

Research and Education Networks around the world: update and trends

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Internet2 interest in international

- Strategic importance to Internet2
 - Support Internet2 community's global collaborations
 - Science, research, education are increasingly global
 - Require an equivalent GLOBAL leading edge networking capability – through partners around the world
 - Interoperability of new networking services
 - Joint development of new technologies
- International Partner Program:
 - Forms partnerships between organizations with similar goals/objectives and similar constituencies
 - Supports activities of Internet2 membership
 - Fosters effective partnerships/National Research and Education Networks [NRENs] in other countries
 - Today, 47 current partner organizations representing over 75 countries

Caveats

- This is not comprehensive
 - I almost certainly did not even get to highlight everyone's favorite projects, initiatives, partners
 - There's A LOT going on in the global R&E networking space
- This is always under revision
 - Especially on links/speeds/funders
 - Interested in where I've gotten it wrong!

Connectivity to/from the US higher education and research networking community

- US-government funded
 - NSF IRNC program (OCI)
 - DOE LHCnet
 - Others?
- Links funded by other US-based entities
 - IEEAF donations
 - Internet2
- Links funded by R&E networks outside the US

Trans-Atlantic connectivity (US centric perspective)

Connection to	Link Operator (<i>Funder</i>)	BW(Gbps)	N.A. Interconnect
CERN	LHCnet (CalTech) (<i>DOE</i>)	10, 10	MAN LAN, StarLight
GEANT2 (Europe)	DANTE (<i>GEANT2</i>)	10, 2x2.5	NGIX-East, MAN LAN
GEANT2 (Europe)	TransLight/StarLight (<i>NSF</i>)	10	MAN LAN
SURFNET (NL)	SURFnet	10, 10	StarLight, MAN LAN
SURFNET (NL)	Internet2&SURFnet (<i>IEEAF</i>)	622Mbps	Abilene-NYC
NetherLight	TransLight-StarLight (<i>NSF</i>)	10	StarLight
NetherLight	Internet2&SURFnet (<i>IEEAF</i>)	10	MAN LAN
RBnet (Russia)	Gloriad (<i>NSF/Russia</i>)	3x1 (rsn)	StarLight
EUN, ENSTINET (Egypt)	ENERGI (<i>MCIT</i>)	155Mbps	MAN LAN
UKLight (UK)	UKERNA (<i>JISC</i>)	10	StarLight
Qatar Foundation Network	Qatar Foundation	155Mbps	MAN LAN
TENET (S. Africa)	Telkom SA (<i>TENET</i>)	GRE tunnel	MAN LAN

Trans-Pacific connectivity (US-centric perspective)

Connection to	Link Operator (<i>Funder</i>)	BW(Gbps)	N.A. Interconnect
APAN TokyoXP	TransPAC2 (<i>NSF/NICT</i>)	10	Pacific Wave-LA
JGN2 (Japan)	NICT (<i>NICT</i>)	10	StarLight
AARNET (Australia)	AARNET (<i>AARNET</i>)	2x10	Hawaii/Pacific Wave
CERNET (China)	CERNET (<i>CERNET</i>)	155Mbps	StarLight
CSTNET (China)	GLORIAD (<i>CSTNET?</i>)	2.5	PacificWave-Seattle
KREONET (Korea)	GLORIAD (<i>KREONET2</i>)	10	PacificWave-Seattle
Hong Kong	HARNET	45Mbps	StarLight
SINET (Japan)	NII (<i>NII</i>)	10, 2.5	MAN LAN, PW-LA
GEMNET (NTT-Japan)	NTT (<i>NTT</i>)	622Mbps	Pacific Wave
SingAREN (Singapore)	SingAREN (<i>SingAREN</i>)	155Mbps	Pacific Wave-LA
NUS (Singapore)	NUS (<i>NUS</i>)	155Mbps	Pacific Wave - Seattle
TWAREN (Taiwan)	NCHC (<i>NCHC</i>)	2, 2.5, 1.2	Pacific Wave, MAN LAN
ASNET (Taiwan)	ASNET (<i>Academica Sinica</i>)	2.5	StarLight
UNINET (Thailand)	UNINET (<i>UNINET</i>)	155Mbps	LA
WIDE	WIDE&PNWGP (<i>IEEAF</i>)	10,000/622	Pacific Wave - Seattle
Qatar FN	Qatar FN (<i>Qatar Foundation</i>)	155Mbps	Pacific Wave - LA

Americas Connectivity

Connection to	Link Operator (<i>Funder</i>)	BW(Gbps)	US Interconnect
CA*net (Canada)	CANARIE (<i>CANARIE</i>)	5?	StarLight/PWave/MAN LAN
redCLARA (Latin America)	WHREN-LILA (<i>NSF</i>)	1, 1.2	CALREN2, AMPATH
redCUDI (Mexico)	WHREN-LILA (<i>NSF</i>)	1, 1	CALREN2
redCUDI (Mexico)	UTEP, CUDI (<i>UTEP, CUDI</i>)	1	UTEP
RNP (Brazil)	WHREN-LILA (<i>ANSP</i>)	1.2	AMPATH
RETINA (Argentina)	AMPATH (<i>AMPATH</i>)	45	AMPATH
REACCIUN-2 (Venezuela)	AMPATH (<i>AMPATH</i>)	45	AMPATH
Gemini/NOAO, Chile	(<i>NSF funding</i>)	10	AMPATH

81 Networks reachable via Abilene

Europe-Middle East

Europe (GEANT2)
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)
Jordan (JUNET)
Latvia (LATNET)
Lithuania (LITNET)
Luxembourg (RESTENA)

Malta (Univ. Malta)
Netherlands (SURFnet)
Norway (UNINETT)
Palestinian Territories
(Gov't Computing
Center)
Poland (POL34)
Portugal (RCTS2)
Qatar (Qatar FN)
Romania (RoEduNet)
Russia (RBnet)
Slovakia (SANET)
Slovenia (ARNES)
Spain (RedIRIS)
Sweden (SUNET)
Switzerland (SWITCH)
Syria (HIAST)
United Kingdom
(JANET)
Turkey (ULAKBYM)
*CERN

Asia-Pacific

Australia (AARNET)
China (CERNET, CSTNET,
NSFCNET)
Fiji (USP-SUVA)
Hong Kong (HARNET)
Indonesia (ITB)
Japan (SINET, WIDE, JGN2)
Korea (KOREN, KREONET2)
Malaysia (MYREN)
New Zealand (REANNZ)
Philippines (PREGINET)
Singapore (SingAREN)
Taiwan (TANet2, ASNet)
Thailand (UNINET, ThaiSARN)
Vietnam (VINAREN)

Africa

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

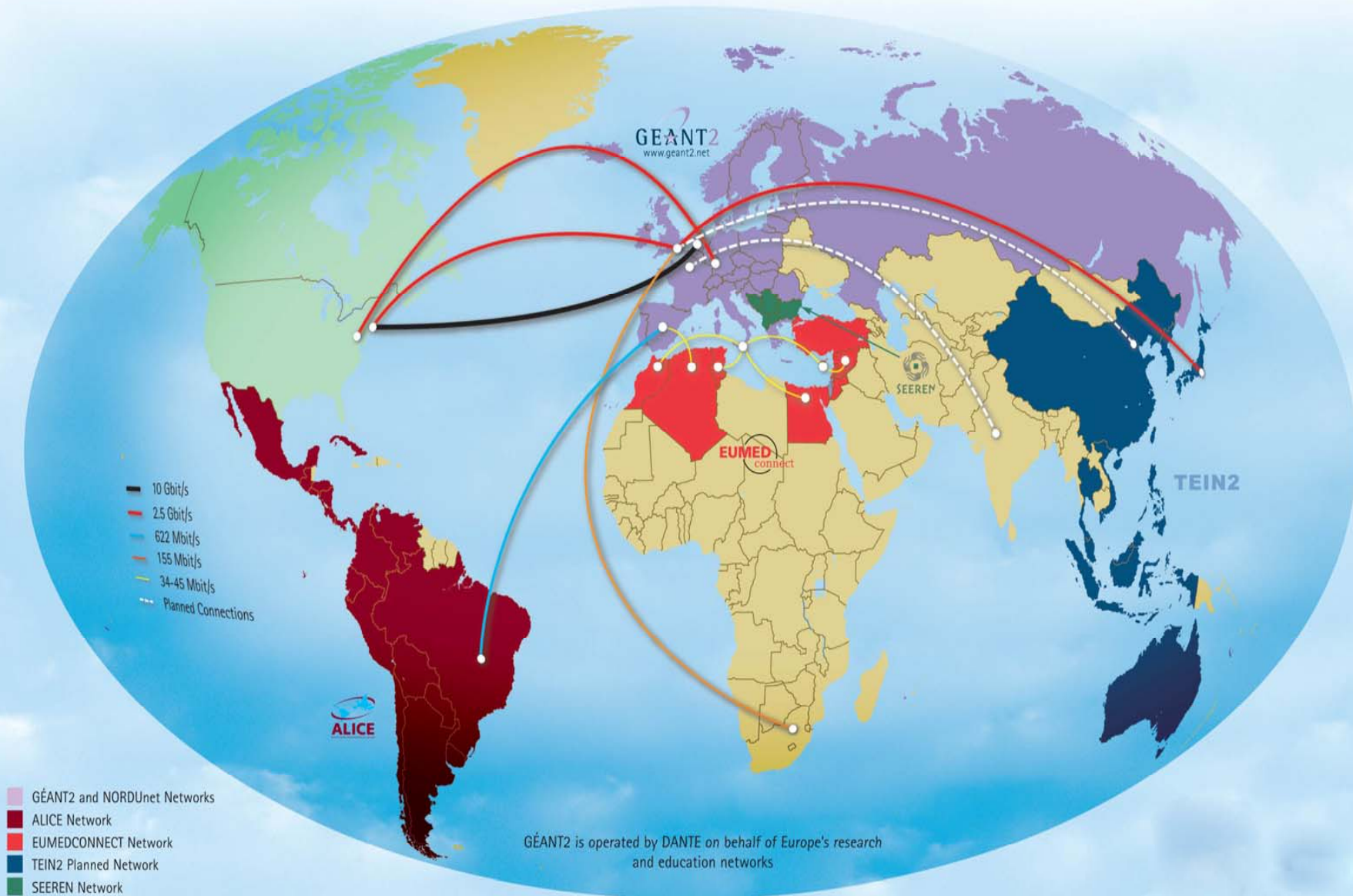
Americas

Latin America (redCLARA)
Argentina (RETINA)
Brazil (RNP2/ANSP)
Canada (CA*net)
Chile (REUNA)
Costa Rica (CR2Net)
Mexico (Red-CUDI)
United States (Abilene)
Panama (RedCyT)
Peru (RAAP)
Uruguay (RAU2)
Venezuela (REACCIUN2)

Central Asia

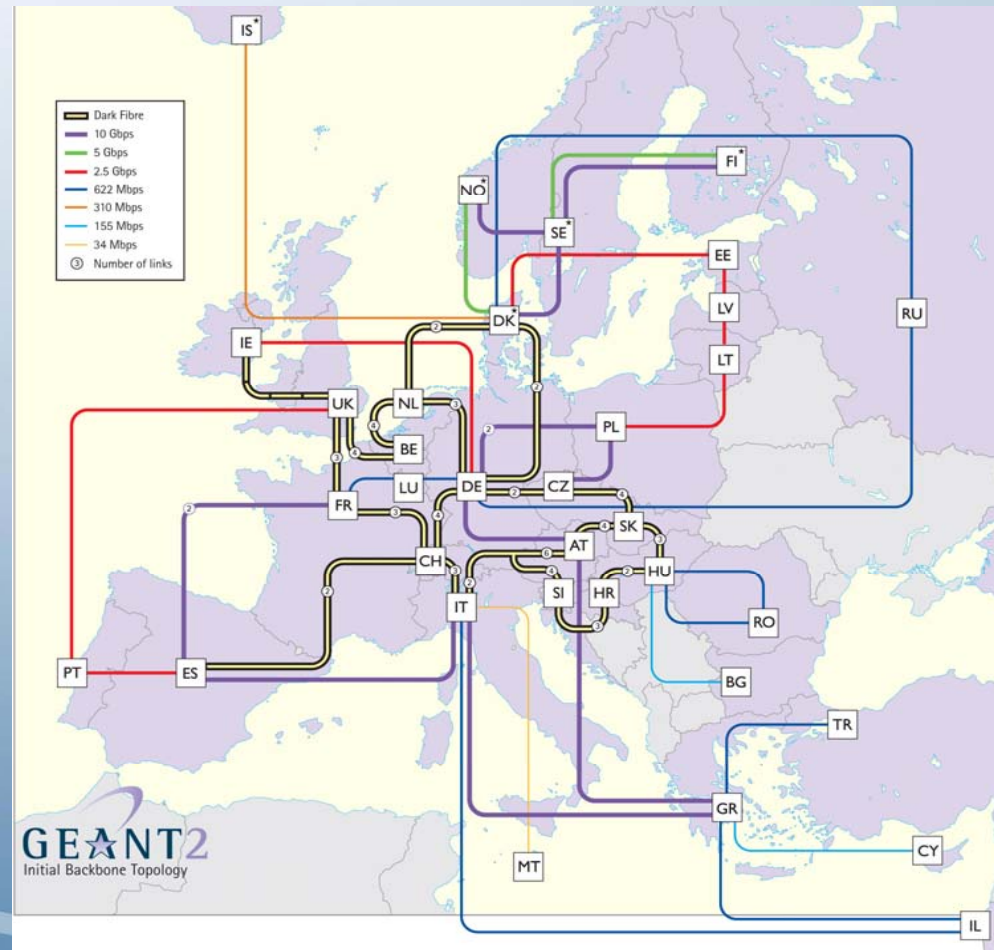
Armenia (ARENA)
Georgia (GRENA)
Kazakhstan (KAZRENA)
Tajikistan (TARENA)
Uzbekistan (UZSCI)





Highlights: Europe

- Pan-European: GEANT2 backbone in place
 - Dark fiber and leased lines
 - Multiple 10G
 - Each NREN has 2x10G connections: 1x10G for IP; 1x10G for point to point services



Highlights, cont'd: Europe

- NREN build-out with dark fiber continues
 - Moving westward – France(RENATER), UK (JANET)
- Hybrid services developing: SURFNET, NRENs engaged in GEANT2 p2p services development work
 - GEANT2-Internet2/ESnet service trial:
 - LSU-Brno
 - IN2P3-Fermi
 - MAGPI-U. Munich
- European-wide performance monitoring/measurement activities – perfSONAR joint development (Internet2, ESnet)
- EduGAIN: ‘confederation’ of national authentication and authorization federations

Highlights: Africa



- Connectivity focus

- North Africa – EUMEDCONNECT

- SubSaharan Africa - UbuntuNet Alliance

- Canada, Sweden, Germany(?) providing \$3M to buy into EASSY cable
- Working on fiber across borders – Kenya, South Africa, Mozambique

- West Africa

- Senegal, Ghana connectivity – proposal going to NSF
- STM1(?) to GEANT

- NREN development

- Canadian IDRC and AAU funded Tunis meeting
- Partnership for Higher Education in Africa
- NSF proposal

Highlights: Middle East

- Qatar Foundation funded connection for Qatar schools (US schools and U. Qatar)
 - STM1 via Pacific to PacificWave
 - STM1 via Atlantic to MAN LAN
- UAE interest – inquiries about connectivity
- Oman potential interest

Highlights: South Asia

- New news! India (ERNET) connected
 - 45Mbps from GEANT to India – co-funded by EU and ERNET (MCIT)
 - ERNET has 8mbps backbone with 2mbps links to IISc and other key research institutes
 - Garuda network – operated by ERNET, connecting CDAC sites and other institutions – 100Mbps connections(?)
 - Opportunities to extend TransPAC2 from Singapore to Chennai
- Still looking to get connected:
 - Pakistan – PERN; exploring connectivity to Europe and/or Singapore (TEIN2)
 - Sri Lanka – LEARN
 - Nepal – NREN
- South Asia looking for extension with TEIN3(?)

Highlights: Asia-Pacific

- TEIN2 network up and running
 - Shared costs (EU major funding)
 - NOC by CERNET (China)
 - APAN majors (Japan, Korea) very supportive
 - TransPAC2 providing link to US
 - Thinking TEIN3 already
- ORIENT connection: China to Europe
 - China two networks (CERNET and CSTNET)
 - CERNET has v6-only network (free to universities) and v4 network

Highlights, cont'd: Asia-Pacific

- Japan
 - JGN2 network – GMPLS-based control plane work
 - Installing DRAGON-developed box in Tokyo
 - Service trial between JGN2 – HOPI/DRAGON to support vLBI
 - SINET3 network – hybrid services
- New Zealand
 - New REANNZ organization/network
 - 622Mbps to US west coast – Pacific Wave

Highlights: Latin America

- redCLARA
 - Latest to be connected: Columbia, Nicaragua, Costa Rica connected (Feb/March 2006), Guatemala, El Salvador (Dec 2005)
 - Links to US: via redCLARA Tijuana node to Calren2 (WHREN-LILA funded) and just last week: redCLARA Sao Paulo node to Miami (AMPATH XP; WHREN-LILA funded)
- Caribbean
 - Interest, efforts to connect Caribbean region
 - IDB possible funding; CLARA interest
 - Interest group meeting/phone calls occasionally
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Summary

- Global R&E network connectivity continues to grow
 - More links; less US-centric
 - More complexity – especially routing
- New network services across international boundaries
 - Point to point services across domains
 - Inter-domain control plane work – GLIF, DRAGON/JGN2, GEANT2/Internet2 work
 - Monitoring, measurement capabilities across domains – perfSONAR
- AAI – adoption of national federation model; still work on inter-federation (confederation? Peering?)
 - Supports p2p services, access to monitoring/measurement tools, let alone content access, sharing of computational, instrument facilities

Thanks!

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