



Internet2: An Overview

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GEMnet2 Symposium
International Collaborations
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- Introduction
- Quick Internet2 Overview
 - Organization
 - Program areas
 - Infrastructure
- International partnerships



Internet2: organization and goals

- Internet2's mission is to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet
- Who we really are
 - Membership organization of 200+ US research universities
 - Parent 501.3c (UCAID) has board of university presidents
 - Project supported by numerous partnerships (government, industry, international)
- Goals
 - Enable new generation of applications
 - Re-create leading edge R&E network capability
 - Transfer capability to global production internet



Internet2 Growth

■ 1996

- Project created as a collaboration among 34 leading research universities

■ 1997

- Over 100 university members, first corporate memberships, formally incorporated as a not-for-profit organization

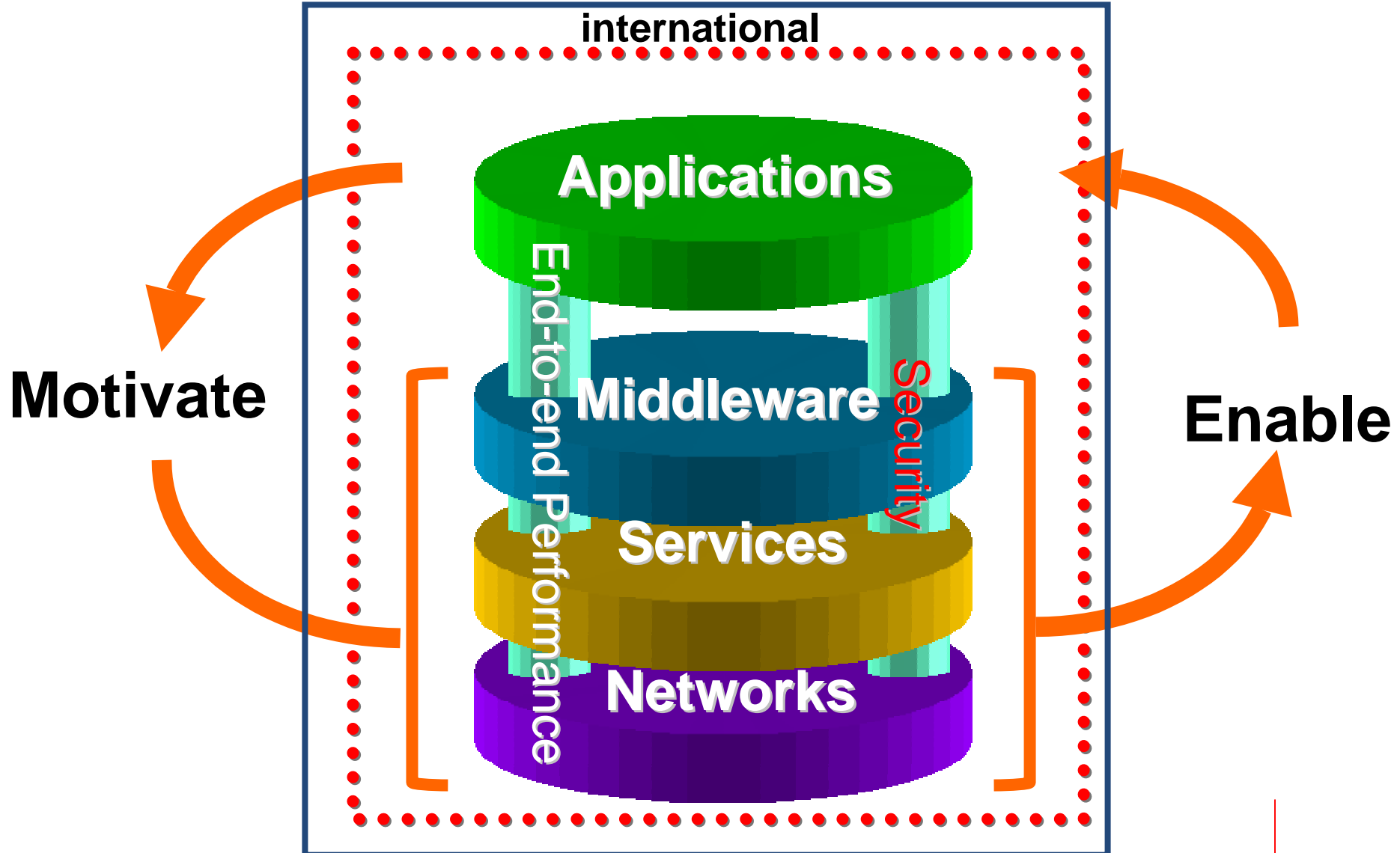
■ 1998

- 123 university members, 30 corporate members, 22 affiliate members, over 10 international partners

■ Today

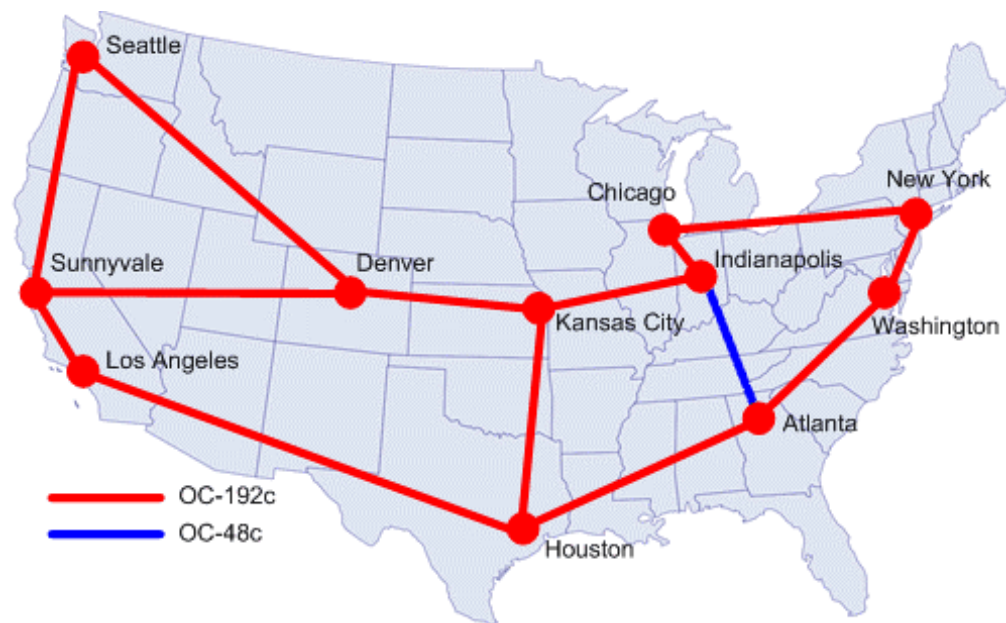
- 206+ regular university members, 66 Corporate members, 41 Affiliate members and 45 International partners

Internet2 Today



Networking

- Abilene: backbone operates at 10 Gbps
- GigaPoPs provide regional high-performance aggregation
 - 228 participants – research universities & laboratories
 - All 50 states, District of Columbia & Puerto Rico
 - Expanded access
 - 104 sponsored participants
 - 33 state education networks



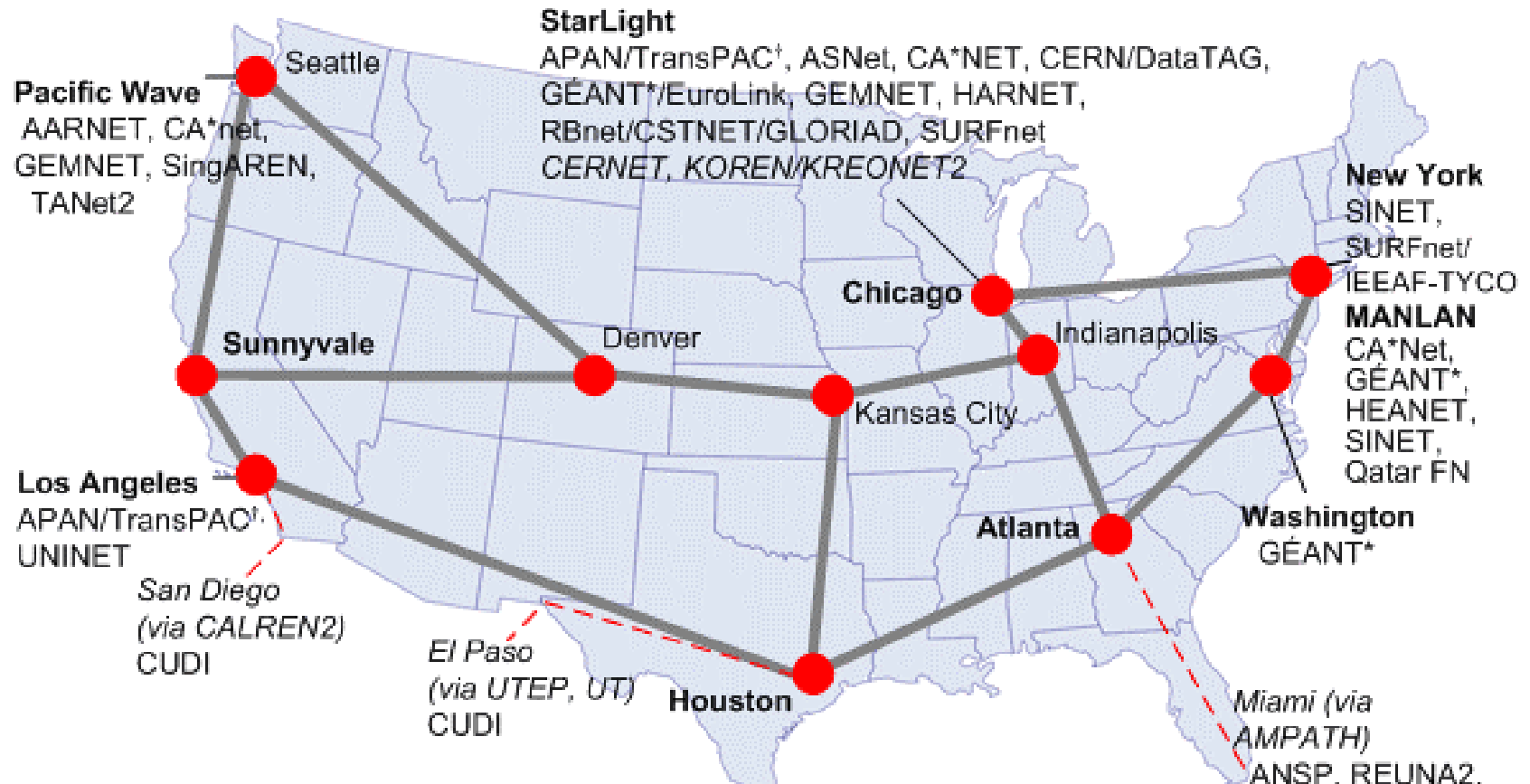
- Optical regional initiatives and national optical capabilities

Abilene – 2004

- Support for high-throughput flows (multi-Gbps)
 - Collaboration with End-to-End Performance Initiative
 - e2e.internet2.edu
- Security
- Network resiliency
- IPv6
- Abilene Observatory – Supporting Network Research and an Open Measurement Platform
 - <http://abilene.internet2.edu/observatory/research-projects.html>
- abilene.internet2.edu
- Provisioning dedicated capabilities (with the HOPI project)

Abilene International Peering

Abilene International Network Peers



^{*} via GEANT: ACOnet, BELNET, CARNet, CESNET, CYNET, Forskningsnettlet, EENet, Funet, Renater, G-WIN, GRNET, HUNGARNET, Rlnet, HEAnet, IUCC, GARR, LANET, LITNET, RESTENA, Univ. Malta, SURFnet, UNINETT, POL34, RCTS2, RoEduNet, RBnet, SANET, ARNES, RedIRIS, SUNET, SWITCH, JANET, ULAKBYM, CERN

[†] via APAN/TransPAC: WIDE/JGN, IMnet, CERNet/CSTnet/NSFCNET, KOREN/KREONET2, PREGINET, SingAREN, TANET2, ThaiSARN, WIDE (v6)



Networks reachable via Abilene - by country

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 (LANET)
Lithuania (LITNET)
Luxembourg (RESTENA)

Malta (Univ. Malta)
Netherlands (SURFnet)
Norway (UNINETT)
Poland (POL34)
Portugal (RCTS2)
Qatar (Qatar FN)
Romania (RoEduNet)
Russia (RBnet)
Slovakia (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, IMNET,
JGN)
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, vBNS)
Venezuela
(REACCIUN-2)

More information at

<http://abilene.internet2.edu/peernetworks/international.html>



New environment for R&E networking in the US

- A model of *facility-based networking often built with owned assets* – Regional Optical Networks (RONs) – has emerged

Several initiatives and projects:

- Fiberco – www.fiberco.org
 - Designed to support optical initiatives
 - Regional and national
 - Not an operational entity – supporting project
 - Will not light any fiber
 - Fiber options
 - Holding company for any future initiatives
 - Assignment vehicle
 - Regional initiatives
 - National initiatives (e.g., NLR)



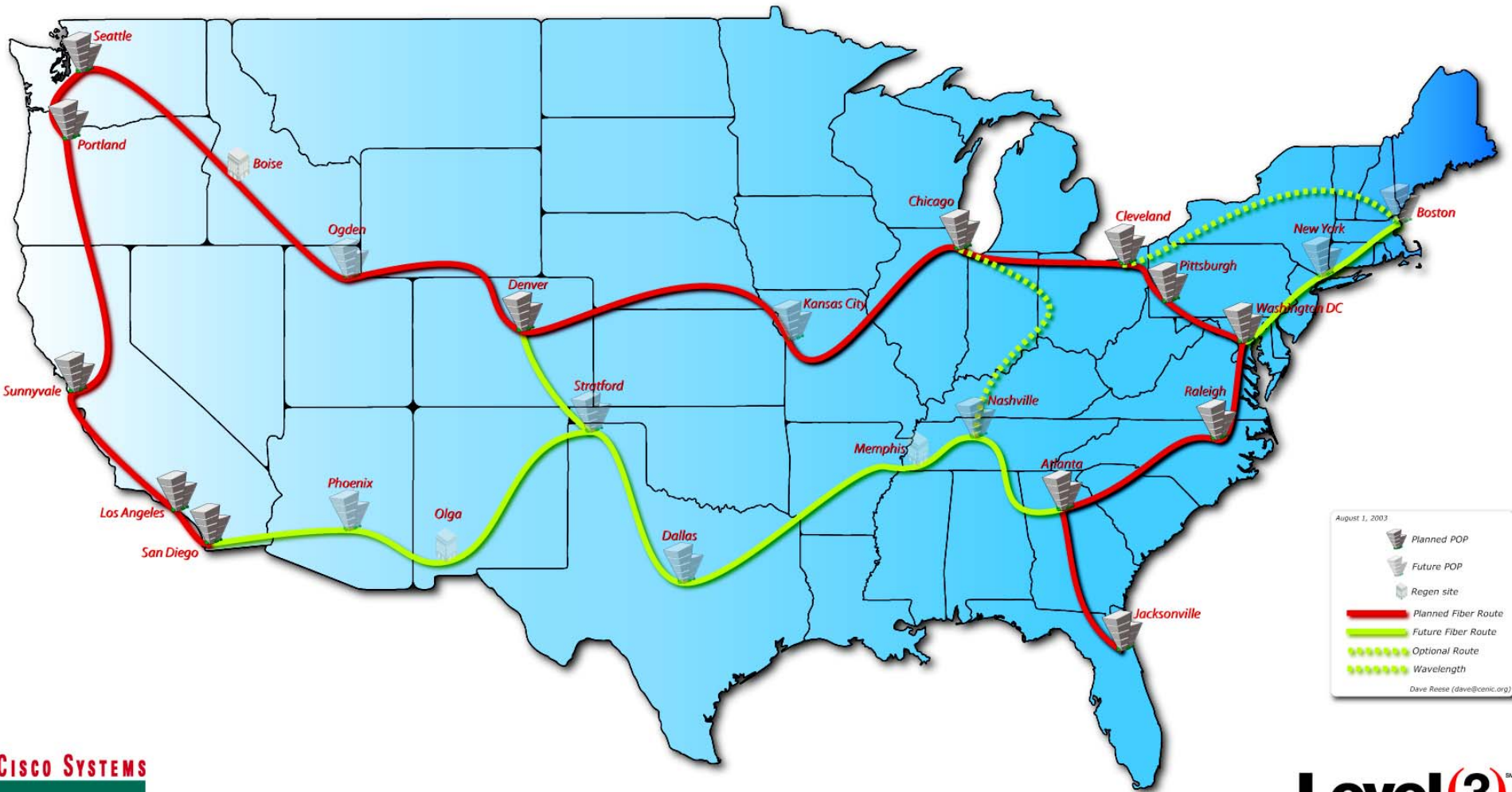


NLR

National Lambda Rail

- Largest higher-ed owned/managed optical networking & research facility in the world
 - ~10,000 route-miles of dark fiber
 - Four 10-Gbps λ 's provisioned at outset
 - One allocated to Internet2
- First & foremost, an experimental platform for research
- www.nationallambdarail.org

NLR National Fiber Network



Initial Coordinating Participants



HOPI : Hybrid Optical and Packet Infrastructure Project

- Some specific disciplines have enormous bandwidth requirements
- Questions concerning packet infrastructures
 - The shared packet infrastructure itself -- the ability to support multiple large flows on the order of 6 Gbps.
 - ? 40 Gbps or 100 Gbps in near future ?
 - Increasing demands by some for deterministic paths
 - Ability to have resources that don't exhibit congestion
 - Demand for more dynamic control of bandwidth and topology
- Availability of dark fiber at the national, regional and campus levels has changed the landscape
- Examine a hybrid of shared IP packet switching and dynamically provisioned optical lambdas

HOPI Project- cont.

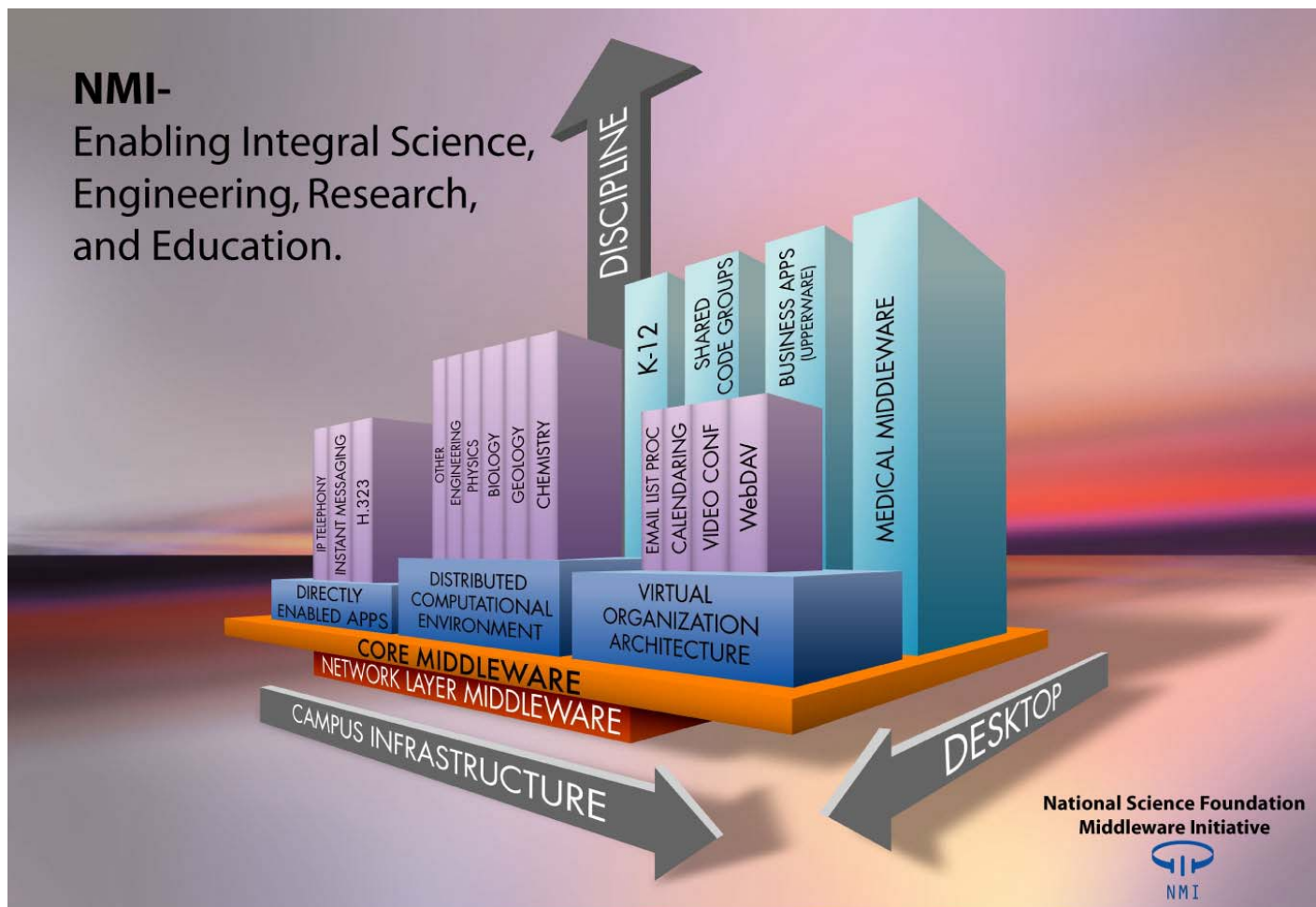
- Goal is to look at future architectures involving a hybrid of shared packet switched networks like Abilene and an infrastructure consisting of dynamically provisioned optical waves
 - In particular, to examine next generation Internet2 architectures

- HOPI Design Team (consisting of many Internet2/Abilene participants) has created a HOPI Testbed Whitepaper

- hopi.internet2.edu

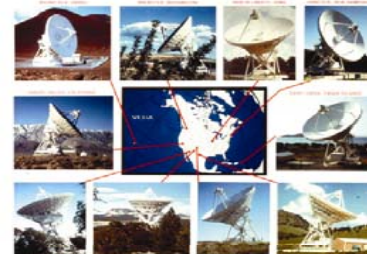
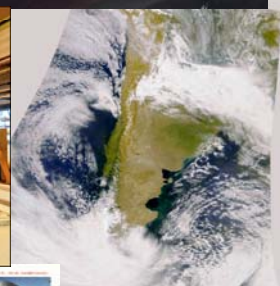
- Middleware is the stuff that makes “transparently use” happen, providing persistency, consistency, security, privacy, and capability.

- Authentication
- Identification
- Authorization
- Directories
- Security

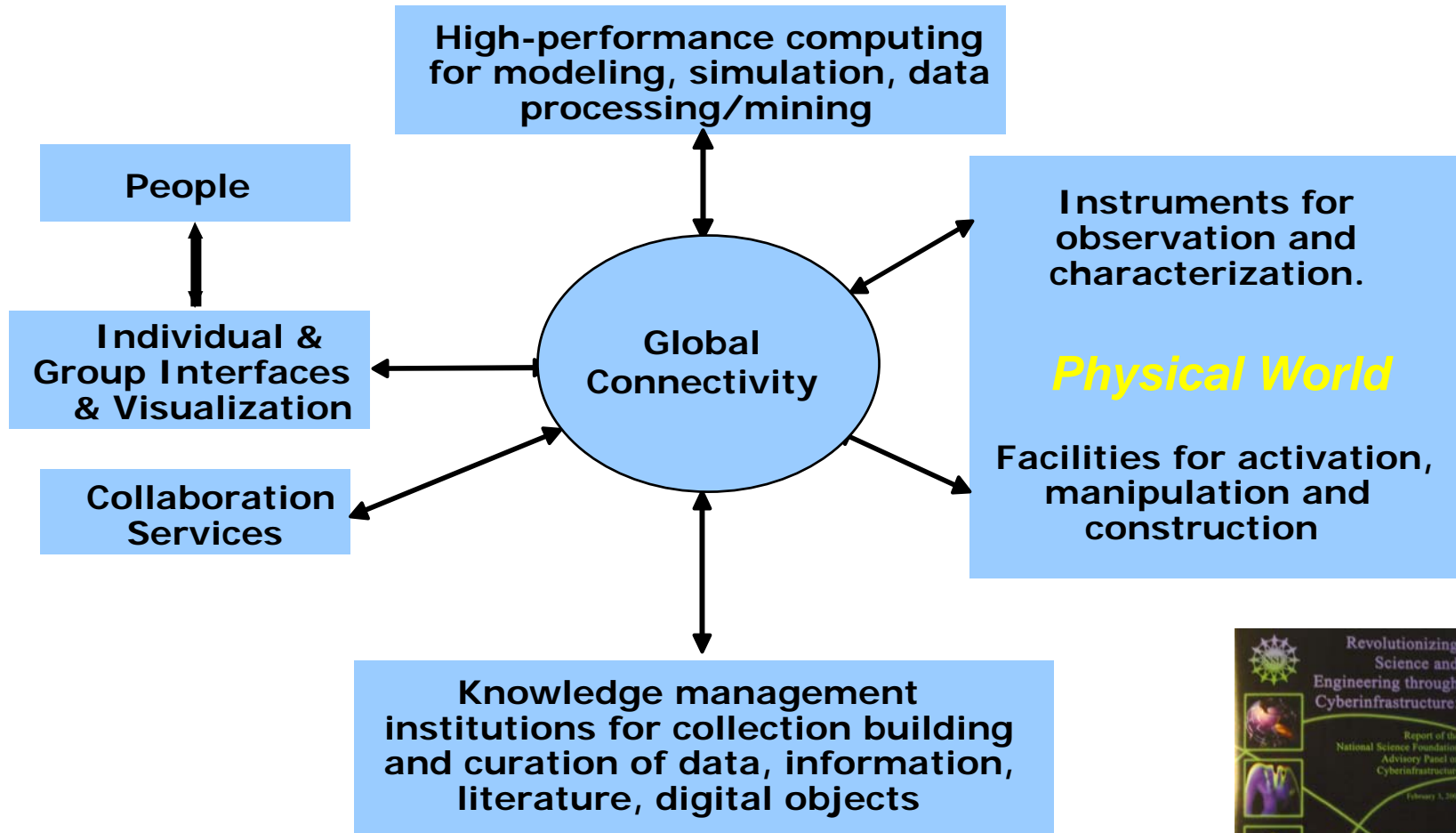


Applications

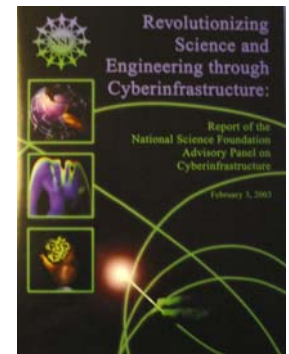
- Advance a vision for applications that motivate and, in turn, are enabled by cyberinfrastructure
- Promote large scale adoption of common applications
- Address the critical needs of research subcommunities
- Encourage innovation at the edge (and be attentive to emergent apps)
- Focus areas:
 - Science and engineering: **science.internet2.edu**
 - Health and Life sciences: **health.internet2.edu**
 - Arts and humanities: **arts.internet2.edu**



Components of CyberInfrastructure-enabled science & engineering



Source: Paul Messina – Fall 2003 Internet2 member meeting, “Cyberinfrastructure: Promises and Challenges” presentation at <http://www.internet2.edu/presentations/fall-03/20031014-Plenary-Messina.htm>



More information

- NSF cyberinfrastructure report:
 - <http://www.cise.nsf.gov/sci/reports/toc.cfm>
- NSF Shared Cyberinfrastructure (SCI) Division
Principal Investigators Meeting
 - <http://hpn.east.isi.edu/nsf-sci/agenda.htm>

- Strategic importance to Internet2
- *Ensure global interoperability*
 - of the next generation of Internet technologies and applications
- *Enable global collaboration*
 - in research and education providing/promoting the development of an advanced networking environment internationally
- Build effective partnerships in other countries
- With organizations of similar goals/objectives and similar constituencies

Current International Partners

Europe-Middle East

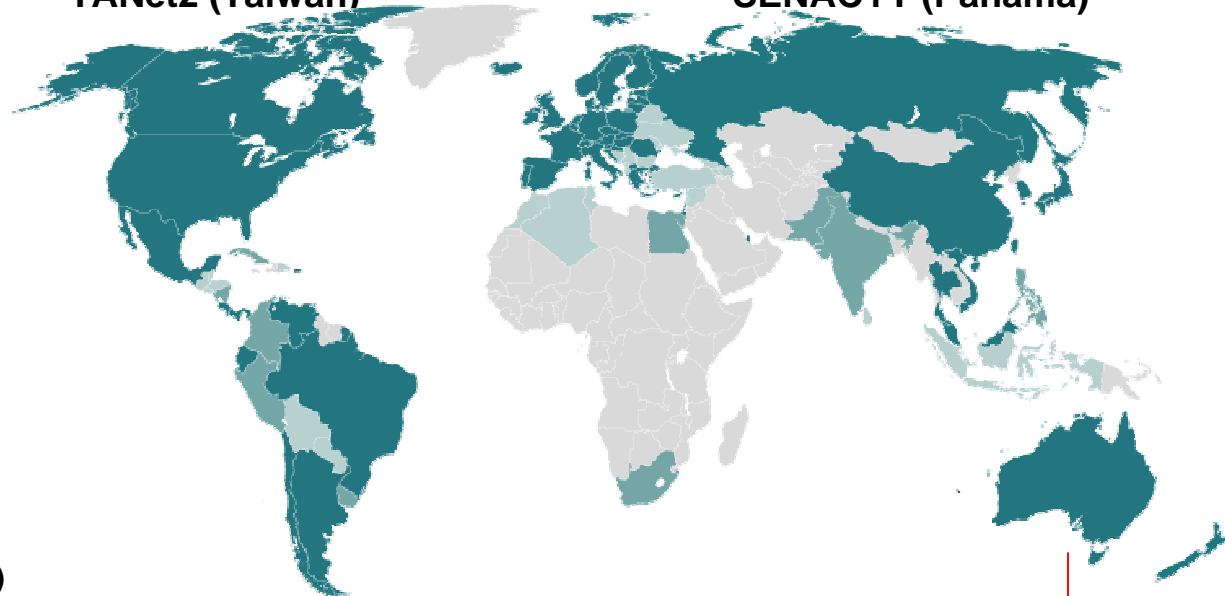
ARNES (Slovenia)
BELNET (Belgium)
CARNET (Croatia)
CESnet (Czech Republic)
DANTE (Europe)
DFN-Verein (Germany)
GIP RENATER (France)
GRNET (Greece)
HEAnet (Ireland)
HUNGARNET (Hungary)
INFN-GARR (Italy)
Israel-IUCC (Israel)
NORDUnet (Nordic Countries)
POL-34 (Poland)
Qatar Foundation (Qatar)
FCCN (Portugal)
RedIRIS (Spain)
RESTENA (Luxembourg)
RIPN (Russia)
SANET (Slovakia)
Stichting SURF (Netherlands)
SWITCH (Switzerland)
TERENA (Europe)
JISC, UKERNA (United Kingdom)

Asia-Pacific

AAIREP (Australia)
APAN (Asia-Pacific)
APAN-KR (Korea)
APRU (Asia-Pacific)
CERNET/CSTNE/NSFCNET (China)
JAIRC (Japan)
JUCC (Hong Kong)
NECTEC/UNINET (Thailand)
NG-NZ (New Zealand)
SingAREN (Singapore)
TANet2 (Taiwan)

Americas

CANARIE (Canada)
CEDIA (Ecuador)
CLARA (Latin America & Caribbean)
CUDI (Mexico)
CNTI (Venezuela)
CR2NET (Costa Rica)
REUNA (Chile)
RETINA (Argentina)
RNP (Brazil)
SENACYT (Panama)





NTT- GEMnet and Internet2

- **NTT and Internet2: lasting collaboration**
 - Corporate member since 1998
- **GEMnet:**
 - peering with Abilene (2001) – Pacific Wave (Seattle)
- **leadership and participation in international networking and support for scientific communities**
 - global experimental collaborations
 - Collaborations with ASTE/ALMA project and Univ. Chile
 - VLBI and e-VLBI (MIT Haystack)
- **strategic importance of peering relationship to research and education communities in the US and beyond**
- **we look forward to continuing working together in support of our communities**

Conclusion

- Leading-edge, high-performance network environments are being put in place to support science, research, teaching and learning in countries around the world
- more information
 - <http://international.internet2.edu>
 - Ana Preston apreston@internet2.edu

Arigato!