

Research and Education Networking: Introduction, architecture and operations Part1

WACREN Webinar:
Research and Education Networks:
Architecture, Routing and Peering

01/12/2020

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Research and Education Networks

- Some Terminology
 - Research and Education = R&E
 - Research and Education Networks = REN
 - National REN = NREN
- Globally, the REN connectivity is very complex and very difficult to understand

REN Characteristics

- High bandwidth networks
 - 10G backbones with 40G and 100G coming
 - Research typically needs uncongested networks
 - Which means many RENs are lightly used with lots of unused capacity (we call it headroom)
- Low latency
 - Terrestrial fiber
- Open Networks with no filtering
 - Firewalls can make it hard for ad-hoc activities

Why a REN?

- **Enable research or services that could not be accomplished otherwise**
- Cost Savings (buyers club)
 - Aggregate demand from multiple parties
- Vision of building alliances
- Successful RENs find that there are unanticipated benefits

Why Are We Doing This?

- Our goal is to build networking capacity to support Research and Education
 - Remember: University = Research & Education
- Buying all service from your local ISP is a losing game – you will spend more money and not have control of the network
- The pattern around the world is to build regional, national, and larger Research and Education Networks (RENs)

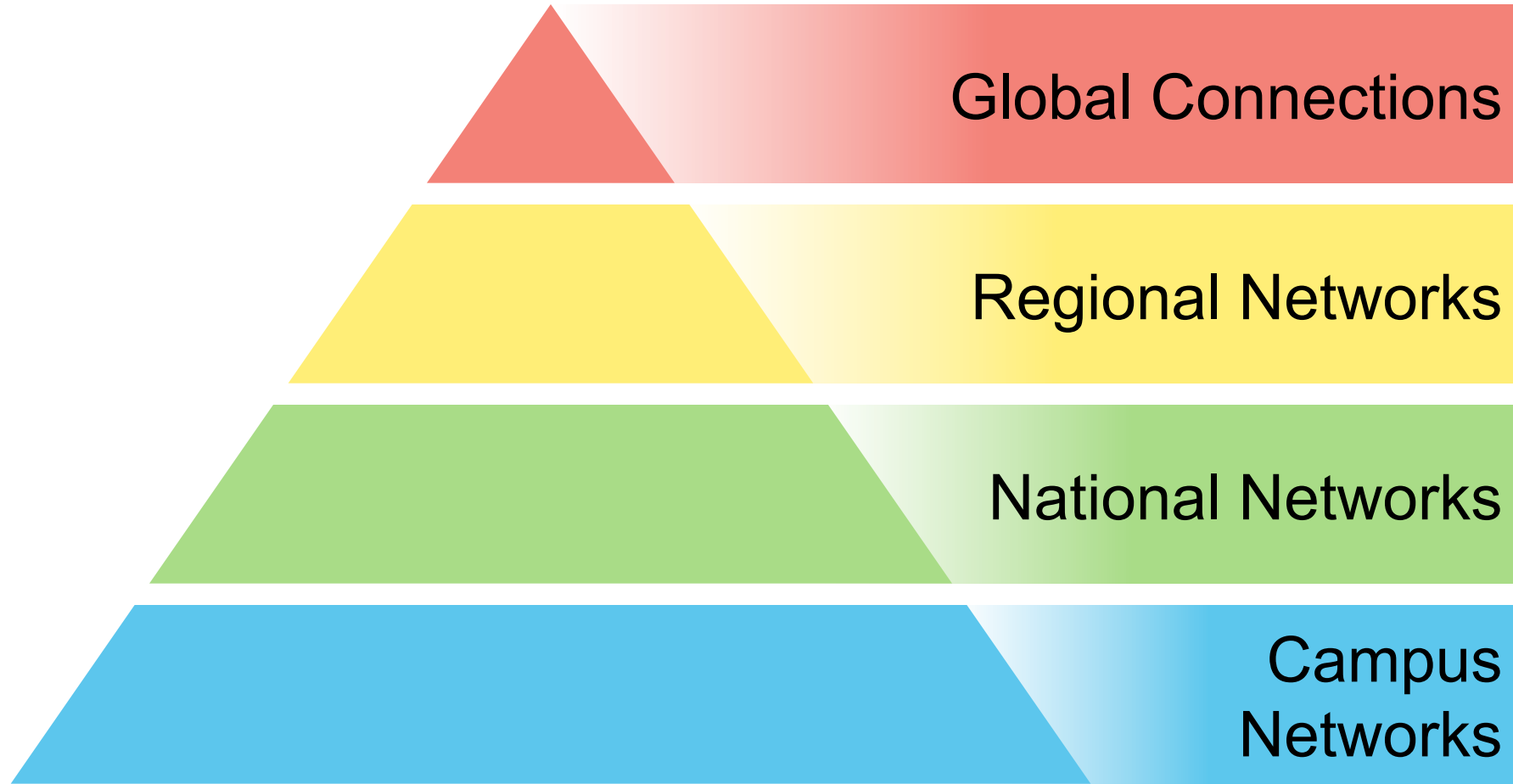
REN Ecosystem

- A layered model
 - Global Connectivity
 - Regional RENs
 - National Research and Education Networks
 - All users are connected at the campus network level

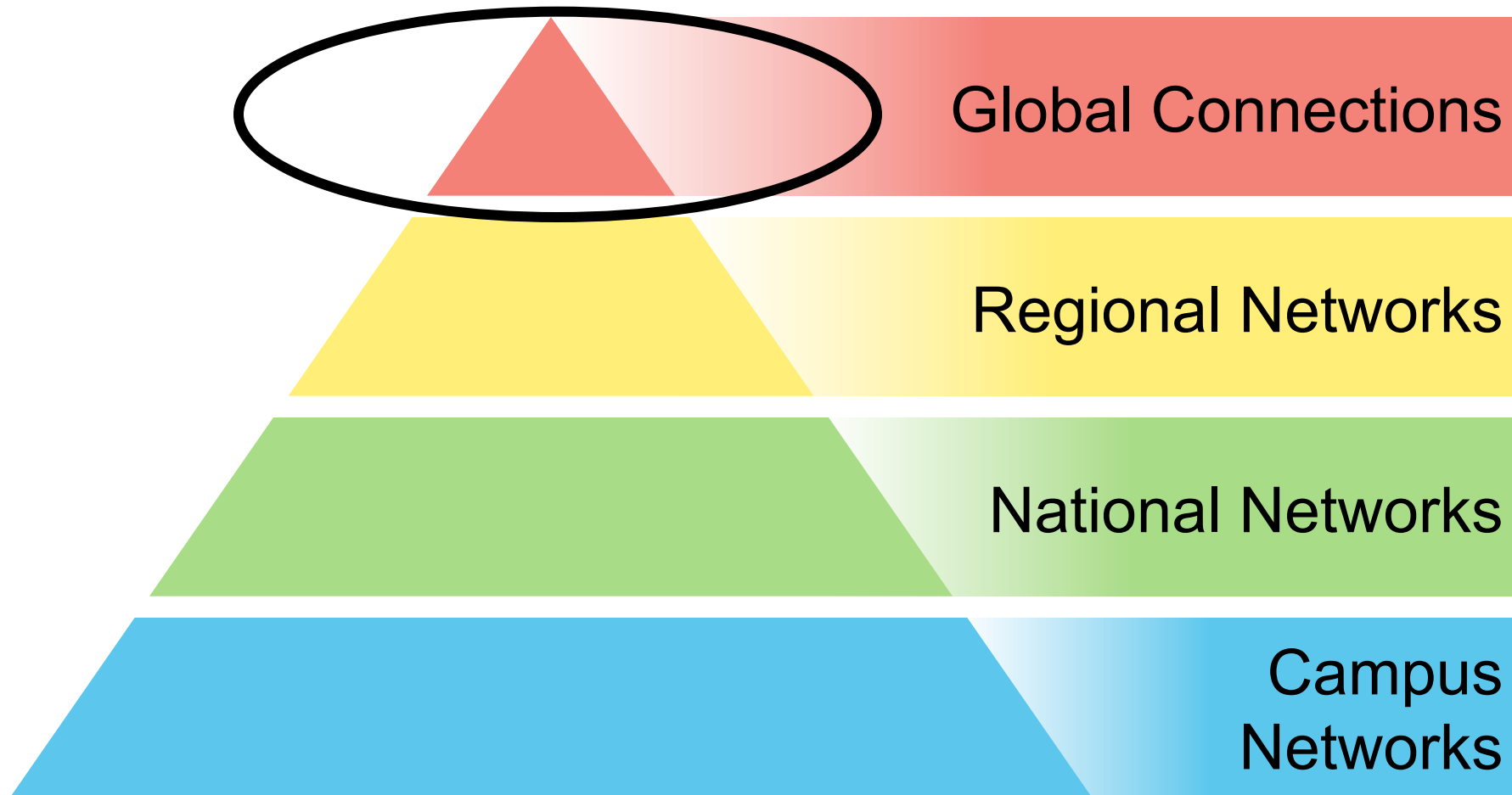
REN Topics

- A look at the Global and Regional REN environment
- NREN IP Transport Models and implications for campus networks
- Importance of Campus Networks to the REN ecosystem

REN EcoSystem



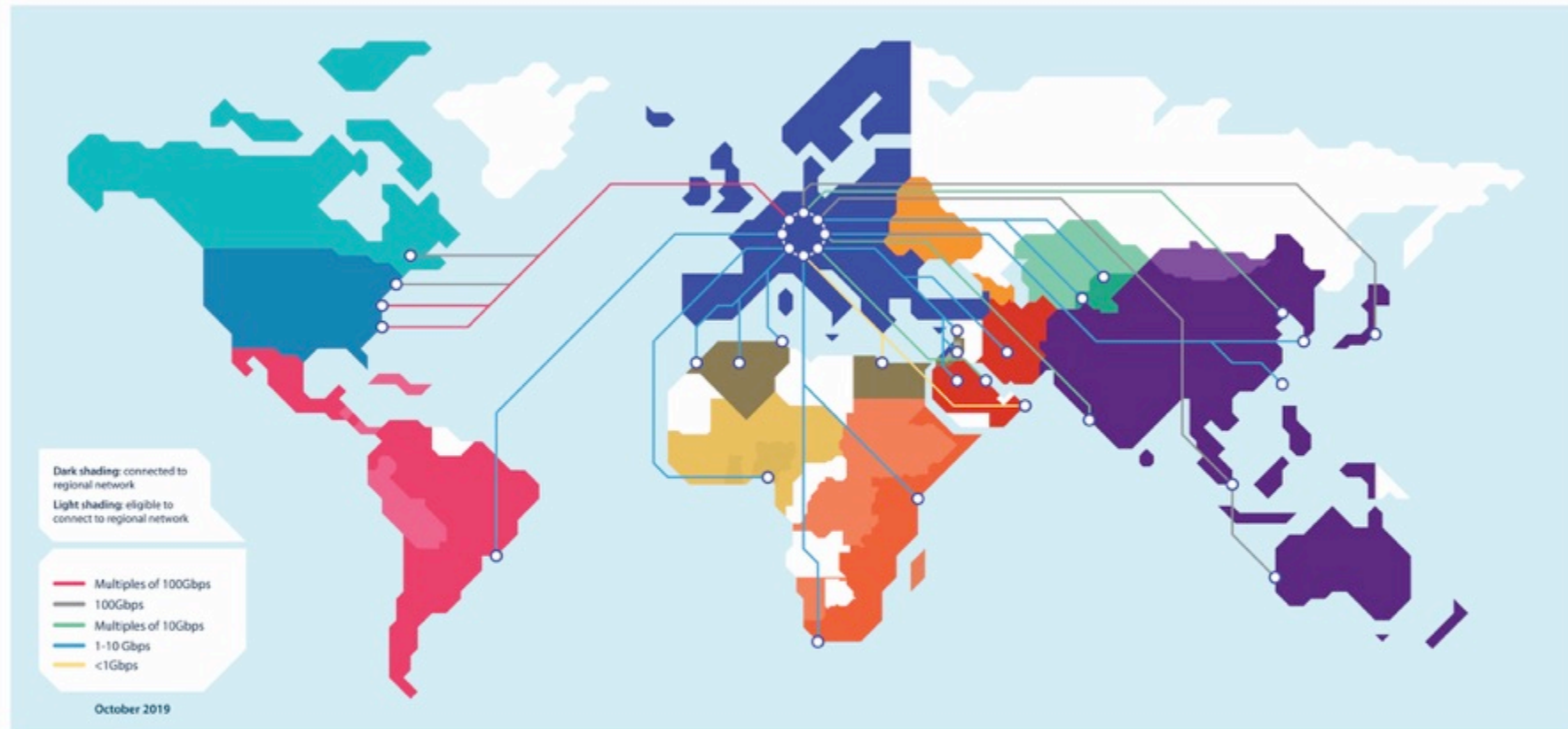
REN EcoSystem



Global REN Connections

- Connect Regional or National networks together
- Tend to be longer, more expensive circuits
- Not always well coordinated
- Routing policies often inconsistent

AT THE HEART OF GLOBAL RESEARCH AND EDUCATION NETWORKING

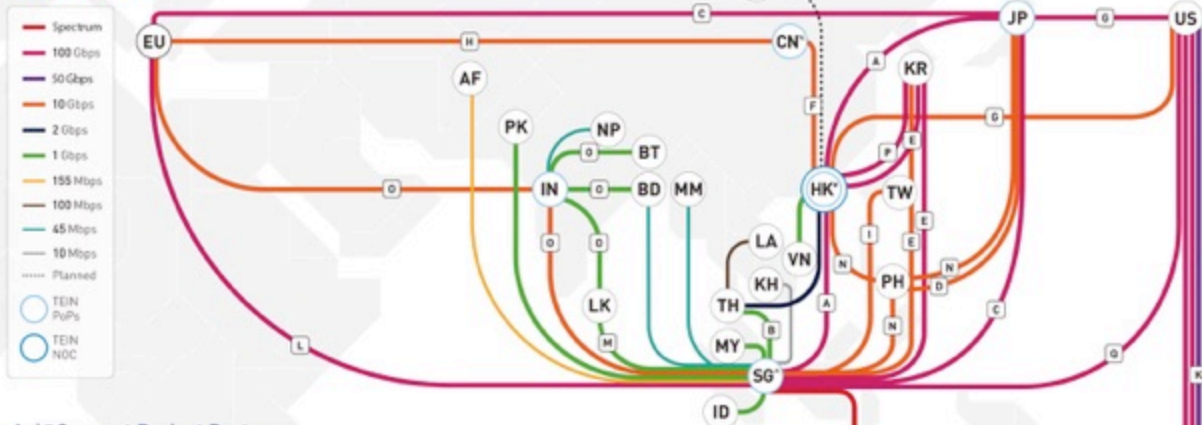


Canada & USA	Latin America	Europe	North Africa & Eastern Mediterranean	West & Central Africa	Eastern & Southern Africa	Central Asia	Asia-Pacific	Other R&E Networks



The EU co-funded Asi@Connect project provides a dedicated regional high capacity and high quality internet network, Trans Eurasia Information Network (TEIN), for Research and Education (R&E) communities across Asia-Pacific and Europe, and leverages e-infrastructures developed for public service projects.

TEIN Map



Asi@Connect Project Partners

AF - Afghanistan Research and Education Network (AfREN)	LA - Laos Education and Research Network (LERNet)
AU - Australia's Academic and Research Network (AARNET)	MY - Malaysian Research and Education Network (MyREN)
BD - Bangladesh Research and Education Network (BdREN)	MN - Mongolian Research and Education Network (ErdemNet)
BT - Department of Information Technology and Telecom (DrukREN)	MM - University of Computer Studies Yangon (ImmREN)
CN - Institute of Technology of Cambodia (CamREN)	NP - Nepal Research and Education Network (INREN)
HK - China Education and Research Network (CERNET) % CERNET connected to TEIN CN PoP at 10 Gbps China Science and Technology Network (CSTNET)	NZ - Research and Education Advanced Network NZ L.M. (REANNZ)
HK' - The Hong Kong Academic and Research Network (HARNET) The Hong Kong Open Exchange (HKOX) # HARNET and HKOX connected to TEIN HK PoP at 10 Gbps	PK - Pakistan Education and Research Network (PERN)
IN - National Knowledge Network (NKN)	PH - Advanced Science and Technology Institute (IPREGINET)
ID - Indonesia Research and Education Network (IDREN)	SG - Singapore Advanced Research & Education Network (SingAREN) * SingAREN connected to TEIN SG PoP at 100 Gbps
JP - Ministry of Agriculture, Forestry and Fisheries Research Network (MAFFIN) National Institute of Information and Communications Technology (NICT) National Institute of Informatics (NII)	TH - Thailand Research Education Network Association (ThAREN)
KR - National Information Society Agency (KOREN) Korea Institute of Science and Technology Information (KRIENET)	VN - National Agency for Science and Technology Information (NinAREN)

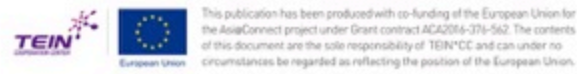
* As of December 2019.
** Other regions (Central Asia, Africa and Latin America) can be connected via global R&E networks such as EUI0(EANT) and US0(Internet2)

The following links are fully financed/co-financed by the link owners whose support is gratefully acknowledged

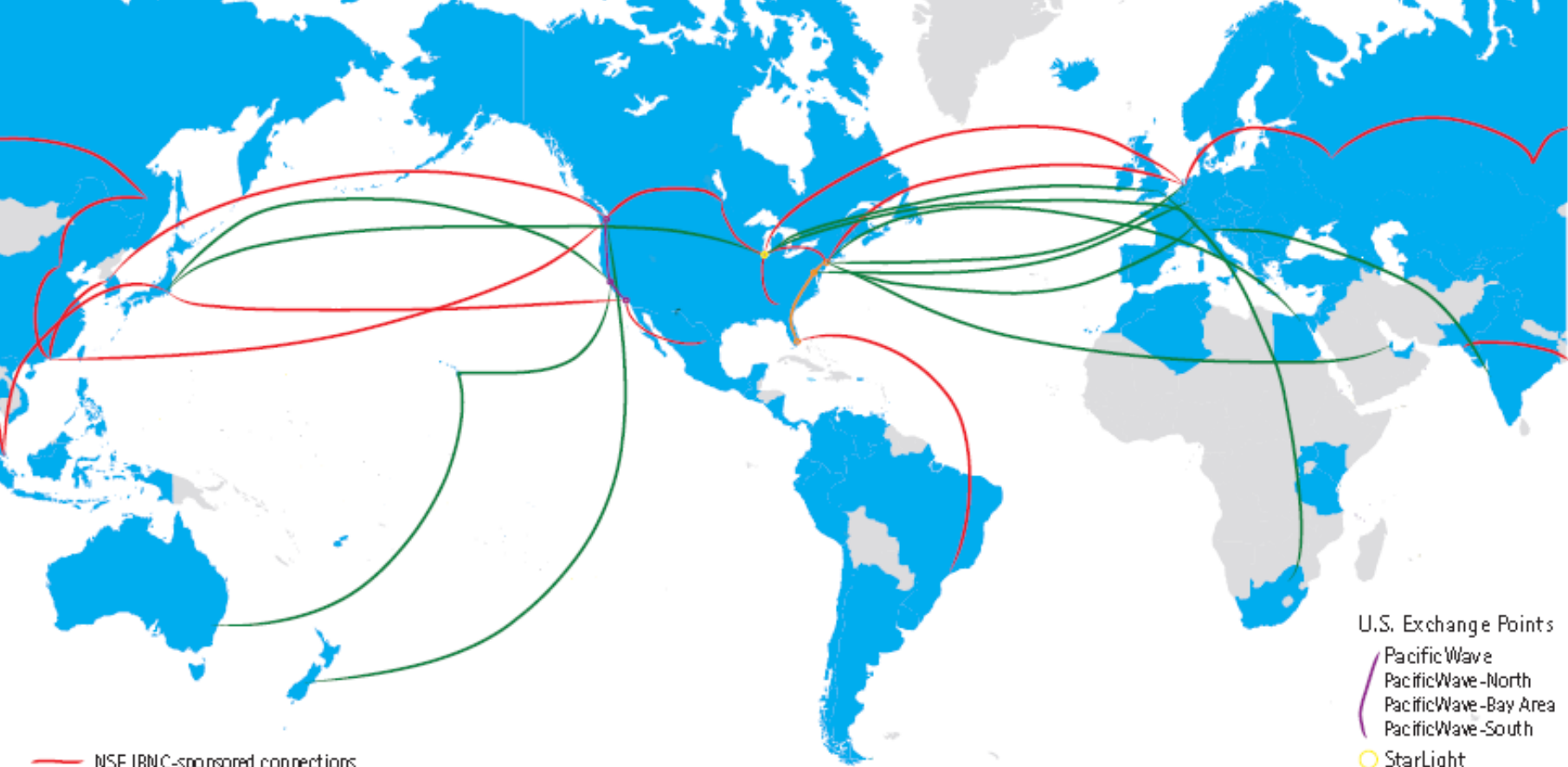
A	National Institute of Information and Communications Technology National Supercomputing Centre Singapore Advanced Research & Education Network
B	National Institute of Information and Communications Technology Thailand Research and Education Network
C	National Institute of Informatics
D	Ministry of Agriculture, Forestry and Fisheries Research Network
E	National Information Society Agency
F	China Education and Research Network
F'	TEIN Cooperation Center
G	TransPAC/Pacific Wave
H	Co-funded by China and EU
I	Academia Sinica Grid Computing
J	Australia's Academic and Research Network
K	Research and Education Advanced Network New Zealand
L	AARNET EANT NORDUNET SAREAN MAFFIN NICT NII
M	LEARN Lanka Education and Research Network
N	Advanced Science and Technology Institute
D	National Knowledge Network
P	Korea Research Environment Open Network
D'	National Supercomputing Centre Internet2 Singapore Advanced Research & Education Network



Possibilities with Asi@Connect



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— NSF IRNC-sponsored connections
— Other international connections

For more information regarding the international programs of Internet2, visit <http://internet2.edu/international> or Heather Boyles, International Relations Director, international@internet2.edu.
 A list of networks reachable via the Internet2 Network is found on the back of this page.

- U.S. Exchange Points
- PacificWave
 - PacificWave-North
 - PacificWave-Bay Area
 - PacificWave-South
 - StarLight
 - AtlanticWave
 - MANLAN
 - NGIX-East
 - AMPATH

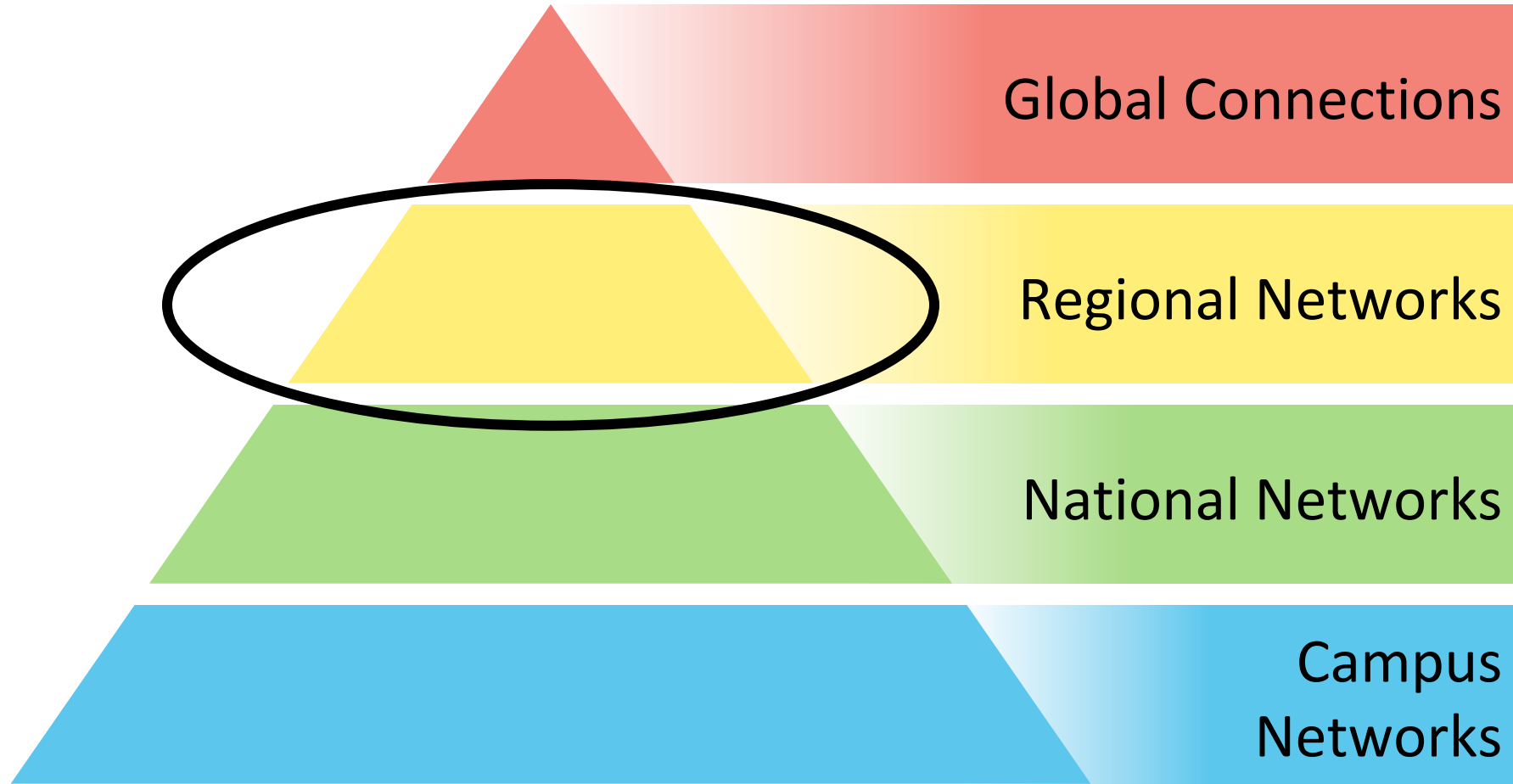
Asia-Pacific Backbone Topology



- APAN(Affiliated)
- TransPAC/PacificWave
- SingAREN/Internet2
- GEANT/TEIN(Affiliated)
- JGN SINET
- AARNet
- Others

As of Oct 7th, 2016

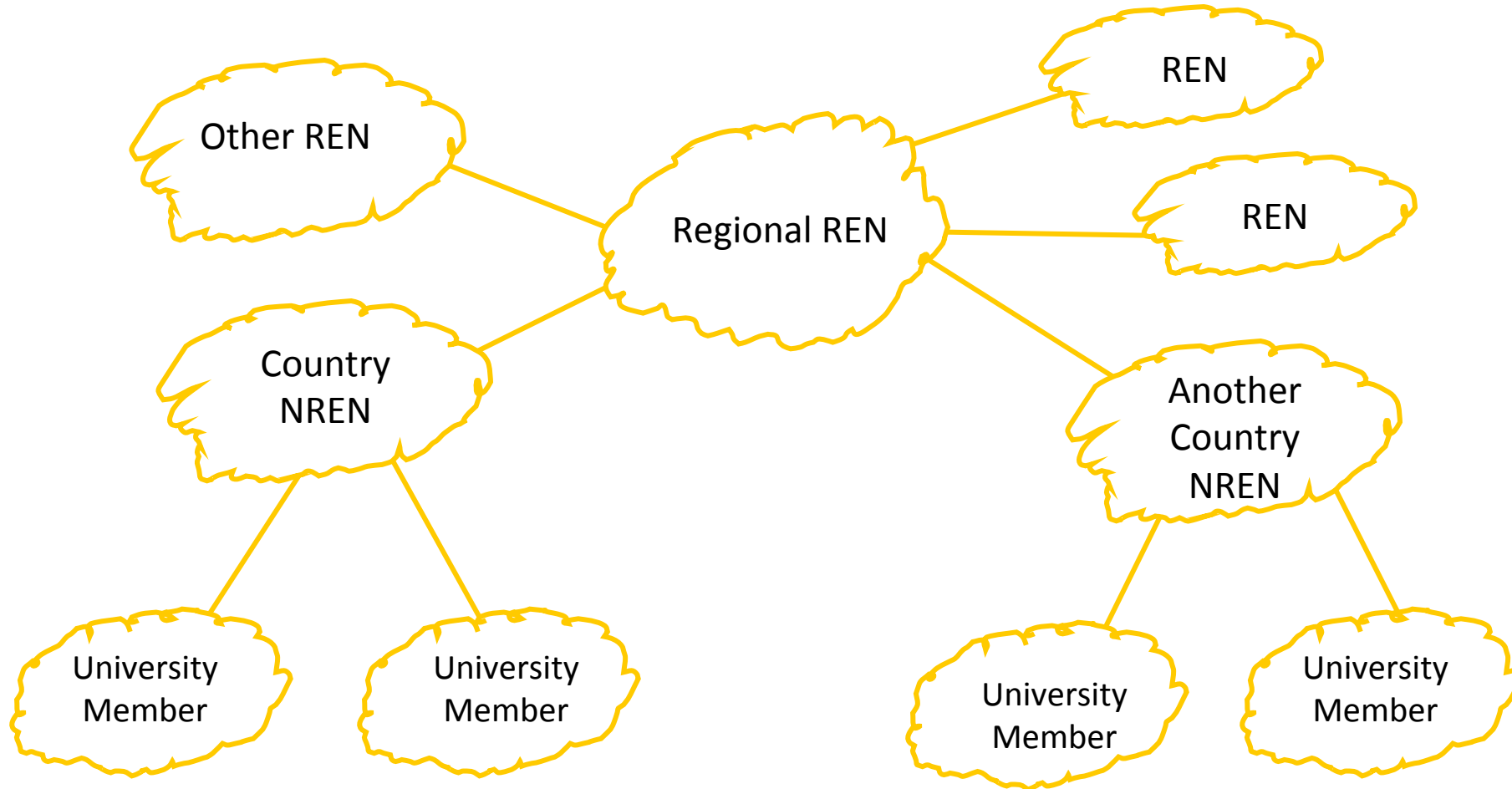
REN EcoSystem

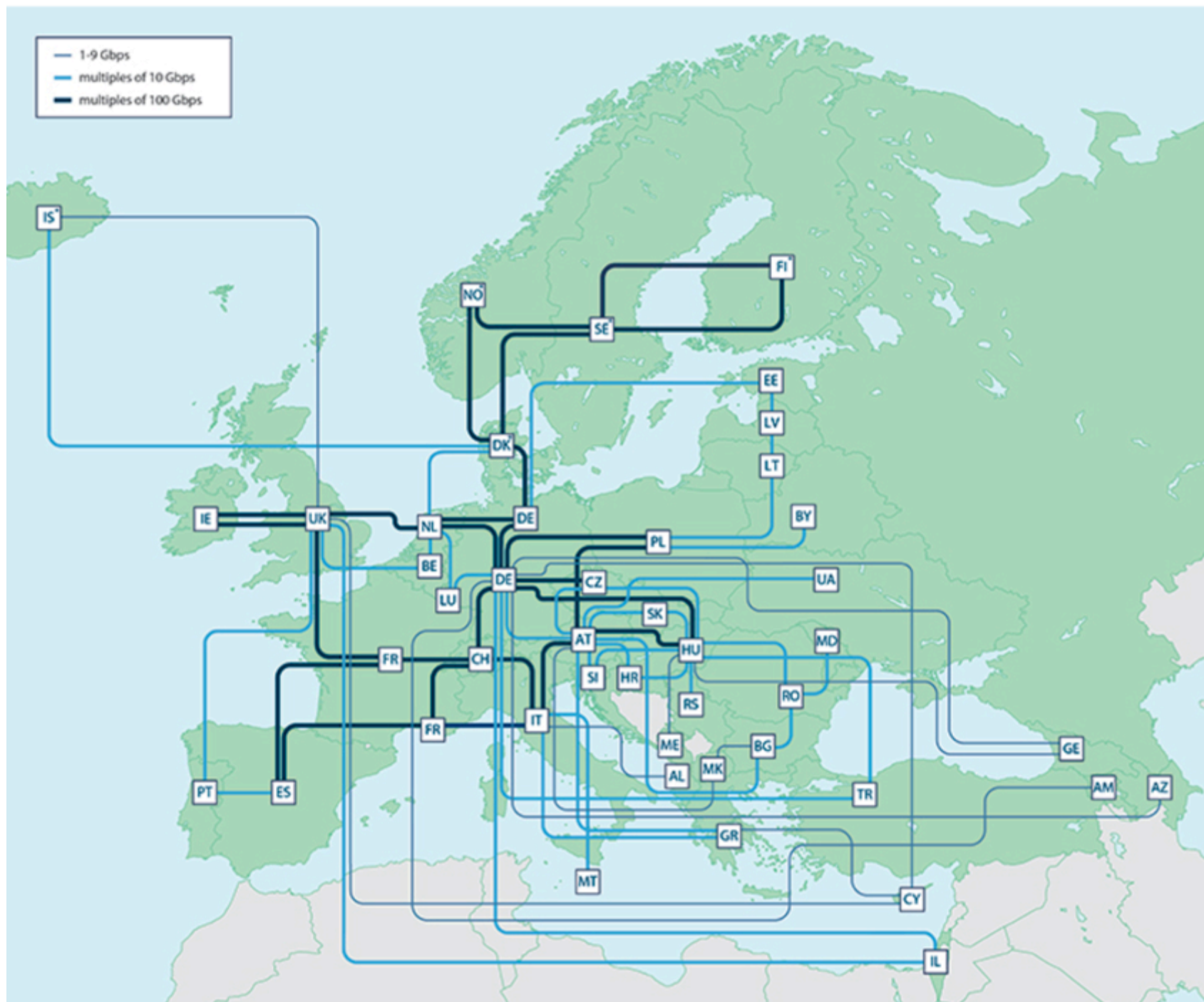


Regional REN Connections

- Regional RENs connect REN of individual countries within a geographic region
- Many regional networks have funding from European Union
 - GEANT, ASREN, TEIN5/Asi@Connect, ALICE/ALICE2 (RedCLARA), Ubuntunet, WACREN, and ASREN

Typical REN





Current RedCLARA's Network Topology

