An overview of research and education networks and interconnectivity around the world

JET Roadmap Meeting
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Purpose

- "…..start the session by painting a global picture of the state of international connectivity, who the players/sponsors are, where the connections are and what the pipe types/sizes are.
- "….give your view of where you think the growth will be, what you see as the major issues and how you think the JET can help"

Caveats

- I’m absolutely sure I’ve missed pieces of information here
- There are many in the room who are intimately involved in many of these projects – so please add/correct/contribute!
- I’ve tried to take a global view, but we all wear our particular tint of glasses…..

What's the point?

- JETnets supporting user communities with needs for access to or interacting with collaborators, facilities, data sources outside the US
- JET charter is to coordinate networking activities, operations, and plans, between multiple Federal agency networks (represented by DOD, DOE, NASA, and NSF), the NGI, and Internet2
- Despite precipitous drop in international (esp. trans-oceanic) bandwidth, still expensive
  - at minimum – sharing plans, information
  - at maximum – jointly leveraging international connectivity, aggregating, sharing bandwidth internationally
  - NGIX – international exchange points coordination activities

Some generalizations

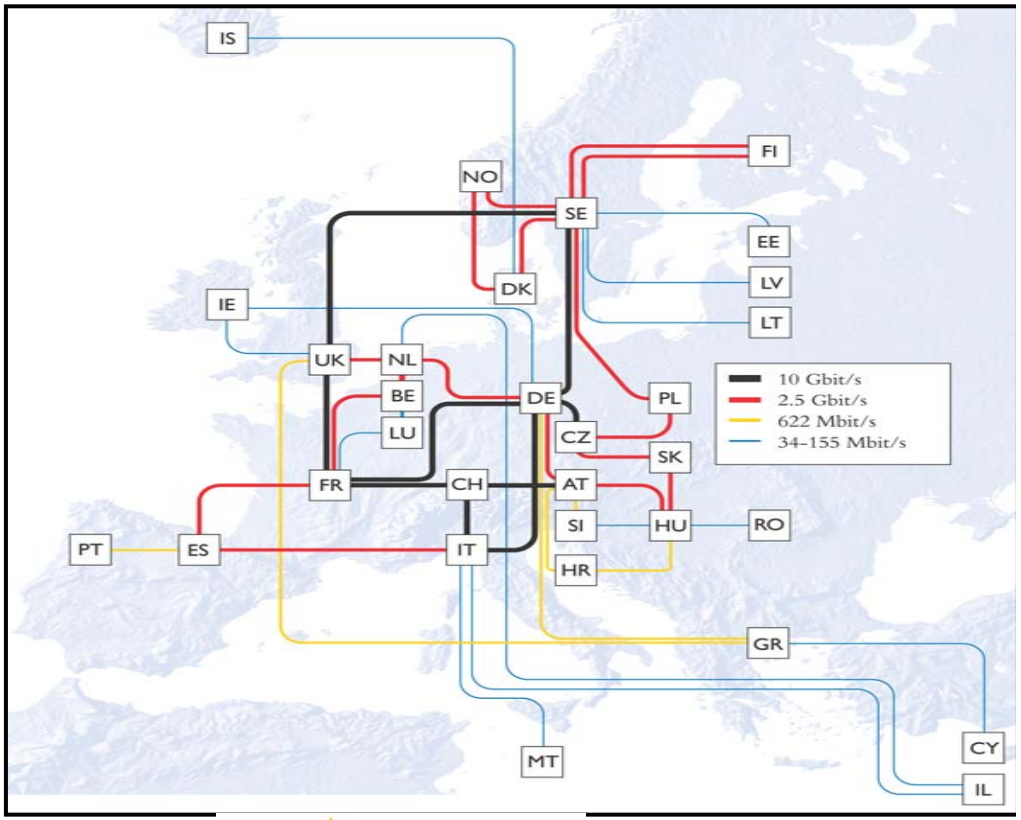
- The idea of national research (and education) networks (NRNs or NRENS) has really taken off
  - New NRENs in Latin America, Eastern Europe, Mediterranean, Middle East
- Many of these NRENs incorporate both government research lab and research university connectivity covered by JETnets
- Regional (continental-scale) backbone growth
- Continuum from commercial Internet access, to reliable-leading-edge (production) to experimental to network research facilitating networks
  - But locus of most effort on supporting the high-performance, leading-edge needs of high-end science (UK e-Science, US CyberInfrastructure) and other high-end research, education, clinical needs

Europe - overview

- High-performance R&E networks
  - GEANT2 backbone in midst of new procurement
    - ~September 2004 start
    - Mix of leased/owned transmission and bought telecom services
  - Several national networks building out owned/leased fiber (NL, CH, PL, CZ, SK)
  - CERN likely to become GEANT PoP in Switzerland
- Wavelength connections to NetherLight
  - Czech Rep., NordicLight, UKLight (coming soon), CERN (by SURFNET)
- Other testbed networks in Europe
  - GEANT2 testbed network
  - New EU IST projects

GEANT
http://www.geant.net

- 30 countries connected
- Consortium of 26 NRENs
- Operated by DANTE
- 10 Gbps core backbone
  - Connectors at 10Gbps(9) and below

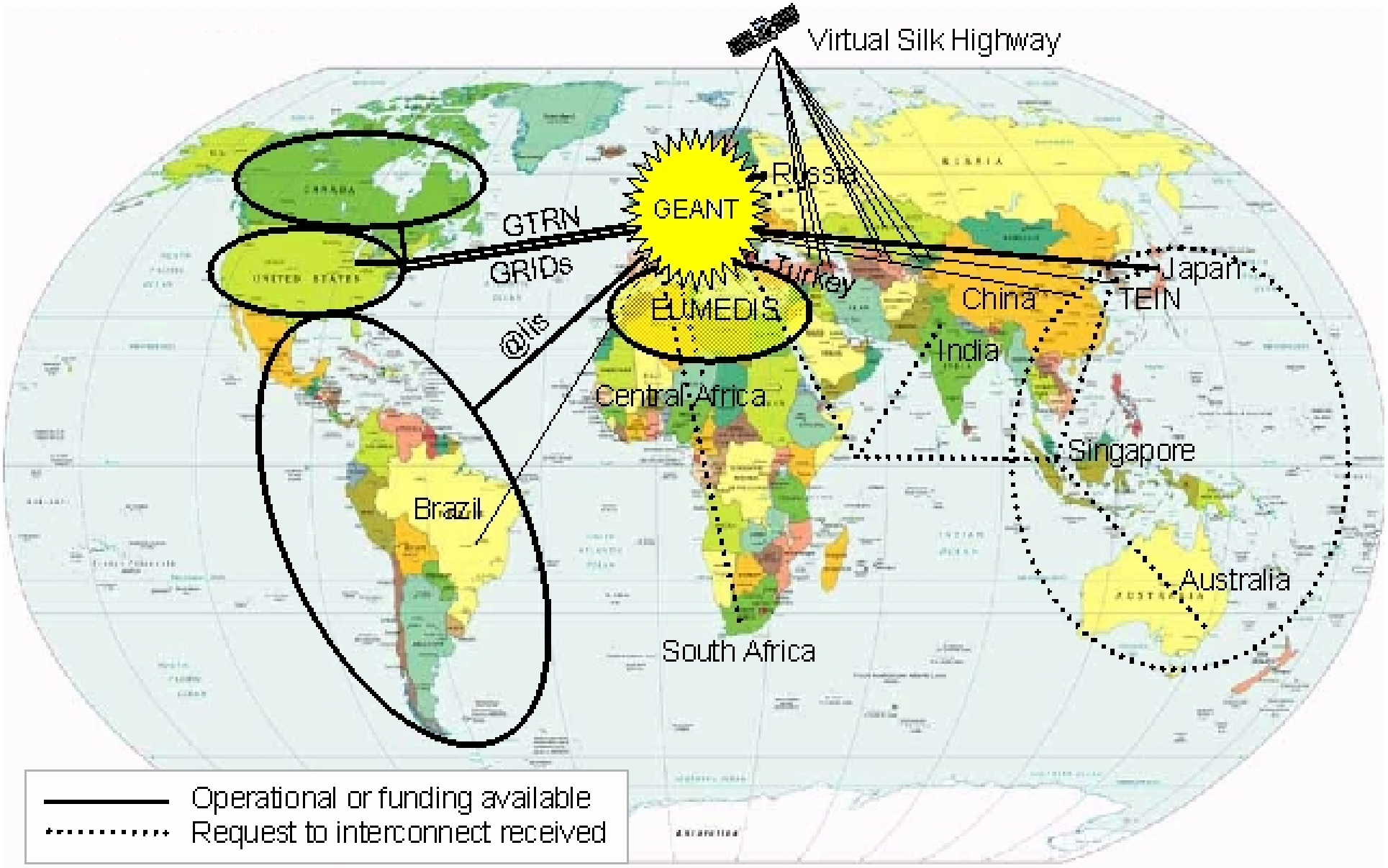


Trans-Atlantic connectivity

Connection to	Link Operator (*Funder)*	BW(Mbps)	N.A. Interconnect
CERN	CERN *(NSF/EU/DOE)*	10,000	StarLight
HEAnet (Ireland)	HEAnet	622	NYC, StarLight
SURFNET (NL)	SURFnet	10,000	StarLight
RBnet (Russia)	Little Gloriad *(NSF/Russia)*	155	StarLight
GEANT (Europe)	GEANT *(GEANT)*	2x2,500/2,500	MAN LAN/Wash
GEANT (Europe)	EuroLink *(NSF)*	2,500	StarLight/Abilene
GEANT (Europe)	“	2,500	StarLight/CA*net
NetherLight	“	4x1,000	StarLight
NetherLight	Internet2&SURFnet *(IEEAF/TYCO)*	10,000/622	MAN LAN
UKLight (UK testbed)	UKERNA *(JISC)*	10,000	StarLight
Qatar Foundation Network	Qatar Foundation	155	MAN LAN

Beyond Europe

- Additions to “Europe”
  - Russia
    - Already had 622Mbps through St. Petersburg to NORDUnet
    - GEANT consortium member proper
- European-funded connectivity to other regions than Europe
  - SEEREN (southeastern Europe)
  - EUMEDCONNECT (Mediterranean)
  - ALICE (Latin America)
  - TEIN2 (Southeast Asia)
  - Support for NATO-led Virtual Silk Highway
  - Discussions with South Africa (SANREN emerging)

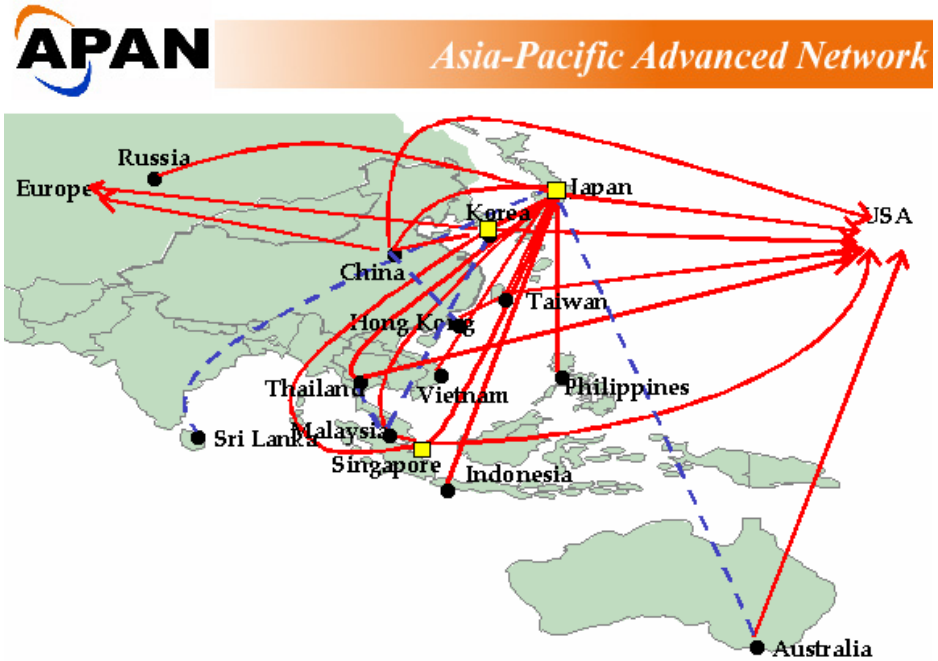


Report on present status of international connectivity in Europe and to other continents

From SERENATE – Study into European Research and Education Networking As Targeted by *e*Europe, *http://www.serenate.org/publications/d6-serenate.pdf*

Asia-Oceania

- APAN: Asia-Pacific Advanced Network
  - APAN network made up of country-owned point2point links contributed to APAN
  - Most connect to APAN/Tokyo XP
  - No real shared regional “backbone” at this point
  - Cluster efforts (Northeast, Southeast, Oceania)



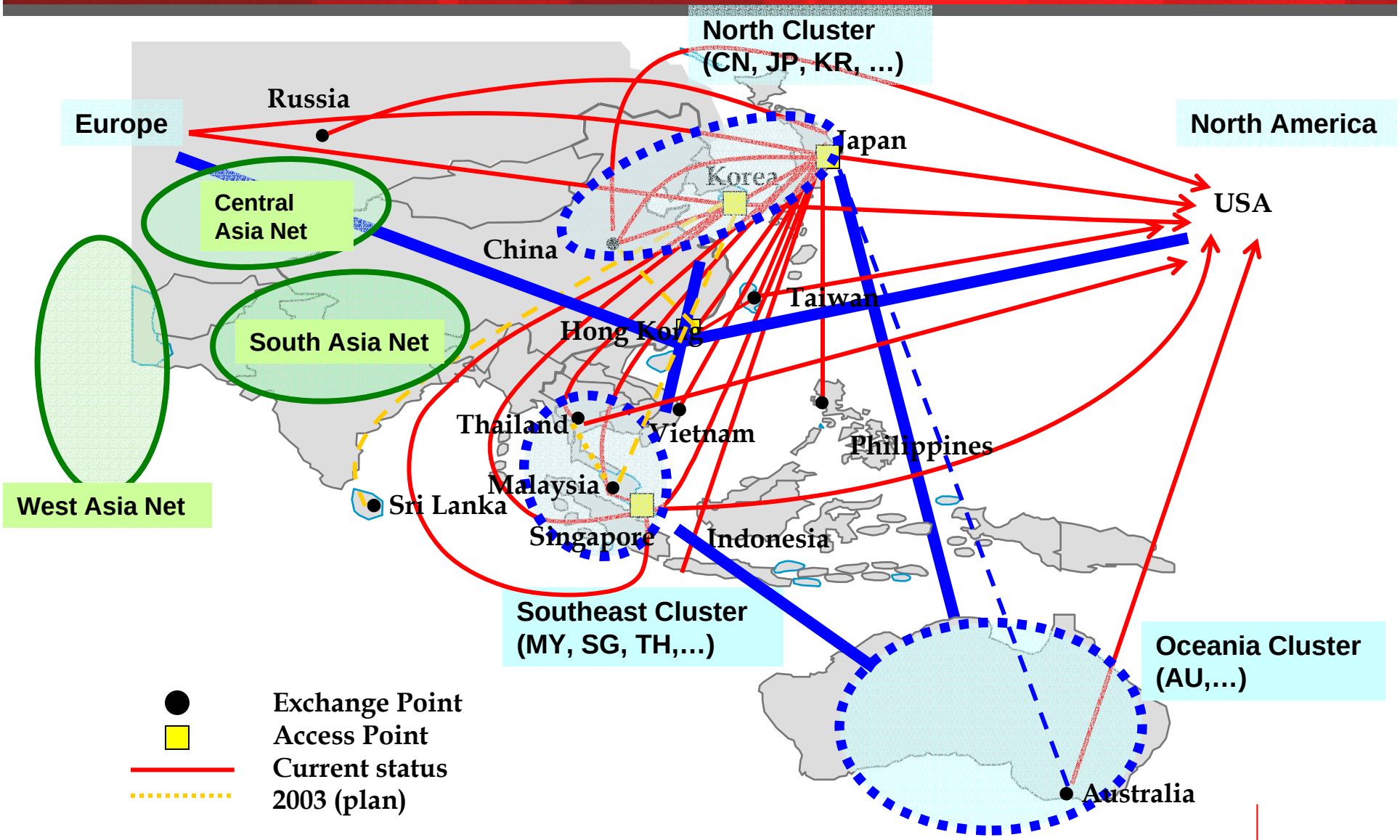
Asia-Oceania to North America connectivity

Connection to	Link Operator *(Funder)*	BW(Mbps)	N.A. Interconnect
APAN/Tokyo	TransPAC/APAN *(NSF, CRL)*	2,500/2,500	LA/StarLight
Australia	AARNET	2 x 155	Pacific Wave
China	CERNET	45	StarLight
CSTNET (China)	LittleGLORIAD *(NSF)*	155	StarLight
Korea	KOREN/KREONET2	2x622	PWave/StarLight
Hong Kong	HARNET	45	StarLight
Japan	SINET	4x2,500	MAN LAN
Japan	GEMNET/NTT	622	Pacific Wave
Singapore	SingAREN	155	Pacific Wave
Taiwan	TANet2/TWAREN	2500/622+1GE	PWave/StarLight
Taiwan	ASNET	622	StarLight
Thailand	UNINET	155	LA
WIDE/APAN-TKY	WIDE&PNWGP (*IEEAF/Tyco)*	10,000/622	PWave
Qatar	Qatar FN	155	MAN LAN

Asia-Oceania future

- Effort to firm up APAN organization underway
  - Effort to move toward regional clusters of interconnection
- Outreach to South Asia
  - India, Sri Lanka, Bangladesh, Pakistan
  - No current connectivity
- Australia
  - SXTransport 2x10G to Hawaii and US mainland
    - Eventually connect New Zealand (new NGI-NZ entity)
    - Fiji
- TransPAC project upgrade
  - Potential to dual 10G in August timeframe

APAN future


North Cluster
(CN, JP, KR, ...)
Europe
Russia
North America
Japan
Korea
USA
Central
Asia Net
China
Taiwan
South Asia Net
Hong Kong
Thailand
Vietnam
Philippines
West Asia Net
Malaysia
Sri Lanka
Singapore
Indonesia
Southeast Cluster
(MY, SG, TH,...)
Oceania Cluster
(AU,...)
Australia
Exchange Point
Access Point
Current status
2003 (plan)

Americas

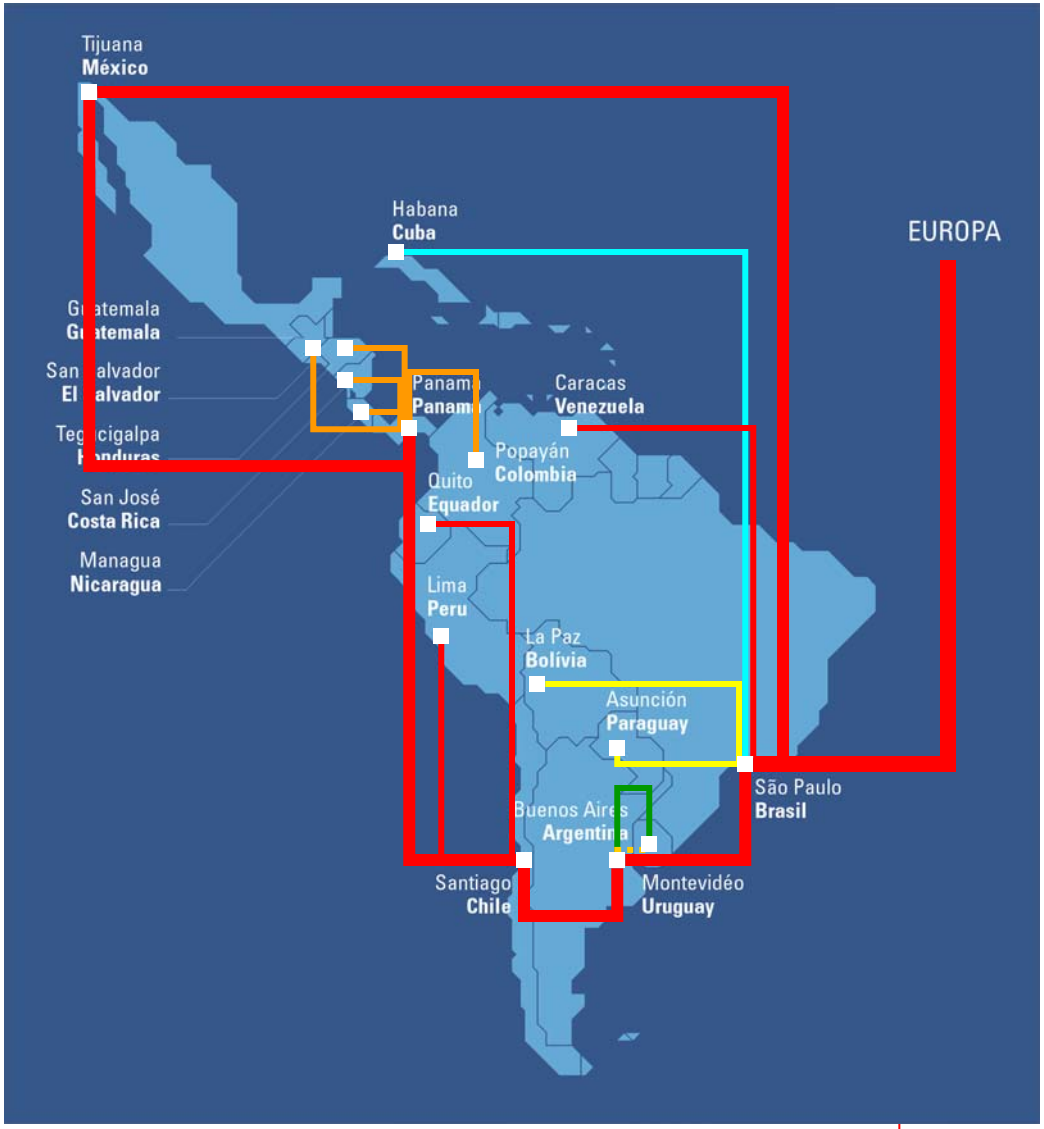
- Canada:
  - CA*net national facility/backbone
  - Cross-border connectivity
    - B.C./Seattle, Toronto-Winnipeg/Chicago, Montreal/Toronto-New York City
  - RON to RON connectictivity
    - Ontario (ORION) to Michigan (Merit)
- Mexico:
  - 155Mbps backbone (Telmex and Avantel)
  - Cross-border connectivity
    - San Diego-Tijuana (CENIC)
    - El Paso-Juarez (UT-El Paso)
- Latin America (Mexico, Central, South, Caribbean) CLARA organization/backbone effort

Americas Connectivity

Country	Network	BW (Mbps)	Interconnect
Canada	CA*net	multiGbps	StarLight/PWave/MAN LAN
Mexico	RED-CUDI	155 /100	Tijuana-San Diego (CALREN-2) / Juarez - El Paso (UTEP-UT)
Chile	REUNA	45	AMPATH
Brazil	RNP2	45	AMPATH
	ANSP	45/622	AMPATH/CHEPREO
Argentina	RETINA2	45	AMPATH
Gemini/NOAO	*(NSF funding)*	10	SFGP
Puerto Rico (Arecibo Observatory)	To Abilene-U.S. *(NSF funding)*	155	SFGP
Venezuela	REACCIUN-2	45	AMPATH

CLARA backbone network

- CLARA: Cooperacion Latino Americana de Redes Avanzadas
  - CLARA network May 2004
  - Support from Europe – ALICE project
  - 155 Mbps backbone ring
  - 622 Mbps to Europe
  - 10-45 Mbps spur links
- Interested in optimizing connections between North America and Latin America



Source: Michael Stanton, CLARA technical committee

Middle East and Africa

- No dedicated R&E network connectivity to/from African continent
- Middle East is mixed bag:
  - Israel (GEANT)
  - EUMEDCONNECT
  - Gulf States
    - Qatar links to MANLAN
    - UAE, Oman interests

Other

- Antarctica
  - South Pole research station
- Non-Western Hemisphere centric
  - TEIN2 project: Europe to Asia NREN connectivity

Growth, issue areas

- Globalness…..less North America centric
- Desire to interconnect testbed networks
  - Deterministic, dynamically configurable paths (lightpaths)
    - Focus of GLIF (TransLight)
  - Experimental
  - Production: CA*net, SURFNET6
- How to architect international links to support in integrated manner production, pre-production, testbed/research efforts?

Where can the JET help?

- International exchange points
  - Pacific Wave (north and south), StarLight, MAN LAN, AMPATH
  - NGIX relationship
- Requirements survey
  - Non-US-based facilities
  - Connected now or able to be connected to existing or emerging NREN?
- Most important international routes for JETnets and their users?
  - Coordinate planning?
  - Coordinate investments?

One plug (ok, two)

- Internet2 International Task Force Meetings
  - Monday, April 19 at Crystal Gateway Marriott Hotel
- Expanding the Reach of Advanced Networking
  - Thursday, April 22 at Crystal Gateway Marriott Hotel
  - Separate workshop, hosted by Internet2
  - Put together by BoF group of Internet2 members, partners, others
  - Key Objective: open dialogue between global research and education networking community and aid/development agencies (World Bank, IDB, OAS, USAID, AUSAID, EuropeAID, etc.)

Finally, Internet2 perspective

- Internet2 members, network users tell us international reach is important
- Abilene, HOPI, NLR network infrastructures all require international access
  - GLIF a key coordinating effort on lightpath services
- Community has built important facilities, relationships toward this end
  - StarLight, Pacific Wave, AMPATH, CENIC, UTEP, IU Global NOC, et al.
- Internet2 seeks to facilitate, coordinate work of its members in collectively doing what can't be done separately