Global Trends in High Performance Research and Education Networking (REN)

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“In the long course of history, having people who understand your thought is much greater security than another submarine.”

-J William Fulbright

Universities in Transition

- Mission- ”facilitation of learning”.

- Learning Tools: Make available all the tools necessary for learning to the learner and the teacher (books, journals, laboratories)

- Meeting Place of Ideas: Provide a stimulating and safe environment for the quest for new ideas. It fosters dialogue based on intellectual merit and free from all other prejudice and fear (academic freedom).

- The above is the only known formal institutional means to harvest human knowledge

ICT and Universities

- ICT used to be an auxiliary service for universities in the 1990's.
- In 2000's it became an essential limb.
- In 2005 it is becoming the central artery in the running of modern universities.
- Almost all the countries in the world have adopted REN as the centerpiece of their information and communication technology (ICT) plan for higher education.
- Now about 92 countries around the world have REN-- 25+ more are building.
- The concept is marching further forward. Countries worldwide are now forming mega REN alliances of continental proportion with a vision of creating a world community of universities- a grand kiosk of higher education and scholarship.

“if you think education is expensive
try ignorance”

-Derek Bok,
-President Emeritus, Harvard

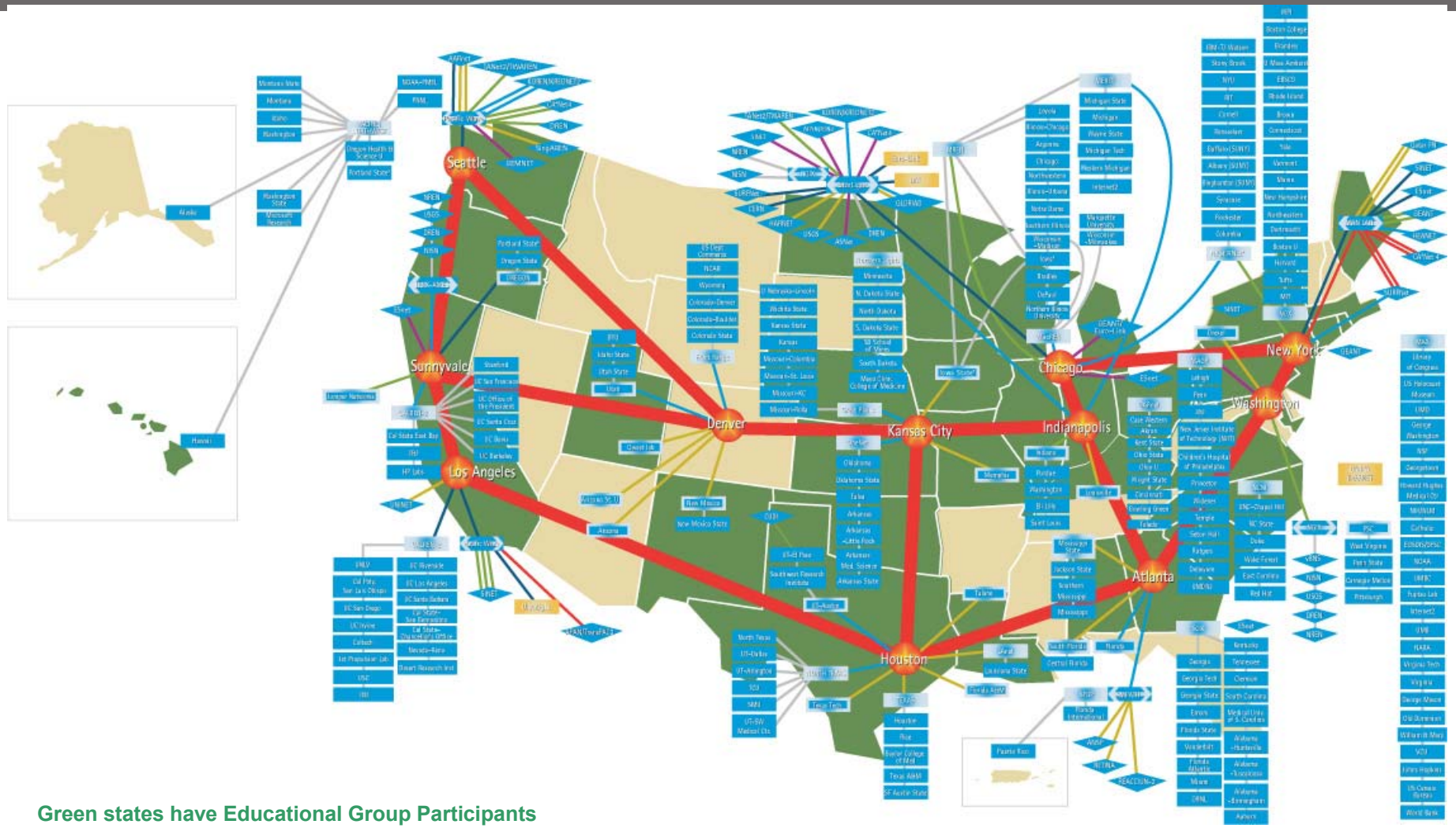
INTERNET2

US universities always needed a network one step ahead..

Internet, Internet2 and REN

- Internet emerged as ARPANET- a network for higher education and research.
- It gradually evolved as NSFNET, HPCC, VBNS, VBNS+
  - The higher education and research networking needs are substantially different.
  - Commodity Internet is often not able to meet their advanced networking need.
  - Nor it is possible to conduct advanced networking experiments.
- Currently there is a worldwide trend for universities to build their own high performance network called **Research and Education Network** (REN) such as Internet2.
- Goals:
  - Provide best ICT services to the higher education and research community
  - Enable new generation of applications
  - Re-create leading edge R&E network capability
  - Transfer technology and experience to the global production Internet

Internet2 Network Environment



Green states have Educational Group Participants

Internet2: Organization

- Internet2
  - The “brain” providing intellectual and technical leadership. A non-profit corporation of 207 member universities.
- Abilene
  - Internet2’s current high performance backbone network with10 Gbps (OC-192) capacity.
- A Set of Taskforces
  - Leading the creation of new applications and services and directions for Internet2.
    - Network and Middleware
    - Applications

ISP or REN?

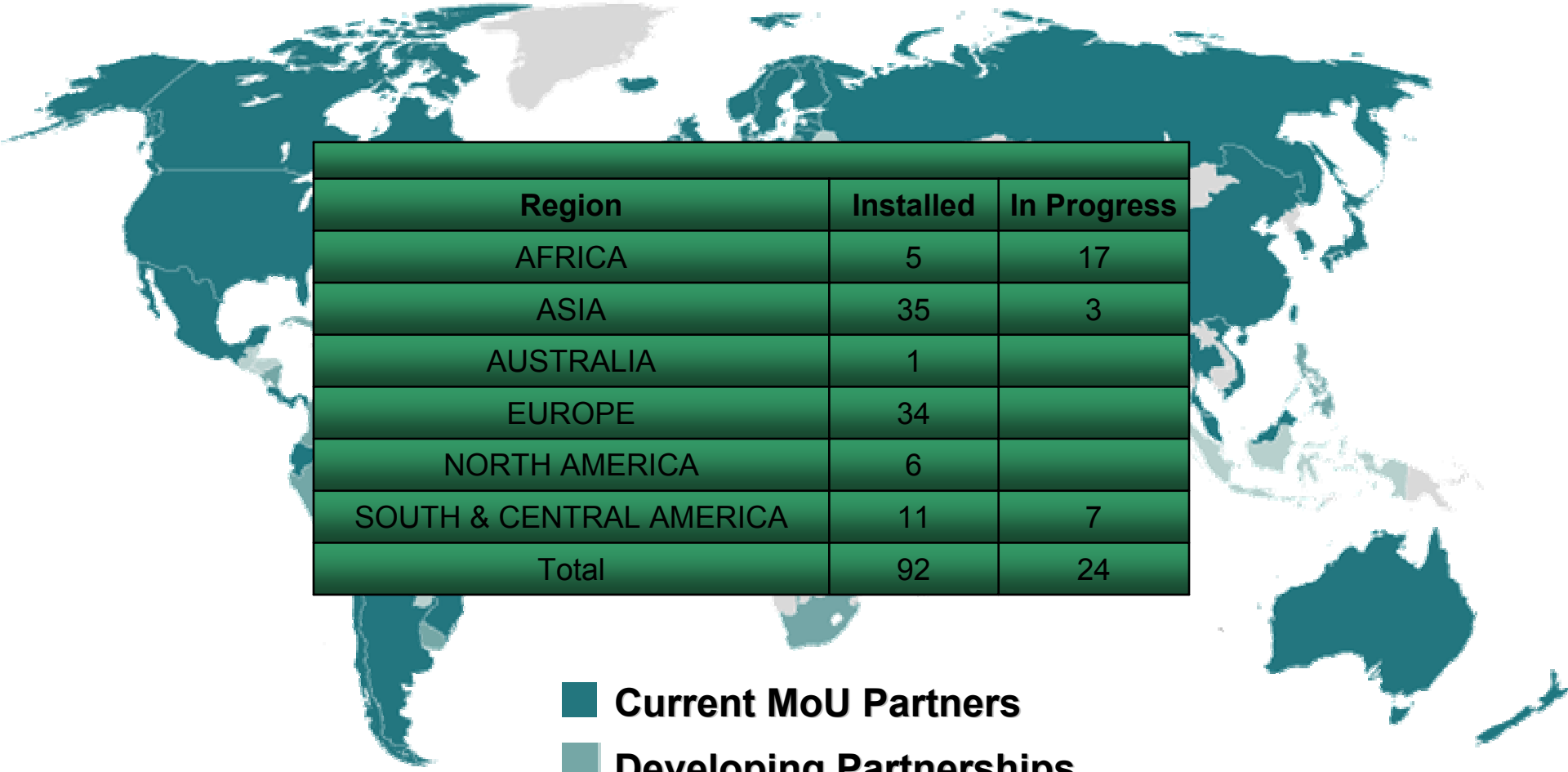
- ISP's business model is to satisfy vast pool of general customers, while university is a very special type of customer.
- Security, performance, and applications considerations are very different for Universities.
  - Universities **needs to experiment** with new protocols.
  - Most ports are blocked. Security is old styled, and now blocking services.
  - Experimental protocols are seldom realized/deployed.
  - Many newer services and applications contradict conventional pricing model and thus acts as a disincentive.
- REN is a worldwide phenomena now (service at cost).
- More recently RENs a moving towards dark fiber to further obtain unrestricted capacity links to run much more capable protocols.

Global Trend

Not Just in USA now the idea of REN is spreading all over the world.

REN A World Phenomenon

Region	Installed	In Progress
AFRICA	5	17
ASIA	35	3
AUSTRALIA	1	
EUROPE	34	
NORTH AMERICA	6	
SOUTH & CENTRAL AMERICA	11	7
Total	92	24



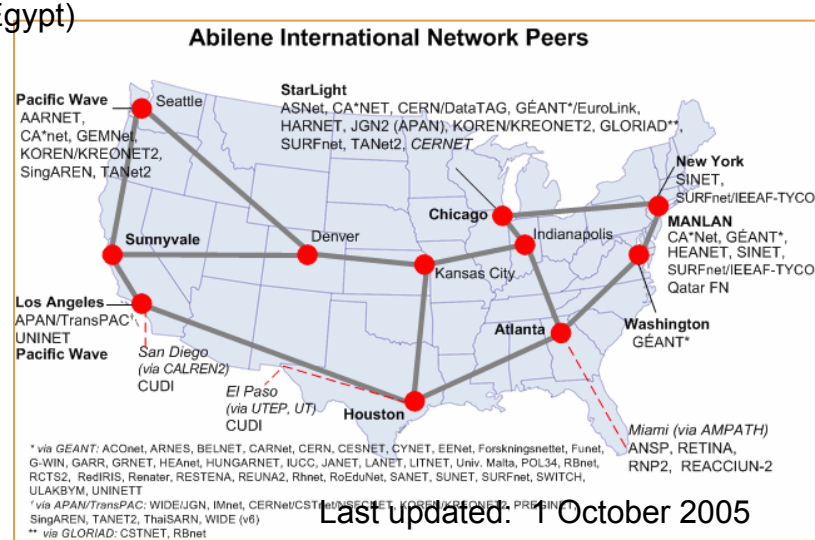
Internet2 International Partners

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

Asia-Pacific
AAIREP (Australia)
APAN (Asia-Pacific)
ANF (Korea)
CERNET, CSTNET, NSFCNET (China)
JAIRC (Japan)
JUCC (Hong Kong)
SingAREN (Singapore)
NECTEC / UNINET(Thailand)
TANet2 (Taiwan)
NGI-NZ (New Zealand)
TERENA (Europe)
MyREN (Malaysia)

Asia-Pacific
MCIT [EUN/ENSTINET] (Egypt)
TENET (South Africa)

Americas
CANARIE (Canada)
CLARA (Latin America & Caribbean)
CEDIA (Ecuador)
CNTI (Venezuela)
CR2Net (Costa Rica)
CUDI (Mexico)
REUNA (Chile)
RETINA (Argentina)
RNP [FAPESP] (Brazil)
SENACYT (Panama)



Last updated: 1 October 2005

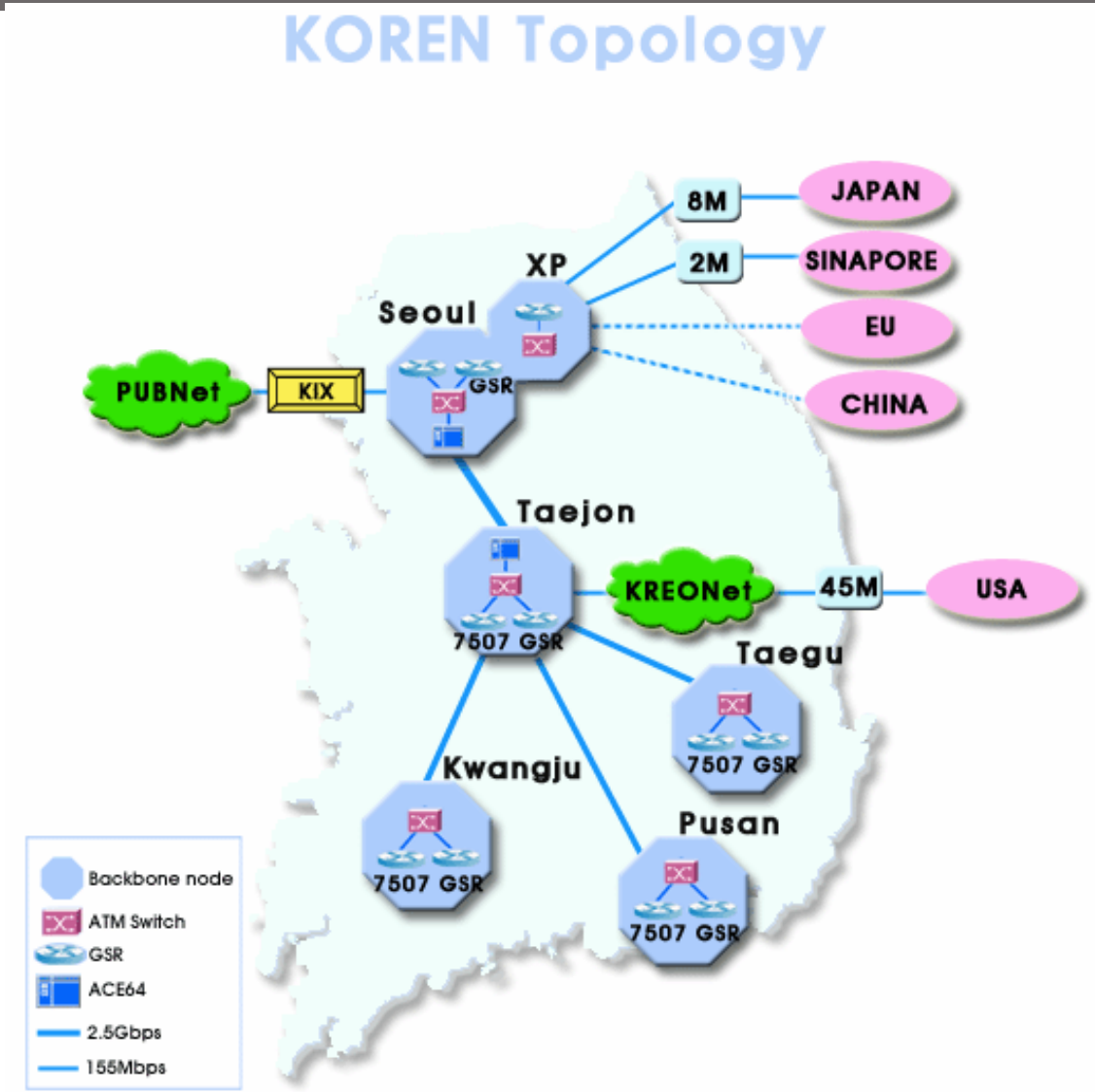
China- CERNET

- 10Mbps to Japan (APAN)
- Within China:
- 16x2.5G DWDM system (two lambda's are currently running)
- OC48 POS links to 8 cities
- OC3 POS SDH links to all provincial capitals (except Lhasa)
- unicast and multicast

Source: Xing Li, CERNET

Korea- KOREN/KREONET2

- Sharing 45mbps link across Pacific to STAR TAP
  - KREONET2 is led by KISTI and funded by Ministry of Sci & Tech
  - KOREN is funded by Ministry of Info and Comm and operated by Korea Telecom



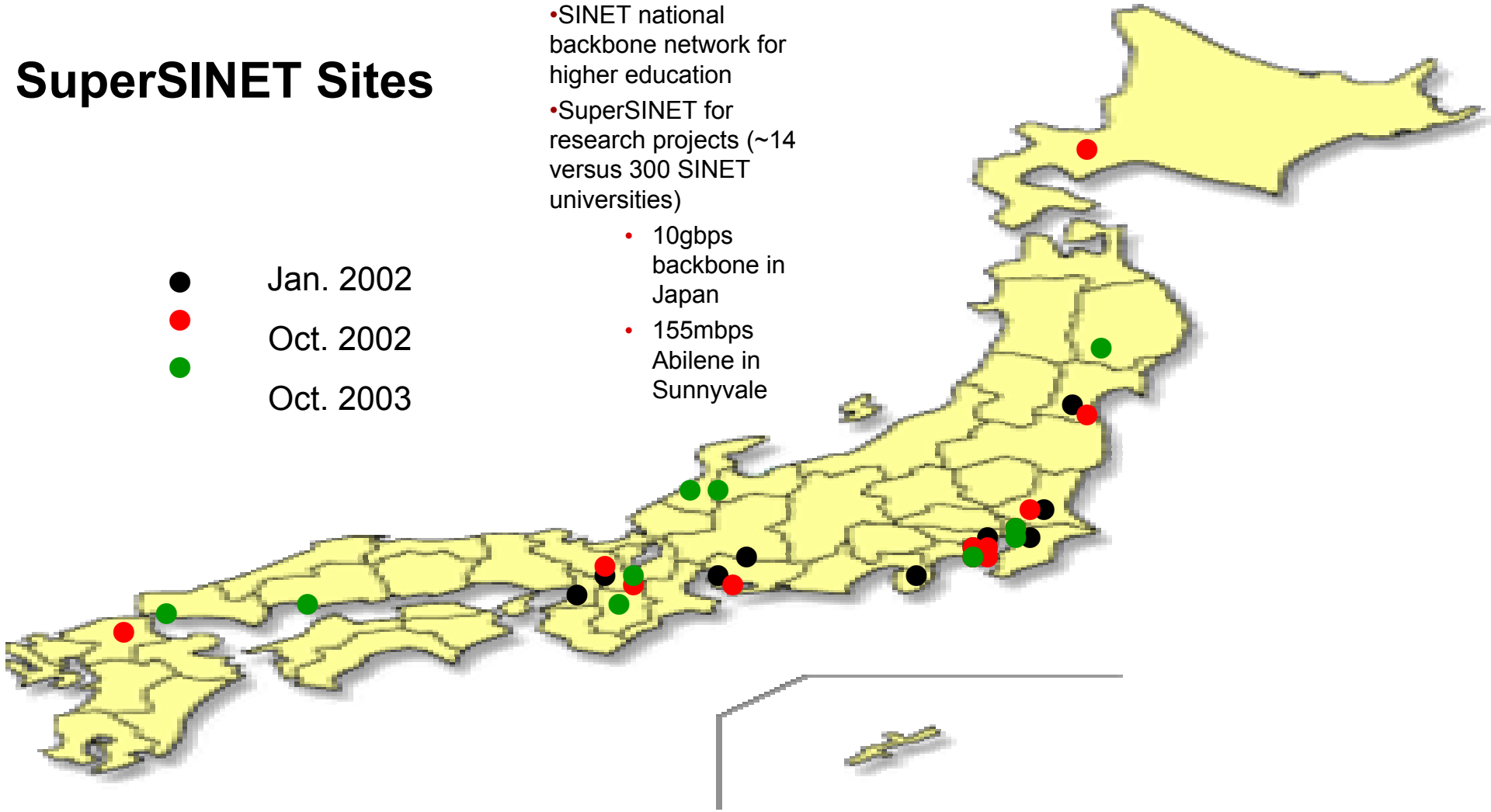
Japan- SINET

www.nii.ac.jp/network-e.html

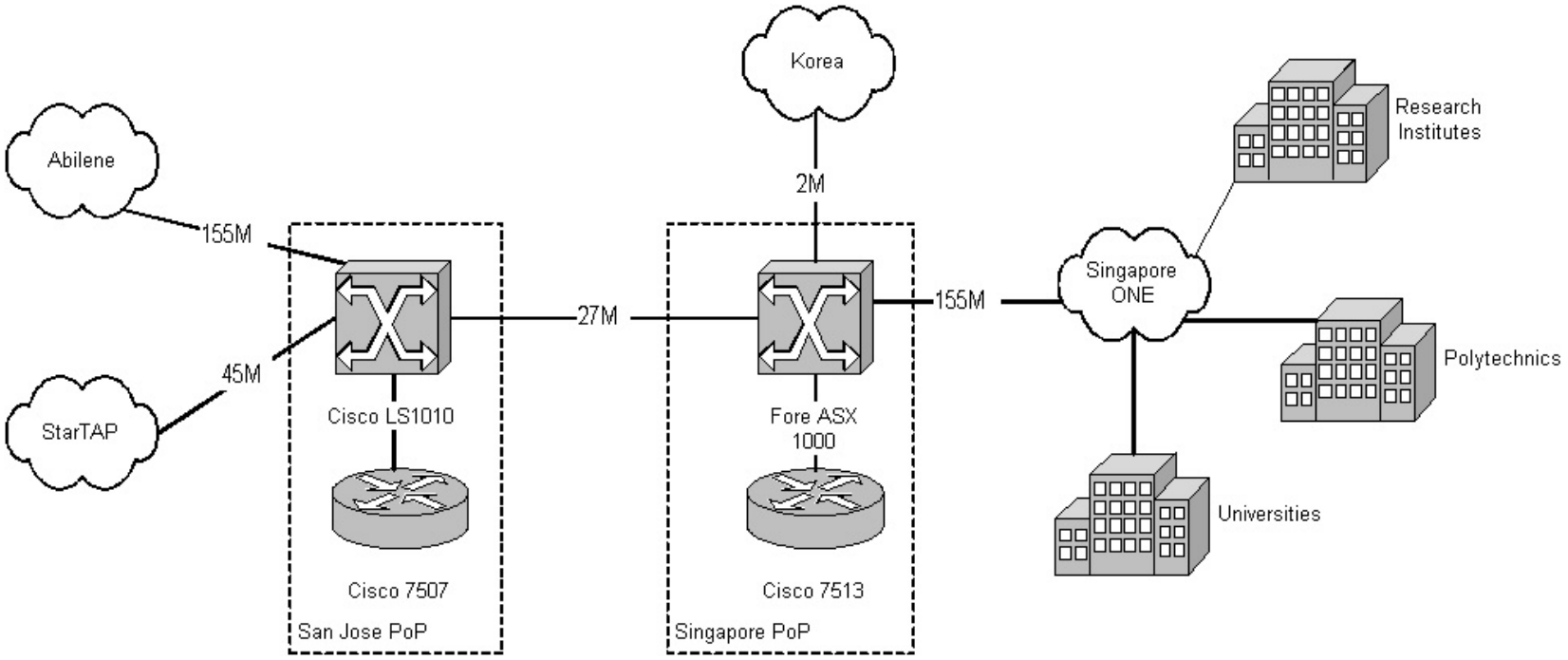
SuperSINET Sites

- Jan. 2002
- Oct. 2002
- Oct. 2003

- SINET national backbone network for higher education
- SuperSINET for research projects (~14 versus 300 SINET universities)
  - 10gbps backbone in Japan
  - 155mbps Abilene in Sunnyvale

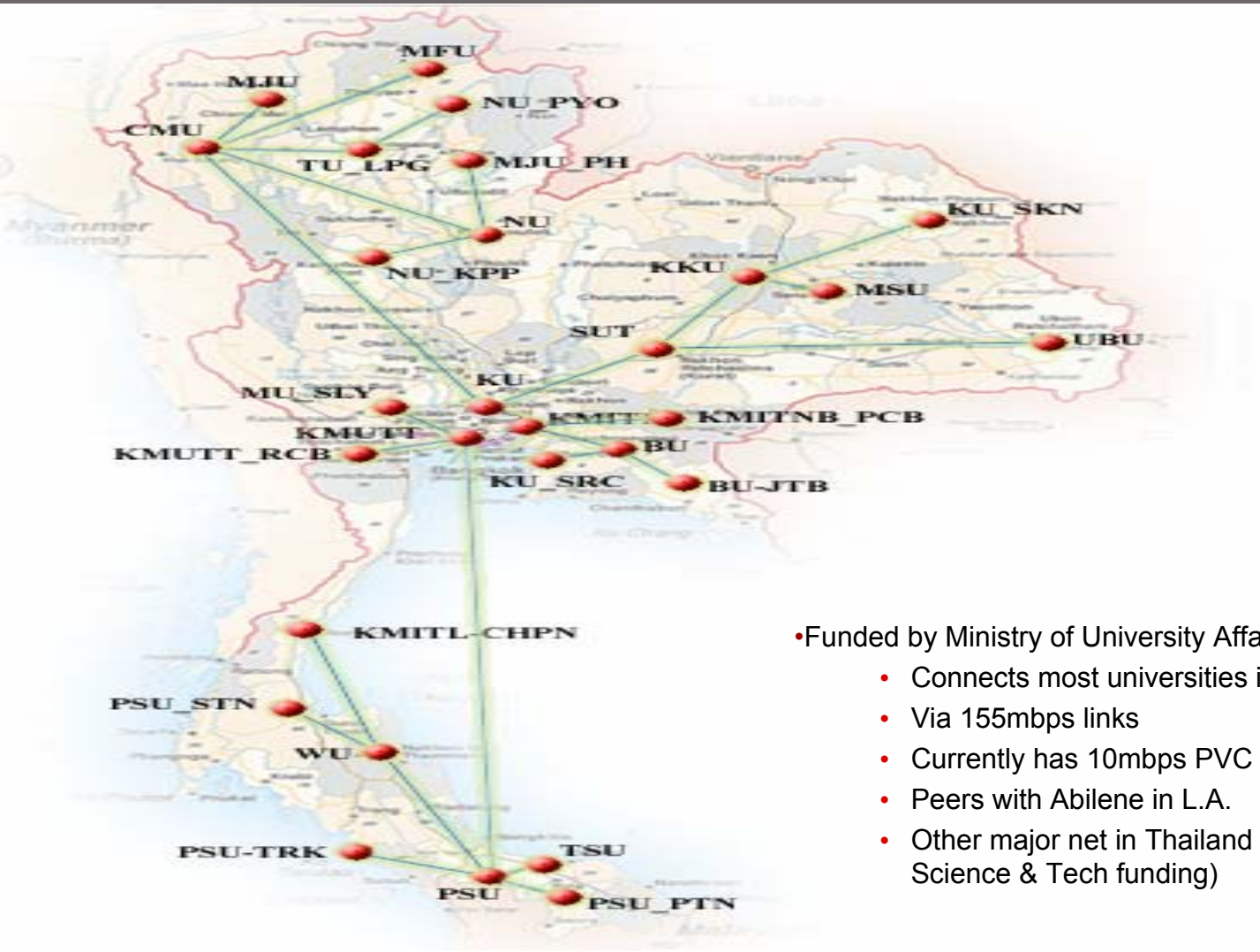


Singapore- SingAREN



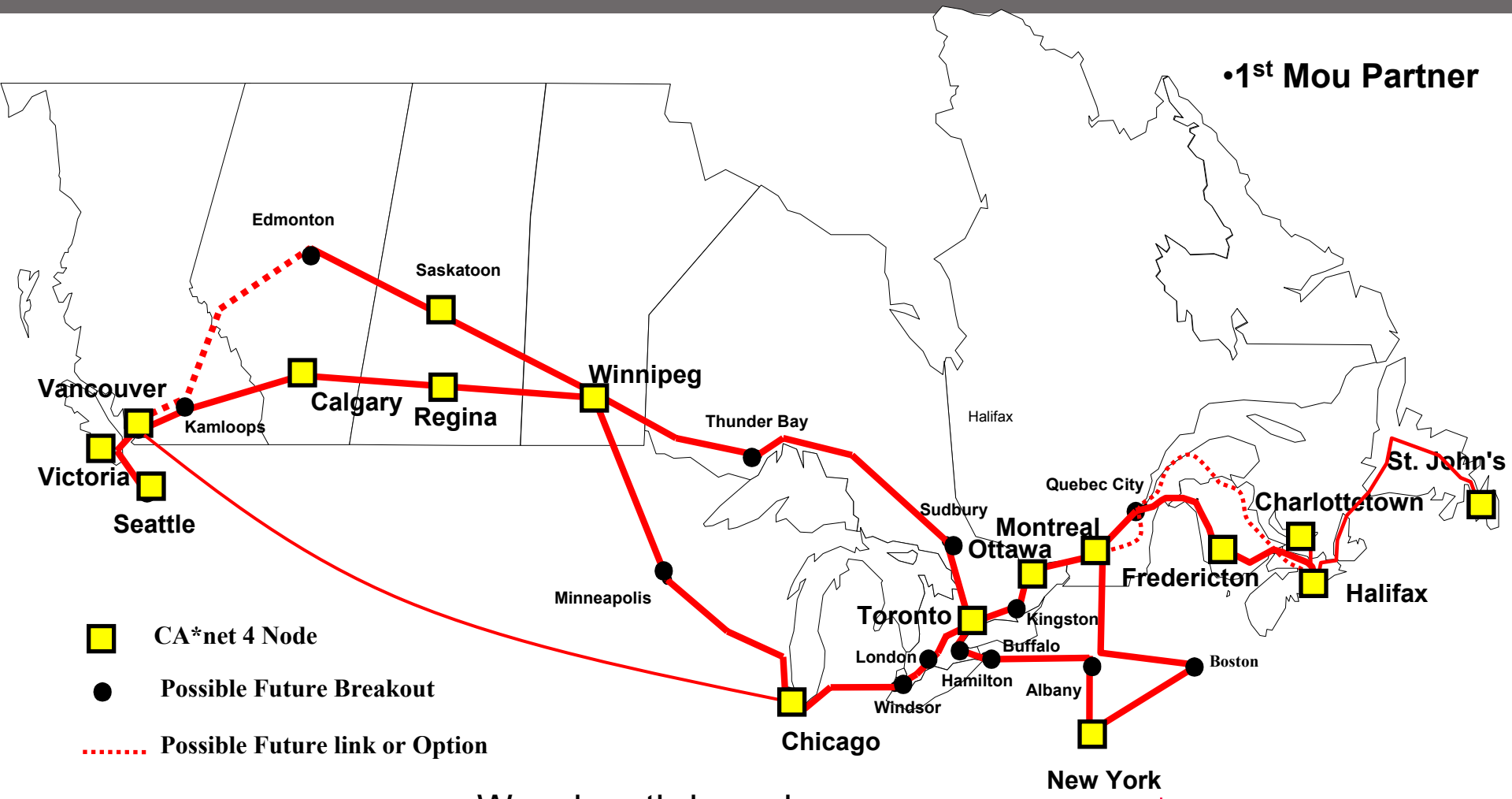
- Currently 27mbps across Pacific
  - Peers with Abilene in Sunnyvale
  - 45mbps PVC to STAR TAP/AADS switch

Thailand- UNINNET



- Funded by Ministry of University Affairs in Thailand
  - Connects most universities in Thailand
  - Via 155mbps links
  - Currently has 10mbps PVC to Los Angeles
  - Peers with Abilene in L.A.
  - Other major net in Thailand is run by NECTEC (Ministry of Science & Tech funding)

Canada- CA*net/CA*net 4



- Wavelength-based
- regional networks

CANARIE INC.

México- CUDI www.cudi.edu.mx

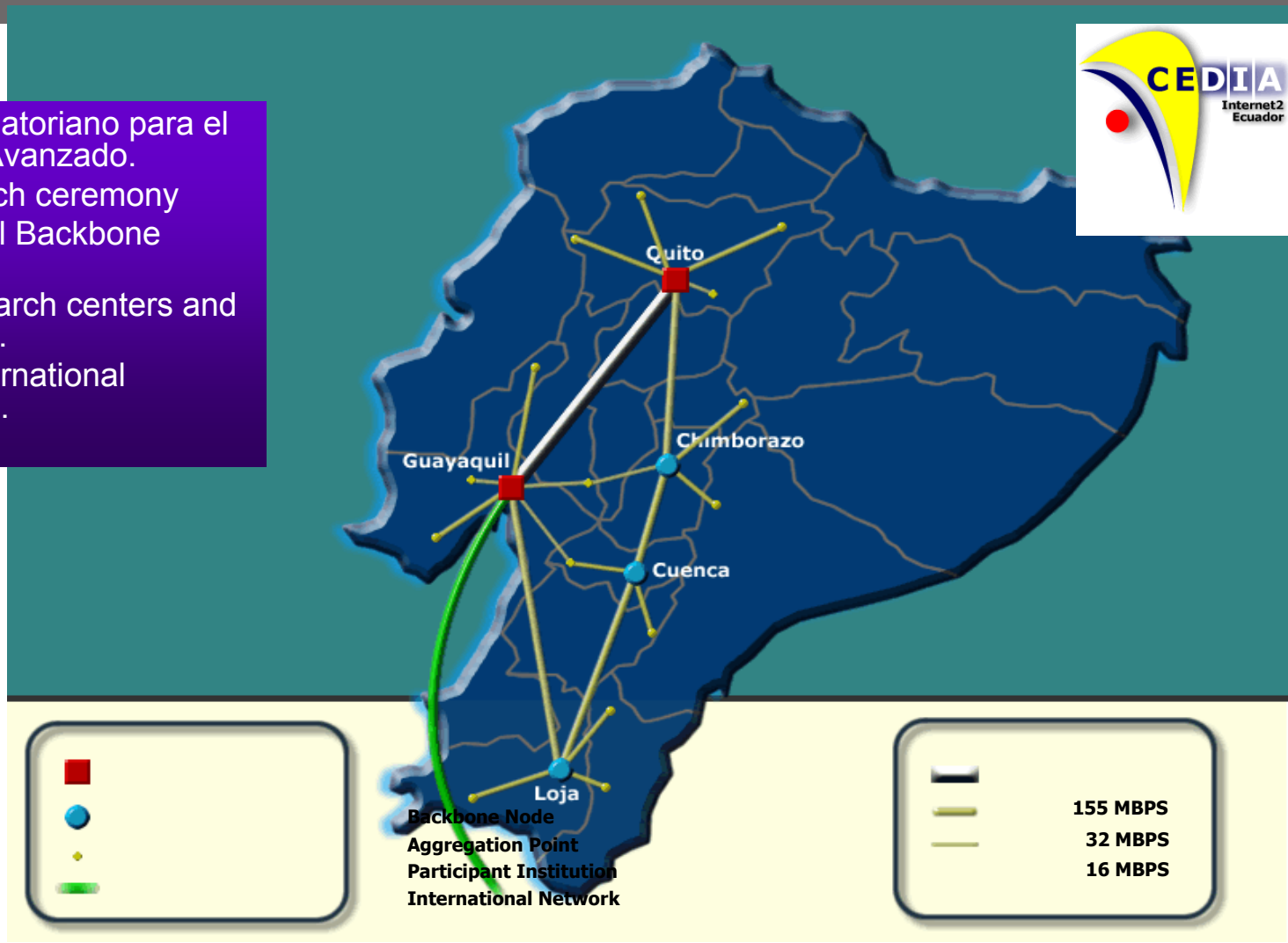
cudi Corporación Universitaria para el Desarrollo de Internet

- +71 universities
- International connections:

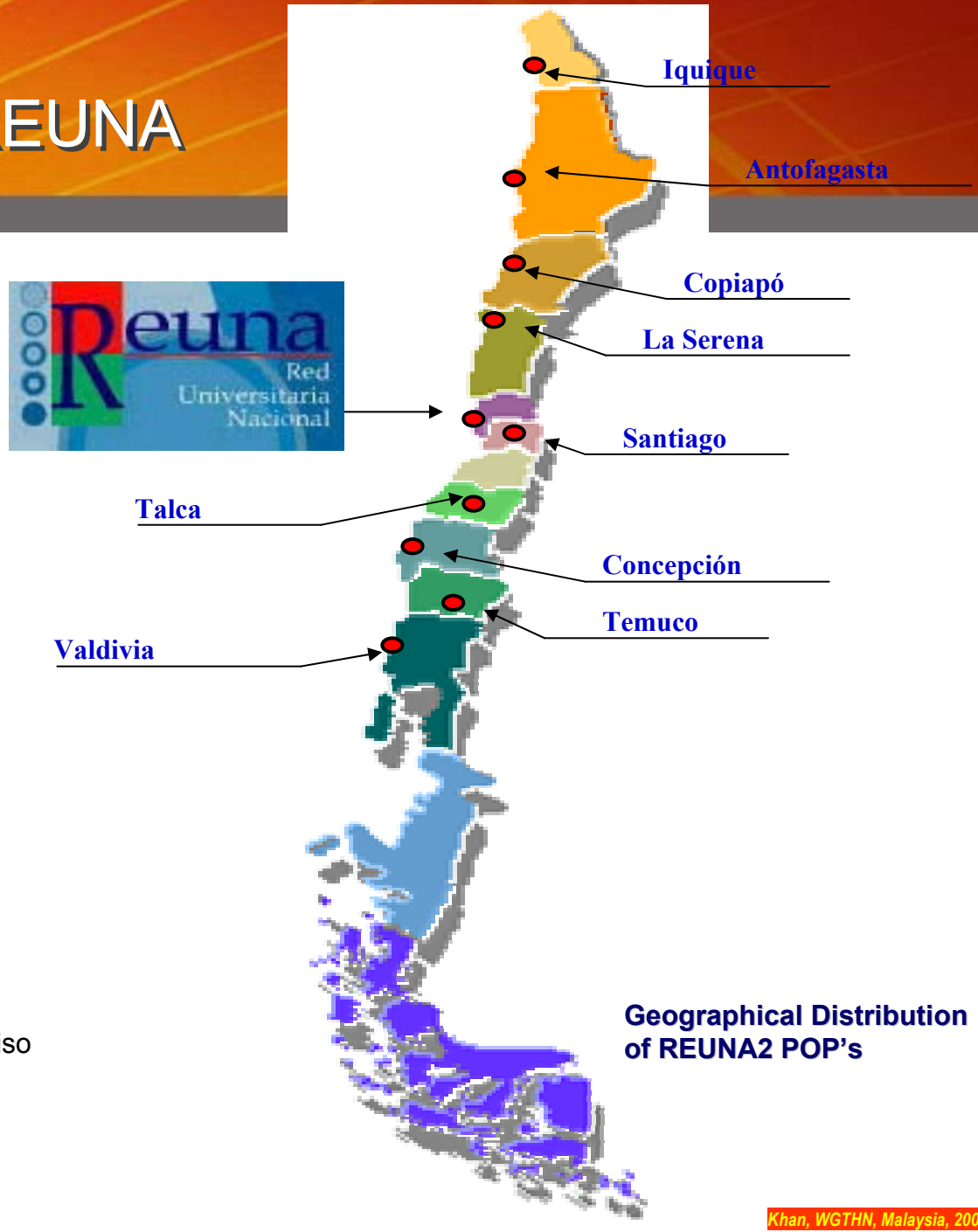
- •EUA: via Tijuana – San Diego (transit via CALREN2 to Abilene) at 155Mbps
- • 100Mbps between Ciudad Juarez and El Paso (to Abilene)
- • vBNS via Houston

Ecuador - CEDIA www.internet2.edu.ec

- CEDIA: Consorcio Ecuatoriano para el Desarrollo de Internet Avanzado.
- September 2002: launch ceremony
- October 2003, National Backbone CEDIA operational
- 15 Universities, 2 research centers and 2 government agencies.
- First quarter 2004, International connectivity operational.



Chile - REUNA

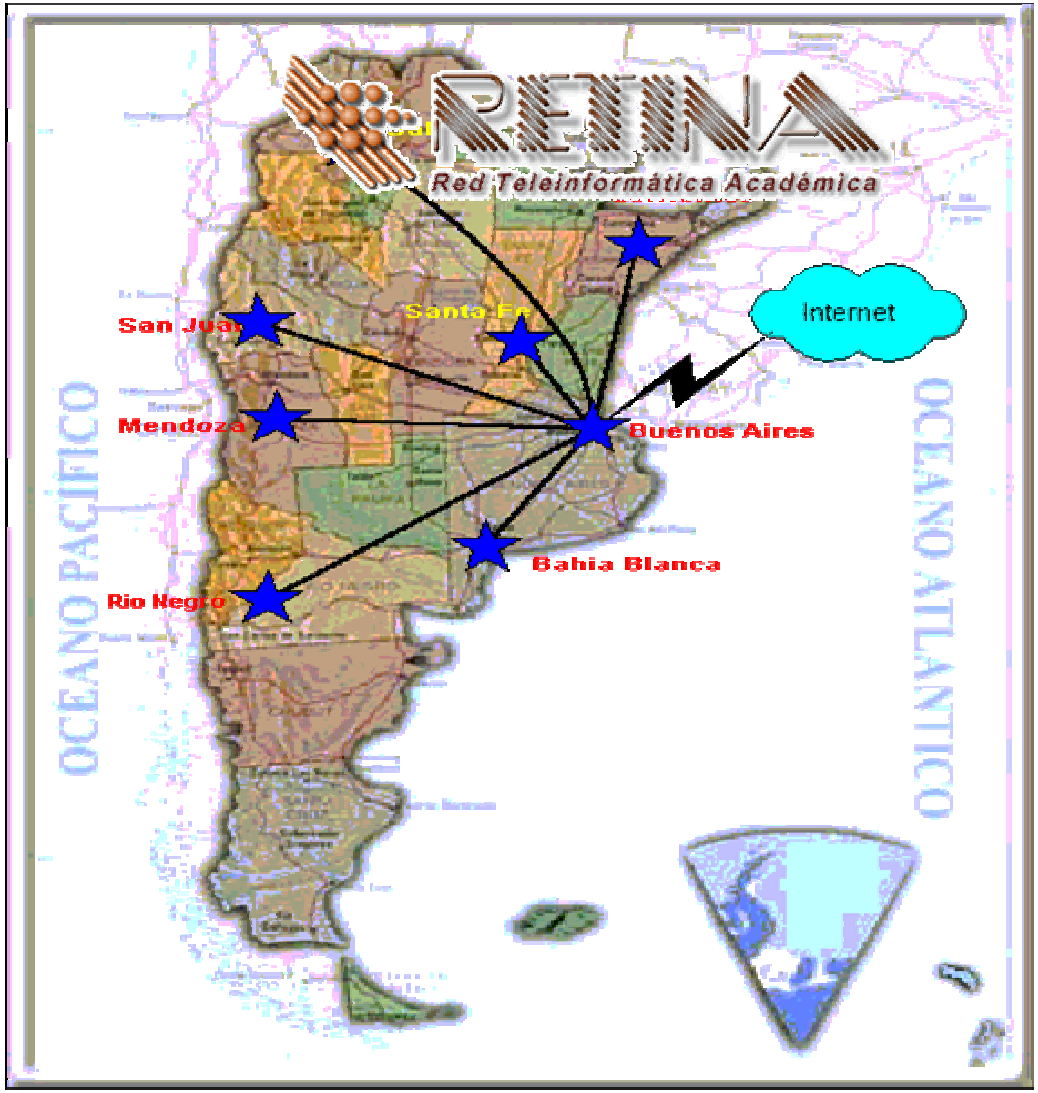


Geographical Distribution of REUNA2 POP's

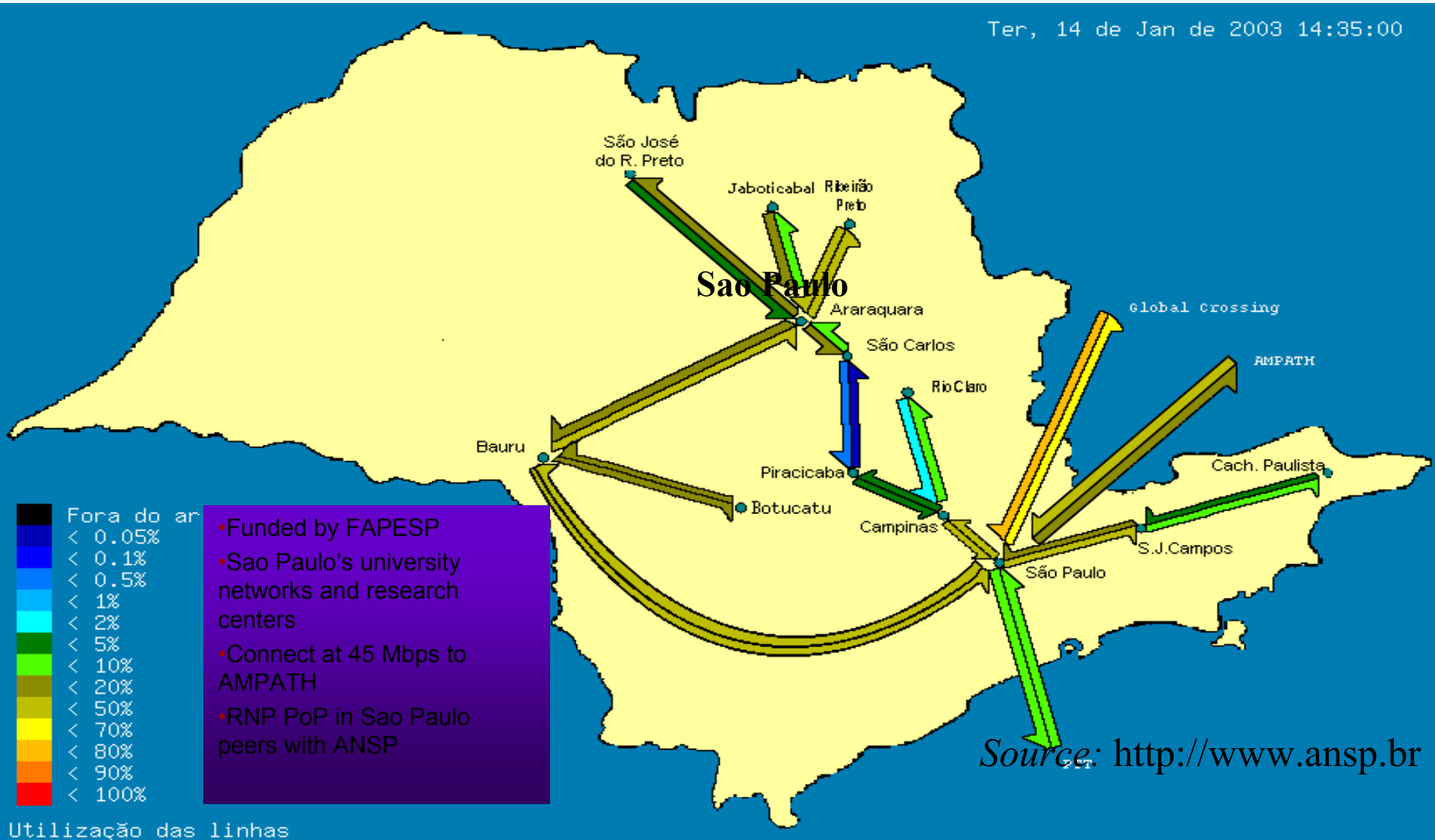
- Red Universitaria Nacional – REUNA
- 10 POP's from Arica to Valdivia
- 155 Mbps ATM/SDH Network
- over 30 universities
- Internet - Internet2 services
- 45 Mpbs to AMPATH
- G-REUNA:
  - backbone proyect
  - Gigabit and application test-bed
  - 140 kim dark fiber, Santiago to Valaparaiso

Argentina - RETINA www.retina.ar

- Red Teleinformática Académica
- Red RETINA:
- ~25 institutions
- International connection: 45 Mbps to AMPATH
- Abundance of fiber in main cities but challenge is expanding reachability into rest of country, plus other issues



Brazil – Sao Paulo http://www.ansp.br

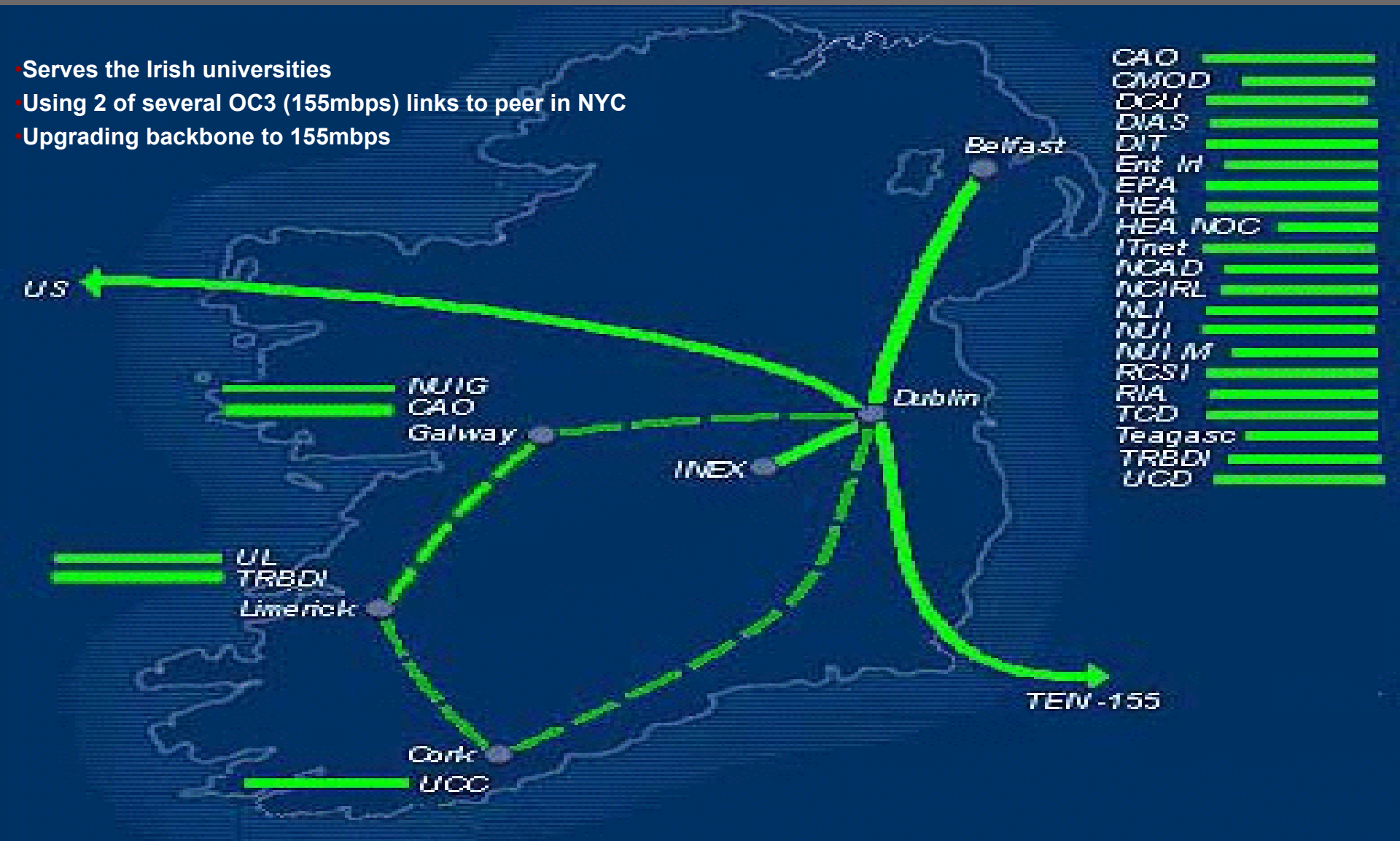


- Funded by FAPESP
- Sao Paulo's university networks and research centers
- Connect at 45 Mbps to AMPATH
- RNP PoP in Sao Paulo peers with ANSP

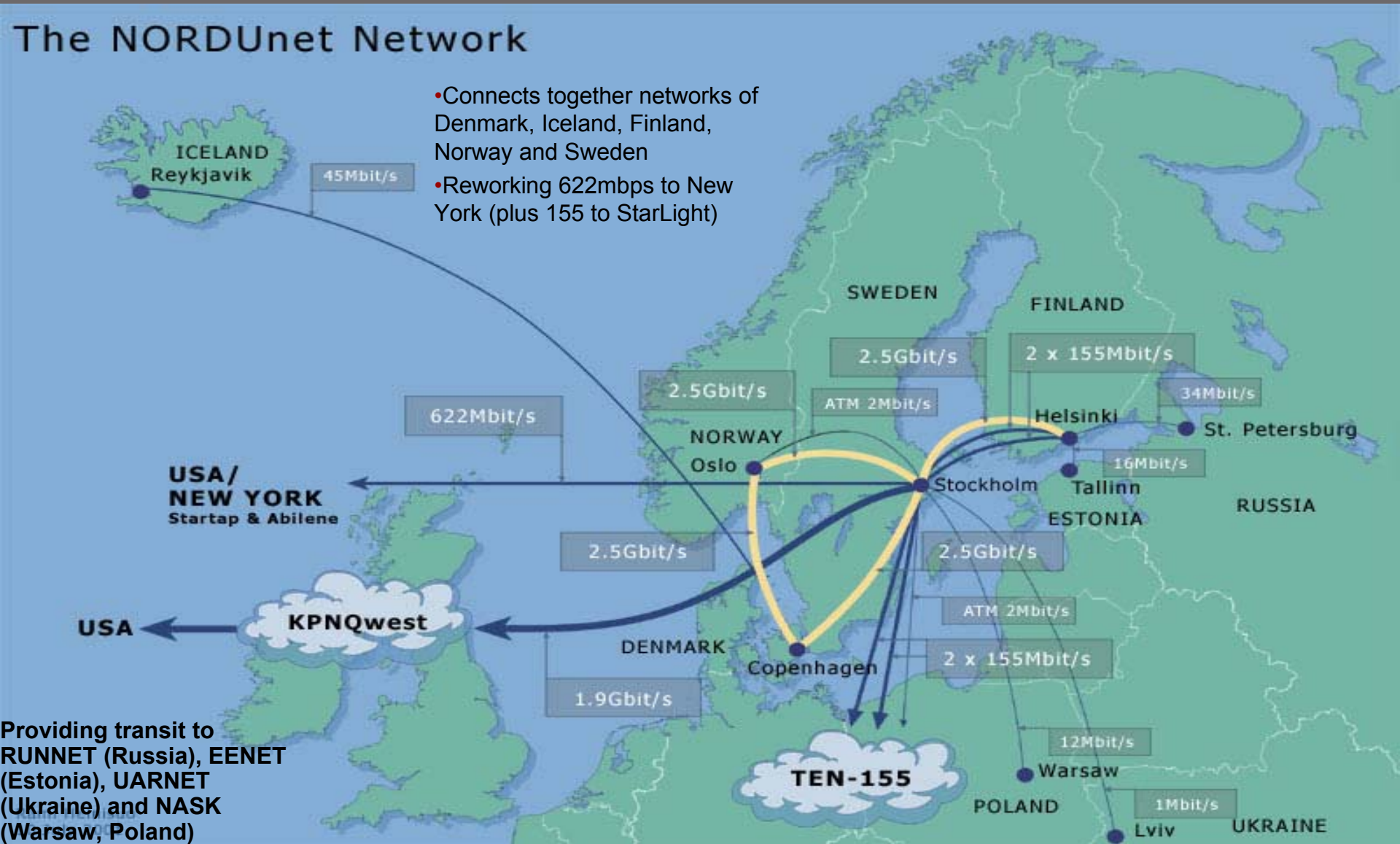
Source: http://www.ansp.br

Ireland- HEANET www.heanet.ie

- Serves the Irish universities
- Using 2 of several OC3 (155mbps) links to peer in NYC
- Upgrading backbone to 155mbps



Scandinavia- NORDUnet www.nordu.net/



Providing transit to RUNNET (Russia), EENET (Estonia), UARNET (Ukraine) and NASK (Warsaw, Poland)

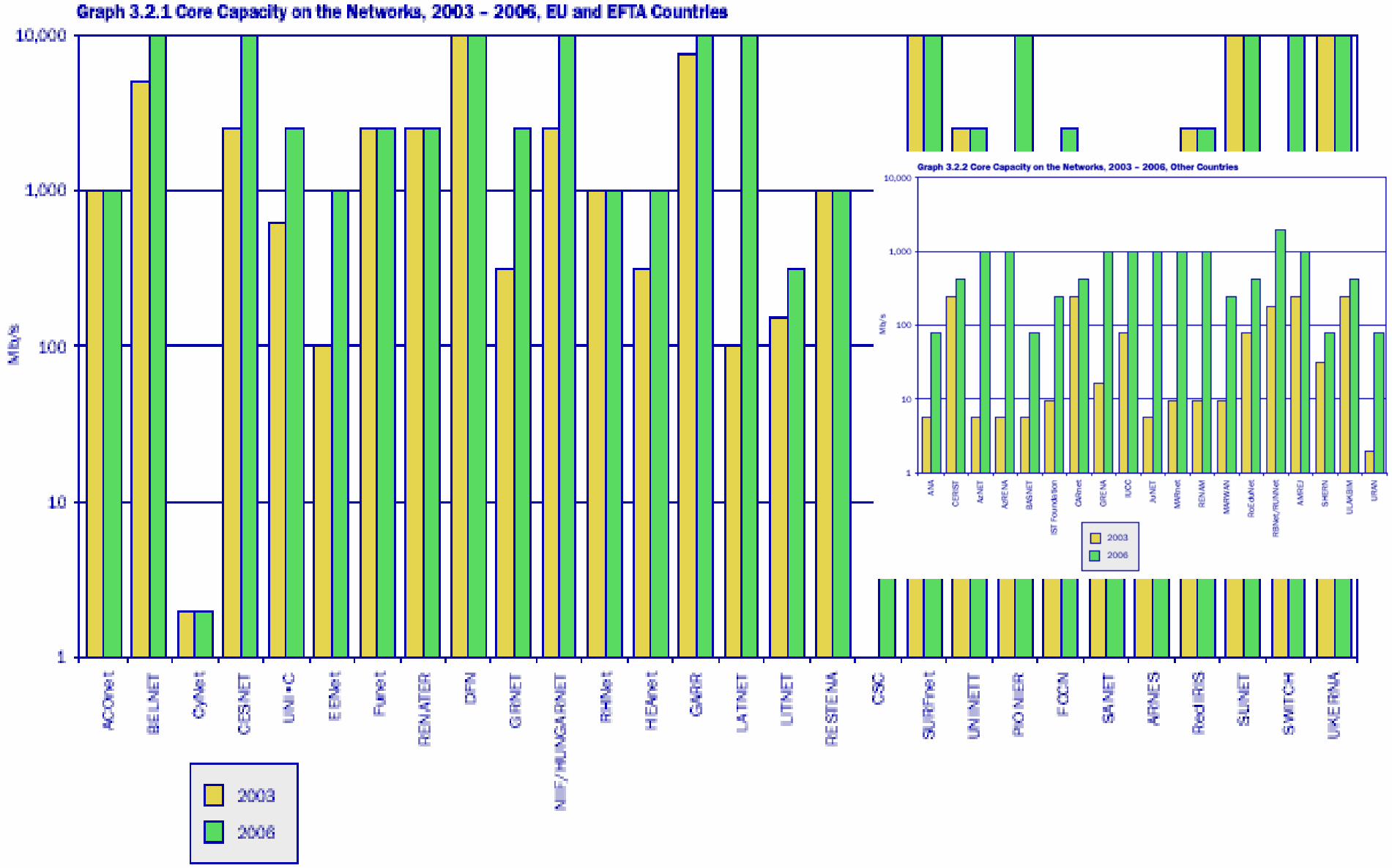
TERENA Snapshot of RENs

2006 Compendium

“ Knowledge will forever govern ignorance, and a people who mean to be their own governors must arm themselves with the power which knowledge gives.”

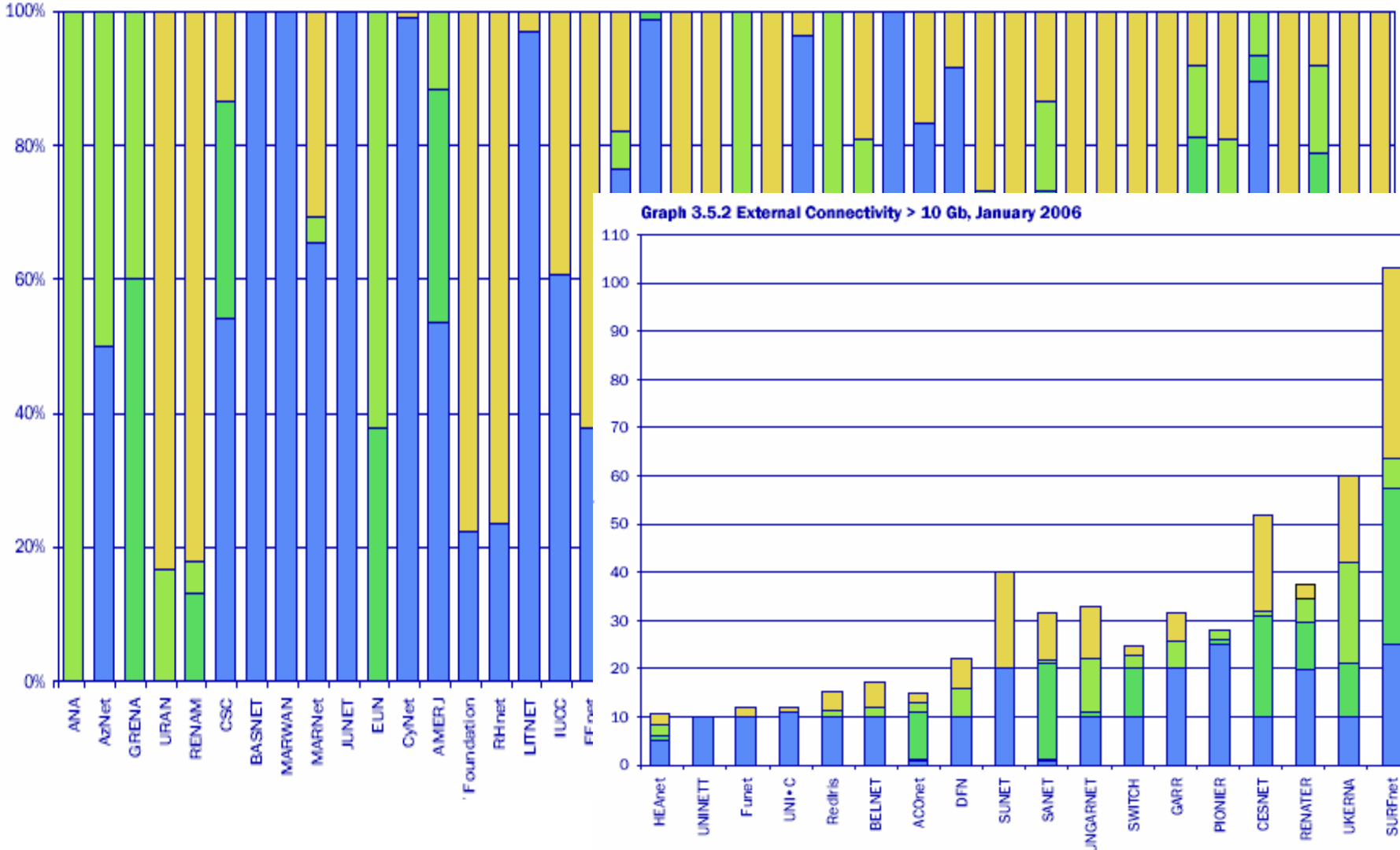
— James Madison

TERENA: Core network capacity



External Connectivity

Graph 3.5.1 Division of External Connectivity over the Categories, January 2006



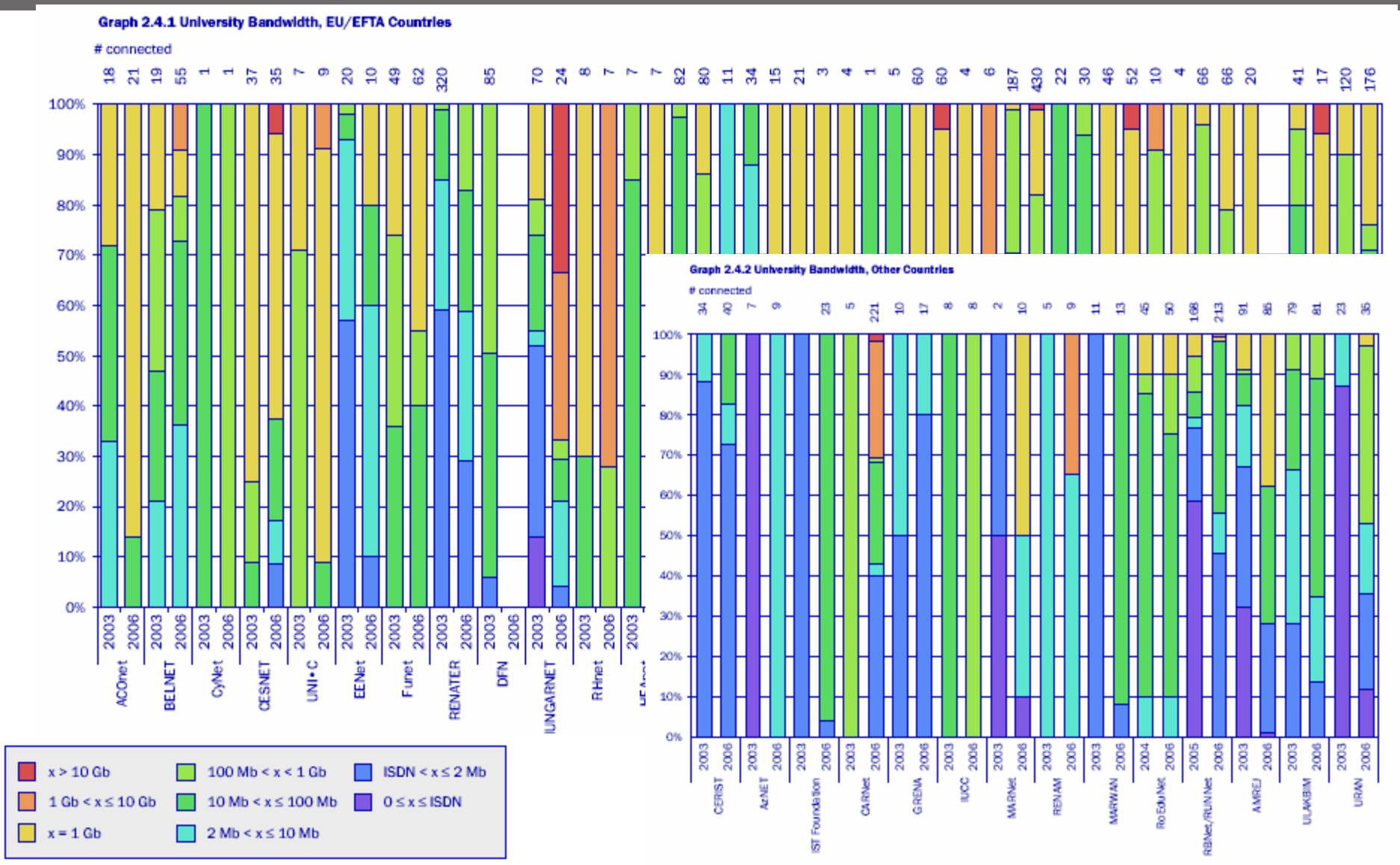
Graph 3.5.2 External Connectivity > 10 Gb, January 2006

2006

Connection Policy

- All NRENs connect universities, research institutes and, with few exceptions, institutes of higher education.
- Many NRENs also connect secondary and primary institutions, though there are great differences in policy.
- Some NRENs connect government departments that have a relation to research and education, etc.

Capacity to Universities



2006

Global Trend

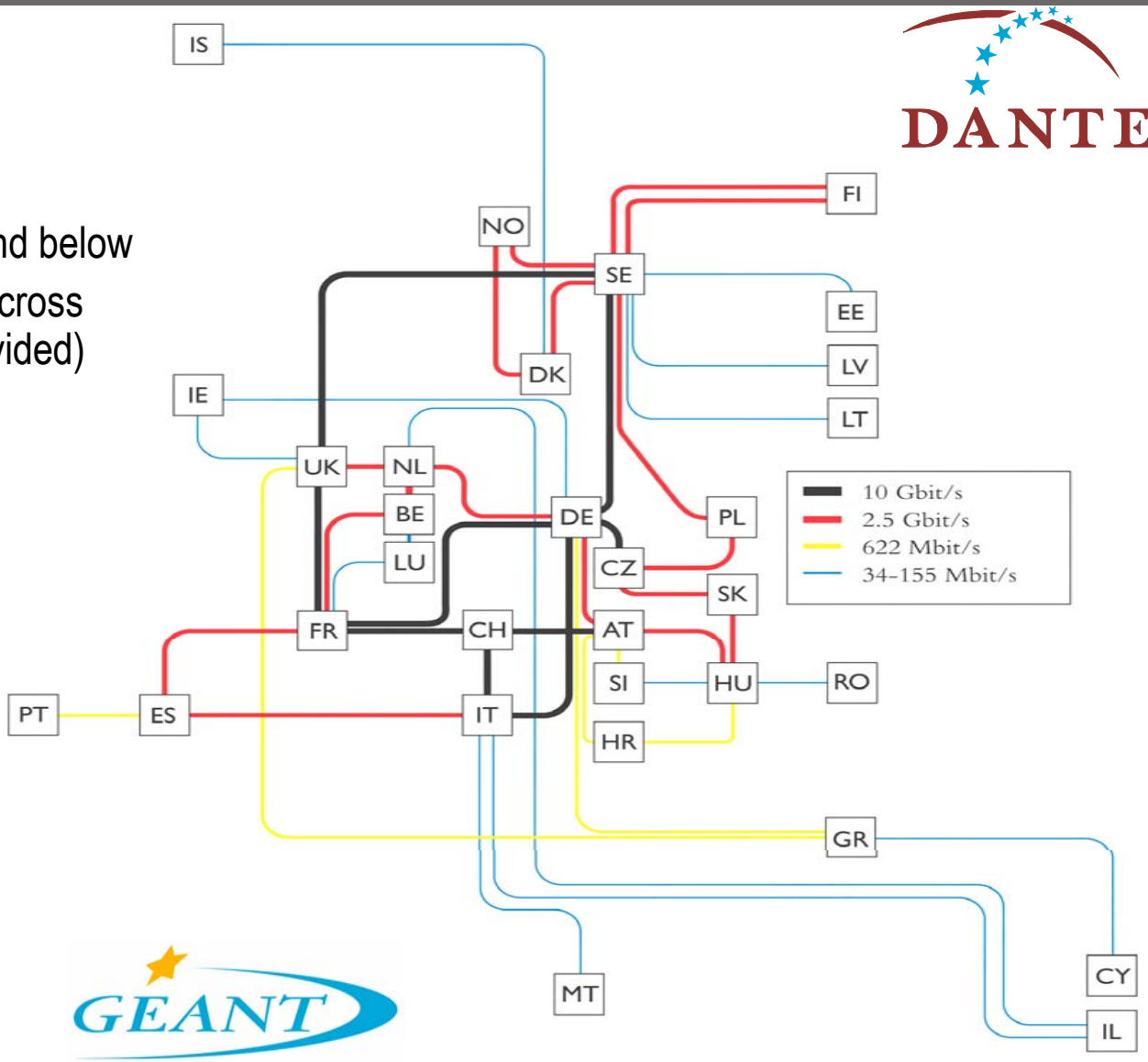
Global REN: And now national RENs are connecting to each other creating advanced research and higher education network of continental proportion…

Federation of RENs

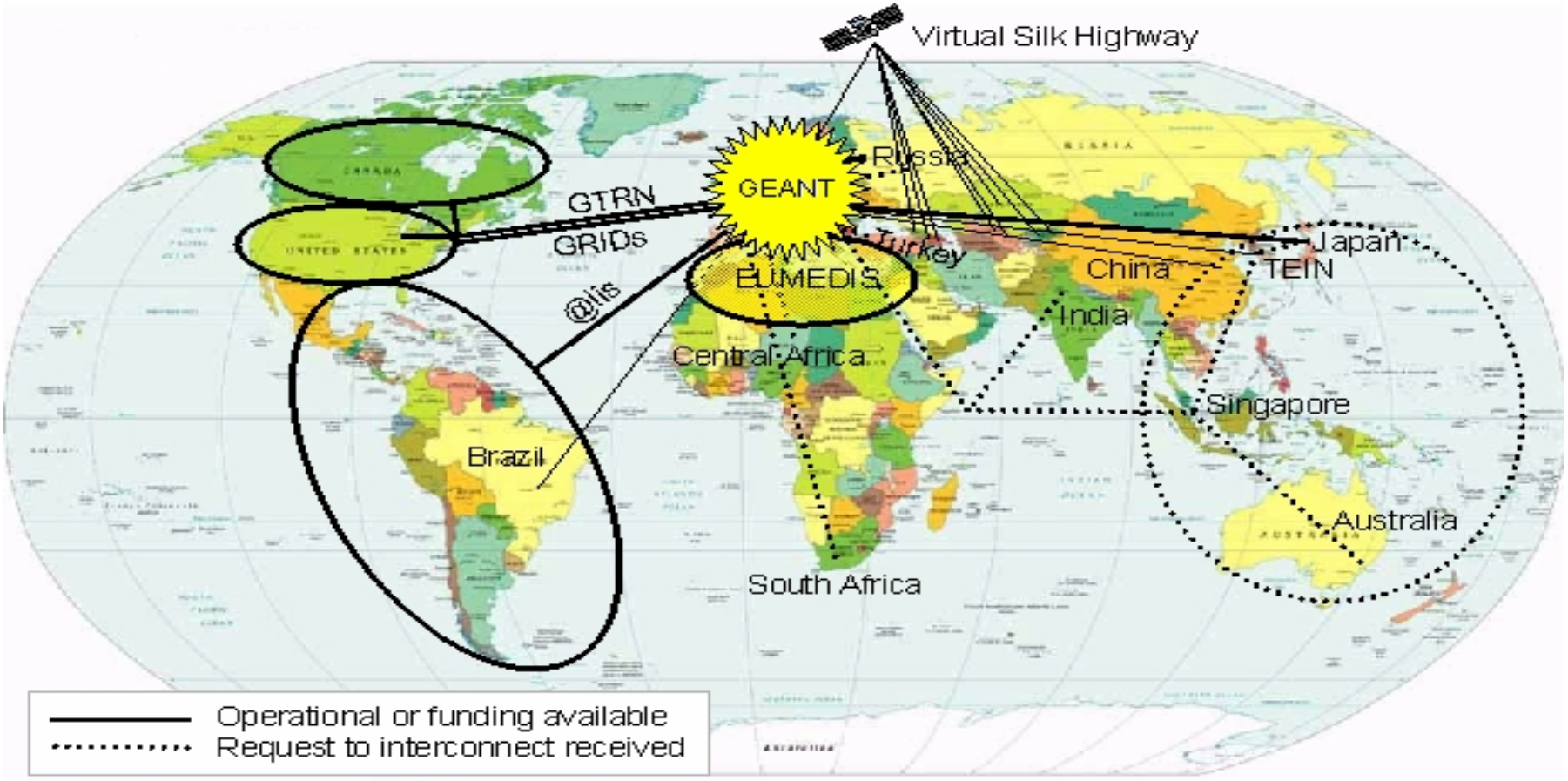
Network	Name	Region	Members
APAN	Asia-Pacific Advanced Network	All Asia	All Asia
TEIN2	Trans-Eurasia Information Network	Asia Pacific	Australia, China, Indonesia, Korea, Malaysia, The Phillipines, Thailand and Vietnum with Europe)
EUMEDCONNECT	Europe and Mediterranean Education Network Connect	Mediterranean	Algeria, Cyprus, Egypt, Israel, Jordan, Lebanon, Malta, Morocco, The Palestainian Authority, Syria, Tunisia and Turkey
Nordunet	The Nordic Internet Highway to Research and Education Networks	Nordic Europe	Denmark, Finland, Iceland, Norway and Sweden
GEANT2	Network for Southeast Europe	All Europe	30 RENS from all Europe
ALICE	America Latina Interconectada Con Europa	Latin America	Argentina, Brasil, Chile, Costa Rica, Guetemala, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela, Bolivia, Columbia, Hondurus, Nicaragua, Cuba, El Salvador, and Ecuador
ERNESA	The Educational Research Network in East and Southern Africa	East and Southern Africa	Botswana, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe)
ERNWACA	The Education Research Network for West and Central Africa	West and Central Africal	Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Mali, Nigeria, Senegal, Sierra Leone and Togo)

GEANT (http://www.dante.net/geant/)

- 31 countries connecting
- Operated by DANTE
- 10 Gbps core backbone
  - Connectors at 10Gbps(2) and below
- Total of 4x2.5Gbps + 2x1Gbps across Atlantic (DANTE & EuroLink provided)

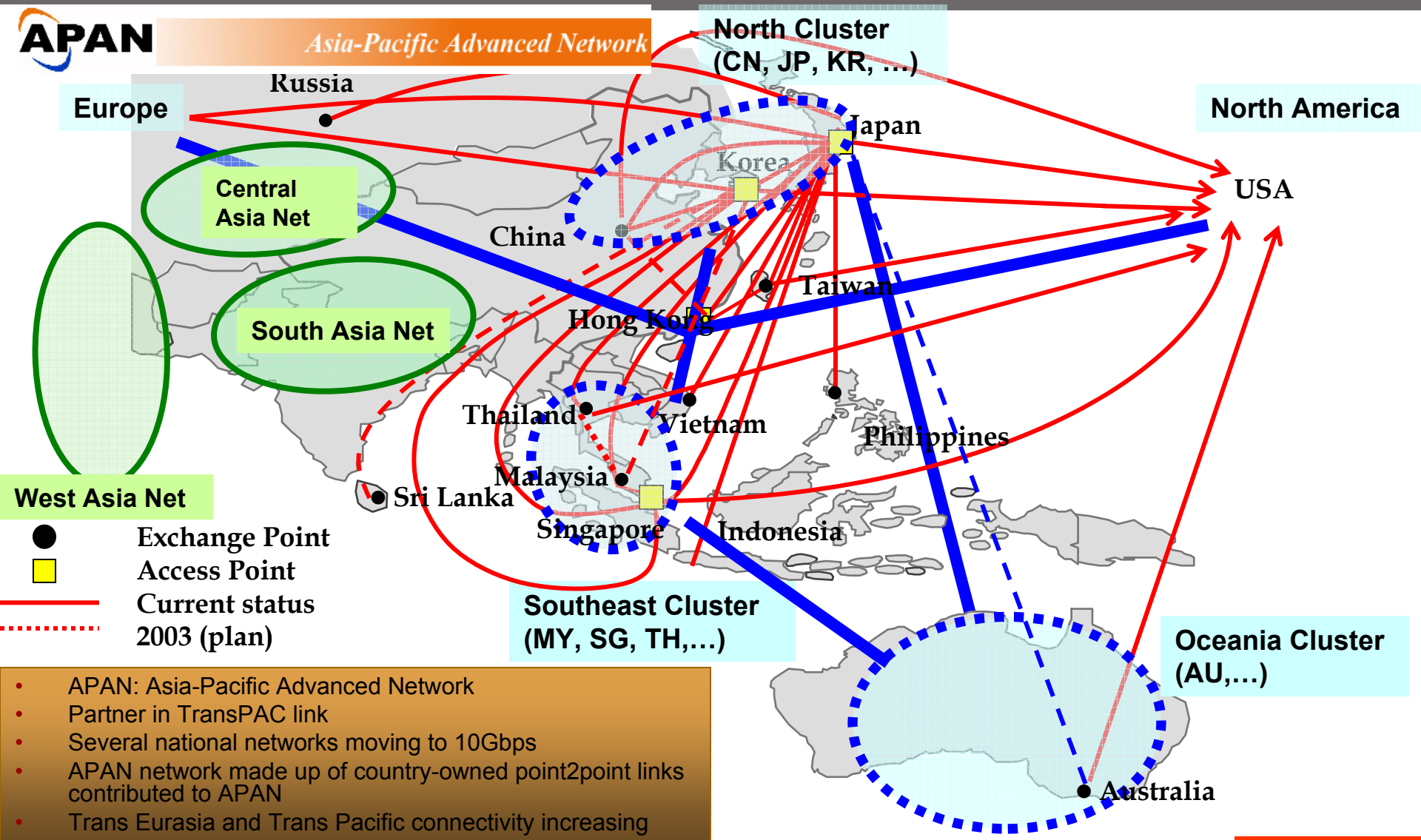


Europe – International connectivity



REF: Report on present status of international connectivity in Europe and to other continents , From SERENATE – Study into European Research and Education Networking As Targeted by eEurope, http://www.serenate.org/publications/d6-serenate.pdf

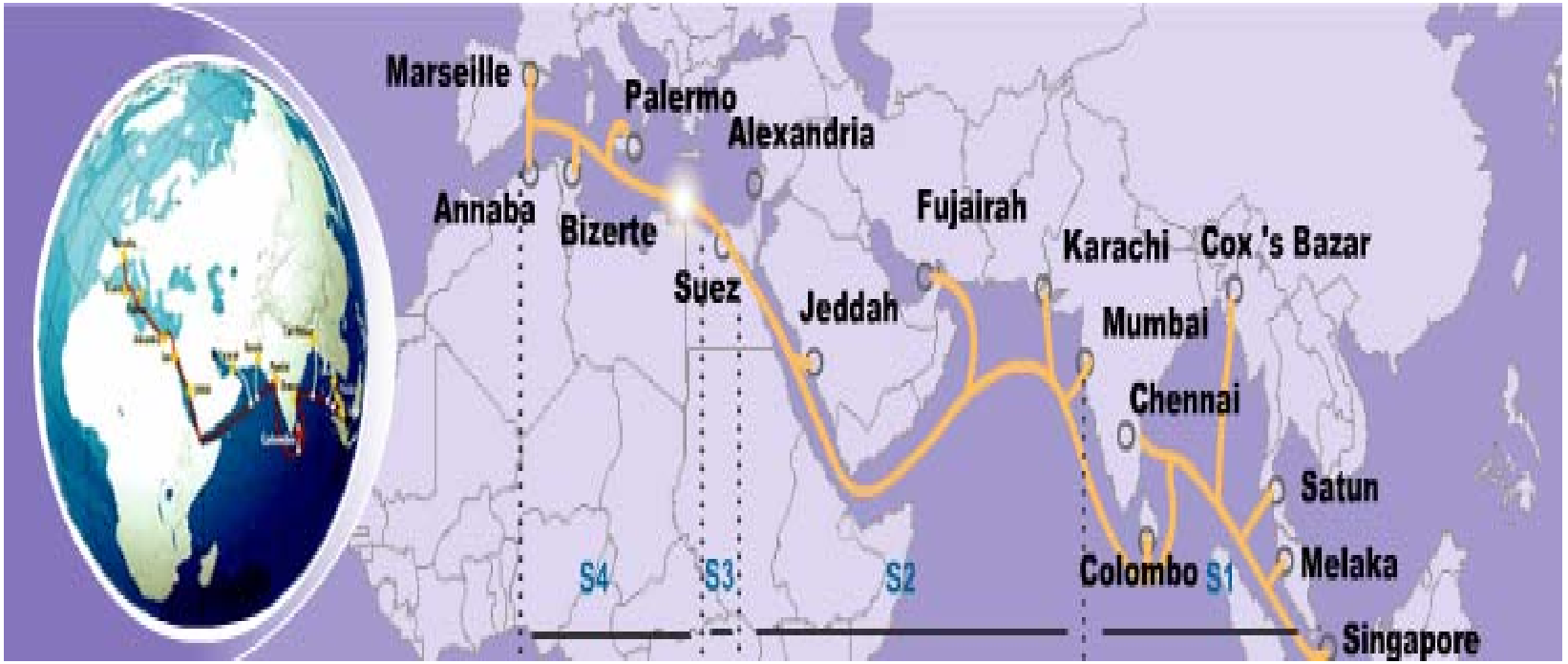
APAN: Asia Pacific Advanced Network



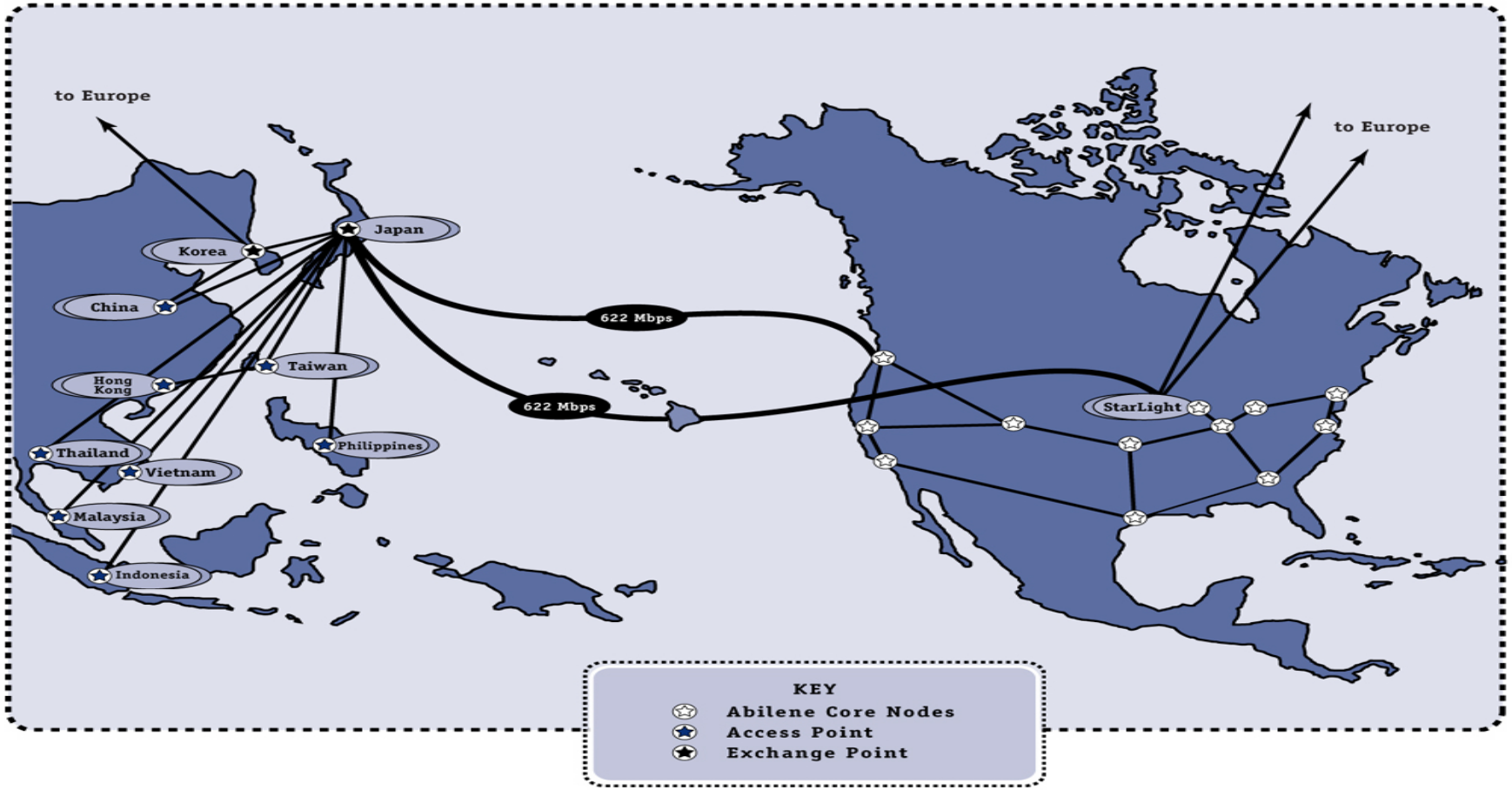
- APAN: Asia-Pacific Advanced Network
- Partner in TransPAC link
- Several national networks moving to 10Gbps
- APAN network made up of country-owned point2point links contributed to APAN
- Trans Eurasia and Trans Pacific connectivity increasing

SEA-ME-WE4

- The latest fiber now will connect South Asia with South East Asia RENs.



TransPAC

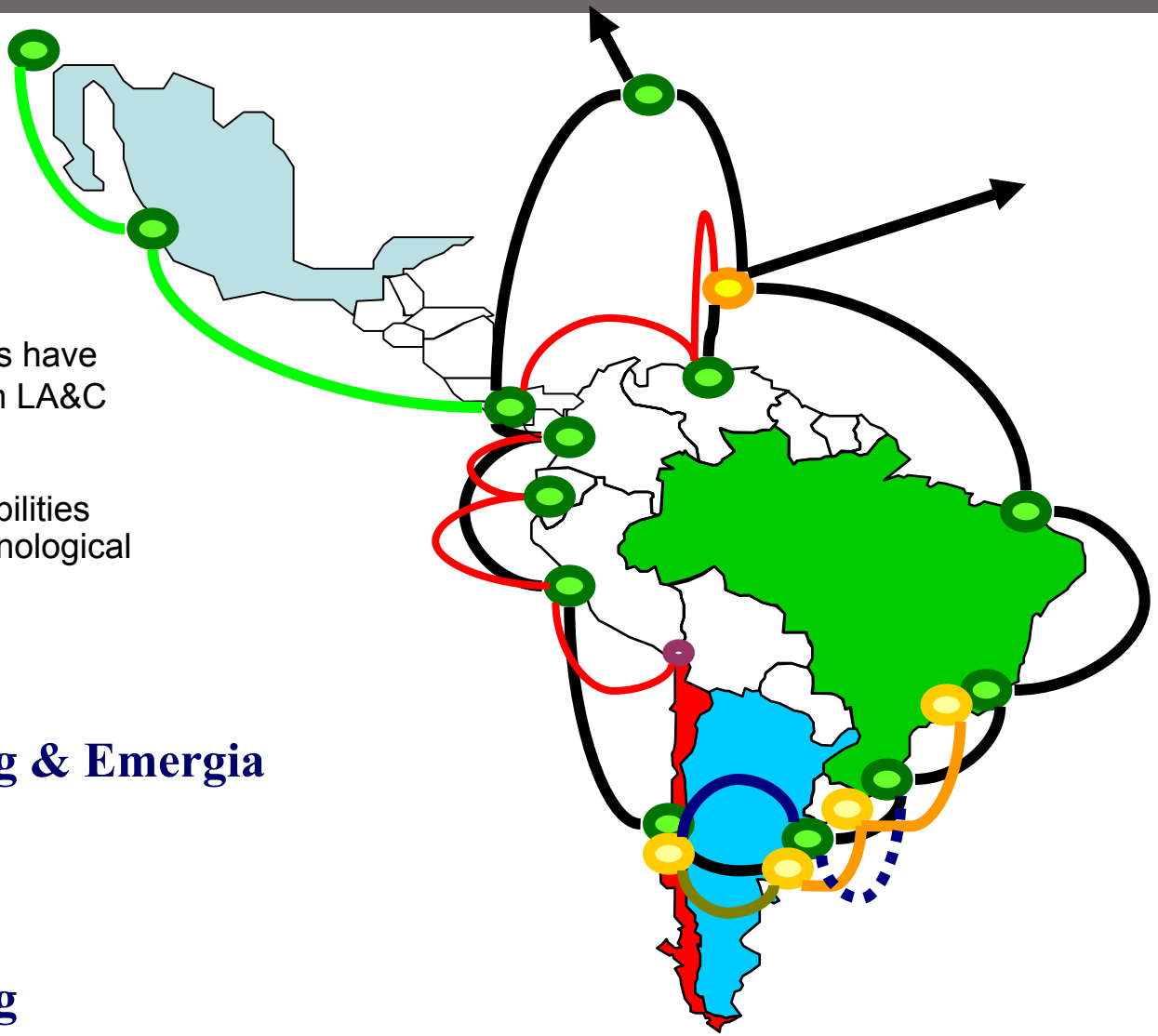


- Connections APAN to US
  - Currently 2xOC12 Tokyo – Seattle, Tokyo - Chicago
  - Upgrading to 2.5Gbps Tokyo – Los Angeles and 2x1GbE Tokyo - Chicago
  - Funded by NSF and Japanese government

SRC: http://www.transpac.org

Latin America

- During last 3 years, several firms have been building optical fiber rings in LA&C
- Significant projects underway
- Opening exciting and new possibilities for cooperation in advanced technological and scientific applications



Panamerican
Global Crossing & Emergia
ImpSat
Transandino
UniSur
Global Crossing

Africa

- No dedicated R&E network connectivity from African continent
- Some national inter-university connections:
  - South Africa: Tertiary Education Network (TENET) *http://www.tenet.ac.za/*
  - Egypt: Egyptian Universities Network (EUN) *http://www.frcu.eun.eg/*
  - Morocco: Maroc Wide Area Network (MARWAN) *http://www.marwan.ac.ma/*

National Institutes of Health MIMcom project

- Satellite connectivity to malaria research sites in Ghana, Kenya, Tanzania *http://www.nlm.nih.gov/mimcom/locations.html*

REN Services & Applications

RENs are spearheading a new generation of advanced applications and services.

Network Services

- Network Operating Centers
- Network Monitoring and Measurement
- Certificate Server
- Federated Authorization & Authentication Infrastructure (AAI)
- Bandwidth on Demand
- Eduroam a facility that provides roaming access for university users to wireless networks.

Digital Divide & Basic Edge Services

- Many developing world institutions does not have even basic internet services (email for UG, user web-pages).
- A REN can provide cost-effective ways to rapidly bridge the digital divide:
  - Federated perpetual email.
  - Course ware management
  - Web hosting
  - Digital library access.
  - Publishing services/Journal centers
- Paperless University

"But...there is a growing digital divide between those who have access to the digital economy and the Internet and those who don't, and that divide exists along the lines of education, income, region and race.... The very information technology driving this new economy gives us the tools to ensure that no one gets left behind...."
-Bill Clinton, 1999

Services Applications

- Digital Library
- E-Learning/ Distance Education
- GRID Computing
- IP Telephony (inter REN gateway forwarding)
- Video Conferencing
- Virtual Conference
- Advanced Laboratory Sharing

A look at REN Services:

Federated Digital Library

Digital Library

- Grand projects are now underway to digitize all available books that mankind possess. Some estimate as much as 10 million books will be soon freely available on our desktops in few years.

- Some of the most valuable resources used to be available only to the limited scholars in the developed world. But now one can 'scroll' the intricate details of original **Diamond Sutra-** which its original printer Wang Jie "reverently made for universal free distribution on behalf of his two parents" in 868 AD, or literally 'turn' the pages of **Sultan Bayber's magnificent Quran** (digital library of British Library, 2005). Materials now can be made universally available irrespective of constraints of time and distance.

The library connects us with the insight and knowledge, painfully extracted from Nature, of the greatest minds that ever were, with the best teachers, drawn from the entire planet and from all our history, to instruct us without tiring, and to inspire us to make our own contribution to the collective knowledge of the human species. I think the health of our civilization, the depth of our awareness about the underpinnings of our culture and our concern for the future can all be tested by how well we support our libraries.

— Cosmos
Carl SAGAN

Digital Library Consortium

- Some of the publishers are very large organization. A federated approach provides higher education community leverage to negotiate better rates for contents.
- Avoid paying duplicate subscription for the same journals by multiple institutions.
- The REN provides fast access to the vast amount of digital education resources which are available worldwide- but can not be accessed otherwise.
- Information property is fast becoming a major commodity in 21st century. communities needs to maintain indigenous expertise to safe guard its financial and strategic rights and interests in this new world. National digital library will help in nurturing this safeguard.

Digital Library Consortium Models

- Developed World/ USA & Europe
  - Initiated by States. (OhioLINK USA)
  - Major libraries are building electronic confederations from state sponsorship, to save and expand into new service.

- Developing World/ INDIA, Pakistan
  - Initiated by UGC/HEC
  - Only opportunity to reduce digital divide.
  - Huge capital saving initiative when most countries are facing rapid expansion of costly higher education need.

OhioLINK: Digital Library Alliance

- The Ohio Library and Information Network (OhioLINK) is a consortium of Ohio's college and university libraries and the State Library of Ohio. Serving more than 600,000 students, faculty, and staff and researchers at 85 institutions. OhioLINK serves faculty,

- Membership:
  - 17 public universities
  - 23 community/technical colleges
  - 44 private colleges
  - State Library System of Ohio.

- Assets:
  - Campus-based electronic library systems,
  - The OhioLINK Central Site and
  - Internet resources

OhioLINK Electronic Services

- Six main electronic services:
  - A library catalog
  - Research databases
  - A multi-publisher electronic journal center
  - A digital media center
  - A growing collection of e-books, and
  - An electronic theses and dissertations center.

OhioLINK Library Catalog

- More than 44.8 million library items.
- More than 9.67 million unique master records from its 85 institutions..
- Supports more than 4,500 simultaneous users.
- Also available to outside users via the Internet.
- Offers user-initiated, non-mediated online borrowing through its statewide library catalog.
- Students and faculty have the ability to request items electronically while searching the catalog.
- Provides a delivery service among member institutions to speed the exchange of library items.
- Users can create portal to receive alert etc.

OhioLINK Research Databases

- OhioLINK offers more than 100 electronic research databases, including full-text resources covering many academic areas at varying levels of detail.
- Generally, the user can find out which OhioLINK members possess copies of the cited journal or link to the relevant full-text article.
- OhioLINK's electronic full-text resources include online dictionaries, literature, and journal articles.
- Access to the research databases is restricted to valid patrons at OhioLINK member institutions.

OhioLINK: Electronic Journal Center (EJC)

- OhioLINK Electronic Journal Center, a massive collection of full-text research journals.
- The EJC contains more than 6,400 scholarly journal titles from 80+ publishers across a wide range of disciplines.
- More than 4.68 million articles are downloaded each year from the EJC, with a total of more than 19.2 million articles downloaded since its inception.

Digital Divide [1]

Table-1 Some National University Libraries Around South Asia			
Institution	**Books**	**Serials**	**DL**
Jauharlal Nehru University, India	500,000	800	Yes
Bombay University, India	700,000	n/a	Yes
Chepauk Library, Madras University, India	509,263	642	Yes
Calcutta University, India	800,000	795	Yes
Punjub University, Pakistan	442,300	N/A	Yes
LUMS, Pakistan	52,000	325	Yes
Quaid-i-Azam University, Pakistan	195,000	276	Yes
University of Colombo, Sri Lanka	400,000	970	Yes
Tribhuvan University, Nepal	n/a	n/a	No
Royal University of Bhutan	n/a	n/a	No
University of Malaya Library, Malaysia	1,239,749	3631	Yes
Maldives has no University	X	x	x
Dhaka University, Bangladesh	550,000	250	No

Digital Divide [2]

- Potential benefits of digital libraries are more pronounced for the libraries of the developing countries.

- An average US university spends about US$ 5 million in journals and periodicals, about US$ 2 million in monographs. It has about 3-8 million books and subscribes about 22,500 serials, and it adds about 30,000 books per year [2]. These are astronomical figures (20-150 times more) compared to the ability of most university in the developing world. For developing world the cost of collection and archiving of traditional print media is becoming prohibitively expensive. Particularly, hard hit areas are cost of periodicals and technological journals. Many libraries are rapidly shrinking.

- Digital content reduces the cost to a library by a factor of ten [3]. A Federated model further shrinks the cost per institution. It seems developing countries can benefit more from the digital library technology. Digital technology might be the only way to narrow this access gap.

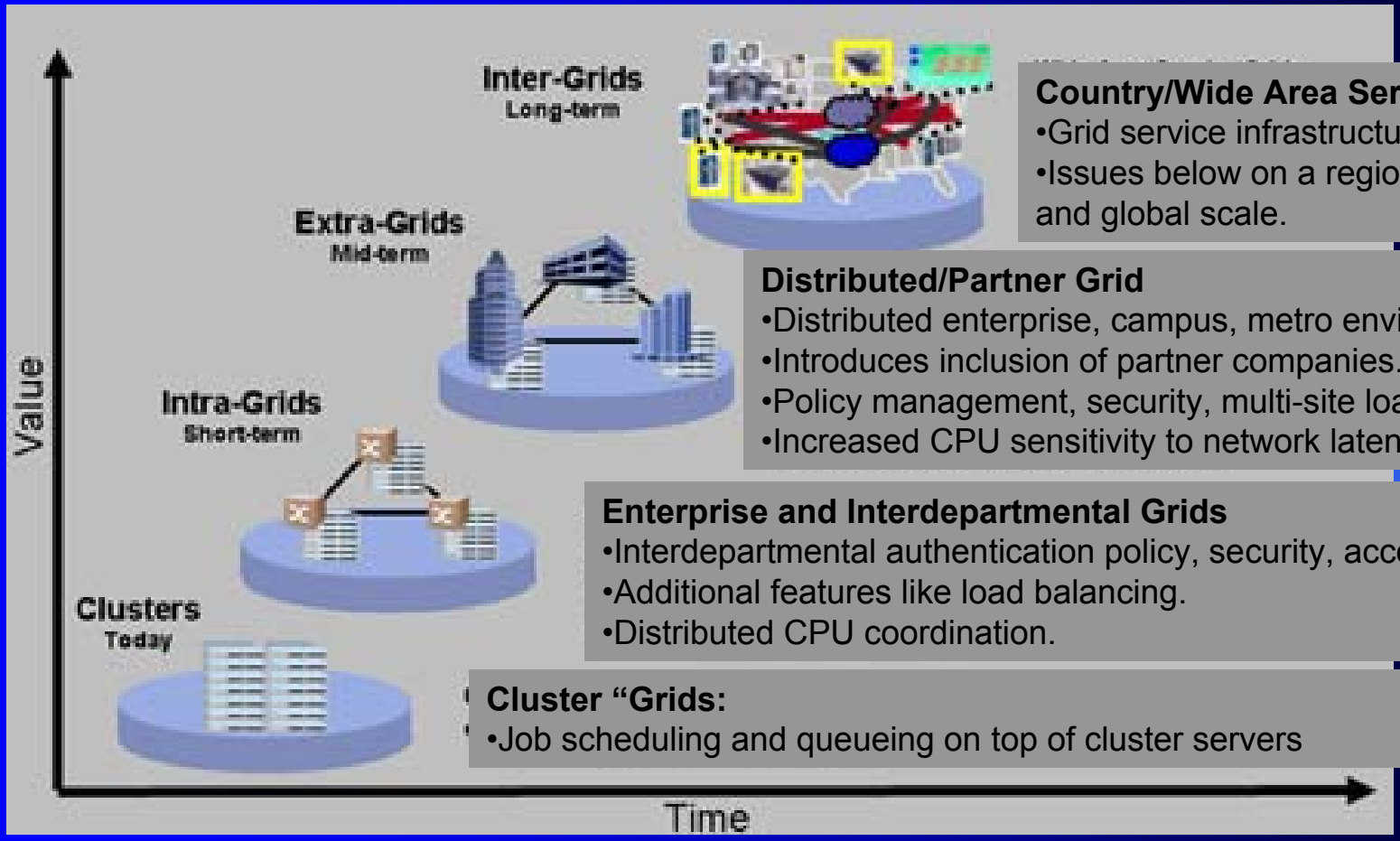
REN Applications

GRID Computing:
Supercomputing for the Poor

Grid Computing

- **Connect the Supercomputers (and all other computing resources) on RENs!**

Expected Evolution of Grid



Country/Wide Area Service Grids
- Grid service infrastructure
- Issues below on a regional, national and global scale.

Distributed/Partner Grid
- Distributed enterprise, campus, metro environment
- Introduces inclusion of partner companies.
- Policy management, security, multi-site load balancing
- Increased CPU sensitivity to network latency.

Enterprise and Interdepartmental Grids
- Interdepartmental authentication policy, security, accounting.
- Additional features like load balancing.
- Distributed CPU coordination.

Cluster "Grids:
- Job scheduling and queueing on top of cluster servers

Grid Application in RENs

Table 5.7.1 Disciplines That Are Running Grid-enabled Applications

Country	NREN	High-energy Physics	Other Physics	Computational Chemistry	Other Chemistry	Biomedical	Astroscience	Earth Science	Climatology	Other Disciplines
EU/EFTA Countries										
Austria	ACOnet	now	planned	-	planned	now	planned	-	planned	Applied Numerical Simulation
Belgium	BELNET	now	now	now	-	now	-	-	-	
Cyprus	CyNet	-	planned	-	planned	planned	-	-	-	
Czech Republic	CESNET	now	now	now	now	planned	-	planned	-	
Estonia	EENet	now	now	now	now	planned	planned	-	-	Material Science - Now running
Finland	Funet	now	now	now	planned	planned	now	planned	planned	
France	RENATER									research on grids - supercomputing
Germany	DFN	now	-	-	-	-	-	-	-	
Greece	GRNET	now	-	now	-	now	now	now	now	Regional Catch All Virtual Organisation
Hungary	NIIF/HUNGARNET	now	now	now	now	now	now	now	planned	
Ireland	HEAnet	planned	now	now	now	now	now	now	now	
Italy	GARR	now	now	now	now	now	now	now	-	
Latvia	LATNET	-	now	-	planned	planned	planned	-	-	
Netherlands	SURFnet	planned	-	-	-	-	now	-	planned	
Norway	UNINETT	now	-	planned	-	planned	planned	-	-	
Poland	PIONIER			now						
Spain	RedIRIS	now	now	now	now	now	now	now	now	
Sweden	SUNET	now	now	now	-	now	now	now	-	
Switzerland	SWITCH	planned	-	-	-	planned	-	-	planned	
United Kingdom	UKERNA	now	now	now	now	now	now	now	now	

- Currently 71 of EU RENS are running Grid and it will be 100% by next 2 years.
- Not only High Energy Physics, the use is expanding in other areas as well.

Applications

Digital Audio& Video

IP Telephony

- Now that IP telephony and its protocols are becoming more mature and products more manageable, NRENs are starting to deploy it.
- 50% of the NRENs in the EU/EFTA countries are running an IP telephony deployment, while about 30% of the NRENs in other countries are running one.
- NEXT: NRENs will begin exchanging IP telephony traffic- extending global direct dial and virtual phones; currently IP telephony peering architectures are being defined and operators are not yet ready to support it

Country	NREN	Running IP Telephony?	Protocol Used	Traffic with Telco via IP?
EU/EFTA Countries				
Austria	ACOnet	no		
Belgium	BELNET	no		no
Cyprus	CyNet	no		no
Czech Republic	CESNET	yes	SIP and H.323	Via IP and via PSTN/ISDN
Denmark	UNI•C	no	SIP and H.323	no
Estonia	EENet	no		no
Finland	Funet	no		no
France	RENATER	yes		
Germany	DFN	no		
Greece	GRNET	yes	H.323	no
Hungary	NIIF/ HUNGARNET	yes	SIP, H.323, Skinny	Via IP and via PSTN/ISDN
Iceland	RHnet	no		
Ireland	HEAnet	no	H.323	no
Italy	GARR	yes	H.323	no
Latvia	LATNET	no		
Lithuania	LITNET	yes	H.323	yes
Luxembourg	RESTENA	yes	SIP	no
Malta	CSC	no		

Country	NREN	Running IP Telephony?	Protocol Used	Traffic with Telco via IP?
Netherlands	SURFnet	no		no
Norway	UNINETT	no		
Poland	PIONIER	yes	SIP	yes
Portugal	FCCN	yes	SIP	no
Slovakia	SANET	yes	SIP	no
Slovenia	ARNES	yes	Cisco Skinny	no
Spain	RedIRIS	no	other	no
Sweden	SUNET	yes	SIP	yes
Switzerland	SWITCH	yes	Cisco	no
United Kingdom	UKERNA	yes	SIP	no
Other Countries				
Algeria	CERIST	no		
Azerbaijan	AzNET	no		no
Azerbaijan	AzRENA	yes	SIP	no
Belarus	BASNET	no		no
Bulgaria	IST Foundation	no		
Croatia	CARNet	yes	H.323	Via IP and via PSTN/ISDN
Georgia	GRENA	no		
Israel	IUCC	no		
Macedonia	MARNet	no		
Moldova	RENAM	no		no
Morocco	MARWAN	no		
Romania	RoEduNet	yes	SCCP	no
Serbia/Montenegro	AMREJ	no		
Turkey	ULAKBIM	yes	H.323	no
Ukraine	URAN	no		no

Megaconference

Internet2 Digital Videoconferencing Group

http://www.mega-net.net/megaconference/

- World's largest videoconference
- Uses H.323 videoconferencing and a system of distributed MCU's located around the world
- Used in every fall Internet2 meeting

Tele-Operation of Remote Equipment

- Computerized excavation backhoe
- Remotely operated, used in hazardous situations.
- Quality of Service is Guaranteed

North Carolina State University

Realistic, Life-Sized, 3D Tele-Immersion

- Brings together geographically distant participants and shared virtual objects
- Tele-immersive recreation of office environment

Advanced Network & Services, Brown University, University of North Carolina, University of Pennsylvania

http://www.cs.unc.edu/Research/stc/office/

Applications

Arts & Humanities

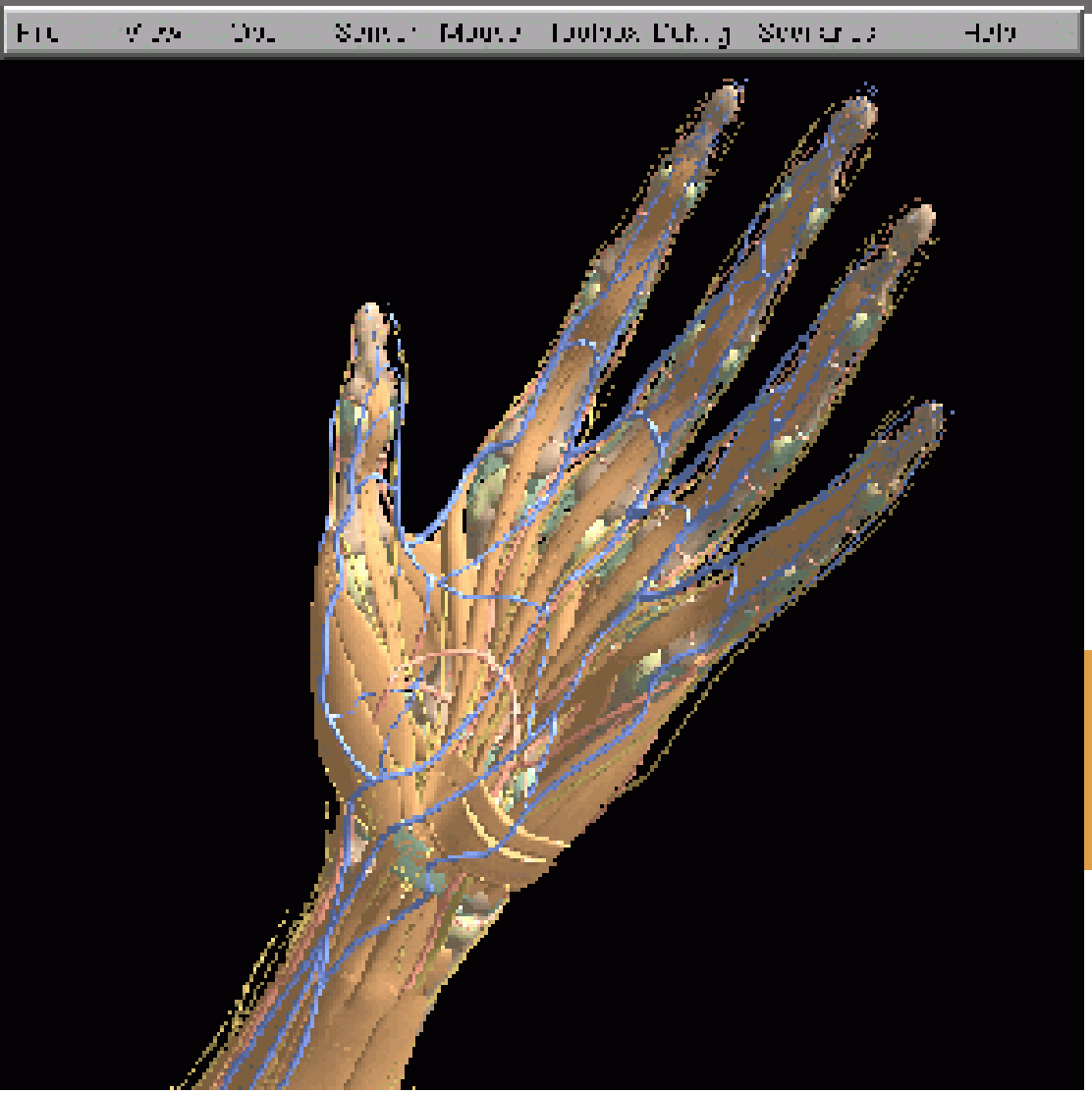
Remote Rehearsal for Fine Arts

Unique Performance Events

Applications

Health & Medical

Improved Medical Training



California Orthopaedic Research Network

- High bandwidth human interaction
- Low latency virtual reality
- Reliable access to computational resources
- Secure retrieval of medical images and data

Source:
Parvati Dev
Stanford

Virtual Pelvic Floor

- Provides 3-D visualization of complex anatomical structures
- Participants use ImmersaDesk™ systems to interact with 3-D anatomical model

http://www.sbhis.uic.edu/vrml/Research/PelvicFloor/PelvicFloor.htm

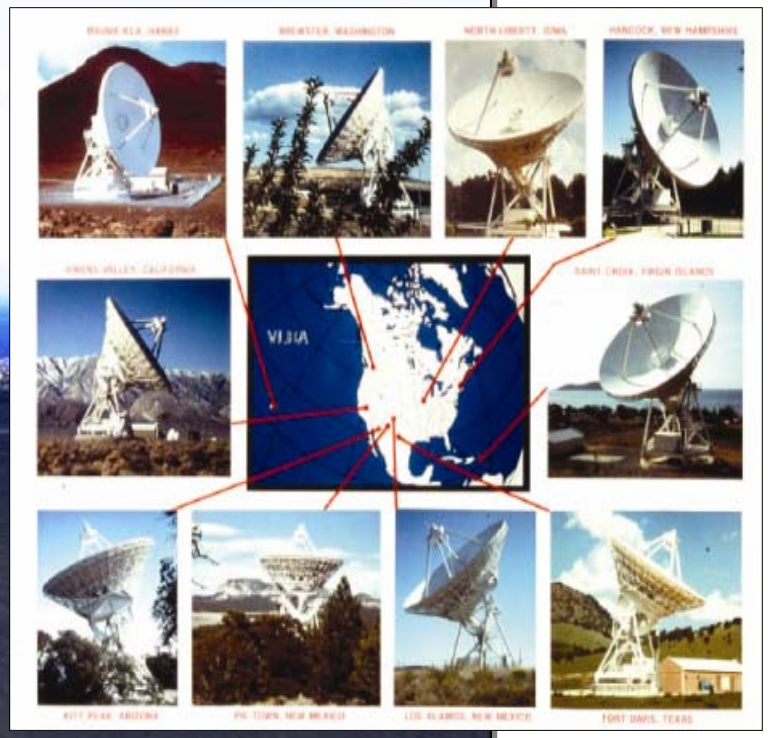
University of Illinois at Chicago

Applications

Remote Instrumentation & Virtual Laboratories

July 2005

New Instruments for Astronomy



Undersea Oceanography

Images National Geographic

Future of Research & Higher Education

- No university, organization, national or regional body can succeed in isolation.
- Advanced Internet will be the key infrastructure component of an University.
- REN is needed to cope up with the advanced applications and systems being deployed/ envisioned by the current world university community. Universities without REN with be increasingly out of touch.
- RENs will enable advanced collaboration between researchers, scholars, research groups in a much more meaningful way across nations breeding new ideas.

Malaysian Perspective [1]

- Malaysian universities must place strategic high priority on ICT & networking infrastructure to connect scholars, scientists, and researchers both internally and internationally to keep its higher education system at-par with the world.
  - However, ICT itself is not the goal it's a means to build a world-class technologically capable country.

Malaysian Perspective [2]

- Malaysian universities can be world leader in building digital heritage collections in several areas such as:
  - Digital archives for Islamic treasures. [IIUM??]
  - Ancient-cultural knowledge archive. [UPM?]
  - Asia-Pacific bio-diversity archive. [??]

Malaysian Perspective [3]

- RENs and Inter-university collaboration can act as a harbinger for a new wave of vibrant intellectual and cultural collaboration in Malaysia.
  - Technology is now dictating the collaboration.
  - RENs can also revive ancient cultural and intellectual ties via technology (with countries like Singapore, China, Thailand, Indonesia, Pakistan, Bangladesh, Egypt, India, Yemen).

Acknowledgements

- Network MAPS provided by the NRENs.
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Thank you!

"In the long course of history, having people who understand your thought is much greater security than another submarine."

-J William Fulbright