-create leading edge R&E network capability
- Transfer technology and experience to the global production Internet
What We Do........

• We provide our members with an environment for partnerships and collaborations in advanced networking:
  • Among themselves and with faculty and research peers
  • With other partners: International, Federal agencies, K20 School networks, the Quilt
  • Applications Collaborations: high energy physicists, arts & humanities, health science, teaching and learning
Internet2 Partnerships

Internet2 fosters the partnerships and collaboration that spurred the development of the Internet.

- Academia
- Industry
- Government
- International
Internet2 Network

Internet2 Communities

<table>
<thead>
<tr>
<th>04/07</th>
<th>Member Community</th>
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<tbody>
<tr>
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<td>Affiliate Members</td>
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<td>Regional Network Members</td>
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</tr>
<tr>
<td>54</td>
<td>International MoU Partners (reaching 80+ networks)</td>
<td>56</td>
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</tbody>
</table>

Network Community

32 Connectors
Internet2 Universities
212 University Members

http://members.internet2.edu/university/universities.cfm
K20 Initiative
K20 Initiative

Brings together Internet2 member institutions and innovators from primary and secondary schools, colleges and universities, libraries, and museums to extend new technologies, applications, middleware, and content to all educational sectors

http://k20.internet2.edu/
Lewis and Clark: Then and Now

http://ali.apple.com/lewisandclark/
JASON

http://www.jason.org/
Digital Learning Commons

The Digital Learning Commons—Thousands of the best educational resources. One click away.

http://www.learningcommons.org/
NEPTUNE

http://www.neptune.washington.edu/
Internet2 Network

Outline

• Network Community
• Network Overview
• Services
Internet2 Network

By the Numbers

• Built on dedicated fiber from Level(3) Communications – 13,000+ mile footprint
• Deployed and configured over 300 Infinera Network Elements
• Day 1 capacity of 100Gbps
• Built 27 custom collocation suites representing 3,365 sqft of space including:
  • 91 Racks - Internet2, ESnet, third-parties
  • 60 Individual bulk cables with 48 & 96 fiber count
• Internet2 and ESNet NOCs get same, real-time feeds as the Level(3) NOCs in Atlanta & Denver
• Developed the Virtual Network Operations Center – Provisioning and Troubleshooting Dashboard
Internet2 Network
### Europe–Middle East
- Austria (ACOnet)
- Belgium (BELNET)
- Croatia (CARNet)
- Czech Rep. (CESNET)
- Cyprus (CYNET)
- Denmark (Forskningsnettet)
- Estonia (EENet)
- Finland (Funet)
- France (Renater)
- Germany (G-WIN)
- Greece (GRNET)
- Hungary (HUNGARNET)
- Iceland (RHnet)
- Ireland (HEAnet)
- Israel (IUCC)
- Italy (GARR)
- Latvia (LATNET)
- Lithuania (LITNET)
- Luxembourg (RESTENA)
- Malta (Univ. Malta)
- Netherlands (SURFnet)
- Norway (UNINETT)
- Poland (POL34)
- Portugal (RCTS2)
- Qatar (Qatar FN)
- Romania (RoEduNet)
- Russia (RBnet)
- Slovak (SANET)
- Slovenia (ARNES)
- Spain (RedIRIS)
- Sweden (SUNET)
- Switzerland (SWITCH)
- United Kingdom (JANET)
- Turkey (ULAKBYM)
- *CERN

### Asia–Pacific
- Australia (AARNET)
- China (CERNET, CSTNET, NSFCNET)
- Hong Kong (HARNET)
- Japan (SINET, WIDE, JGN2)
- Korea (KOREN, KREONET2)
- Singapore (SingAREN)
- Philippines (PREGINET)
- Taiwan (TANet2, ASNet)
- Thailand (UNINET, ThaiSARN)

### Americas
- Argentina (RETINA)
- Brazil (RNP2/ANSP)
- Canada (CA*net)
- Chile (REUNA)
- Mexico (Red-CUDI)
- United States (Abilene)
- Peru (RAAP)
- Venezuela (REACCIUN-2)

### Africa
- Algeria (CERIST)
- Egypt (EUN/ENSTIN)
- Morocco (CNRST)
- Tunisia (RFR)
- South Africa (TENET)

### Central Asia
- Armenia (ARENA)
- Georgia (GRENA)
- Kazakhstan (KAZRENA)
- Tajikistan (TARENA)
- Uzbekistan (UZSCI)
Internet2 Network

International Connectivity

PacWave: TANet2/TWAREN, AARnet, KOREN/KREONet2, CA*Net4, GEMNET, REANNZ, TransPac2

PacWave: UNINET, SINET, QatarFN, APAN/TransPac2 TANet2/TWAREN, SingAREN

GLORIAD, France Telecom (v6), TANet2/TWAREN, HARNET, CERN

StarLight: KOREN/KREONet2, CA*Net4, ASNet, CERN, JGN2, SINET

NGIX-Ames: AARnet

NGIX-East: CLARA

AtlWave: FIU

MAN LAN: TANet2/TWAREN, TENET, MCIT/ENERGI, QatarFN, CA*Net4, SURFNet, CERN, GEANT (2), SINET, NetherLight/IEEAF

redCLARA, CUDI via CALREN/PacWave

CUDI via UTEP / UT

AMPATH: RNP2, ANSP, REACCIUN-2

Saturday, March 15, 2008
US-based International Exchange Points

- **PacificWave-N**
  Seattle, WA

- **PacificWave-Bay Area**
  Sunnyvale, CA
  Palo Alto, CA

- **PacificWave-S**
  Los Angeles, CA

- **StarLight**
  Chicago, IL

- **AMPATH**
  Miami, FL

- **NGIX-East**
  College Park, MD

- **MAN LAN**
  New York, NY
US-based International Exchange Points

- PacificWave-N
  Seattle, WA
- PacificWave-Bay Area
  Sunnyvale, CA
  Palo Alto, CA
- PacificWave-S
  Los Angeles, CA
- StarLight
  Chicago, IL
- MAN LAN
  New York, NY
- AtlanticWave
  Distributed across
  MAN LAN, NGIX-East, SOX, AMPATH
- AMPATH
  Miami, FL
- NGIX-East
  College Park, MD
Internet2 International Relations Resources

• ~1FTE Director – Heather Boyles
• ~.33 FTE Program Coordinator – Jocelyn Gerich
• Work across organization to engage technical, operational, discipline engagement staff in engaging in and supporting international collaborations
• Community volunteers chair, lead SIGs and SIG interest areas
Middleware

Renee Woodten Frost
Associate Director, Middleware & Security
rwfrost@internet2.edu
Integrated Systems Model

Motivate

APPLICATIONS

E2E PERFORMANCE

MIDDLEWARE

PROTOCOLS

NETWORKS

Enable
Middleware Infrastructure

• Focus:
  • Inter-institutional collaboration
  • Scalable authenticated/authorized access to remote resources

• Internet2 role:
  • Defining/creating architecture: Shibboleth
  • Tools to implement: Shibboleth, Grouper, Signet
  • Infrastructure/Services to scale: InCommon, USHER
Role of the Federation

1. Agreed upon Attribute Vocabulary & Definitions:
   EduPerson: Member of, Role, Unique Identifier, …

2. Criteria for IdM practices (user accounts, credentialing, etc.), personal information stewardship, interoperability standards, technologies

3. Digital Certificates

4. Trusted “notary” for all universities and partners

5. and… Metadata
International Research & Education Federations

- Mature in many countries, including UK, France, Germany, Switzerland, Netherlands, Norway, Sweden, Spain, Denmark, Australia, etc.
- Most are Shibboleth-based; some use other federation products
- Scope is usually higher ed, but some are broader (UK, Spain, Netherlands)
- Use cases range from content access to collaboration support to learning management systems to wireless roaming.
Security
Relationship between Middleware and Security

- Middleware = well-defined infrastructure layer
- Security = more like an attitude, not crisply defined, spans all layers
Near-term Initiatives
Computer Security Incidents (CSI2)

• A development working group, chaired by Chris Misra, UMass
• Working closely with REN-ISAC at Indiana U
• Funded in part by Dept of Justice grant
• Facilitating secure exchange of real-time security information; aimed at incident handlers
• Augmenting the diminishing value of signature analyses (due to encrypted attacks) with statistical analyses
Near-term Initiatives
Disaster Planning & Recovery

• Explore
  • contingency planning;
  • developing & testing recovery plans, policies, & procedures;
  • Warm/hot site strengths, weaknesses, potential pitfalls;
  • contractual & SLA models and guidance for

• Develop set of best practices & services

Chaired by Don McLeod, Cornell
Physicists are generating Terabytes of data (1,000,000,000,000 or 1x10^{12}) per experiment from the CERN lab in Switzerland.

Types of network usage:
- Bulk data transfers
- multicast and low-latency/jitter networks for effective video conferencing
NEES – Earthquake Research

• Remote control of computer simulations
• Video is crucial for conferencing and as scientific data
• Types of network usage:
  • Remote control of resources
  • Bulk data transfer and distributed data storage
  • Video as data
VLBI

- Astronomers collect data about a star from earth based antennae.
- End goal is to send data at 1Gb/s from over 20 antennae located around the globe.

Types of network usage:
- Long time duration data streaming
- Distributed data storage, real-time dynamic retrieval, and distributed processing
Shoah Foundation Institute
For Visual History and Education

• A 180 terabyte multimedia archive of Holocaust testimonies
• Currently being accessed by
  • University of Southern California
  • Rice University
  • Yale University
  • University of Michigan
Master Classes

Active involvement...

- Columbia University
- Manhattan School of Music
- Cleveland Institute of Music
- New World Symphony
- Curtis Institute of Music
- University of Michigan
- Eastman School of Music
- University of Oklahoma
- Florida State University
- Wayne State University
- Indiana University
- And many others......
Key Health Science Members

• 112 Academic Medical Colleges (AAMC) and their medical centers
• 130 Health Science related colleges
  • Public Health, Nursing, Dentistry, Pharmacy
• Affiliate Members
  • NIH, NSF, NASA, NOAA
  • Howard Hughes Medical Institute
• Pharmaceutical Companies
  • Johnson & Johnson, Pfizer, Eli Lilly
• Industry
  • Cisco, IBM, Microsoft, SUN, Polycom, Haivision
• Partnership with Health Information Management Systems Society (HIMSS)
Comparisons must be made across several image sets.

Slide courtesy of Arthur Toga (UCLA)

Volume sizes by resolution:
- brain = 1500 cm³

GB = Gigabyte = 10⁹
TB = Terabyte = 10¹²
PB = Petabyte = 10¹⁵

<table>
<thead>
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<th>Voxel size</th>
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<th>High res (2 B/p)</th>
<th>Color (3 B/p)</th>
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<td>3 KB</td>
<td>4.5 KB</td>
</tr>
<tr>
<td>mm</td>
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<td>3 MB</td>
<td>4.5 MB</td>
</tr>
<tr>
<td>10 μm</td>
<td>1.5 TB</td>
<td>3 TB</td>
<td>4.5 TB</td>
</tr>
<tr>
<td>μm</td>
<td>1.5 PB</td>
<td>3 PB</td>
<td>4.5 PB</td>
</tr>
</tbody>
</table>
Research Team of the Future:
Cancer Biomedical Informatics Grid

- Global Cancer Research Community
- Grid deployment to Cancer Centers
- Bioinformatics infrastructure
- Public data sources

Funded by: NCI/NIH http://cabig.nci.nih.gov/
Cyberinfrastructure

Russ Hobby, Internet2
Internet2 Member Meeting
8 October 2007
The Nature of Research Today

- Discipline groups working on a common project.
- The groups are made of researchers from multiple institutions.
- They use the network in support of Virtual Organizations (VOs)
The Network is the Backplane for the Distributed CI Computer

- Instrumentation
  - Control
  - Data Generation
  - Security
- Management Security and Access
  - Access Control
  - Authentication
  - Authorization
- Computation
  - Analysis
  - Simulation
  - Program
- Data Sets Storage
  - Input
  - Archive
  - Schema Metadata
  - Ontologies
  - Data Directories
- Researcher
  - Security
  - Program
  - Control
  - Viewing
- Policy and Funding
  - Funding Agencies
  - Resource Providers
  - Campuses
- Human Support
  - Help Desk
  - Collab Tools
  - Publishing
- Network
  - 3D Imaging
  - Display Tools
  - Data Input
  - Security
- Display and Visualization
  - Education and Outreach
  - Training
  - Publishing
Traditional Grid Computing

- Built by Supercomputer Sites or in Researcher’s Labs
- Support internal to discipline
- Campus IT generally not involved
- There have been problems with facilities in researcher’s labs (power, HVAC, network)
More Info:
Membership – Marianne Smith
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Network – Heather Martinson
heather2@internet2.edu
Middleware – Renee’ Frost
rwfrost@internet2.edu
Discipline Communities – Ann Doyle
adoyle@internet2.edu
Cyberinfrastructure – Russ Hobby
rdhobby@internet2.edu
Internet2 at Cal Poly

- Overview
- I2 Activities
How Cal Poly Connects to I2

Cal Poly Backbone (1 GB/S)

Pipe to ISP in LA (622 MB/S)

Abilene I2 Network

To I2 Network (2.2 GB/S)

CalREN Network

To Commercial Internet (slow)

http://www.i2.calpoly.edu/
Internet2 and Education

- videoconferencing and tele-collaboration
  - guest speakers in classes
  - joint classes or projects between different campuses
- remote access
  - special-purpose equipment
    - shake table
    - Cal Poly Avila pier
    - Swanton Pacific ranch [http://www.spranch.org](http://www.spranch.org)
- large data sets
  - GIS
- real-time computation
Internet2 Activities at Cal Poly

- Internet2 Champions
- Internet2 Mini-grants
- Internet2 in Teaching
  - Interlude: David Gillette
- Internet2 in Applied Research
  - Interlude: Foaad Khosmood
  - Pointer: Presentation by Michael Haungs and Rollin Strohman later today
- Experiences
- Future Work
Internet2 Champions

❖ established in March 2002
❖ more details http://www.i2.calpoly.edu/
❖ representatives from each college and ITS
❖ dissemination of information within the colleges
   ❖ education of faculty and staff about the capabilities of Internet2
❖ identification of people with suitable interests and applications
   ❖ find people who may have a problem that Internet2 can help solve
   ❖ e.g. GIS server, access to Avila pier laboratory
❖ interest groups
   ❖ video conferencing, GIS, remote collaboration
Experiences Internet2 Champions

❖ good for dissemination, coordination purposes
❖ direct personal contact seems to work best
  ❖ e.g. presentations at department meetings, brown-bag lunches
❖ substantial commitment required
❖ newer faculty seem to be more open to the use of Internet2
❖ interest groups only work if people have significant related activities
Internet2 Mini-grants

- Cal Poly internal
  - supported by a grant from the Office of Naval Research, Cal Poly’s Office of Research and Graduate Programs, and Cal Poly’s ITS dept.
- relatively small grants
  - to help faculty and students get started with Internet2
  - use Internet2 for existing projects
- first phase in Spring/Summer 2003
  - 7 projects funded
- second phase for the 2003-04 academic year
  - 6 projects, funding started in May 2004
Ongoing Internet2 Mini-grants

- Pest Control Advisor Continuing Education Conference
  - Neal A. MacDougall, Agribusiness Department and Sustainable Agriculture Resources Consortium (SARC)
- Testbed for Internet2 Applications
  - Michael Haungs, Computer Science Department
- Objective Networks Collaboratory
  - Fred Abler, Landscape Architecture Department
- Real-Time Searching on Internet2
  - Foaad Khosmood, Franz Kurfess, Computer Science Dept.
- Virtual Team Collaboration Using Internet2
  - Brett M. Johnson, Franz Kurfess, Computer Science Dept.
- Lumiere Ghosting and CompuObscura
  - David Gillette, English, and Enrica Lovaglio, Art & Design Dept.
Franz Kurfess: Internet2 and Education

Internet2@Cal Poly Video Documentary

❖ one of the Internet2 mini-grants
❖ produced by two computer science students, Jordan Small and Aaron Peckham, during the Spring and Summer 2003 terms
❖ total length about 23 min from about 11 hours footage
❖ Canon ZR-30 digital video camera, Apple iMovie and Final Cut Pro 3 software on a dual CPU 1 GHz G4 Apple computer
❖ in total about 60 GB project files
❖ on the Web in high, medium, low versions at

http://mediaserver.calpoly.edu/Engineering/Computer_Science_Department/fkurfess

or directly to the Quicktime movies

http://mediaserver.calpoly.edu/Engineering/Computer_Science_Department/fkurfess/internet2_high.mov
http://mediaserver.calpoly.edu/Engineering/Computer_Science_Department/fkurfess/internet2_mid.mov
http://mediaserver.calpoly.edu/Engineering/Computer_Science_Department/fkurfess/internet2_low.mov
Pest Control Advisor Continuing Education Conference

❖ Neal A. MacDougall, Agribusiness Department and Sustainable Agriculture Resources Consortium (SARC)

❖ SARC organizes an annual continuing education “Sustainable Agriculture PCA Conference”

❖ the minigrant is used to explore the possibility of expanding the conference by making presentations and material available via Internet2

❖ technical aspects
❖ organizational aspects
❖ acceptance by the participants
Internet2 Course

❖ seminar-style course offered in Spring 2003
❖ guest lectures featuring speakers from
  ❖ Internet2 consortium
    ❖ Ann Doyle, Charles Yun, Doug van Houweling,
  ❖ CENIC
    ❖ Dave Reese
  ❖ Cal Poly
    ❖ Rosemary Bowker, Jerry Hanley, Johanna Madjedi,
❖ excursion to CENIC meeting in Santa Barbara
❖ student projects
  ❖ Internet2 @ Cal Poly video documentary, virtual collaboration tools, library services, satellite control, optical transmission technology
Testbed for Internet2 Applications

- Michael Haungs, Computer Science Department, Cal Poly SLO
- collaboration between Cal Poly and UC Davis
- the distributed nature of net-based applications makes testing very challenging
  - acquisition and configuration of remote resources
  - software distribution
  - scheduling of the experiments
  - analysis of the results
- the testbed provides an environment that allows the developer to concentrate on the application
- possible use in networking, distributed systems classes
Objective Networks

- Fred Abler, Department of Landscape Architecture, Cal Poly SLO, in collaboration with Penn State and Cuesta College
- Enhancement of a server for 3D architectural engineering and construction component objects (models)
  - Mainly conversion of the existing system from commodity Internet to Internet2
- Component objects contain rather detailed information about architectural models
  - Geometry, texture, attributes, behaviors
- Their use quickly results in high bandwidth needs
- Used in architecture classes
Virtual Team Collaboration

- Brett Johnson and Franz Kurfess, Computer Science Dept., Cal Poly SLO
- Geographically dispersed teams require more than simulated face-to-face communication
  - Application sharing, remote window display, collaborative editing, shared file systems, archiving of meetings
  - Systems and applications are available that satisfy some, but not all of these aspects
- Design of a collaboration framework and protocols to integrate multiple applications and systems
- Development of a proof of concept prototype
David Gillette, English Dept., and Enrica Lovaglio, Art & Design Dept., Cal Poly SLO

Lumiere Ghosting refers to the process of image-based cultural transmission, interaction, and transformation

- intermixing of prerecorded video images with a live video and motion tracking system so that a live subject can interact with the recorded video

CompuObscura is a virtual space for such interactions

- much of the material was developed and used in a class
Real-Time Searching on Internet2

❖ Foaad Khosmood and Franz Kurfess, Computer Science Dept., Cal Poly SLO
❖ in some situations, cached search results are not sufficient
❖ time-sensitive information requires real-time (online) search capabilities
❖ not realistic with commodity Internet
❖ design and implementation of a prototype real-time search engine
❖ queries target sites, evaluates and ranks the results, and displays them to the user on the fly
Cal Poly Avila Pier

- formerly used by Unocal as oil terminal, it was donated to Cal Poly in 2002
  - more info at http://www.marine.calpoly.edu (partially complete) and http://polyland.lib.calpoly.edu/topics/florafauna/studentsites/2003a/
- team-taught marine biology course together with Rutgers University, and a Florida university
  - live field trips with remotely controlled submersibles in three different ecosystems (sandy continental shelf, coral reefs, rock coast)
- joint research involving shared real-time environmental data from a network of sensors combined with satellite images
Experiences Internet2 Mini-grants

- currently in its second year, third year in preparation
  - 6-7 projects/year funded
- excellent incentive for the exploration or integration of Internet2 capabilities
- springboard for more substantial projects with major funding agencies
  - two NSF Course, Curriculum, and Laboratory Initiative (CCLI) proposals as an outcome of the mini-grants
  - several other proposal with a significant role for Internet2
- good opportunity to get students involved
  - so far about 20 students have been involved
  - several senior projects and Master’s thesis
- better coordination of follow-up activities
  - presentations to Internet2 champions, other interested groups
  - collection of information about related projects
Conclusions

❖ teaching-oriented institutions can make good use of Internet2
  ❖ enhancement of teaching activities, better learning experience
❖ a core group of people across the institution is critical
  ❖ disseminate information, scout out opportunities, coordinate activities
❖ student involvement provides additional benefits
  ❖ students may be more curious about new technology
  ❖ some innovative project proposals were initiated and written by students
  ❖ utilize academic incentives (courses, credit)
❖ administrative and budgetary constraints may interfere
  ❖ extra effort for new activities
  ❖ access to critical resources
    ❖ classroom with videoconferencing, Internet2 capabilities
  ❖ difficult to support such initiatives with tighter budgets