



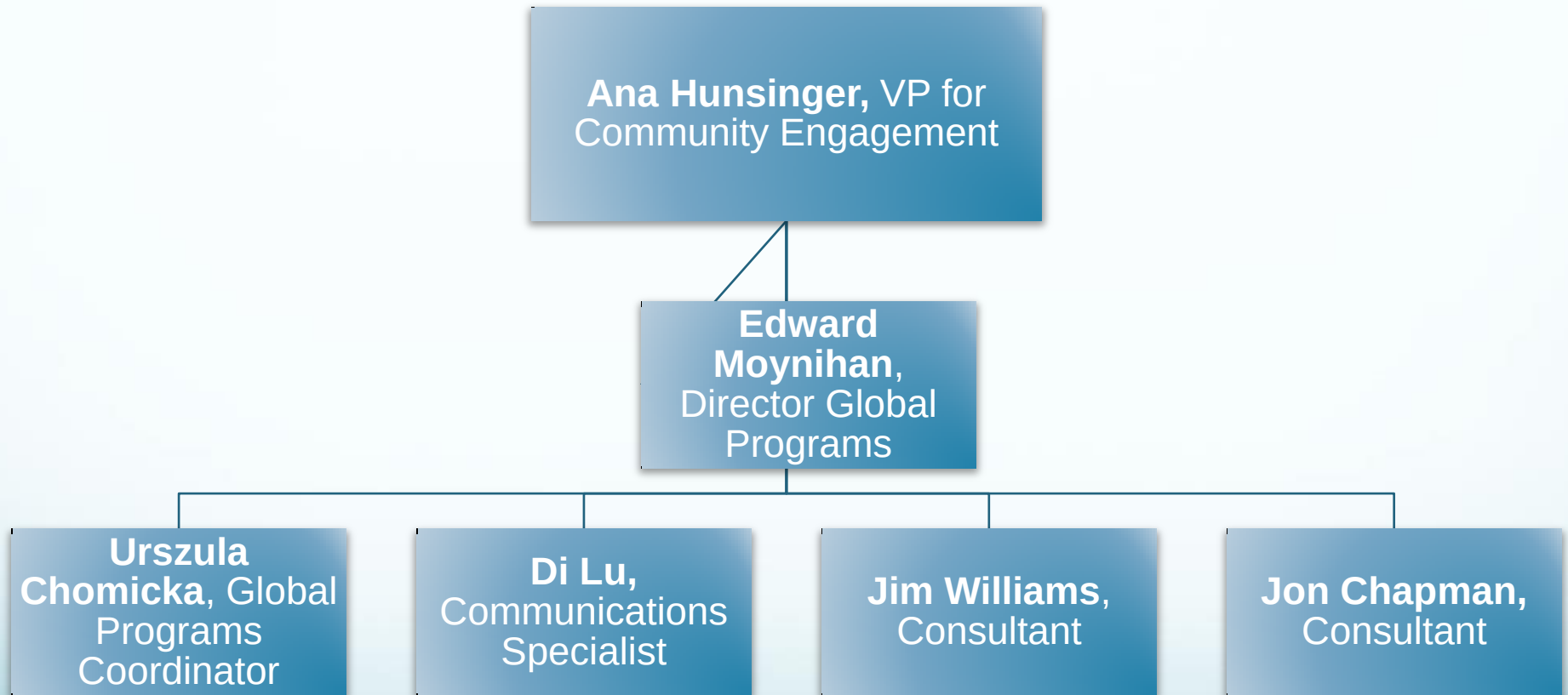
URSZULA CHOMICKA

FEB. 16 2016

Internet2's Global Programs:
International Connectivity

Update for JET meeting

Global Programs Team



AMERICAS

CANARIE (Canada)
 CEDIA (Ecuador)
 CNTI (Venezuela)
 CR2Net (Costa Rica)
 CUDI (Mexico)
 INNOVA|RED (Argentina)
 REUNA (Chile)
 RNP [FAPESP] (Brazil)
 SENACYT (Panama)

MULTI-NATIONAL

AAU (Africa)
 APAN (Asia - Pacific)
 CKLN (Caribbean)
 CLARA (Latin America and Caribbean)
 GEANT (Europe)
 NORDUnet (Nordic Countries)
 TEIN*CC (Asia-Pacific)
 UbuntuNet Alliance (Africa)
 University of the West Indies (Caribbean)
 WACREN (West and Central Africa)

EUROPE

ARNES (Slovenia)
 BELNET (Belgium)
 CARNET (Croatia)
 CESnet (Czech Republic)
 DFN (Germany)
 FCCN (Portugal)
 GARR (Italy)
 RENATER (France)
 GRNET (Greece)
 HEAnet (Ireland)
 HUNGARNET (Hungary)
 JISC, JANET (United Kingdom)
 PSNC, PIONIER (Poland)
 RedIRIS (Spain)
 RESTENA (Luxemburg)
 RIPN (Russia)
 SANET (Slovakia)
 SURF (Netherlands)
 SWITCH (Switzerland)

ASIA and PACIFIC RIM

AARNet (Australia)
 ANF, KREOnet (Korea)
 NKN (India)
 CERNET, CSTNET (China)
 JAIRC (Japan)
 JUCC (HongKong)
 MYREN, MDeC (Malaysia)
 NECTEC, UniNet (Thailand)
 NKN (India)
 NREN (Nepal)
 PERN (Pakistan)
 REANNZ (New Zealand)
 SingAREN (Singapore)
 TWAREN (Taiwan)
 VinaREN (Vietnam)

MIDDLE EAST and GULF STATES

ANKABUT (UAE)
 Israel-IUCC (Israel)
 MCIT [EUN, ENSTINET] (Egypt)
 Qatar Foundation (Qatar)
 KACST (Saudi Arabia)

AFRICA

TENET (South Africa)
 TERNET (Tanzania)
 NUC (Nigeria)
 SANREN (South Africa)

Current Networks Reachable

AFRICA

Algeria (ARN)
Egypt (EUN / ENSTINET)
Kenya (KENET)
Morocco (MARWAN)
South Africa (TENET)
Tanzania (TERNET)
Tunisia (CCK)
Uganda (RENU)

AMERICAS

Argentina (INNOVA|RED)
Brazil (RNP2/ANSP)
Canada (CAnet 4)
Chile (REUNA)
Colombia (RENATA)
Costa Rica (CR2Net)
Ecuador (CEDIA)
El Salvador (RAICES)
Guatemala (RAGIE)
Mexico (CUDI)
Panama (RedCyT)
Peru (RAAP)
Trinidad (UWI)
Uruguay (RAU2)
Venezuela (Reacciu2)

ASIA and PACIFIC

Australia (AARNet)
Bhutan (BdREN)
Cambodia (CamREN)
China (CERNET2, CSTNET, NSFCNET)
Hong Kong (HARNET)
India (ERNET)
Indonesia (ITB)
Japan (SINET3, WIDE, JGN2)
Korea (KOREN, KREONET2)
Laos (LERNET)
Malaysia (MYREN)
Nepal (NREN)
New Zealand (KAREN)
Pakistan (PERN)
Philippines (PREGINET)
Singapore (SingAREN)
Sri Lanka (LEARN)
Taiwan (TANet2, ASnet)
Thailand (UniNet, ThaiSARN3)
Vietnam (VinaREN)

CENTRAL and SOUTHWEST ASIA

Armenia (ASNET-AM)
Azerbaijan (AzRENA)
Georgia (GRENA)
Kyrgyz Republic (AKNET)
Tajikistan (TARENA)
Turkey (ULAKBIM)
Turkmenistan (TuRENA)

EUROPE

Albania (ASA / INIMA)
Andorra (Univ. of Andorra)
Austria (ACOnet)
Belarus (BASNET, UNIBEL)
Belgium (BELNET)
Bosnia-Herzegovina (BIHARNET)
Bulgaria (ISTF)
Croatia (CARNET)
Cyprus (CyNET)
Czech Republic (CESnet)
Denmark (Forskningsnettet)
Estonia (EENet)
Finland (Funet)
France (RENATER)
Germany (X-WiN)
Greece (GRNET)
Hungary (NIIF/HUNGARNET)
Iceland (RHnet)
Ireland (HEAnet)
Italy (GARR)
Latvia (LATNET)
Lithuania (LITNET)
Luxembourg (RESTENA)
Macedonia (MARNet)
Malta (UofM/RicercaNet)
Moldova (RENAM)
Montenegro (MREN)
Netherlands (SURFnet)

EUROPE cont'd

Norway (UNINETT)
Poland (PIONIER)
Portugal (FCCN)
Romania (RoEduNet)
Russian Federation (RBnet, RUNNET)
Serbia (AMRES)
Slovakia (SANET)
Slovenia (ARNES)
Spain (redIRIS)
Sweden (SUNET)
Switzerland (SWITCH)
Ukraine (URAN)
United Kingdom (JANET)

MIDDLE EAST and GULF STATES

Israel (IUCG)
Jordan (JUNet)
Palestinian Territories (Birzeit Univ./Al-Quds Open Univ.)
Qatar (Qatar FN)
Syria (HIAST)
United Arab Emirates (ANKABUT)

MULTINATIONAL NETWORKS

APAN
GEANT2
NORDUnet
redCLARA
TEIN*CC
UbuntuNet
WACREN



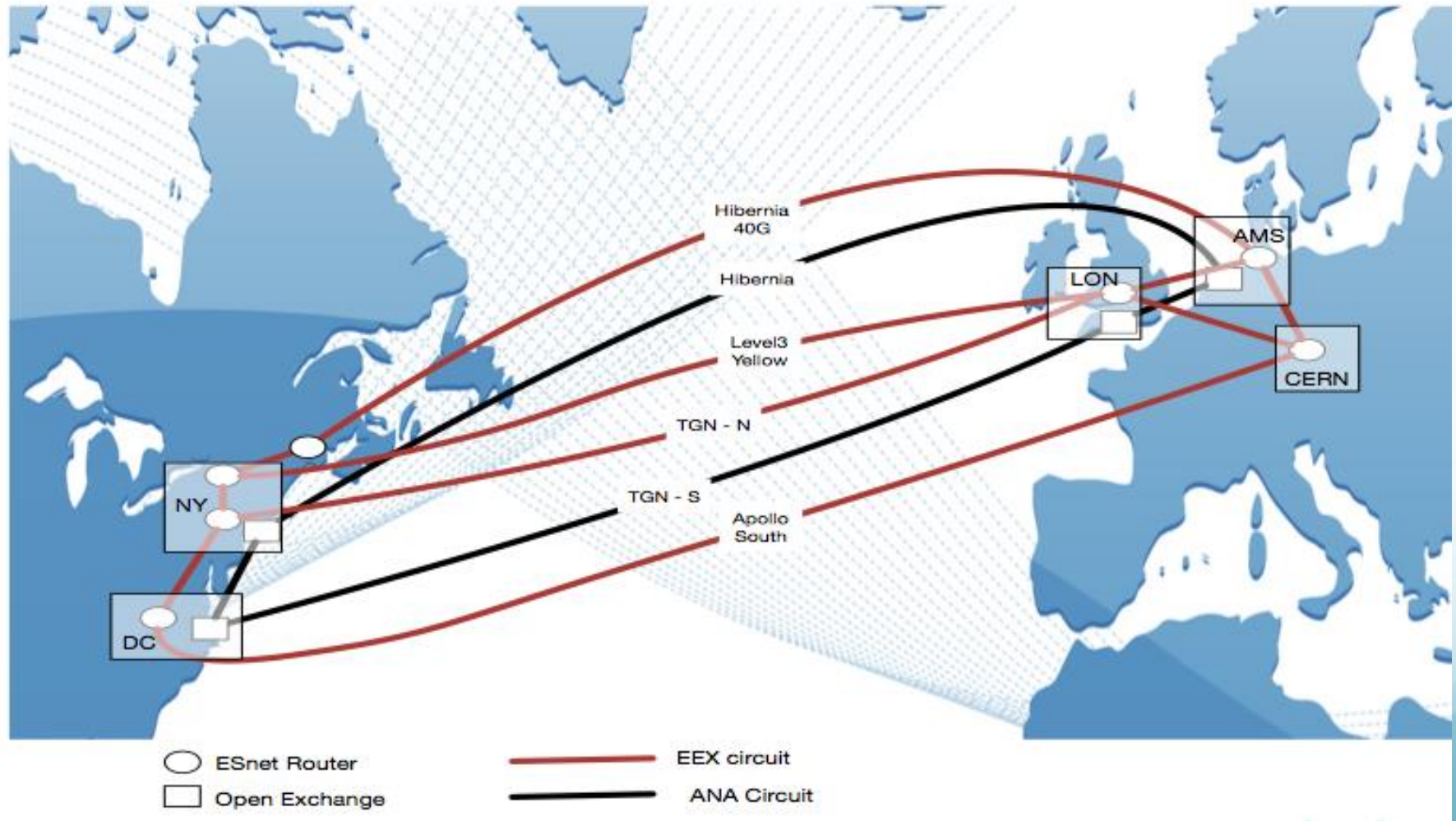
Internet2 Investments

- Internet2 is making major investments:
 - ANA
 - Fujairah
 - Singapore.

Transatlantic

- ANA-200G production ring completed in Nov. 2014- redundant 100 Gbit/s ring between four open exchange points spanning the North Atlantic.
- Internet2, NORDUnet, CANARIE and SURFnet partnered on this project.
- Both ANA-200G and ESnet attained full production status at the end of 2014.
- Reciprocal back-up agreement of 340Gbit/second between ANA-200 and ESnet since April 2015

Fat Pipes: ANA-200G - production ready Q4 2014



Other Internet2 Investments

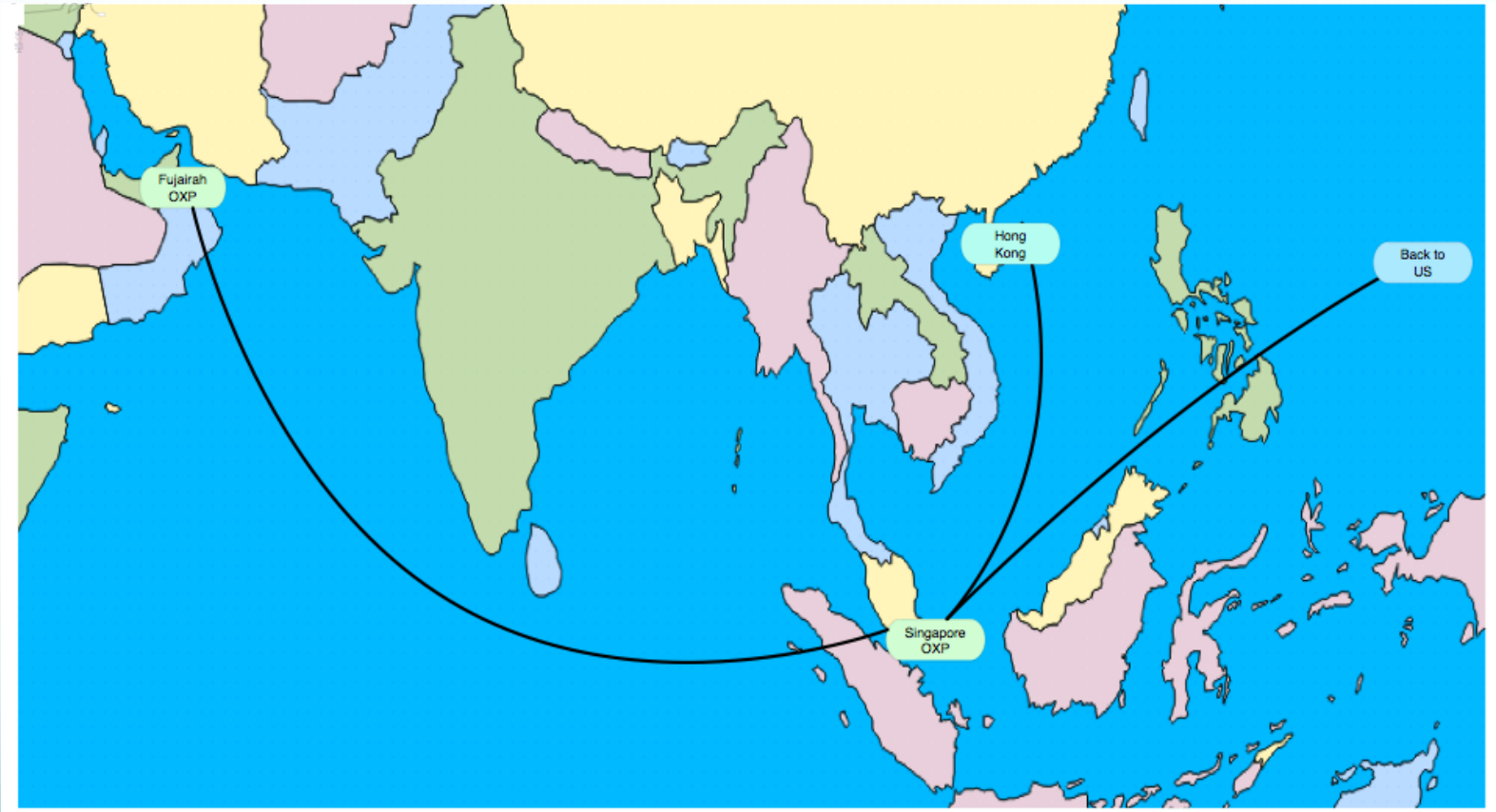
Middle East:

- AGE – OX (Arabian Global Education Open Exchange Point) in Fujairah
- Commitment to fund 10G connectivity to Singapore – NYU Abu Dhabi/Ankabut/Internet2 (currently 2.5G)

TransPacific:

- 100G Internet2/SingAREN partnership (Singapore to LA). Production 2016.
- 10G Internet2/CERNET partnership (Beijing/LA).

Singapore connections





US-Mexico border connectivity upgrade

- Internet2 and CUDI are working together to upgrade cross-border connectivity at El Paso from 1 gb to 10 gb (expected March 2016)

New strategic investments will:

- Support the extension of Internet2 Innovation Platform into Mexico
- Enhance support of US/Mexico big data science collaborations

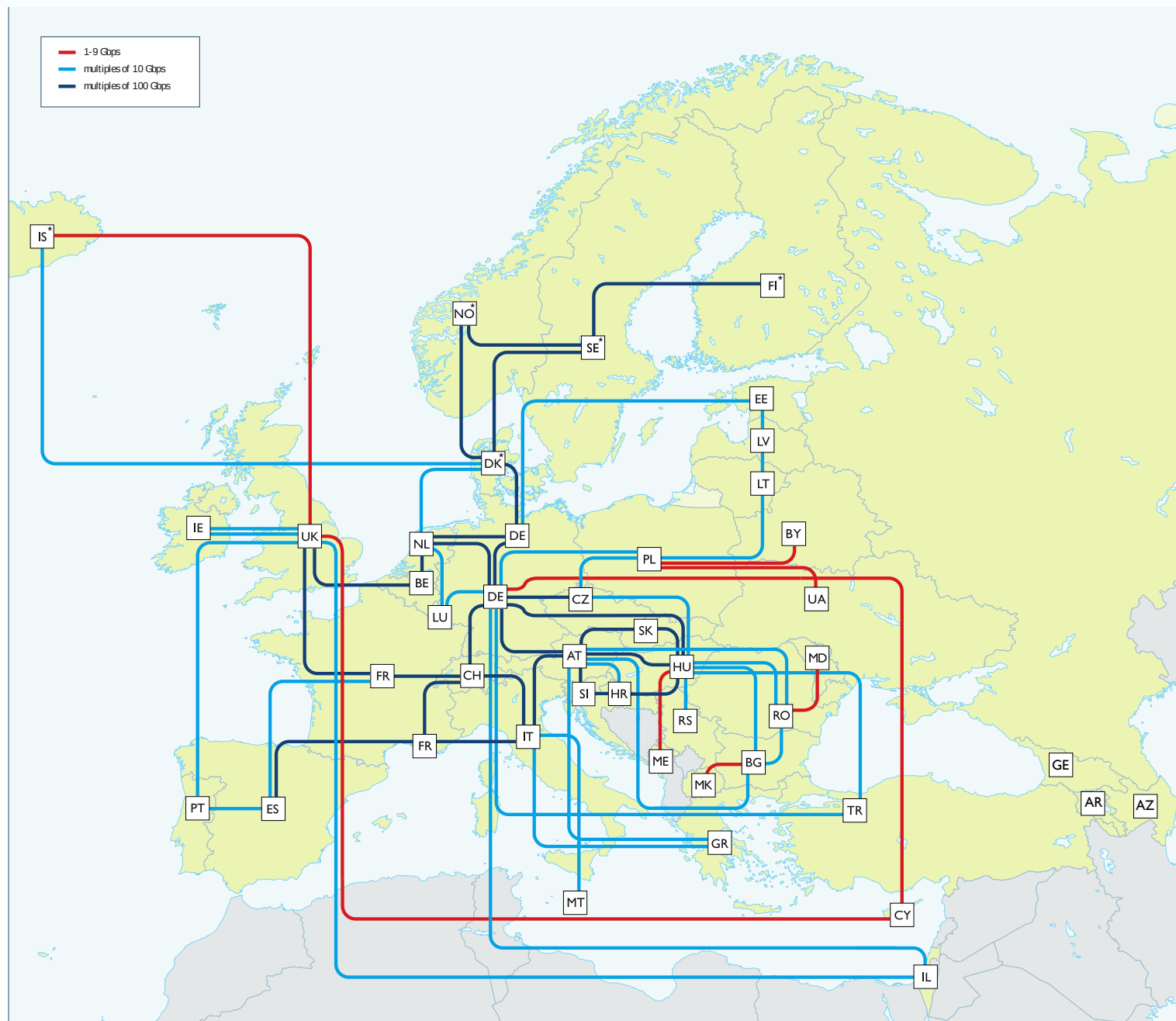
IRNC links

- Americas Lightpaths Express and Protect (AmLight ExP) project - grant to implement a hybrid network strategy that combines the use of optical spectrum (Express) and leased capacity (Protect).
- FIU and Georgia Tech - award for the collaborative AtlanticWave-SDX, a distributed experimental Software-Defined Exchange Point (SDX), supporting research, experimental deployments, prototyping and interoperability testing, on national and international scales.
- IU Global Research Network Operations Center, or GlobalNOC - \$3.6 million award to manage the Network Operations Center for all IRNC infrastructure projects.
- The IU GlobalNOC won a \$4.8 million networking grant to enable continued planning, operation, engineering support and management of TransPAC, the high-speed network that connects researchers in the US with their counterparts in Asia.
- IU, UH Mānoa and UC Davis - grant of \$5 million for 5-year project called NetSage, an open privacy-aware network measurement analysis and visualization service that will monitor and visualize all the network traffic flowing over the NSF's R&E networks.
- Northwestern, UCSD and UIC - 5-year grant to develop an international Software Defined Networking Exchange (SDX) at the StarLight International/National Communications Exchange Facility in Chicago.

Europe

- GEANT Project, Dante and TERENA have merged to become GEANT, formed October 2014 and effective May 1, 2015.

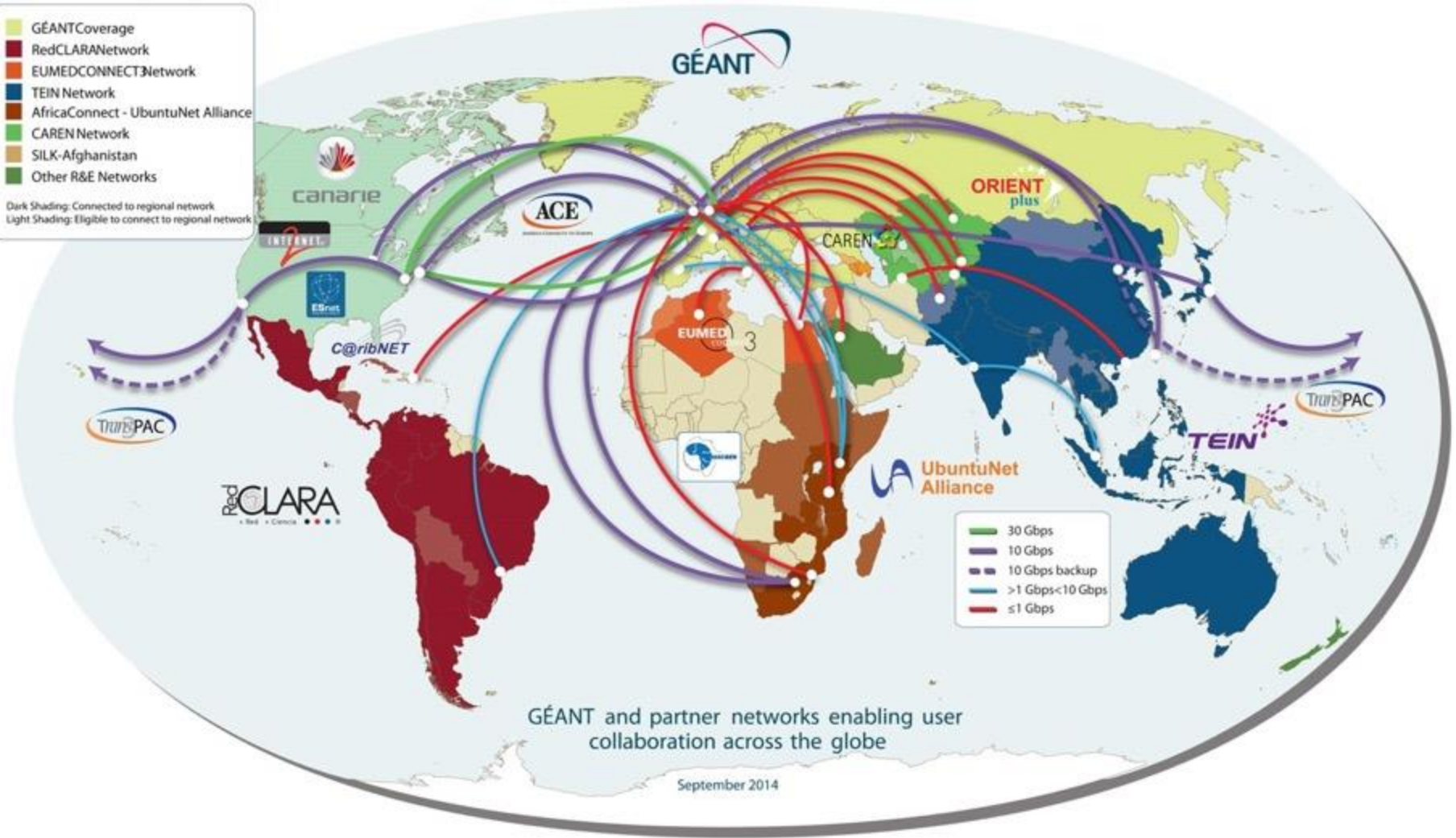




European network status

- 40 European countries connected
- Routers with 100Gbps capability, optical transmission platform designed to provide 500Gbps super-channels
- 27,114km of dark fibre, 100,000+ km of leased capacity (including transatlantic connections)
- 28 main sites covering European footprint
- New 10G circuit London-Beijing inaugurated Sept 2015 (operational since July), cost-share model

- GÉANT Coverage
 - RedCLARANetwork
 - EUMEDCONNECT Network
 - TEIN Network
 - AfricaConnect - UbuntuNet Alliance
 - CAREN Network
 - SILK-Afghanistan
 - Other R&E Networks
- Dark Shading: Connected to regional network
Light Shading: Eligible to connect to regional network



Asia connectivity

- TEIN*CC is an independent, Asia Pacific based network organization
- TEIN4 since 2012 (transferring responsibility from DANTE to TEIN*CC until 2016). European Commission is contributing 8M € for TEIN4.
- Interconnects universities and research centers in 18 countries: China, India, Indonesia, Japan, Korea, Malaysia, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Vietnam, Australia, Bangladesh, Cambodia, Laos and New Zealand.
- It also connects to GÉANT at 2.5Gbps from Madrid to Mumbai and at 10Gbps via the ORIENTplus Beijing-London link.

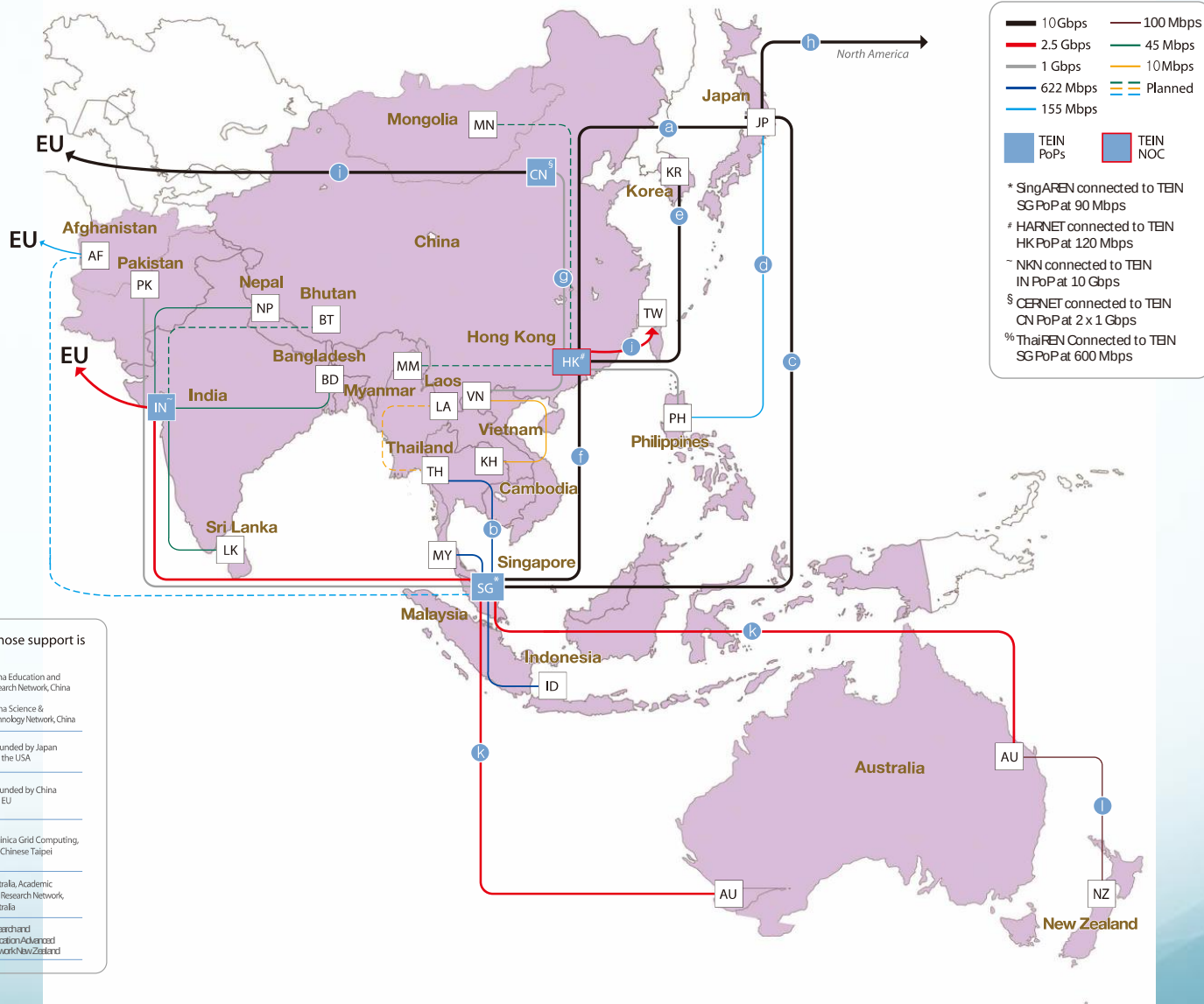
TEIN Project Partners

AF Afghanistan	ID Indonesia	NZ New Zealand
AU Australia	JP Japan	PK Pakistan
BD Bangladesh	KR Korea	PH Philippines
BT Bhutan	LA Laos	SG Singapore
KH Cambodia	MM Myanmar	LK Sri Lanka
CN China	MN Mongolia	TH Thailand
HK Hong Kong	MY Malaysia	TW Taiwan
IN India	NP Nepal	VN Vietnam

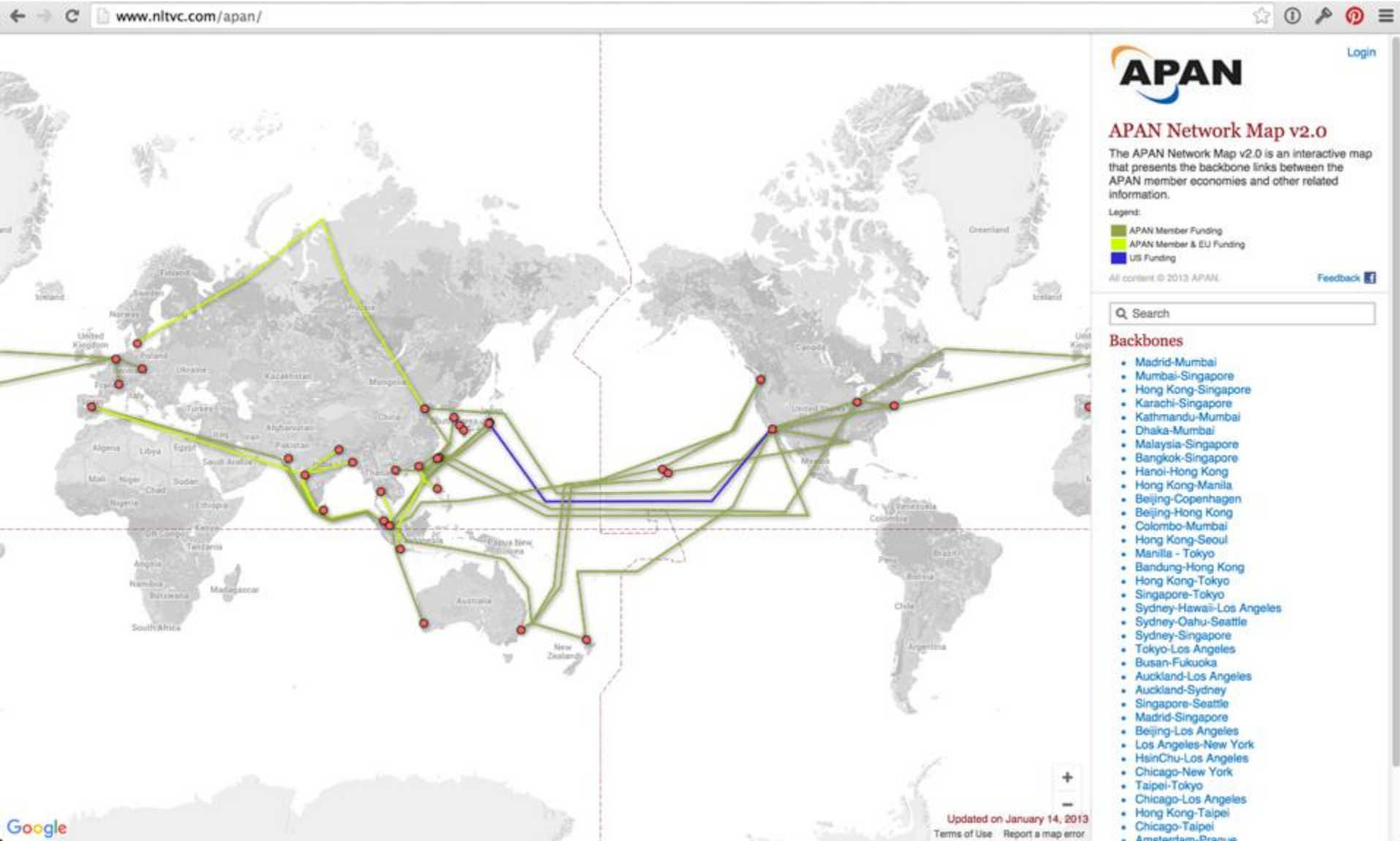
The following links are fully financed by the link owners whose support is gratefully acknowledged.

a National Institute of Information and Communications, Japan	g China Education and Research Network, China
b National Institute of Information and Communications, Japan	h co-funded by Japan and the USA
c National Institute of Informatics, Japan	i co-funded by China and EU
d Ministry of Agriculture, Forestry and Fisheries Research Network, Japan	j Academia Sinica Grid Computing, Republic of Chinese Taipei
e National Information Society Agency, South Korea	k Australia, Academic and Research Network, Australia
f National Information Society Agency, South Korea	l Research and Education Advanced Network New Zealand

As of July 2015



APAN Network Map Version 2.0



Future TransPacific

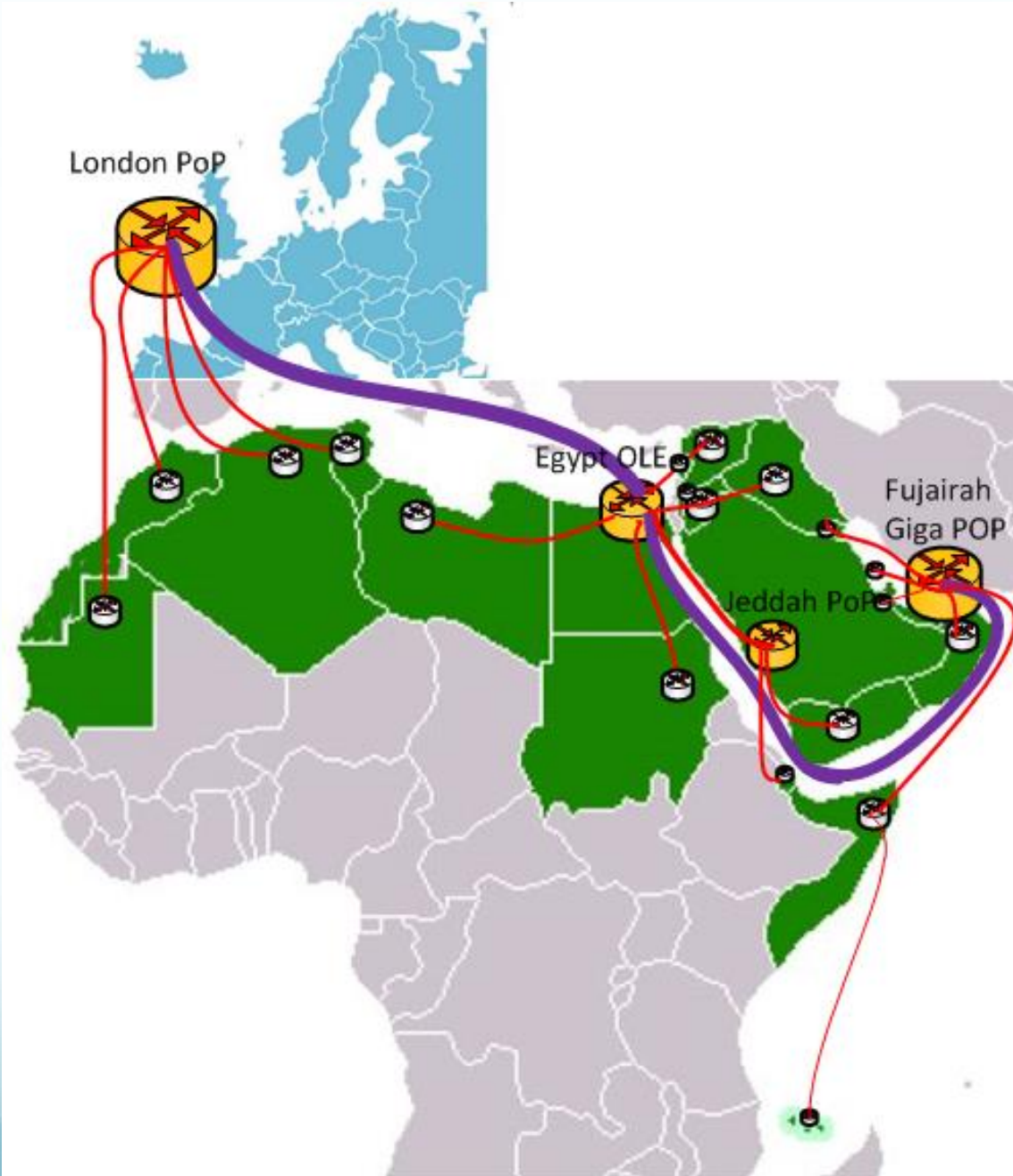
- India: 10G – potential 3 10 G (Quarter 2, 2016)
- China: CERNET 10G (Beijing to LA)
 - New US peerings for CERNET and CSTNET
- Japan: SINET 100 G to US; WIDE 100G (TransPAC)
- Korea: KREONET 100G to Chicago
- Australia/Hawaii – upgrades to 100 G

MENA Update

- The North African project partners from EUMEDCONNECT are migrating into AfricaConnect2.
- A lot of difficulties stemming from the political instability, particularly of North Africa.
- 3 links currently in service:
 - Algeria – ARN - 622Mbps
 - Jordan -ASREN (JUNET) - 155Mbps (Nov. 2014)
 - Egypt -ENTSTINET - 622Mbps

ASREN

- Established in 2012
- 6 Shareholders:
 - Abu-Ghazaleh GmbH (Jordan)
 - JUNET (Jordan)
 - EUN (Egypt)
 - CNRST (Morocco)
 - SudREN (Sudan)
 - CCK (Tunis)
- Connected to the global R&E network via links to GEANT and Internet2



Africa connectivity

- AfricaConnect ended in 2015 (4-year project). 80% EU funding, 20% local.
- **July 2014:** commissioning of the UbuntuNet network (interlinking Eastern and Southern Africa, providing connectivity to Europe)
- AfricaConnect2 awarded and announced July 2015 (3.5-year project)

AfricaConnect2 – future

- 3 geographical clusters:
- Cluster 1: Southern and Eastern Africa (contracted between the EC and the UbuntuNet Alliance)
- Cluster 2: Western and Central Africa (coordinated by GÉANT in conjunction with WACREN)
- Cluster 3: North Africa (coordinated by GÉANT in conjunction with ASREN).

UA Updates

- **July 2014: commissioning of the UbuntuNet network (Eastern and Southern Africa)**
- **Block A:** February 2014 – established PoPs in Mtunzini, Maputo, Dar es Salaam, Nairobi, Kampala and Kigali, and upgraded the UA PoP in London.
- Procured cross-border links and transcontinental link between Nairobi and UA PoP in Amsterdam.
- Serves 6 NRENs: TENET (South Africa), MoRENet (Mozambique), TERNET (Tanzania), KENET (Kenya), RENU (Uganda) and RwEdNet (Rwanda).
- equipment procurement, installation of high capacity cross-border links connecting the NRENs: Eb@le (Democratic Republic of Congo), MAREN (Malawi) and ZAMREN (Zambia).
- Link between Dar es Salaam in Tanzania and Lusaka in Zambia completed May 2014
- Links from Lusaka to Blantyre in Malawi, and from Cape Town to Moanda in DRC (future)
- Result: connectivity costs have dropped from a regional average of \$4000 per megabit per second per month to \$135per megabit per second per month

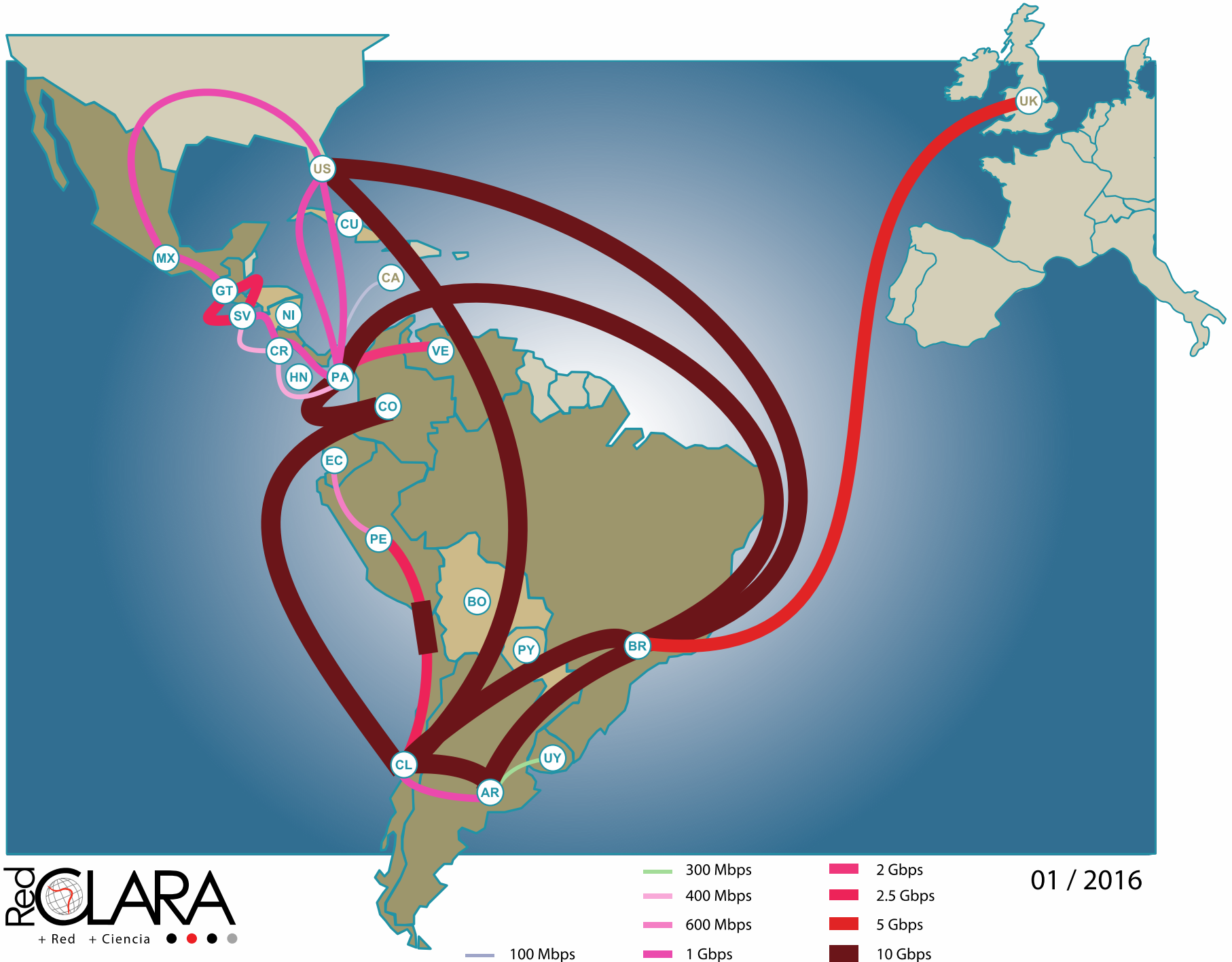


WACREN - Update

- 8 formally established NRENs, 4 in development
- Capacity-building:
 - 2 workshops: Open source tools for server virtualisation; clustering and management, and network monitoring and measurement.
 - Training needs assessment
- Involved in 3 EU Projects (HORIZON2020)+ AfricaConnect2
- MOU signed with Internet2 – call for collaboration

West and Central Africa

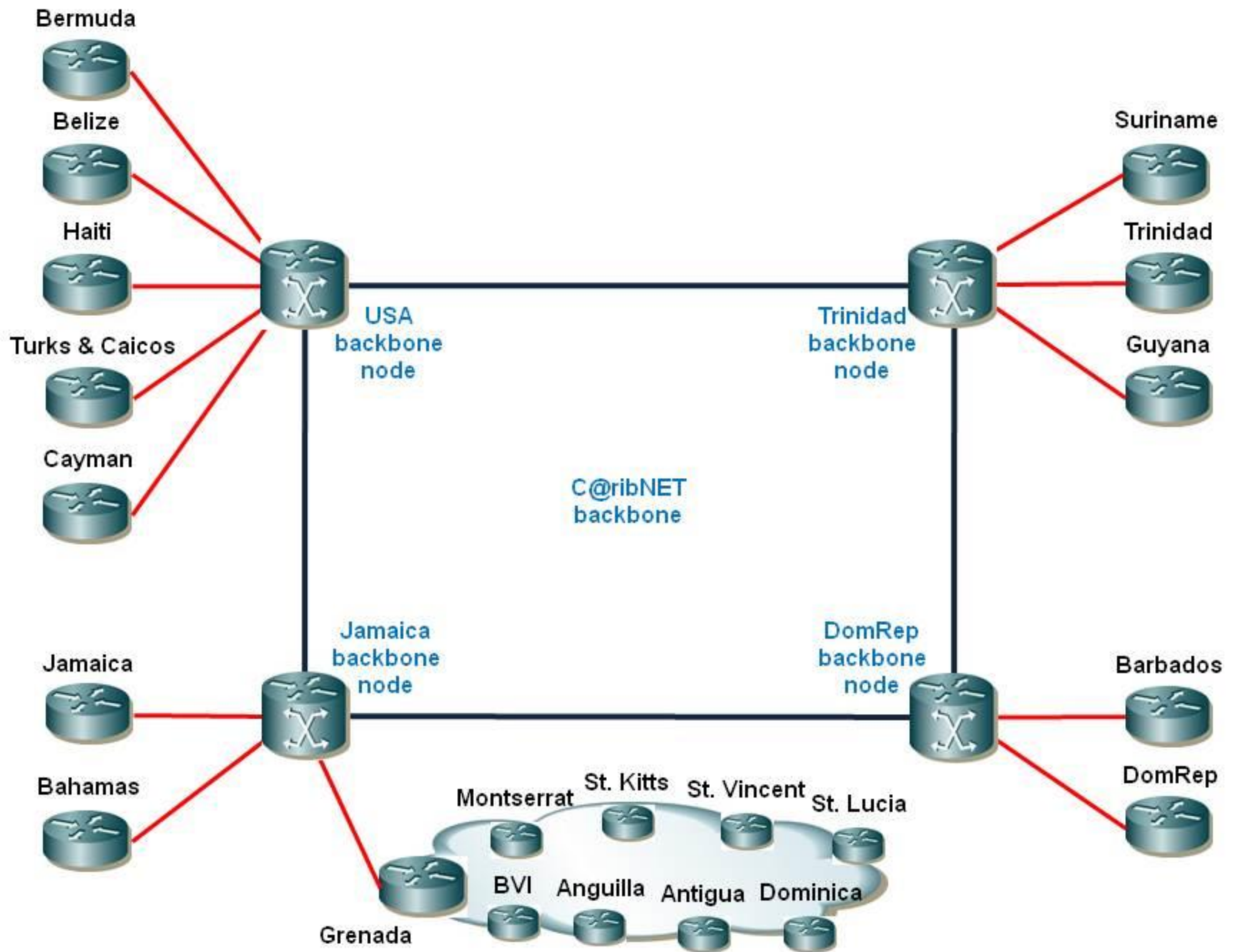




C@ribnet

- 2013: Caribbean institutions connected.
- Launch of C@ribNET
- C@ribNET Portal developed
- Network services introduced
- More institutions have been connected, technical representatives trained, the e-infrastructure for the national networks in most CARICOM countries exists, and C@ribNET has been demonstrated to be functional and operational with scalable infrastructure.
- Partnership with Internet2







Questions? Comments?

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