



Navigating the Future of Intercontinental Connectivity

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GÉANT

Internet2 Community Exchange 2023

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Charting Our Course

- GÉANT global connectivity waters
- Rigging the boat for the next cruise
- Setting Sail
- Charting the waters
- Addressing the digital divide

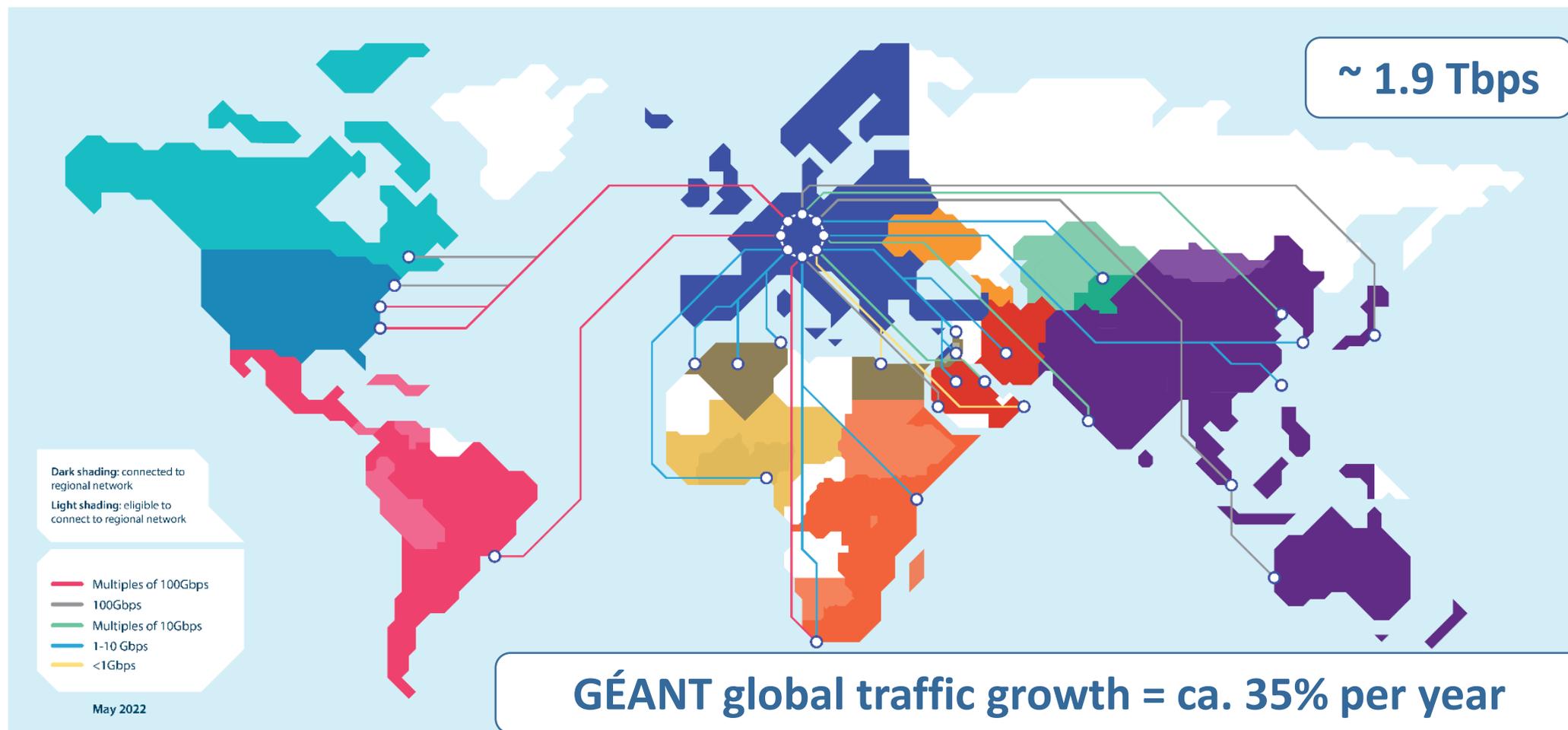


Source: T. Fryer



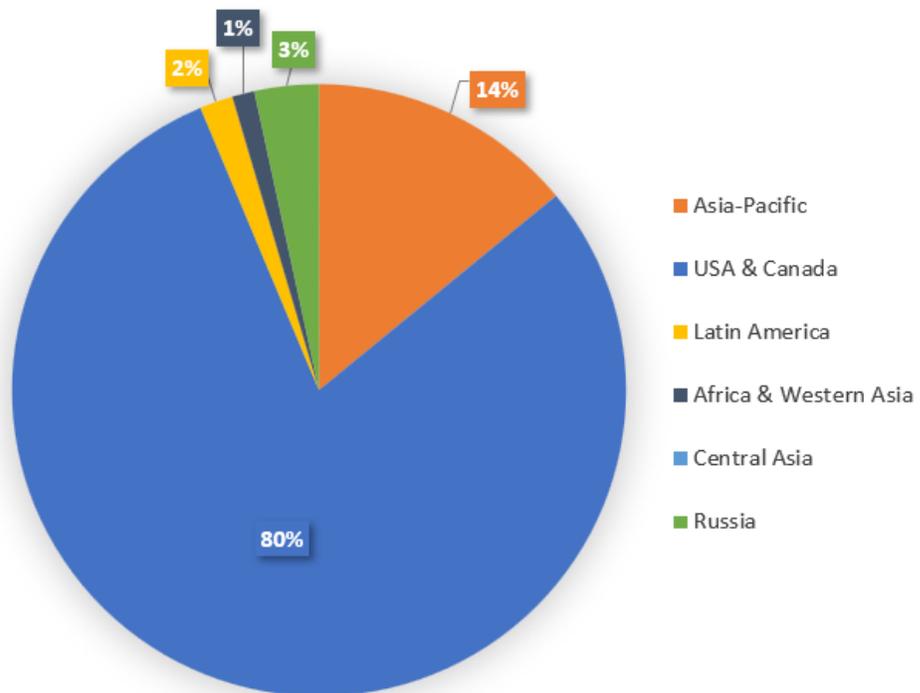
Source: <https://www.flickr.com/photos/internetarchivebookimages/>

GÉANT Global Connectivity Today!

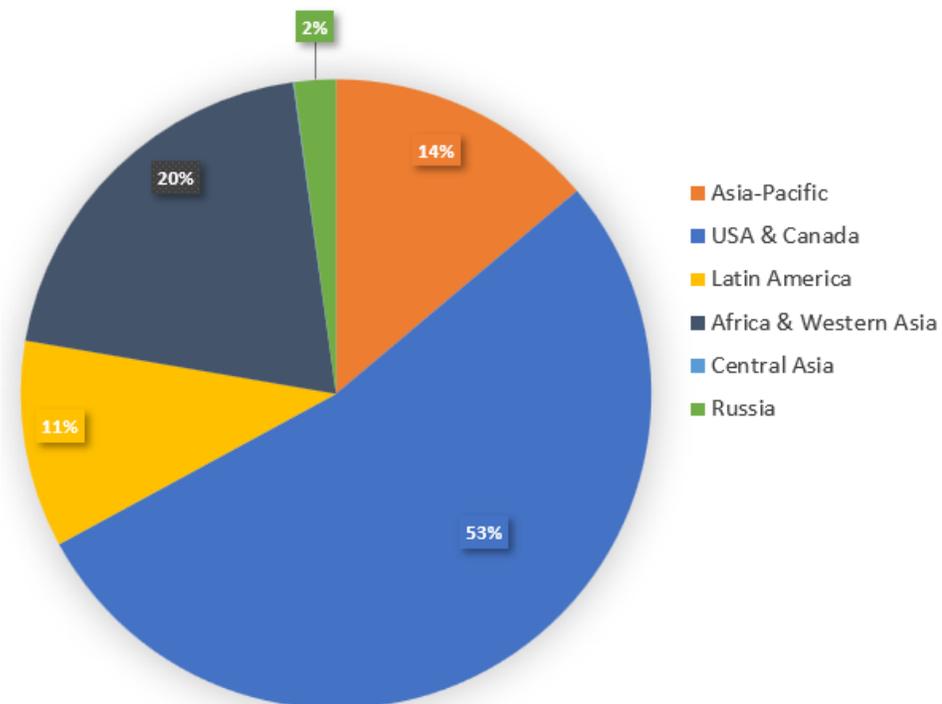


Average global traffic in 2022 = 110 Gbps ingress / 105 Gbps egress

Capacity and Traffic Distribution (2022)

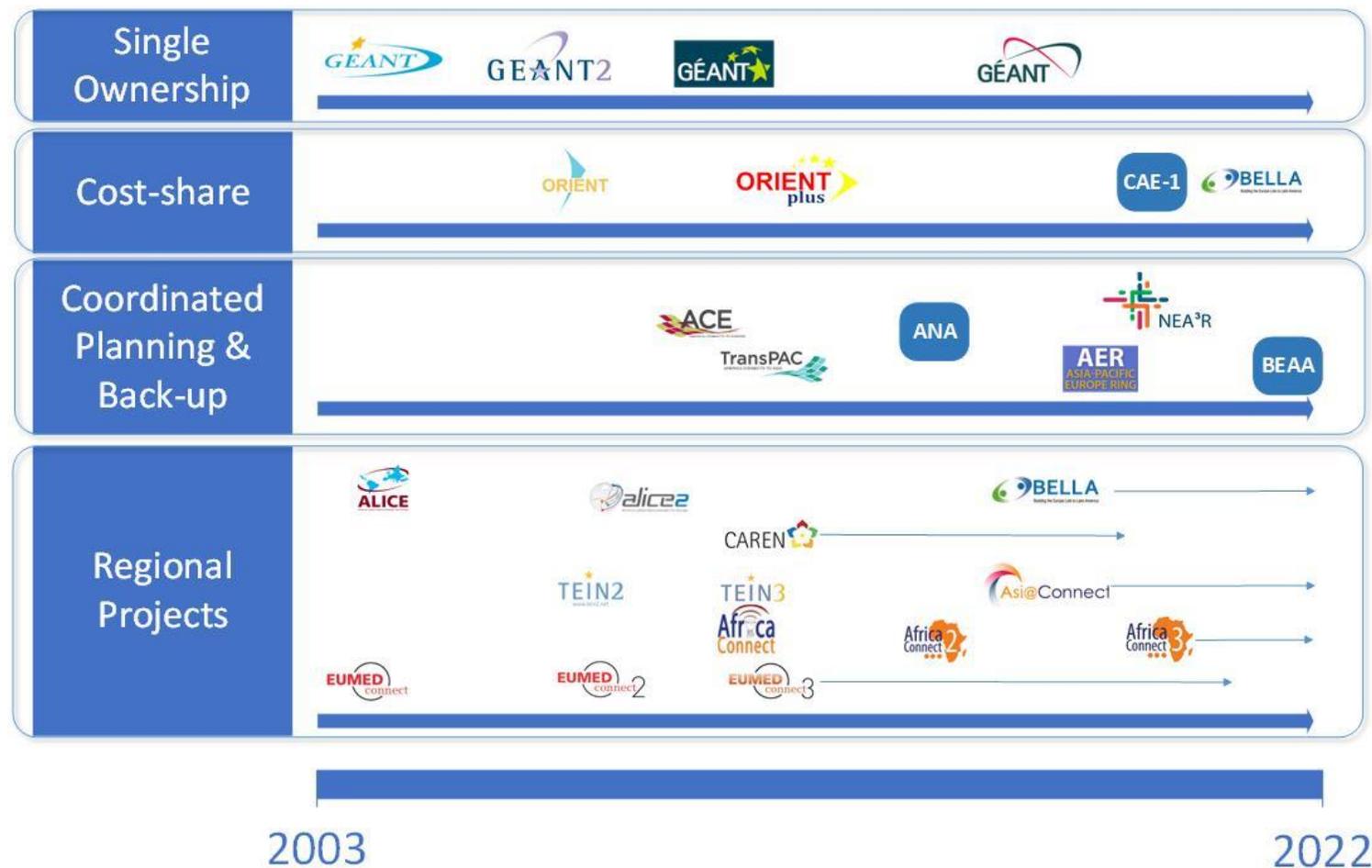


Average Global Traffic Distribution by Region



Global capacity distribution by region

Navigating a History of Connectivity Delivery



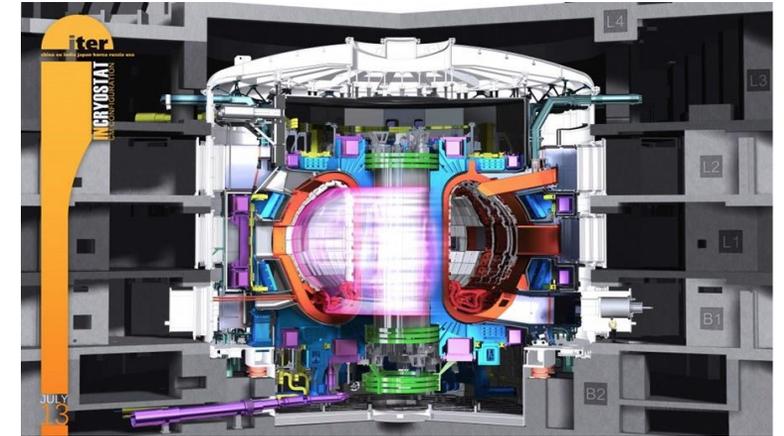
The Cargo

LHC

- 200 sites across the globe
- 50% of GÉANT global traffic
- High Luminosity HLC from 2029



Map courtesy of Google.com



ITER – Fusion Research

- Several PBs of data per year
- To be copied from France to multiple locations globally

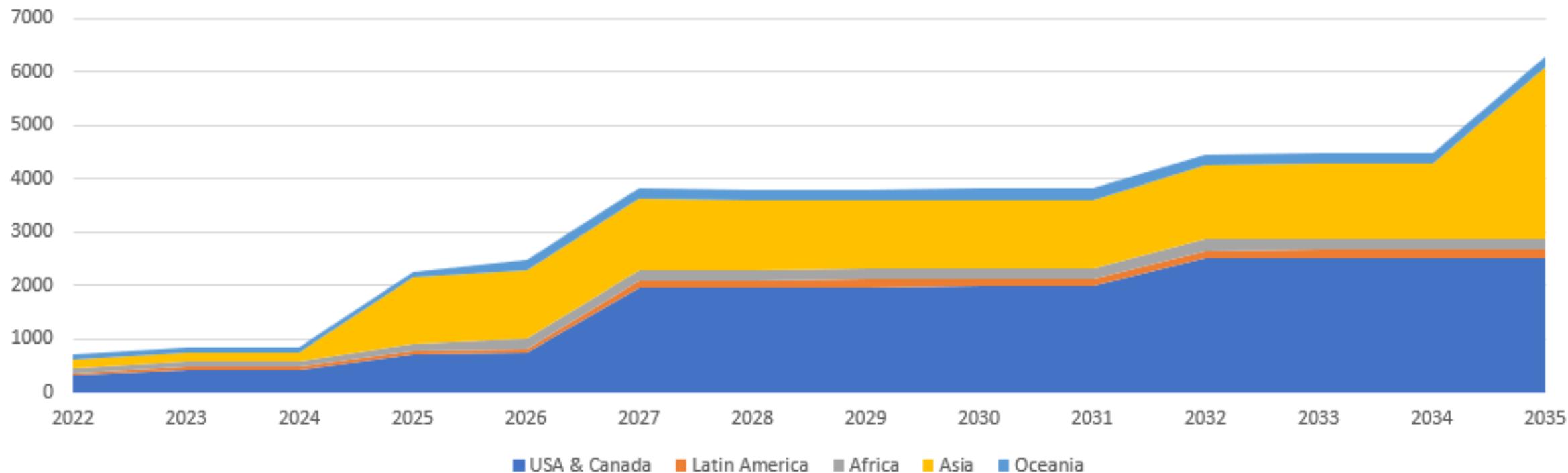


Astronomy

- Square Kilometre Array
 - Detectors in Australia and South Africa
 - 100 Gbps capacities required
- Chile:
 - Cherenkov Telescope Array
 - ESO – Very Large Telescope

Growing Cargo

Global Traffic Forecast 2022-35 (Gbps)



- Growth forecast from large data movers (LHC, Astronomy, ITER, HPC, etc.)

Captain's Orders: 2021-26 GÉANT Strategy

2021-26 GÉANT Strategy

- “...trusted partner for... global advanced R&E networking.”
- “...acknowledged worldwide as a leader for developing and supporting R&E networking communities, and global REN development.”

The GÉANT Association is driven by Eight Strategic Goals



Network

We are the trusted partner for pan-European and global advanced R&E networking.



Security

We provide a safe and secure information ecosystem for researchers, educators, and students.



Innovation

We continually evolve key infrastructures, innovate, and develop new services in order to fulfil the needs of the R&E community in a sustainable way.



Community

We are acknowledged worldwide as a leader for developing and supporting R&E networking communities, and global REN development.



European Union

We are seen by the EU as an indispensable partner for their vision.



Stakeholders

We forge relationships with other e-infrastructure providers, research infrastructures (RIs), and other stakeholders, to benefit the R&E community.



Governance

We have a governance structure that is agile and benefits from the diversity of our membership.



Funding

We will ensure financial sustainability to benefit our members.



Shipmates

R&E Networking organisations



Team Europe approach:

- EU, Member States, European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD).
- With the private sector in order to leverage investments for a transformational impact securing digital global gateways.

BELLA on the EllaLink Submarine Cable System



First-ever direct GÉANT-RedCLARA interconnection



Transatlantic R&E connectivity needs met for next 25 years

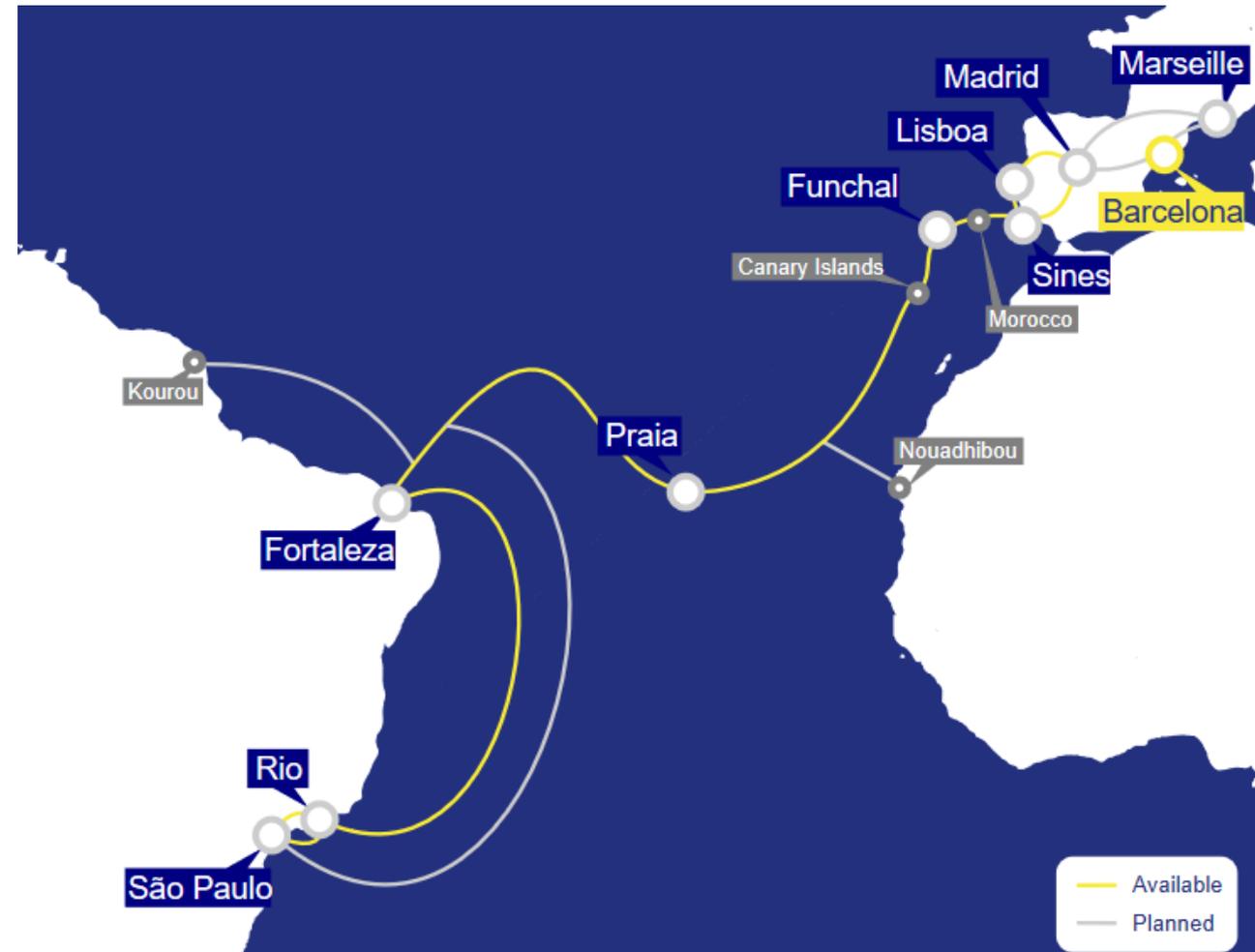
- Spectrum available for use by European & Latin American NRENs
- Supports Copernicus traffic with dedicated wave



Secure capacities for specific R&E collaborations



GÉANT-RedCLARA latency reduced up to 2/3



Source: <https://ella.link>

BELLA Establishes Connectivity on EllaLink



- Over 10 years in the making
- BELLA – a key role in making EllaLink a reality

Over 2 years for manufacture and deployment

Final Splice: 400km NE Mid-Atlantic ridge in early March 2021

BELLA connectivity went live in August 2021



EllaLink Inauguration
Sines, Portugal - 1 June 2021

Enhancing Shipping Lane Usage (i)

- **Advanced North Atlantic (ANA) Collaboration:**

- A collaborative effort to provide multiple, diverse links to support R&E collaboration across the North Atlantic
- Individual Transatlantic links are provided on diverse paths by:



100 Gbps

PAR-NY



SURF

100 Gbps

AMS-MONT

canarie



INTERNET[®]

100 Gbps

LON-WASH



International
Networks
at Indiana University

2 x 100 Gbps

NY-LON

NY-AMS



ESnet
ENERGY SCIENCES NETWORK

4 x 100 Gbps

WASH-GEN

BOST-AMS

2 x NY-LON

NII
国立情報学研究所
National Institute of Informatics



100 Gbps

AMS-NY

Enhancing Shipping Lane Usage (ii)

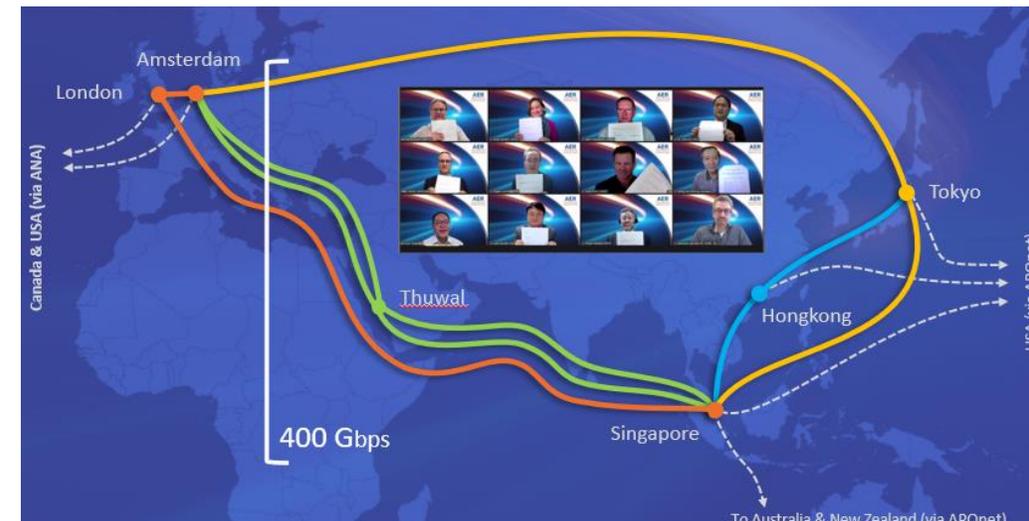
- **CAE-1**

- A 10-year collaboration starting in 2019 to connect Europe and Asia-Pacific at 100 Gbps between London and Singapore



- **Asia-Pacific Europe Ring (AER)**

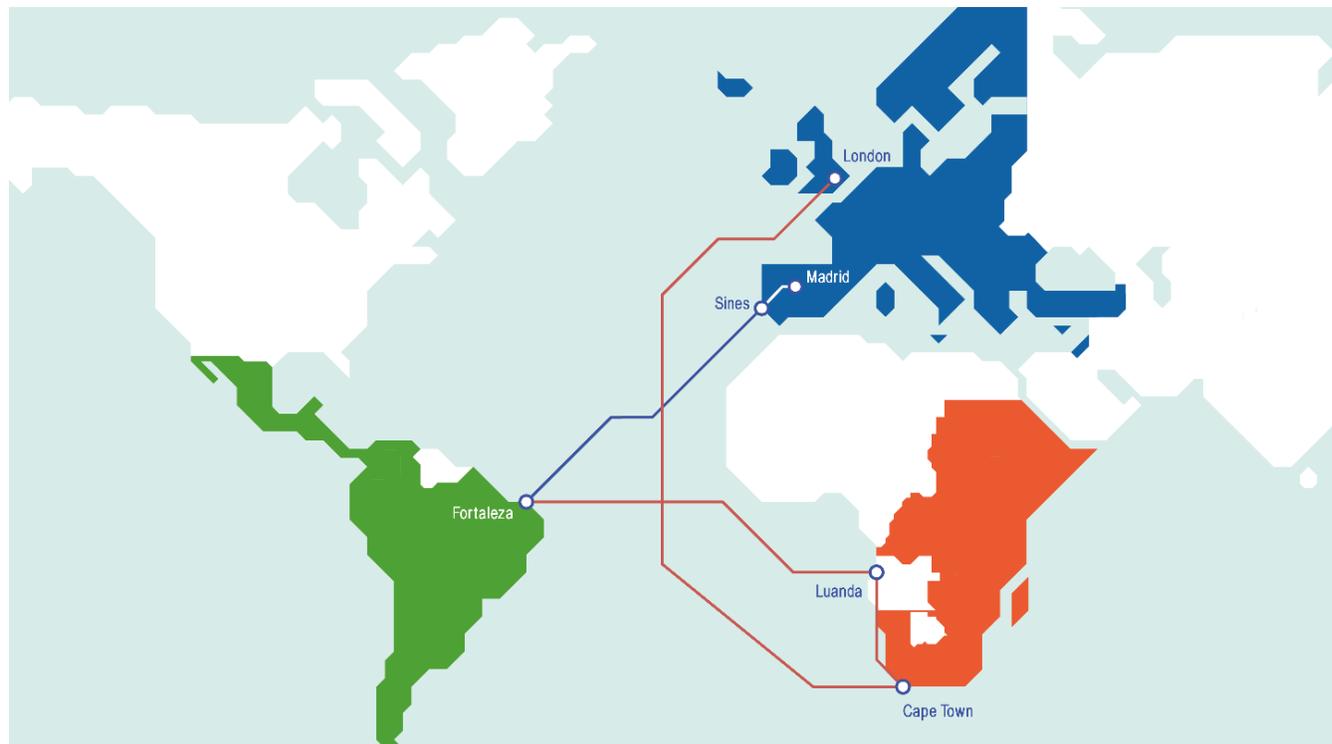
- A collaboration of ten R&E networks and institutions to provide mutual back-up between Europe and Asia-Pacific across diverse links.



Enhancing Shipping Lane Usage (iii)

Bridging Europe, Africa and the Americas (BEAA):

- A collaboration of R&E networks in Europe, Africa and the Americas to provide mutual back-up via diverse links in the Southern Atlantic

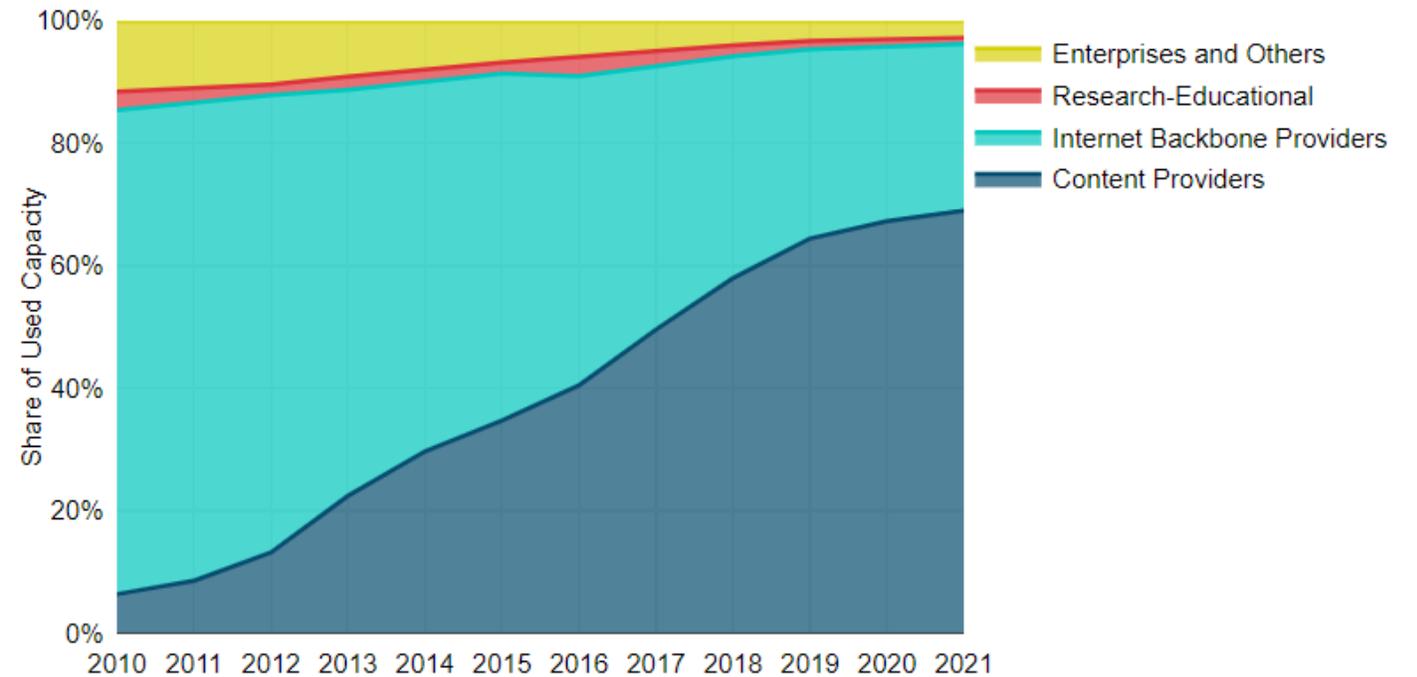


Size of the Cargo Hold

- Dominance of content providers changing the wholesale market, however.....
- R&E networks are big enough to make a splash

Continued demand fuelling investment

Used International Bandwidth by Source



Source: TeleGeography

[Download spreadsheet](#)

© 2022 TeleGeography

Shipping Forecast

- Aging submarine network estate fuelling replacement
- Silicone shortages
- Geopolitical concerns
- Security of supply



- Less populous routes/markets of interest emerging
- Carbon efficient computing
- Price erosion – regionalised
- New technologies: 400Gbps / spectrum

Setting Sail

Sustainability:
Distribution of capex/opex
EUR/Gbit acceptability and
lifetime efficacy

Network Topology:
Optimisation
Resilience
Traffic patterns
Gateways
Spectrum/capacity
Requiring upgrade

Other issues:
Existing contracts expiring
Requiring upgrade

Planning

International co-ordination:
Peer capability and capacity
Models for collaboration
Position on equity

User demands:
Background growth rates – 35%
Step-change use cases, e.g. ITER, LHC

Partner
collaboration &
user demand

Strategic Opportunities:
EU Global Gateway and role for GÉANT

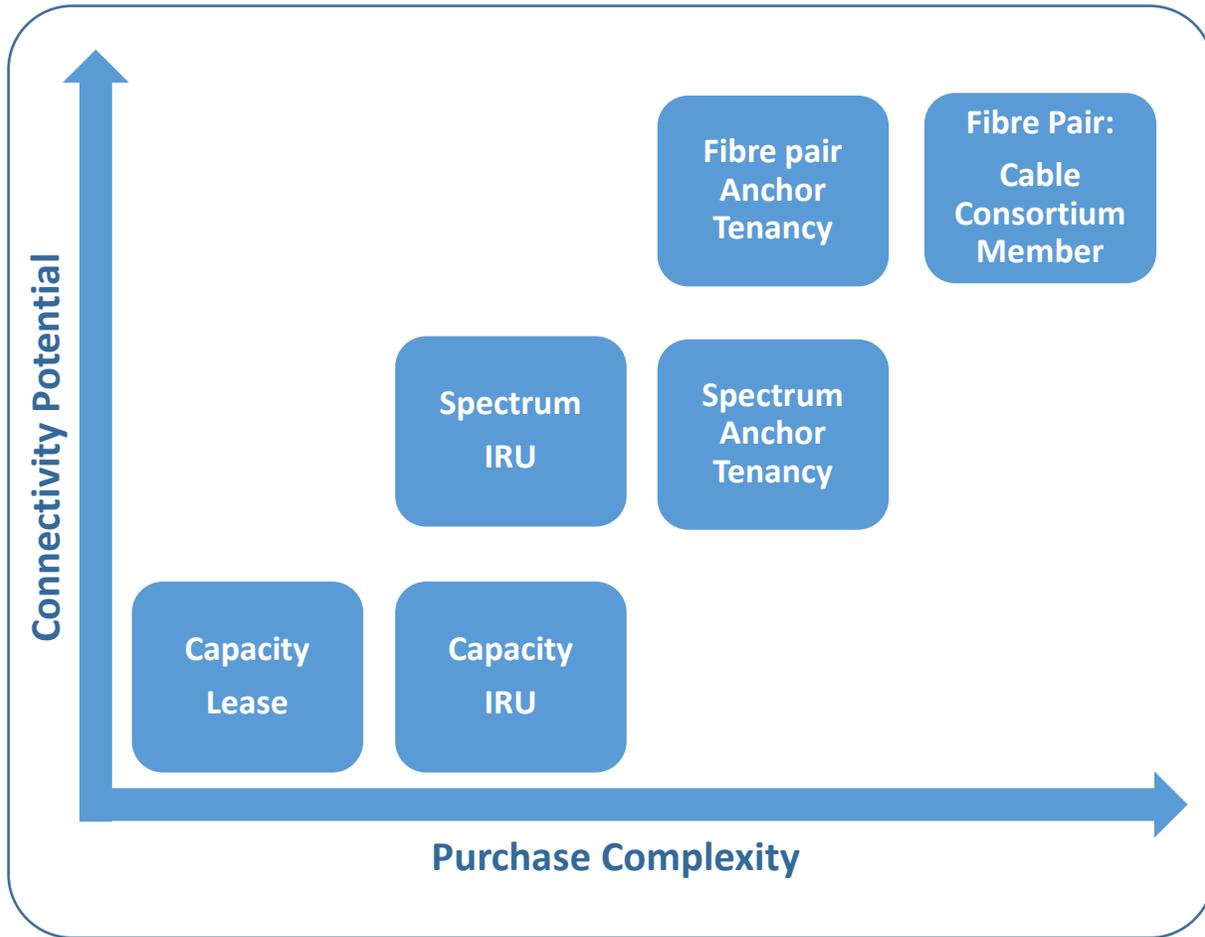
Market Engagement:
New routes
New services/pricing step change
Innovative commercial models

Market
engagement

Procurement/
Contracting

Implementation

Different Shapes and Sizes



#HorizonEU Funding for Intercontinental Connectivity

- GN5 Framework Partnership Agreement (FPA) signed
 - 7-year strategic framework for R&E networking projects
- GN5 IC1 (Intercontinental Connectivity) SGA (project) approved; signature process in progress.
 - **Funding:** 15M EUR
 - **Started:** 1 December 2022
 - **Duration:** 3 years
 - **Outcomes:** long-term connectivity to at least two continents and planning for further activities



Harnessing Cable Systems for Earth Observation



Existing and future submarine cables provide huge potential as seismic sensors

SUBMERSE project:

- Proof of concept:
 - Use of using existing telecommunication systems to monitor earth and oceans without disrupting telecoms traffic
- Funded by EU
- Started 1 May 2023
- Duration – 36 months

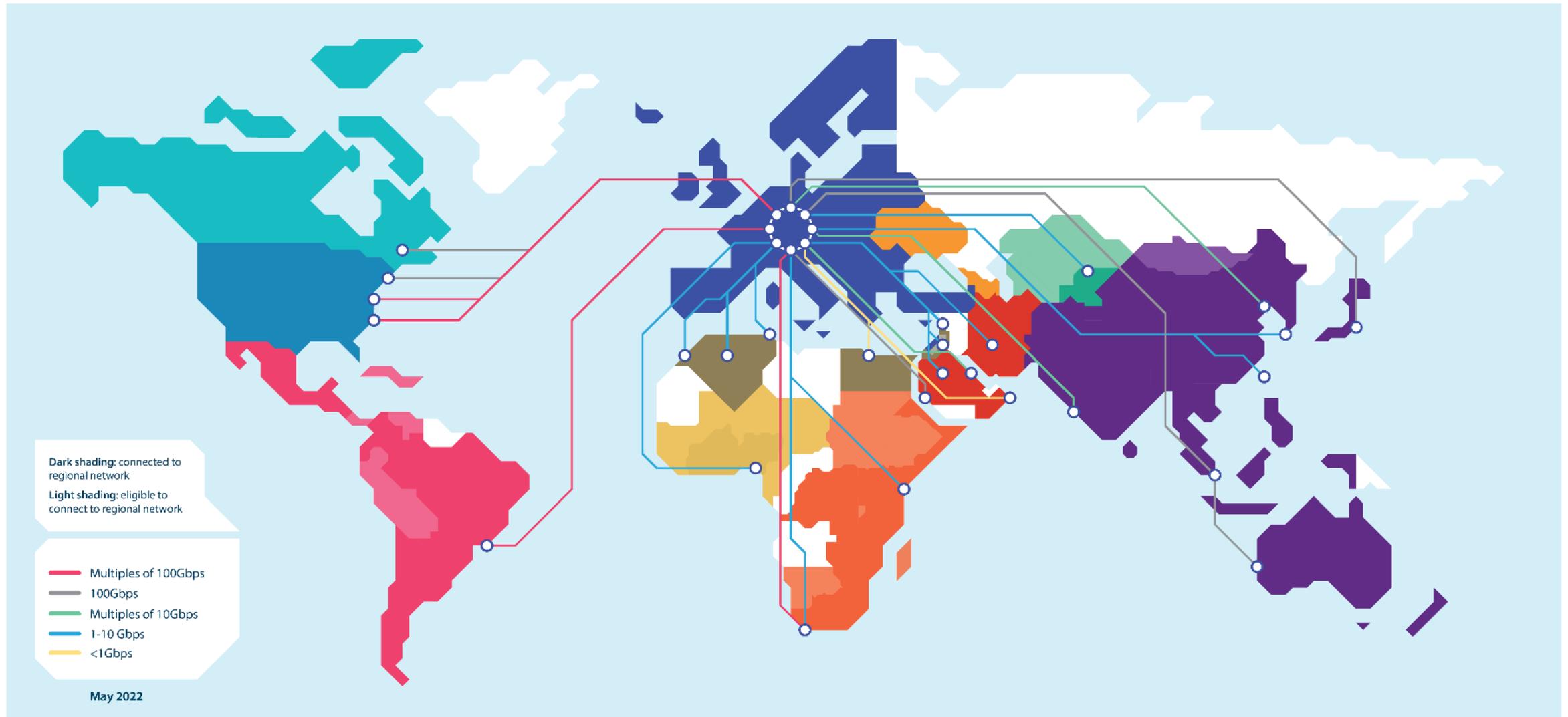




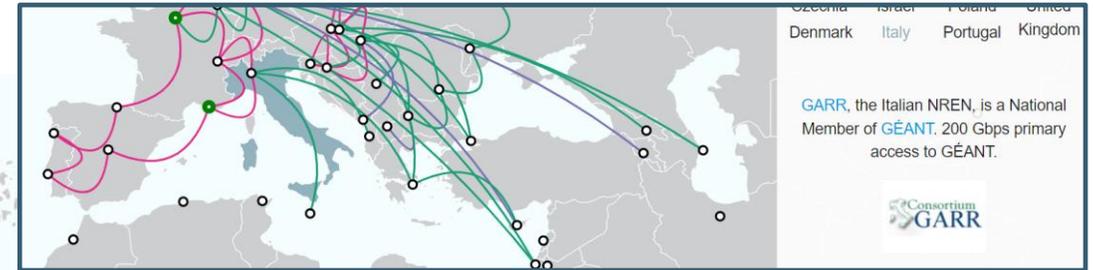
Charting the Waters



The Traditional Chart

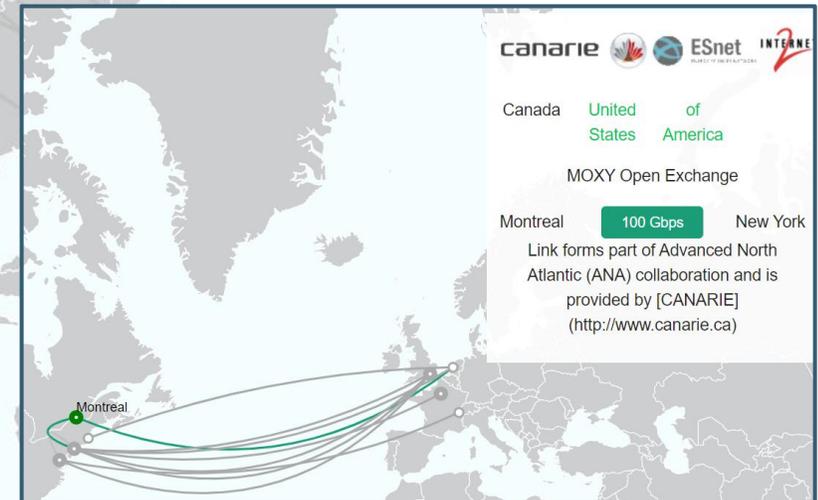


The GÉANT Interactive Chart



Paris 100 Gbps New York

Connects GÉANT to: [CANARIE](#); [ESnet](#); [Internet2](#); [SINET](#); [TWAREN](#) Link forms part of Advanced North Atlantic (ANA) collaboration and is provided by [GÉANT](#) and complements transatlantic connectivity provided by [ESnet](#) and the [Indiana University NEAAR Project](#)



<https://map.geant.org>

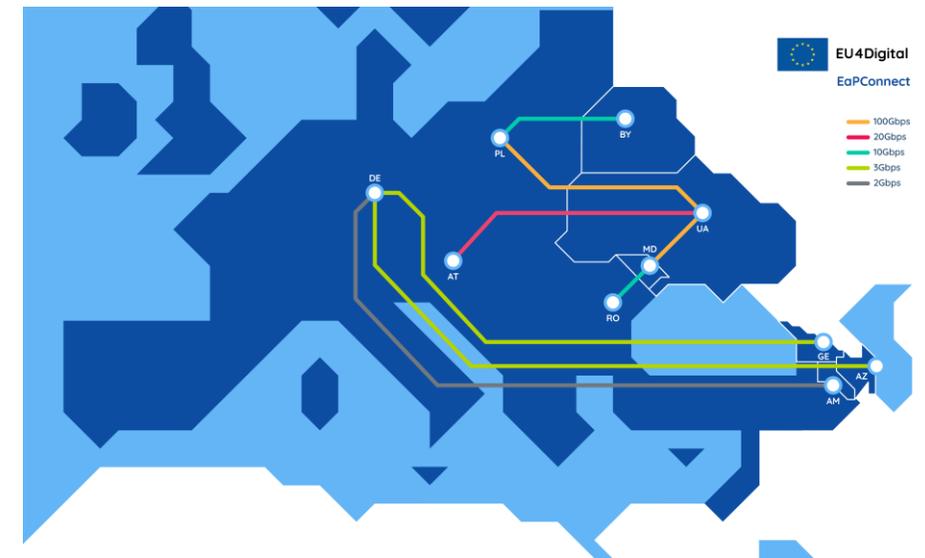


Addressing the Digital Divide

EaPConnect – Eastern Partnership Countries



Budget:	€10.5 Million 95% EU funding via DG NEAR
Duration:	60 months – July 2020 to July 2025
Website:	https://eapconnect.eu/
Coordinator:	GÉANT
Beneficiaries:	<ul style="list-style-type: none"> • IIAP NAS RA (Armenia) • AzScienceNet (Azerbaijan) • UIIP NASB / BASNET (Belarus) (until March 2022) • GRENA (Georgia) • RENAM (Moldova) • URAN (Ukraine)
Associate Partners	<ul style="list-style-type: none"> • DFN; GARR; GRNET; RoEduNet; LITNET; PSNC
Previous Phase:	€13M (95% EU funding) July 2015 until February 2021 (extension)



Central Asia



GEANT Connects To:	<ul style="list-style-type: none"> • CAREN CC - https://www.redclara.net/ <ul style="list-style-type: none"> • Central Asian R&E Network • CAREN CC connects: <ul style="list-style-type: none"> • KRENA (Kyrgyzstan) • TARENA (Tajikistan)
EU-funded projects	<ul style="list-style-type: none"> • Previous: CAREN Central Asia <ul style="list-style-type: none"> • 3 phases, 2010-2019
eduroam	<ul style="list-style-type: none"> • Kazakhstan; Kyrgyzstan; Tajikistan
eduGAIN	<ul style="list-style-type: none"> • Kyrgyzstan



Latin America



GÉANT Connects To:	<ul style="list-style-type: none"> • RedCLARA - https://www.redclara.net/ <ul style="list-style-type: none"> • Latin American Research and Education Network • 10 NREN members across the region; other countries across the regional eligible to join RedCLARA
EU-funded projects	<ul style="list-style-type: none"> • BELLA-T • Previous Projects <ul style="list-style-type: none"> • BELLA-S (2016-2021) • ALICE & ALICE2 (2003-2012) • ELCIRA (2012-2014) • MAGIC (2015-2017)
Other Collaborations:	<ul style="list-style-type: none"> • BELLA Programme • BEAA (Bridging Europe, Africa and the Americas) collaboration
eduroam	<ul style="list-style-type: none"> • Argentina; Brazil; Chile; Colombia; Costa Rica; Ecuador, Mexico; Peru; Uruguay
eduGAIN	<ul style="list-style-type: none"> • Brazil; Chile; Colombia; Ecuador; Mexico



Asi@Connect – Asia-Pacific

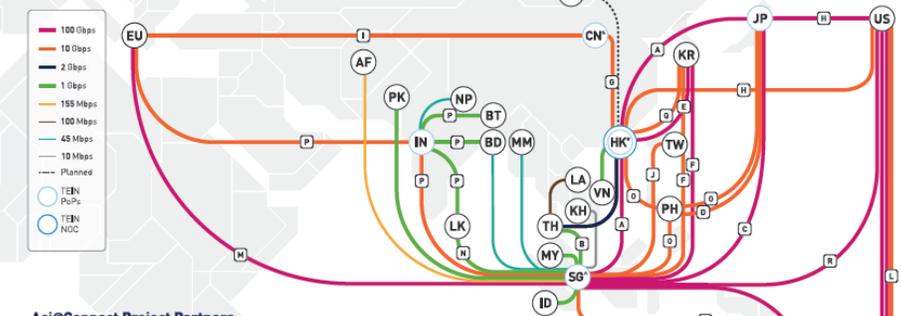


Fourth phase of EU funding phase for Asia-Pacific R&E networking

Objectives:

- Increase internet connectivity for R&E between Asia and Europe (GÉANT)
- Improve intra-regional connectivity across Asia-Pacific
- Support UN Sustainable Development Goals (SDGs) through improved access to education and research resources
- Promote international R&E collaboration between Asian and European partners
- Expand geographical coverage of the network to include other Asian countries
- Promote broadening of SDG-relevant user applications supported by the TEIN network, and increase the use of the TEIN network.
- Enhance human capacity of the Asi@Connect partners

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)
EU - University Grants Commission (BjREN)	MM - Mongolian Research and Education Network (ErdemNet)
IN - Department of Information Technology and Telecom (I2UAREN)	NP - University of Computer Studies Yangon (InmREN)
JP - Institute of Technology of Cambodia (CamREN)	PH - Nepal Research and Education Network (NREN)
KR - China Education and Research Network (CERNET)	RU - Research and Education Advanced Network NZ Ltd. (REANNZ)
US - % CERINET connected to TEIN CN PoP at 10 Gbps	SG - Pakistan Education and Research Network (PERN)
US - China Science and Technology Network (CSTNET)	TH - Advanced Science and Technology Institute (PREGINET)
US - The Hong Kong Academic and Research Network (HARNET)	US - Singapore Advanced Research & Education Network (SingAREN)
US - The Hong Kong Open Exchange (HKOO)	US - * SingAREN connected to TEIN SG PoP at 10 Gbps
US - # HARNET and HKOO connected to TEIN HK PoP at 10 Gbps	US - Lanka Education and Research Network (LEARN)
US - National Knowledge Network (NKN)	US - Academia Sinica Grid Computing (ASGC)
US - Institut Teknologi Bandung (IdREN)	US - Thailand Research Education Network Association (ThaiREN)
US - Ministry of Agriculture, Forestry and Fisheries Research Network (MAFFIN)	US - National Agency for Science and Technology Information (VinaREN)
US - National Institute of Information and Communications Technology (NICT)	
US - National Institute of Informatics (NII)	
US - National Information Society Agency (KOREN)	
US - Korea Institute of Science and Technology Information (KREONET)	

* As of June 2019. Ongoing updates
 ** Other regions (Central Asia, Africa and Latin America) can be connected via global R&E networks such as EU(GÉANT) and US(Internet2)

Africa has only 326.4 **researchers per million people**, while the European Union has 4069.2*



Africa is contributing to only 2% of the world's **research output****



Tech investment in Africa significantly trails investment in tech in other continents, i.e. Asia



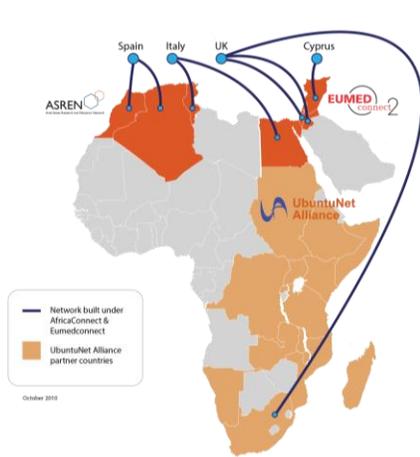
Internet penetration in Africa is behind other parts of the world (24.2% in Africa vs 48.4% in the rest of the world)*



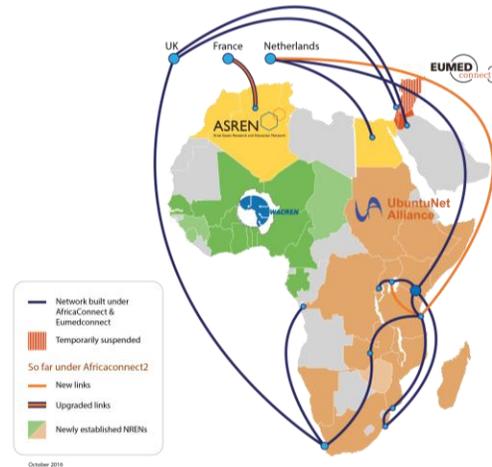
Access to reliable and affordable connectivity in Africa hinders students and researchers' potential



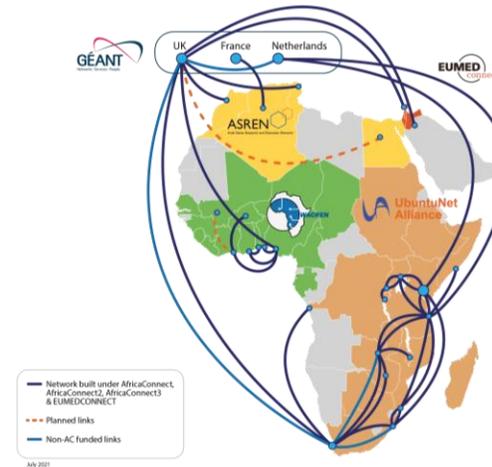
A Pan-African Network in the making



October 2010



October 2016



December 2021

22 out of 38 African NRENs connected



- Burundi, DRC, Kenya, Malawi, Mozambique, Rwanda, Somalia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.



- Ghana, Nigeria and Togo, Benin, Burkina Faso and Côte d'Ivoire.



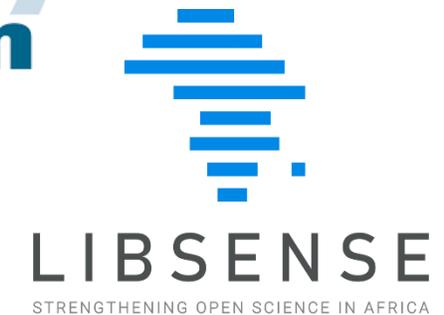
- Algeria, Egypt, Morocco and Tunisia.

Next Countries to be connected: **Mali and Ethiopia.**



Developing R&E Services

- Service outreach to science communities, deployment of R&E applications and access to repositories
- Trust and Identity for seamless access
- Proactive Cybersecurity for NRENs and their Digital Assets
- Federated Identity Management for Libraries



Scientific Use Cases in Africa



**Astronomical
collaborations
with South
Africa**



**Fishery Management
in Somalia**



**Remote Surgery
assistance in
Uganda**



**Food security in Kenya
Sequencing cassava virus
genomes**

.E THE FIELD

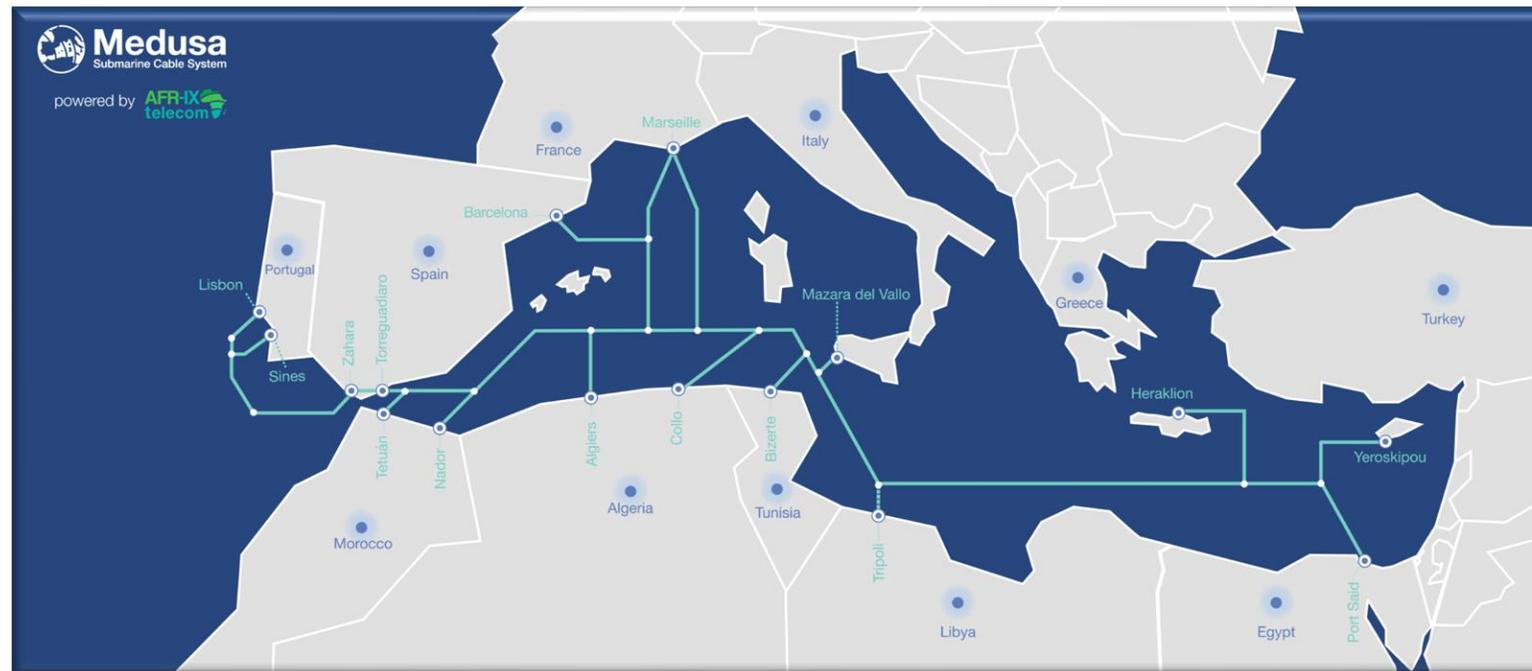
<https://www.inthefieldstories.net>

NRENs contribute to the United Nations Sustainable Development Goals



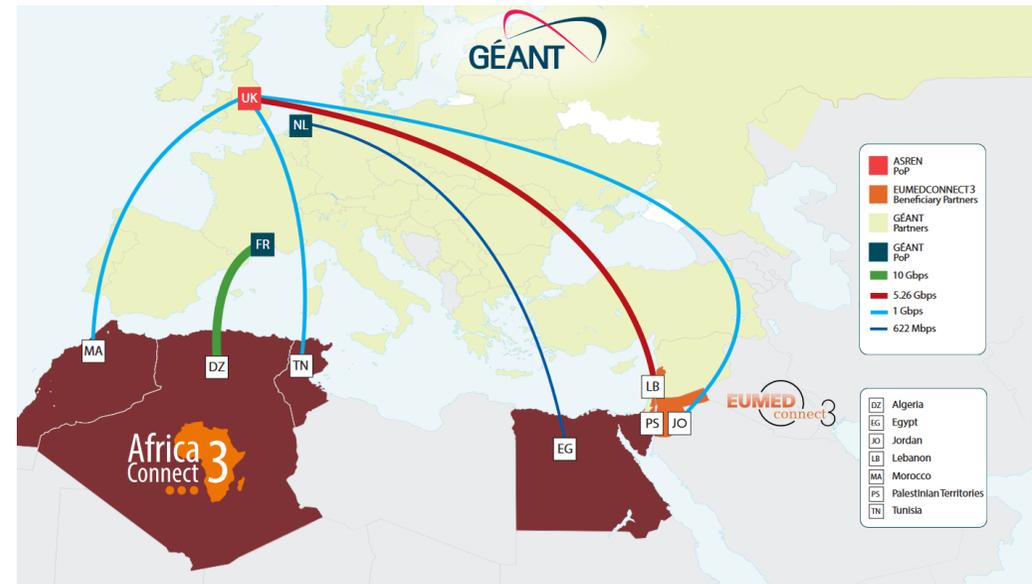
EU-Mediterranean: 1st EU Global Gateway for R&E Networking

200 Gbps end-to-end international connectivity:
Algeria, Egypt, Morocco, Tunisia



Additional EU-funding support for Neighbourhood South

- Discussions underway on project proposal for Neighbourhood South (North Africa & Eastern Mediterranean countries) – EUMED+
 - To support NRENs and ASREN in North Africa in preparations for delivery of Medusa connectivity
 - Support NRENs in the region, including Eastern Mediterranean, where EU funding stopped in December 2021
-
- Expected duration: 4 years
 - To Start 1 January 2024





Wash-up

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As part of the GÉANT 2020 Framework Partnership Agreement (FPA), the project receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856726 (GN4-3).

Set to Sail & Explore



- Delivery of intercontinental connectivity evolving;
- GÉANT aims ensure long-term security of supply;
- Funding mechanisms in place;
- Collaboration across the globe will be crucial:
 - Information-sharing;
 - Planning;
 - Infrastructure delivery;
- Commitment to reducing digital divide remains strong;
- New discoveries await us!



Time to lower the anchor!

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