

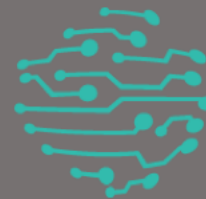
Reaching R&E world-wide: Global Network Architecture

EaPEC 2018

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Policy & Strategy Officer
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Chişinău, Moldova
17-18 October 2018

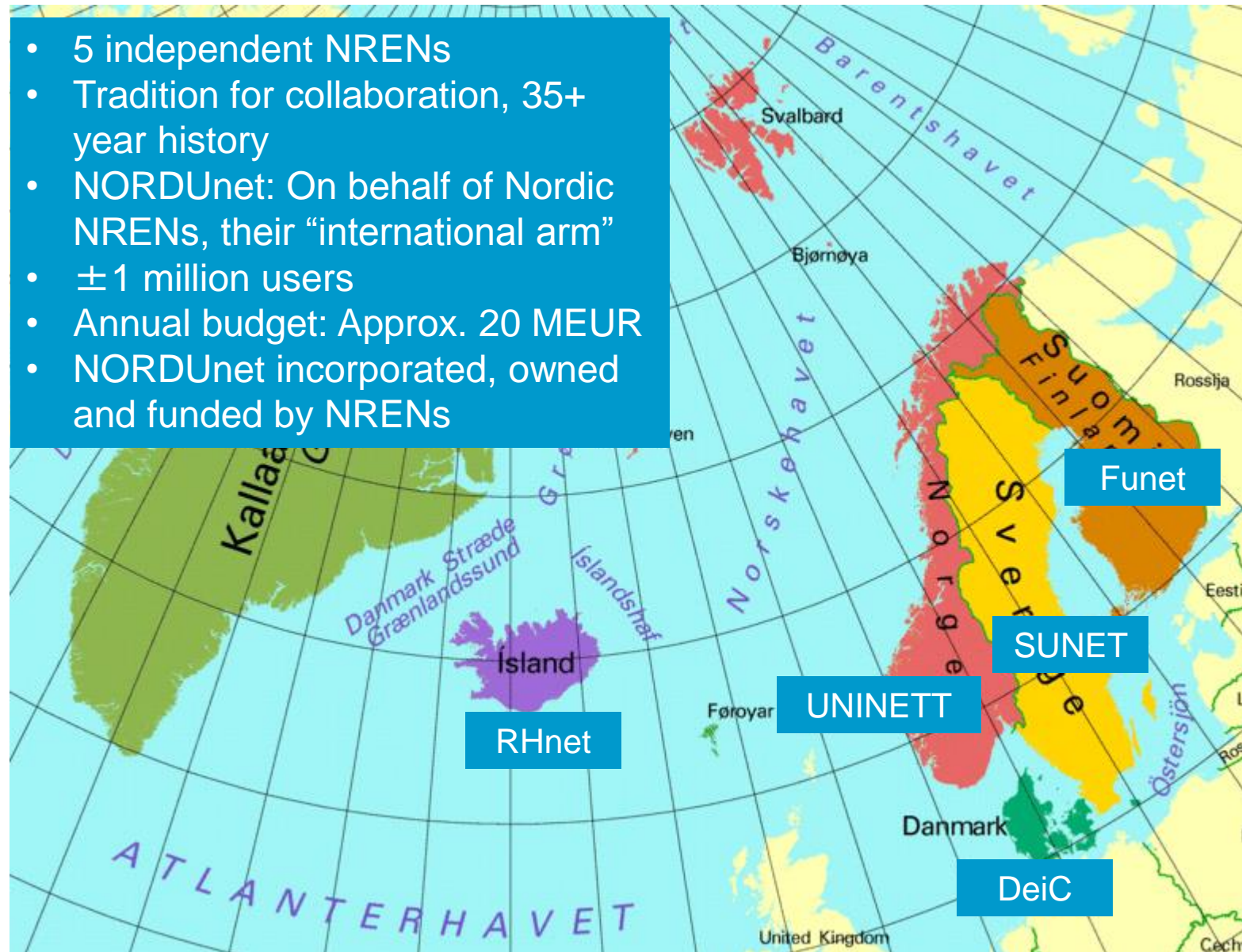


global network architecture

- About NORDUnet
- A few words on global Internet networking
- The Why and History of GNA
- Where are we now with GNA?
- Opportunities & Future steps
- Conclusion
- Q&A



- 5 independent NRENs
- Tradition for collaboration, 35+ year history
- NORDUnet: On behalf of Nordic NRENs, their “international arm”
- ±1 million users
- Annual budget: Approx. 20 MEUR
- NORDUnet incorporated, owned and funded by NRENs



- NORDUnet provide platform for Regional and Global Collaboration:
 - Interregional Connectivity
 - European Connectivity
 - Global Connectivity
 - State of the Art Tier1 Peering Infrastructure
- NORDUnet provide a range of ICT services:
 - System integration, not "Build from Scratch"
 - Leverage common integration and development
- NRENs Share Network Infrastructure:
 - Avoid duplication of infrastructure
 - Reduce operational cost

zoom



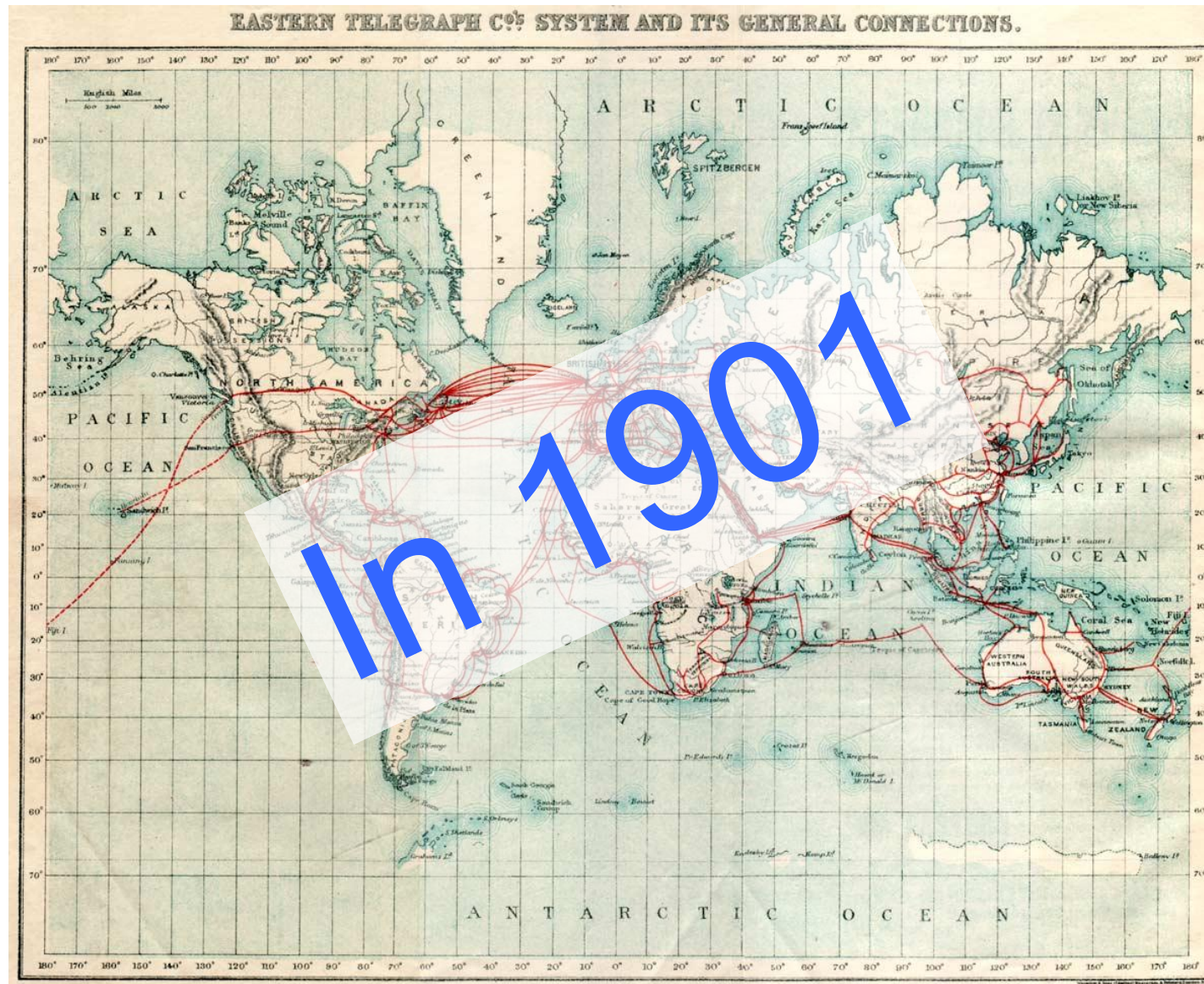
KALTURA

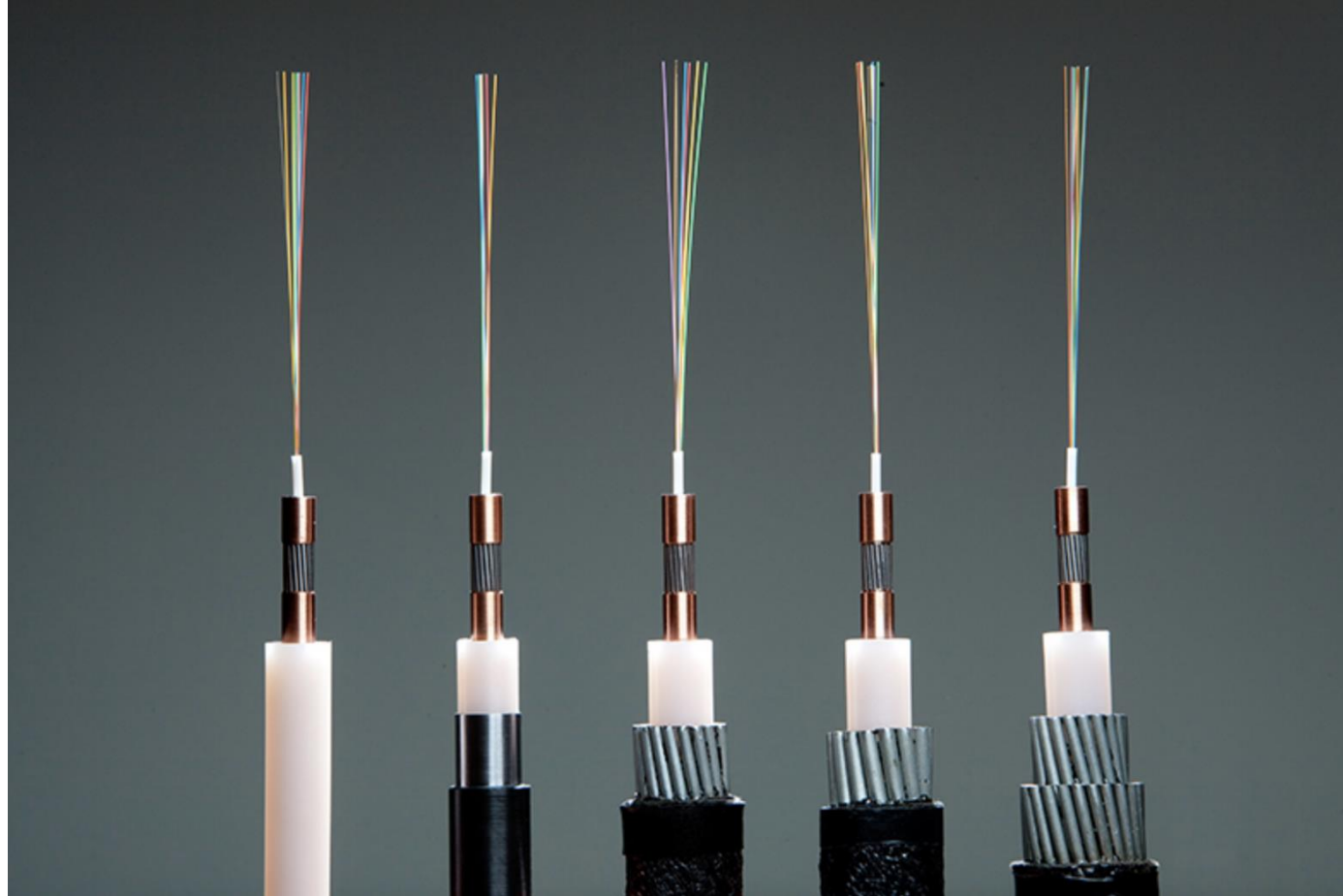




A word on subsea cables:

- Enabling global Internet networking
 - Carrying your and my data



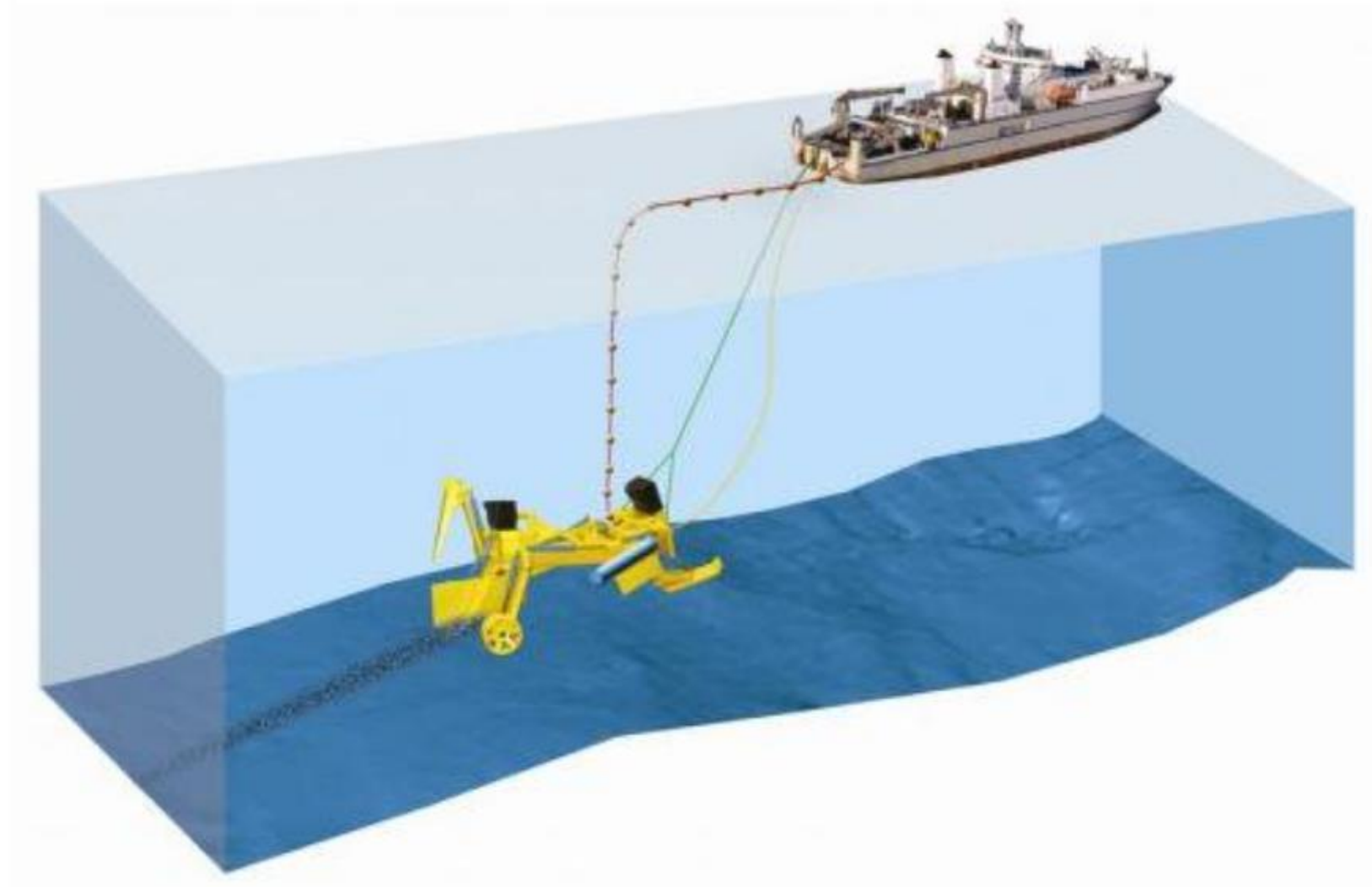




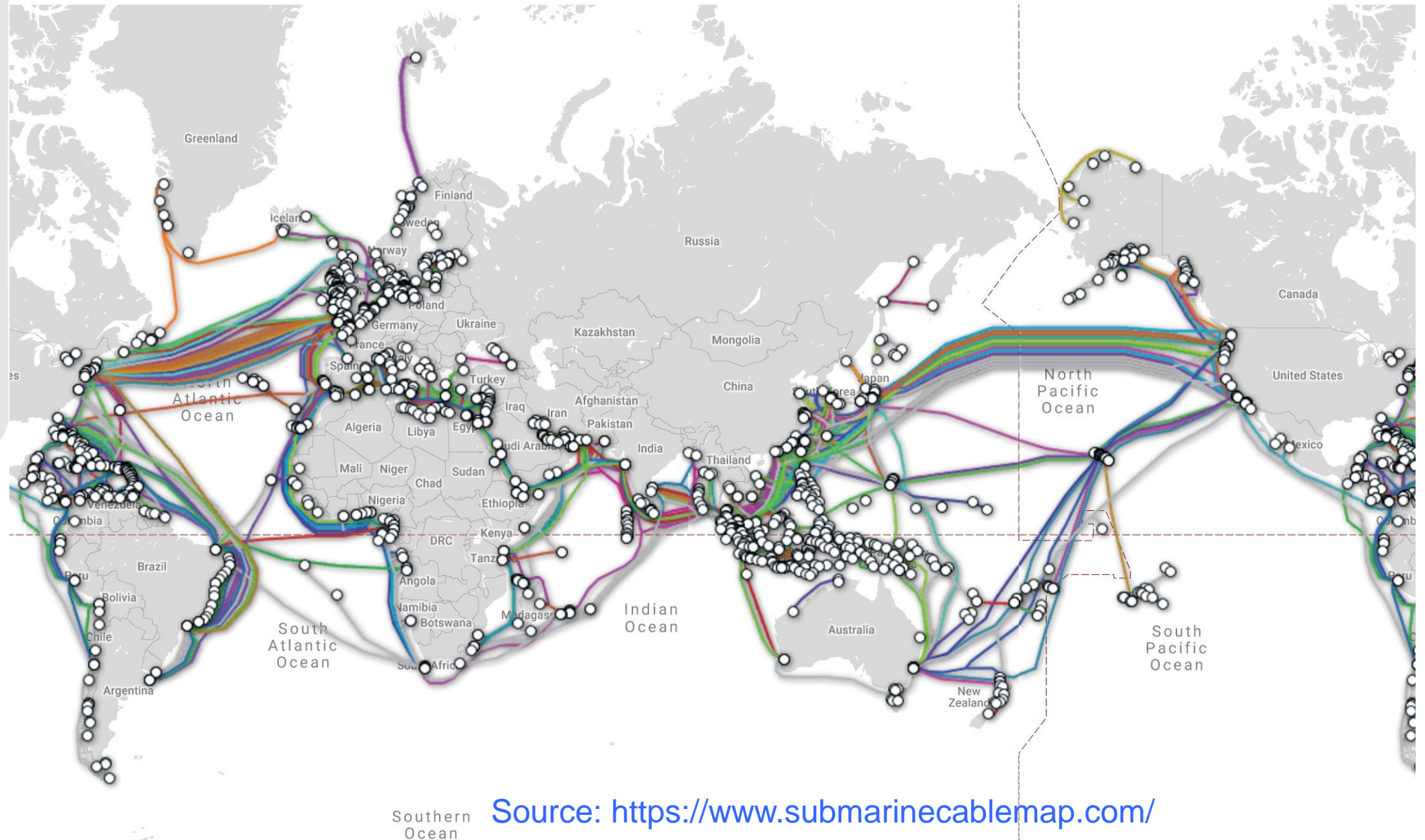
Source:
Hawaiki











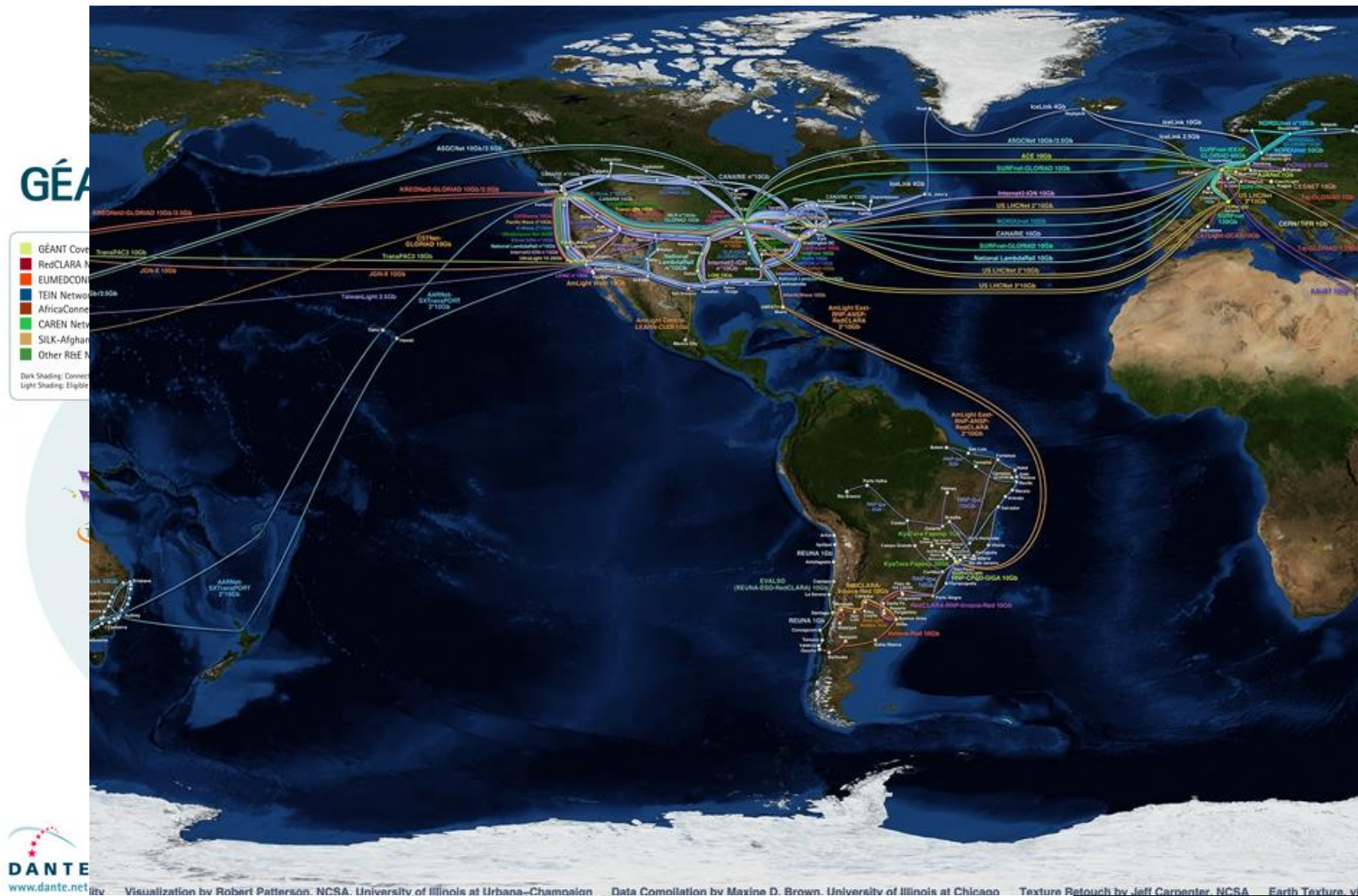
Southern
Ocean

Source: <https://www.submarinecablemap.com/>

Last updated on October 9, 2018



And how does this subsea world apply to R&E Networking?



So, can we please add more:

- Coordination
- Collaboration
- “Think Global, Act Local”

The GNA Vision: **Globally Connecting Science, Research & Education**

Creating bandwidth and services in support of research and education between R&E Networks on a global scale that is equivalent to that within continents

The GNA Mission:

- Creating an inclusive architecture to increase collaboration and resource sharing between the global R&E community
- Developing a strategic blueprint that R&E Networks can use to align their investments in intercontinental circuits



- Ensure we take network services into production by following the GNA Mission



One of the key parameters: Collaboration

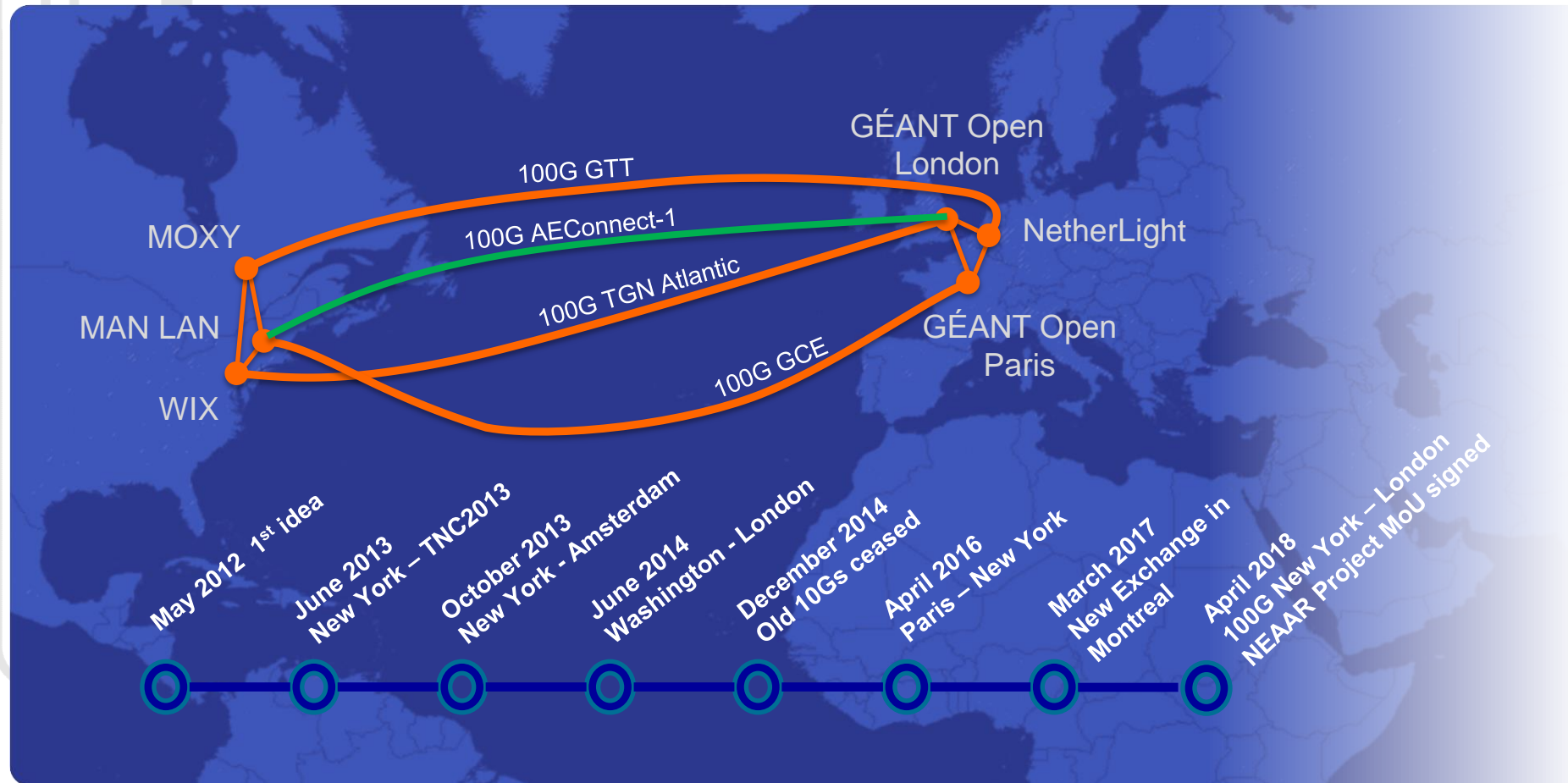
- Starting point of the GNA Technical WG:
 - 2013: White paper by Prof. Jianping Wu (CERNET) and H. David Lambert (Internet2)
- Building on the work of GLIF:
 - Concept of lambda networking
 - Concept of an Open Lightpath Exchange

- Build on what we know and do already
- Global R&E Exchange Points: GXPs
- Fat pipes between the GXPs:
 - With participant R&E Networks connected to GXPs
- Federated Operations:
 - Collaborating NOCs
- Examples of GXPs in Europe:
 - Helsinki: NOX-HEL
 - Amsterdam: NetherLight
 - London: GÉANT Open London

- Six Reference Architecture v1.0 documents
- Three White Papers
- Phase I Compliant infrastructure
- Instrumentation
- Maintained website

- 2012: 25+ individual 10Gs across the Atlantic
- 2012: Challenging the subsea market for 100 Gbit/s
- 2013: ANA-100G Pilot link up and running
- 2014: Resilience: Ring @ 100G
- 2014: ESnet mutual backup, NORDUnet production
- 2016: ANA-300G
- 2017: NEAAR added: 400G (+ESnet's 400G)

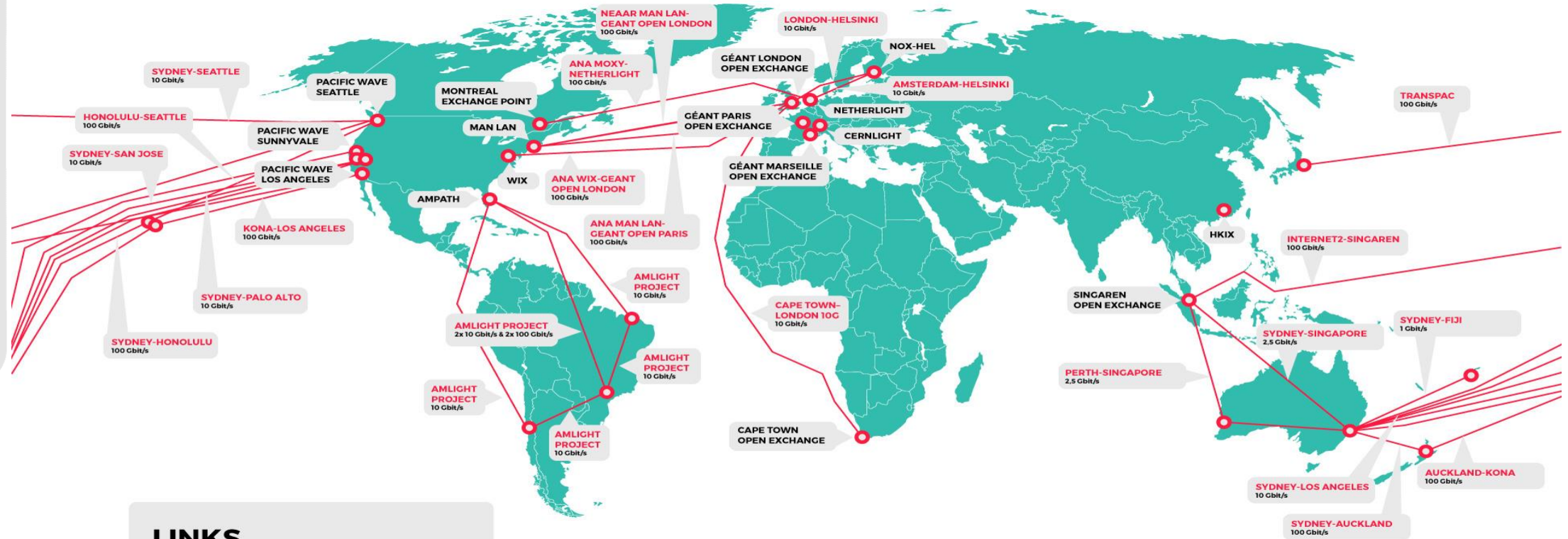






Coordinated, architected, with long term commitments

- A 'Proof of Concept' project (ANA) proved successful and stable
- Consortia developing (similar to ANA) in other regions
- Number of Global Exchange Points "GXPs" continues to grow
- The GNA concept has achieved broad buy-in
- Formal announcement of the GNA Phase I @ I2 Global Summit 2017



LINKS IN THE GNA PHASE I

APAC
AARNet
SingaREN

EMEA:
GÉANT
NORDUnet
SANReN (and TENET)
SURFnet

AMERICAS
Internet2
ESNet
CENIC/PacWave
AMPATH/AmLight
NEAAR
TransPac



global network architecture

HOME

ABOUT

OUR PLAN

RESOURCES

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White papers:
Global R&E Network Architecture Program

FIND OUT MORE

Developing a blueprint for global R&E network architecture

The Global Network Architecture (GNA) embodies a vision and an ambition of an international collaboration of national research and education (R&E) networks. The GNA Technical Working Group is charged with drafting a blueprint for interconnecting R&E networks on a global scale, based on the latest technologies and promising developments, with a five to ten-year horizon. This blueprint will enable R&E networks to align their spending for intercontinental bandwidth. Participation is open to all regions of the

<https://gna-re.net/>

APR Start:

- Q4 2017

APR Partners:

- NICT,
- NSCC,
- SingAREN,
- Internet2,
- NII/SINET,
- Pacific Wave,
- TransPAC,
- The WIDE Project, and
- CENIC.



- NORDUnet's 1G between NORDUnet PoPs in Frankfurt and Hong Kong
- A 10G between London and Beijing, dedicated to Europe-China traffic
- A 10G between London and Singapore, dedicated to Europe-SingAREN and TEIN traffic
- 2x 10G between London and Tokyo, dedicated to Europe-Japan traffic

- Problem: Long RTTs & very expensive
- Or... How could we create a ANA & APR like collaboration on this path
- Demands from several organizations
- Current efforts to start a collaboration on two levels:
 1. Jointly procuring a 100G
 2. Forming a system (ring) with SINET's 100G

- From AsiaPac:
 - SingAREN,
 - AARNet, and
 - TEIN*CC.
- From Europe:
 - GÉANT,
 - SURFnet, and
 - NORDUnet.
- Looking at a long-term 100G, jointly



CAE100G





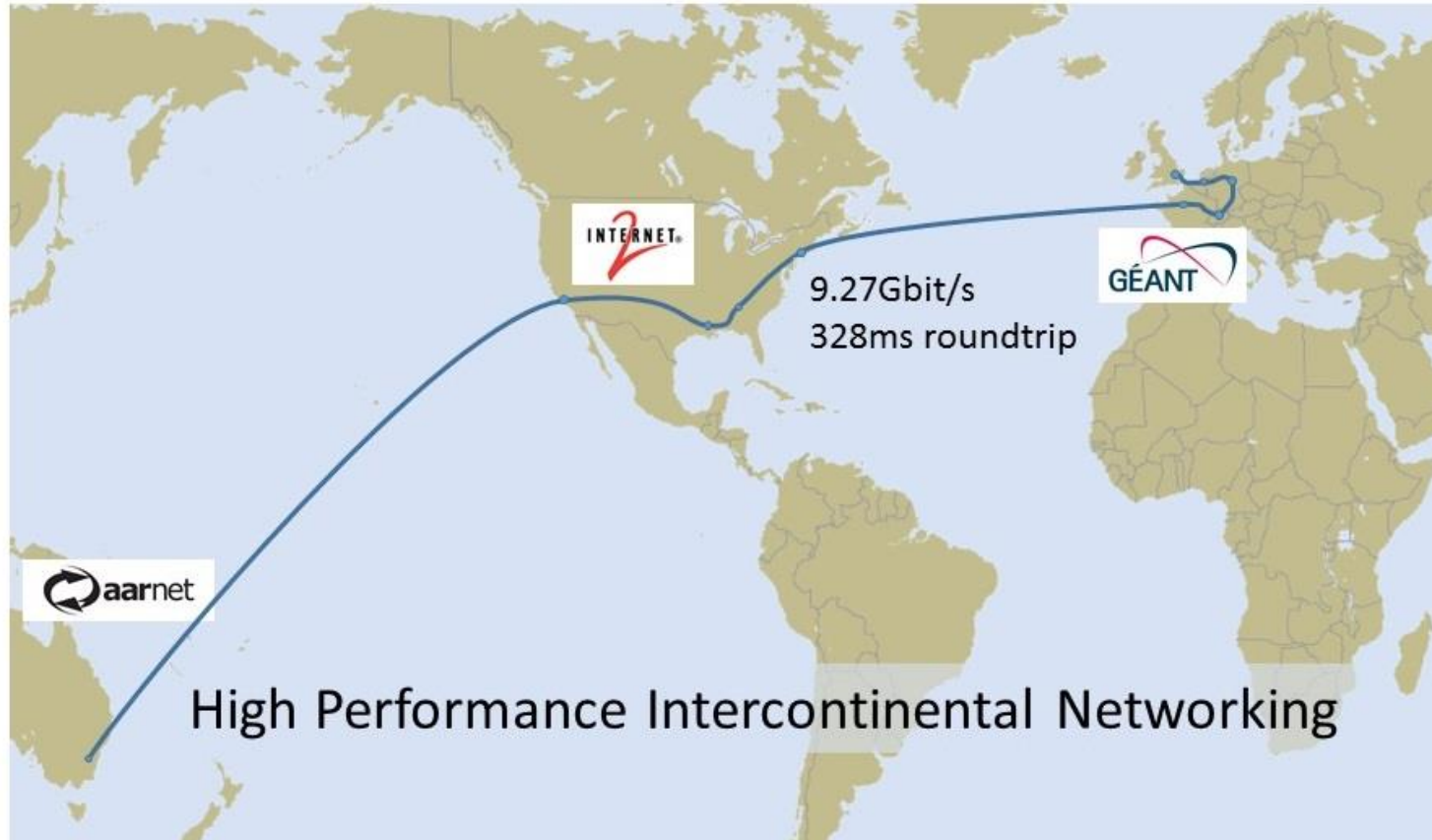


- Europe-Asia pricing:
 - 2016 10 Gbit/s quote: 250 kEUR/year
 - 2017 1 Gbit/s actual: 78 kEUR/year
 - 2018 10 Gbit/s price levels:
 - TeleGeography Retail Benchmark: 220 kEUR/year
 - Budgetary pre-tender Wholesale: 29-57 kEUR/year
 - Tender Result: ...

- Hawaiki:
 - New Zealand – Australia – US West Coast
 - 15,000 km cable system
 - 445 Million NZ Dollar project
 - REANNZ anchor tenant
- Indigo:
 - Sydney – Perth – Singapore
 - AARNet anchor tenant
- UNINETT fiber on Svalbard:
 - <https://www.youtube.com/watch?v=pZpo6zepZWw>
- EllaLink (planned):
 - Brazil – Portugal
 - GÉANT & RedCLARA involved

- Most Importantly: Stimulate other Collaborations
- Network Services definition v2.0
- Dynamic Mapping of network infrastructure
- Virtualization and Orchestration
- Automation on ANA: Pathfinder using AutoGOLE experiences
- Instrumenting the GNA:
 - MaDDash
 - NetSAGE

- Oh, and what about the commercial Internet?
 - <https://blog.geant.org/2017/05/15/taking-it-to-the-limit-testing-the-performance-of-re-networking>



- GNA ideas being implemented:
 - Bandwidth between some continents now on par with bandwidth within continent
 - Other inter-continent paths to follow, e.g.:
 - Africa – South America
 - Europe – South America
- More bandwidth, more resilience, less money
- Will the Black Sea Region join in?

"The fee you pay your regional network, not only connects you to CANARIE and the rest of Canada, but also to the Global R&E Network!"

Jim Ghadbane, President & CEO at CANARIE

Thank you! Questions?

GNA website:

<https://gna-re.net/>



global network architecture

In the Field Stories:

<https://www.inthefieldstories.net/>

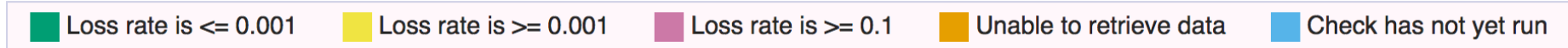
Explore stories by featured topics



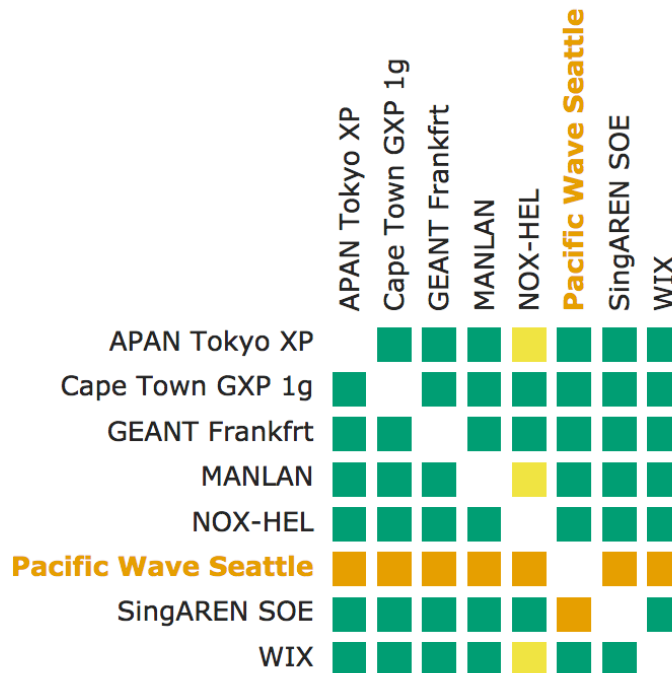
BACK UP SLIDES

GNA Sites Dashboard

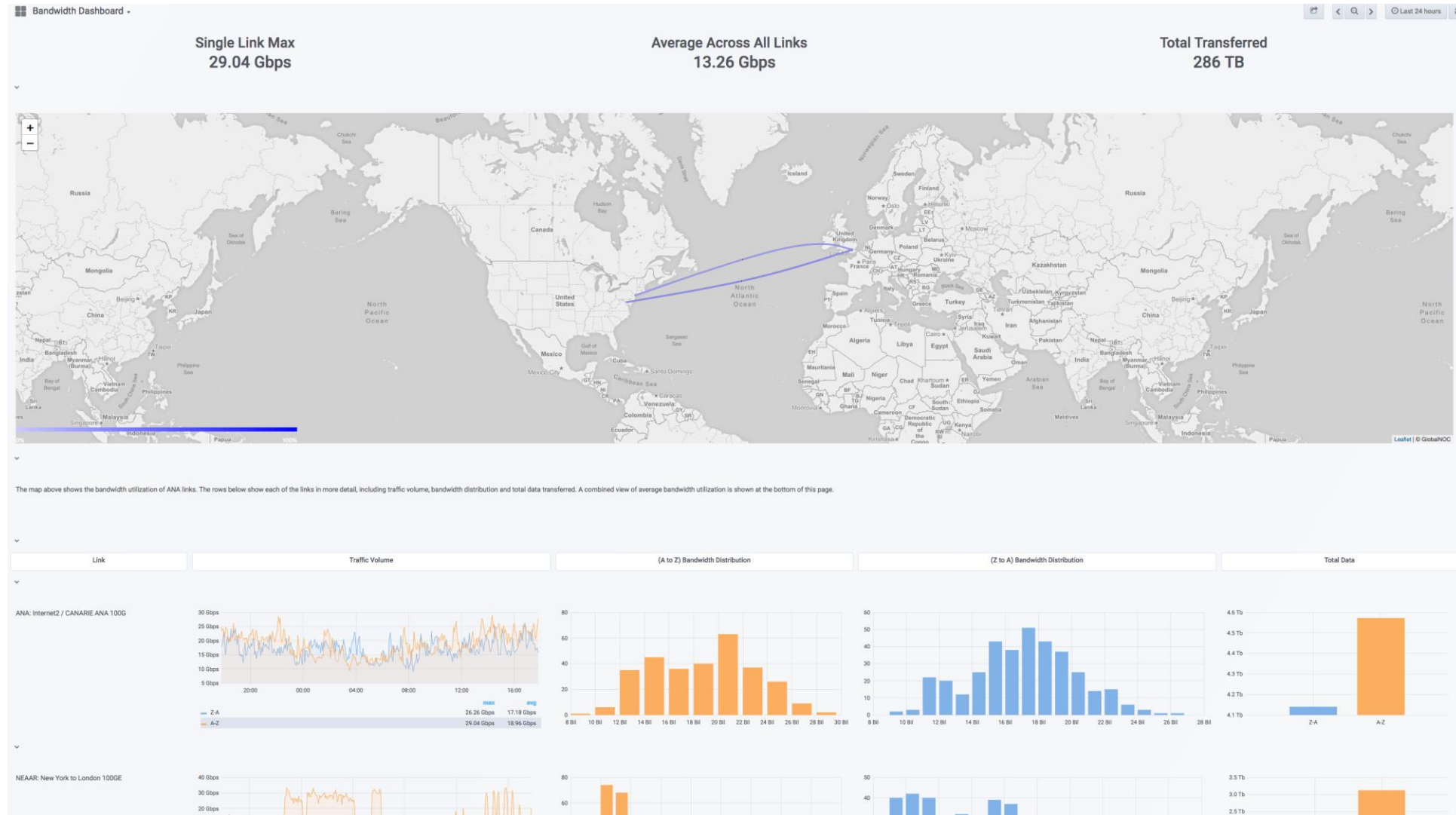
Loss and Delay -GNA-



! Found a total of 1 problem involving 1 host in the grid



Thanks to
Takatoshi-san
(APAN-JP / KDDI)



Thanks to NetSAGE project, Jennifer, Andrew, Edward, et. al.

GNA Reference Documents v1.0 – January 2017

The GNA Technical Working Group produced six documents that together are the **Global Network Architecture Reference v1.0**. These documents were published in January 2017:

- [GNA Reference Architecture v1.0](#)
- [GNA Exchange Point Specifications v1.0](#)
- [GNA Multi-Layer Transport Services v1.0](#)
- [GNA Operations v1.0](#)
- [GNA Technical Notes v1.0](#)
- [GNA Glossary v1.0](#)

The files above are in “PDF/Universal Accessibility” (PDF/UA) format, and hence are available to those equipped with appropriate software. The conformance with PDF/UA ensures accessibility for people with disabilities who use assistive technology such as screen readers, screen magnifiers, joysticks and other technologies to navigate and read electronic content.

Please also note that the above six documents replace the older version numbered lower than v1.0 or with version number v1.0-technical.

White Papers

The GNA Technical WG also maintains an archive of GNA White Papers that are published by their respective authors, and are relevant to the GNA and define possible future work:

- [The Commons in the GNA v2.5](#)
- [GNA Information Architecture v0.6](#)
- [Global Virtualization Architecture for the GNA v0.91](#)