

# Developments in R&E networking in South America and the South Atlantic Ocean

Americas' Research Platform (AmRP) Working Group Meeting  
San Diego-CA, 17th September 2019

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# Agenda



Development of high-capacity optical networking in South America has developed strongly in recent years.

Our objective is to show how this capacity is being built by advanced R&E networks in this part of the world.

- Brazil terrestrial infrastructure – 100G backbone
- New submarine cables in the South Atlantic
- International collaborations in the South Atlantic:
  - US-Brazil-South Africa
  - Europe–South America
- International Development Collaborations

# Brazil terrestrial infrastructure – 100G backbone

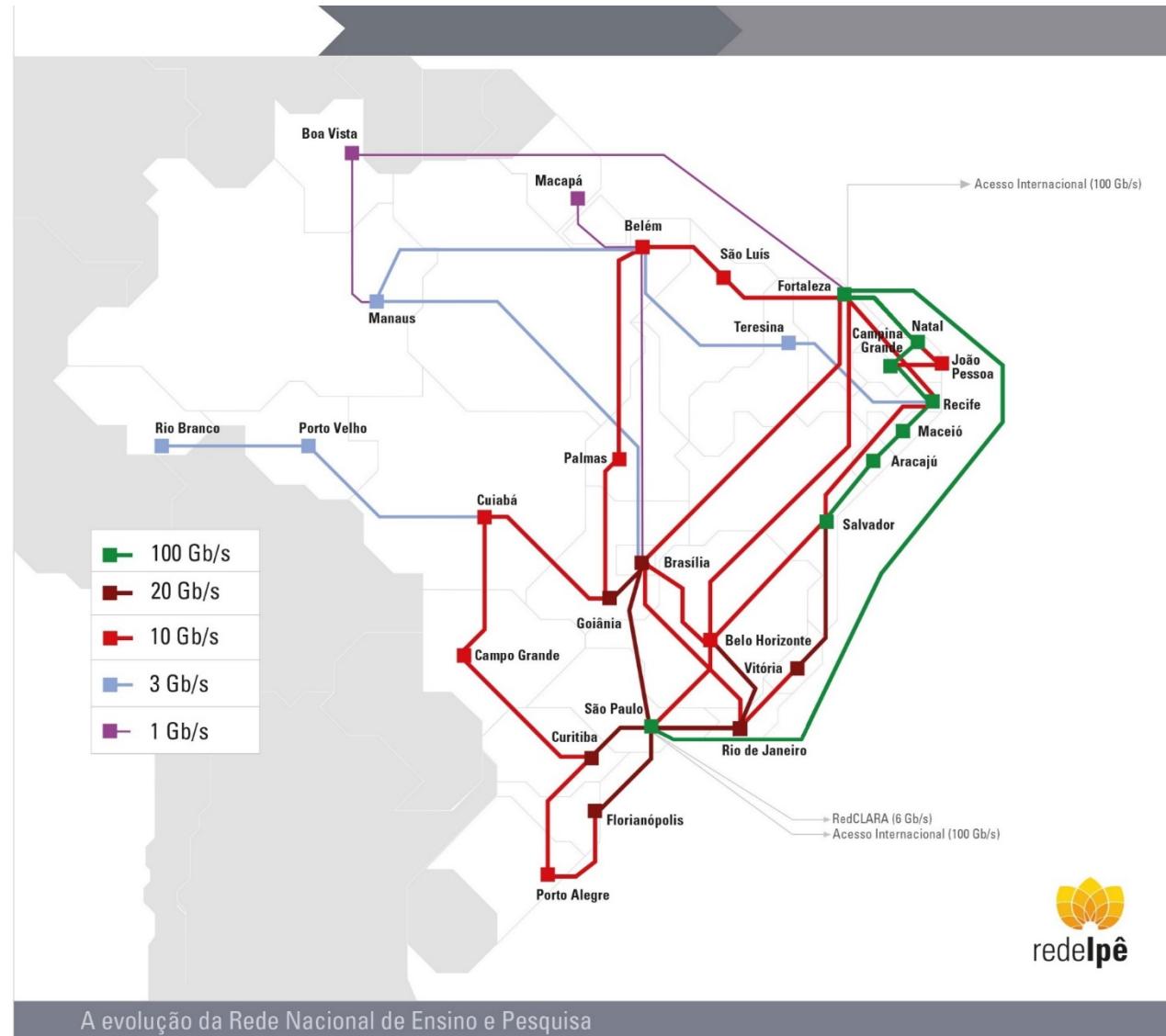


- In 2011, RNP completed its (mainly 10G) national backbone, reaching most of its 26 states and the federal capital in the process.
- In recent years, the 3 remaining states (north of the Amazon River) have also been connected by FO links, so that all state capitals are now reachable by broadband connections
- Since 2016, a new process is being carried out to upgrade the national backbone, involving agreements with electrical power-generating companies with FO assets, jointly to light these up with 100G technology and to share the resulting capacity.
- This process began in 2018, and is expected to be concluded by 2020. It involves the major government-owned companies: **Chesf**, **Furnas** and **Eletrosul**, as well as **Taes**a, a large non-governmental electric power transmission company,

# Current RNP backbone 2019



- **Multigigabit**
- **100% optical fibre**
- **A Point of Presence (PoP) in each capital (26 states and federal capital)**
- **First 100G circuits in 2018 in NE Brazil (using Chesf infra)**
  - Recife – Campina Grande
  - Campina Grande – Natal
- **100G route Fortaleza-Salvador (July, 2019)**

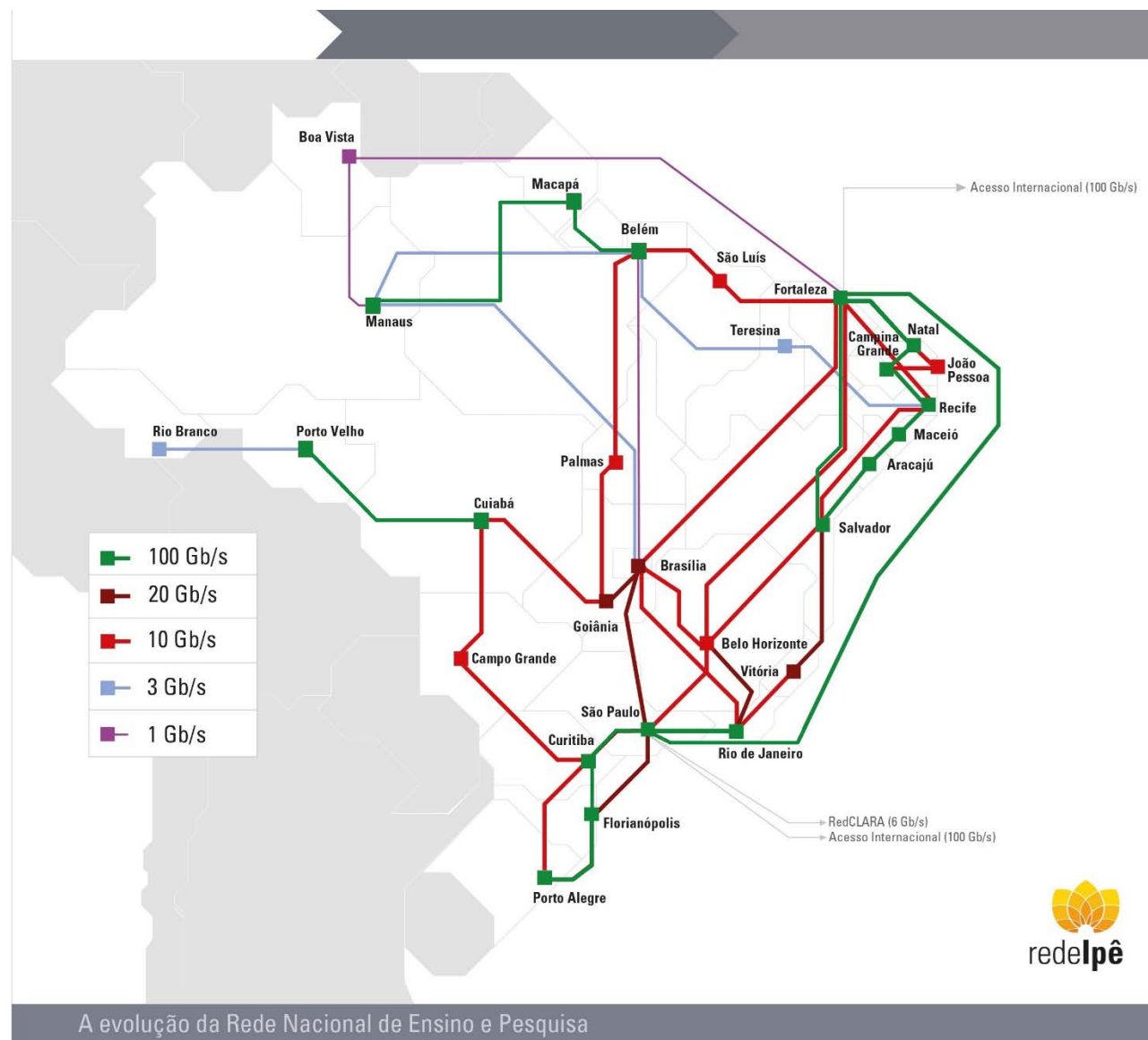


# Future backbone by late 2019/early 2020



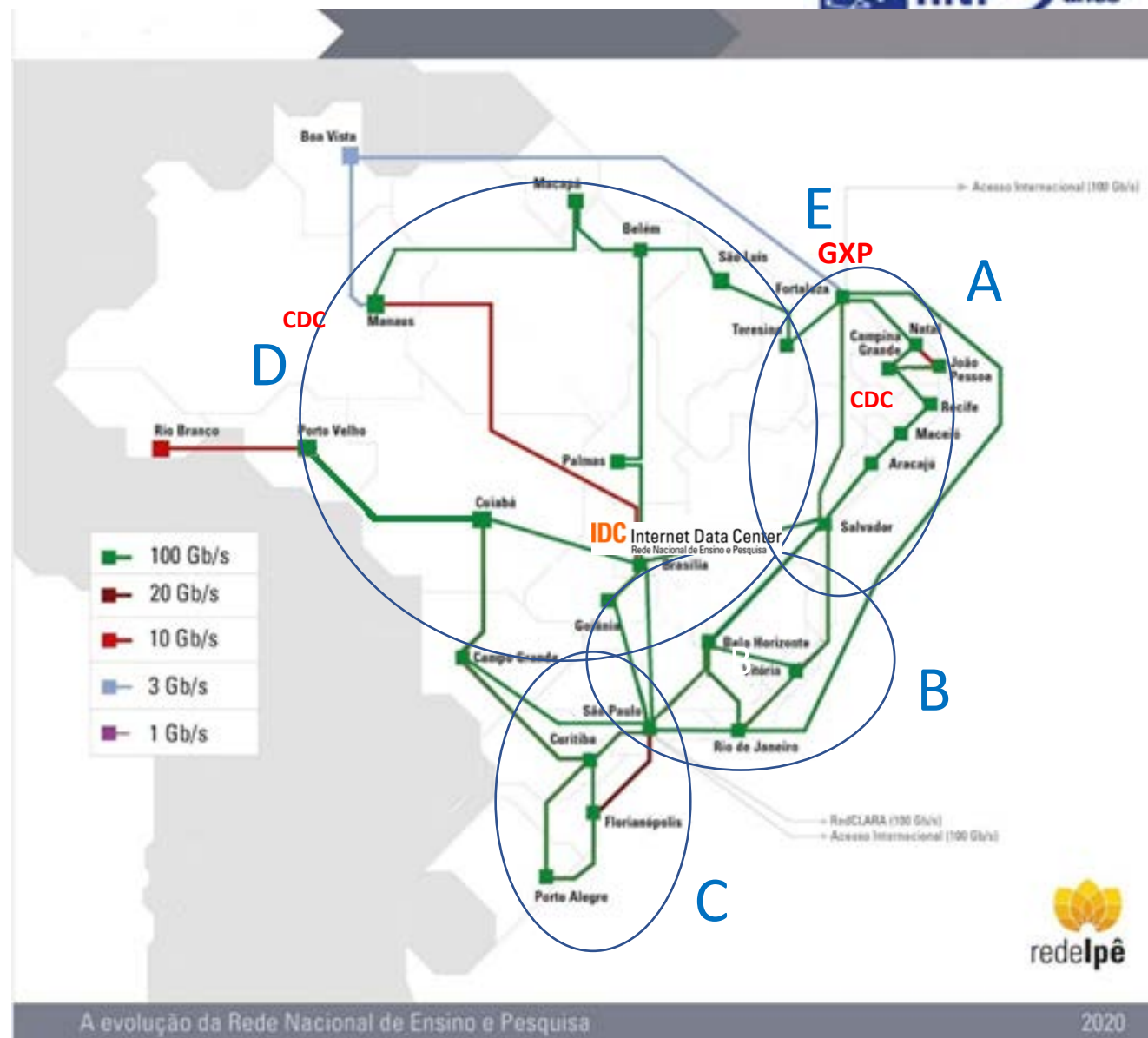
- **Activated:**

- Chesf: Phase I
- Furnas: Rio – S Paulo – Campinas
- Eletrosul: Curitiba – Florianópolis – Porto Alegre
- Telebras: Belém – Macapá – Manaus
- Telebras: Cuiabá – Porto Velho



# Backbone 2021 - Partners

- A** North East:  
CHESF (contracted in 09/2016)
- B** South East & Centre West:  
Furnas (contracted in 11/2017)
- C** South & Centre West :  
Furnas  
Eletrosul (contracted in 01/2018)  
Regional providers (swap)
- D** North & Centre West  
Telebras (contracted in 02/2019)  
Regional providers (swap)
- E** Global Exchange Point (GXP) in Fortaleza  
Angola Cables DC (contracted 08/2018)

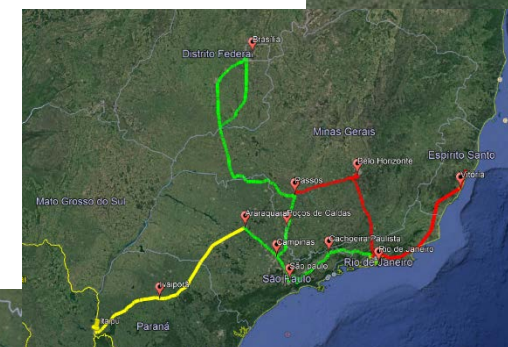
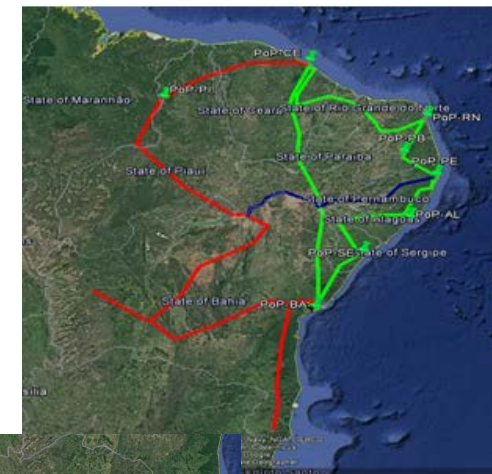




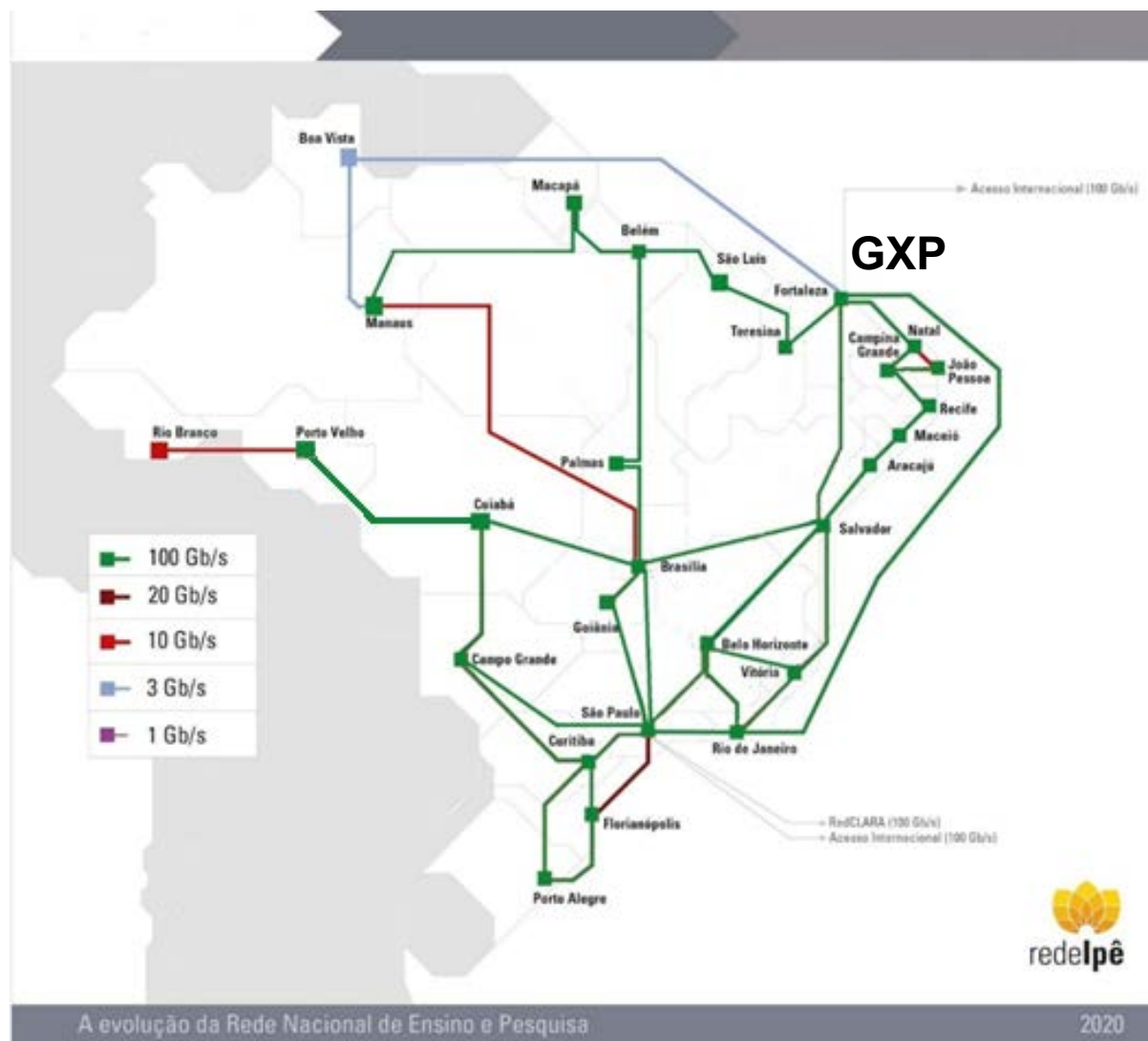
# Sharing the backbone built with the power companies (Chesf, Furnas, Eletrosul)



- **With regional providers and states (State Information Highways Infovias)**
  - States of Amapá, Bahia, Ceará, Mato Grosso, Pernambuco, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, ...
- **Along primary routes (directly linking capital cities)**
  - Possibility of swapping optical channels to obtain "interesting routes", through a tender process, mainly in the North, Centre West and between regions
- **Along secondary routes (within one or more states )**
  - Possibility of a joint build or swap of optical channels in Exchange for routes of interest, through a tender process, mainly in the Northeast, North and Centre West
- **Multiple optical channels available along all routes**



# Backbone in 2021 & international links



## International Exchange Points (GXP):

AMPATH: Miami, FL, USA

SAX: Fortaleza, CE, Brazil

SOL: São Paulo, SP, Brazil



# International infrastructure: RNP's collaborations



- North America:
  - Since 2001, enduring collaboration with Florida International University (FIU) in Miami, FL, USA
    - 2001: Global Crossing provision for 3 year 45M access to Miami
    - 2005: 1<sup>st</sup> IRNC award: with FIU and ANSP (S. Paulo state network) (10G in 2009)
    - 2010: 2<sup>nd</sup> IRNC award: with FIU and ANSP (multiple redundancies – 4x 10G)
    - 2015: 3<sup>rd</sup> IRNC award: with FIU and ANSP (100G)
    - 2016: LSST (Large Synoptic Survey Telescope in Chile) (access to spectrum)
- Europe:
  - 2003: ALICE project: build RedClara network in Latin America
  - 2008: ALICE2 project: expand and professionalise
  - 2016: BELLA project: create robust long-term infrastructure
- Africa:
  - 2017: AarcLight project (NSF), with FIU: collaboration US-Brazil-Africa

# South Atlantic cables reaching Fortaleza or Cape Town



## USA-Brazil

- **America Movil (AMX-1)**: Fortaleza, BR - Jacksonville and Hollywood, FL. **Operational**
- **Monet**: Boca Raton, FL - Fortaleza, BR. **Operational**

## USA-Brazil-Africa

- **South Atlantic Express (SAEx1)**: Virginia Beach, VA - Cape Town, SA, **RFS 2021 Q1**

## Brazil-Africa

- **South Atlantic Inter Link (SAIL)**: Fortaleza, BR - Kribi, Cameroon. **Operational**
- **South Atlantic Cable System (SACS)**: Fortaleza, BR - Sangano, Angola. **Operational**
- **South Africa-Brazil (SABR)**: Cape Town, SA - Recife, BR. **RFS 2019**

## Europe-Brazil

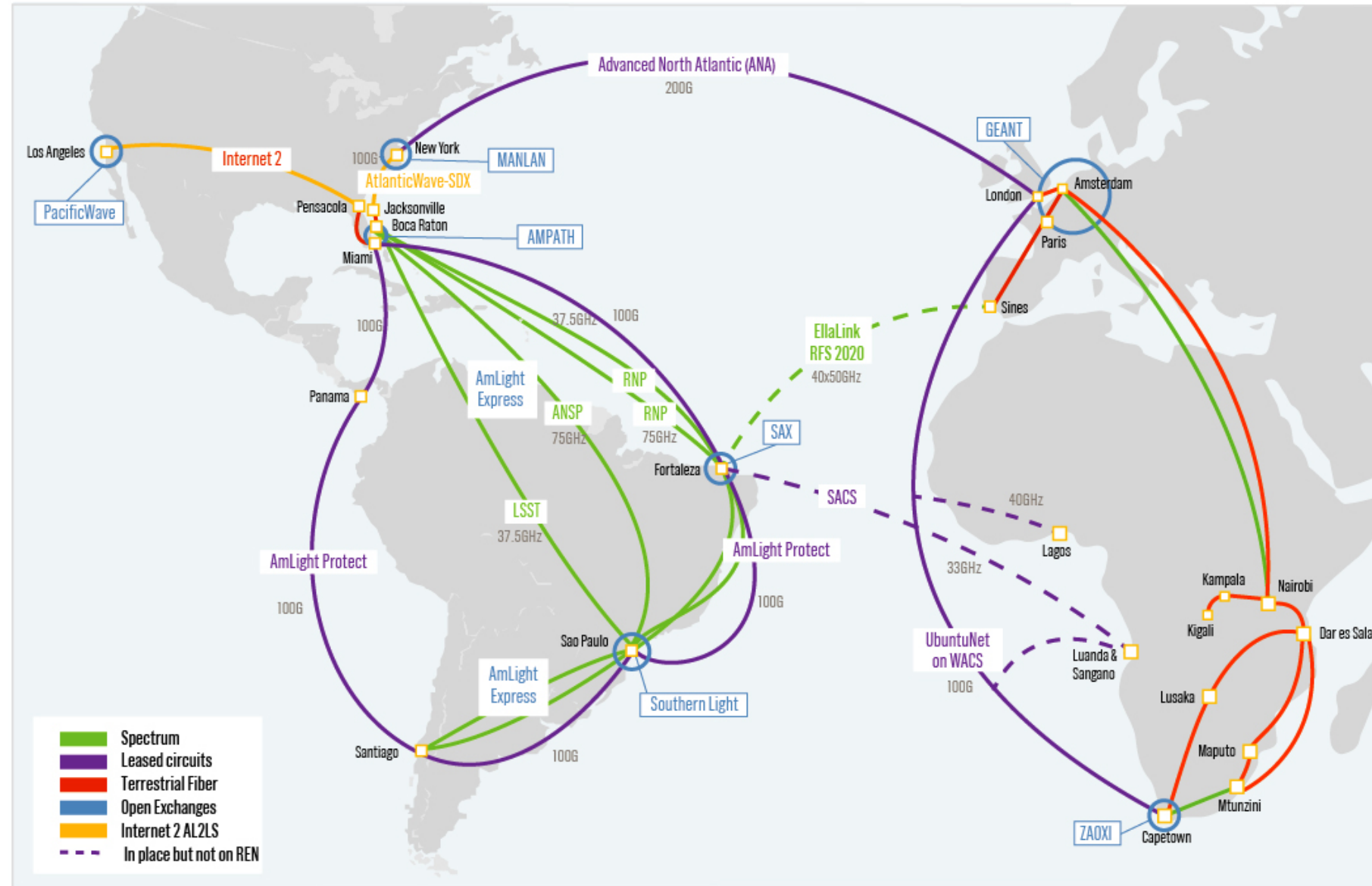
- **EllaLink**: Fortaleza, BR - Sines, Portugal. **RFS 2020**



# Benefits of interconnecting across the South Atlantic



- Until now, South America and Africa has been annexes, respectively, of the USA and Europe, and all traffic passes through them.
- With the use of the SACS cable, now there are alternatives

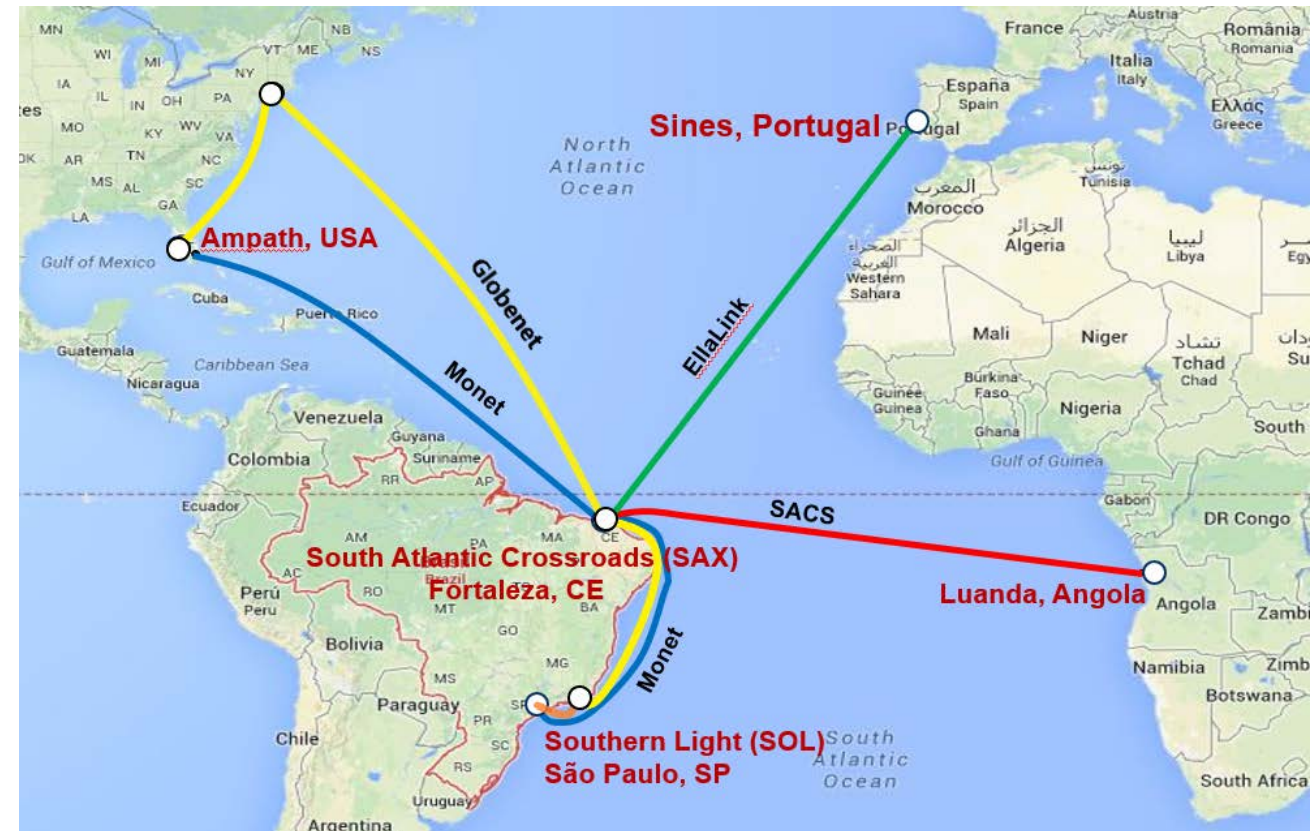




# RNP expectations for international links by 2021



- Brazil already has a GLIF GOLE/GXP in São Paulo, and this interconnects the N-S cables from the US used by R&E networks (Monet, SAC), the Brazilian R&E networks (ANSP, RNP) and the Regional R&E network (RedClara)
- To cater for this new international connectivity, RNP has begun to build a new GXP in Fortaleza, called SAX - South America eXchange (also referred to as South Atlantic Crossroads)
- SAX will initially interconnect the Monet and SACS cables, and will later be extended to others used by R&E network, especially EllaLink, part of the BELLA project to link S America and Europe from 2021.



- **RNP Global Exchange Point, SAX (South America eXchange), is been deployed in Fortaleza, CE, Northeast Brazil as a hub for multiple international connections in the region.**
- **Planned to be operational by the end of September 2019;**
- **Initial connections (ready to use):**
  - 100G to AMPATH (Monet - FIU at Miami)
  - 100G to SouthernLight (Monet - ANSP/RNP at SP)
- **Future connections (committed projects):**
  - 1H2020 - 100G to Angola (AARCLight project – SACS cable – SANREN/TENET)
  - 2H2021 - N x 100G to Portugal (BELLA-S project – Ellalink cable – GEANT/RedClara)
- **Equipment activation planned to finish in the next 2 weeks:**
  - Juniper MX10003 with 24x100G ports (MAC-SEC support)
  - Juniper SRX345 (firewall for out-of-band/management connections)
  - OpenGear console server
  - perfSONAR server (10G initially)



# International Development Collaborations



- **MEICAN**

- Development of MEICAN a frontend to AutoGOLE/NSI for interdomain circuit provisioning and operation
- Collaboration on GNA-G Mapping Visualization WG

- **MonIPE/perfSONAR**

- Migration from custom to stock perfSONAR components
- Dynamic loopback circuit testing
- 1 FTE allocated for improvements to perfSONAR
  - containers, virtualization, automation and resource allocation

- **Orchestration**

- Development of SOLO orchestrator for Software Defined Infrastructure
- Collaboration on GNA-G Virtualization and Orchestration WG

MEICAN

2

About

Help

Marcos

Sign out

Step 1: Path

Source

Destination

ampath.net

Network: ampath.net:2013

Port: fiu-ge

VLAN: 1779-1799

twaren.nchc.org

Network: twaren.nchc.org:2014

Port: ofport2

VLAN: 1779-1799

Next step

Domain: funet.fi

From here

Add waypoint

To here

sttwa.pacificwave.net

canarie.ca

ampath.net

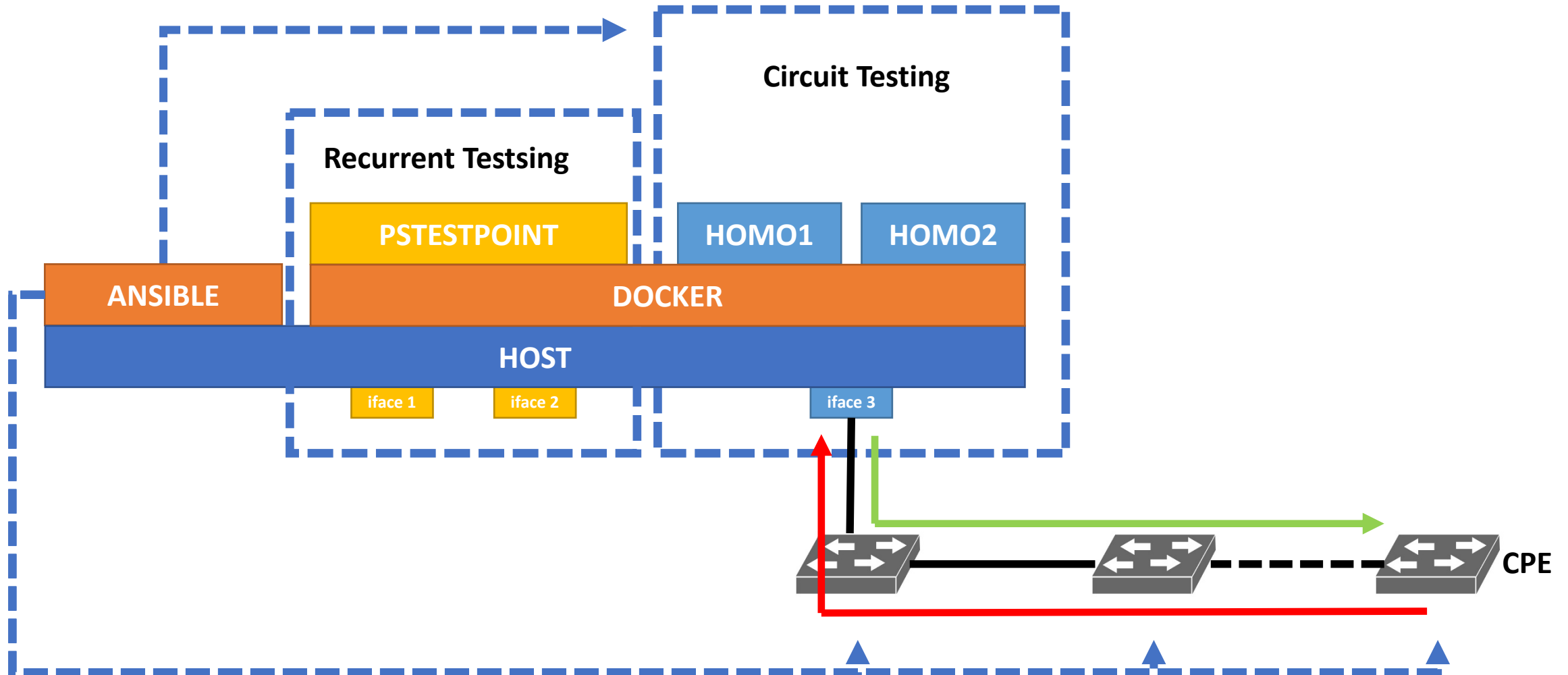
mad.ccs.nsi.geant.net

ham.ccs.nsi.geant.net

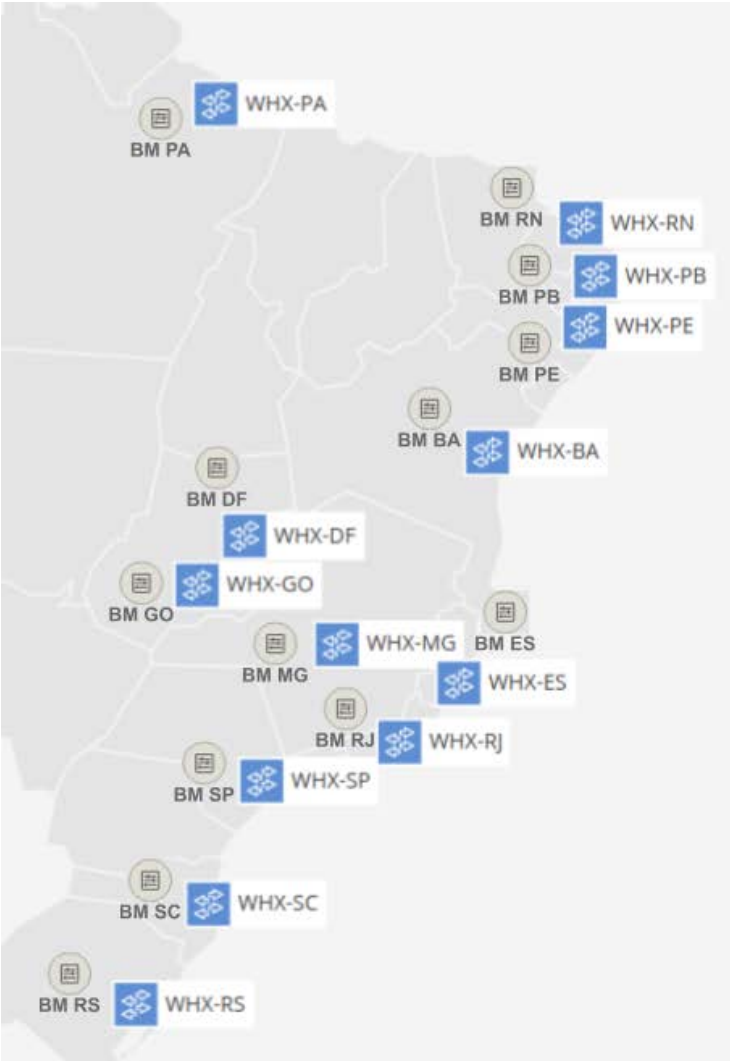
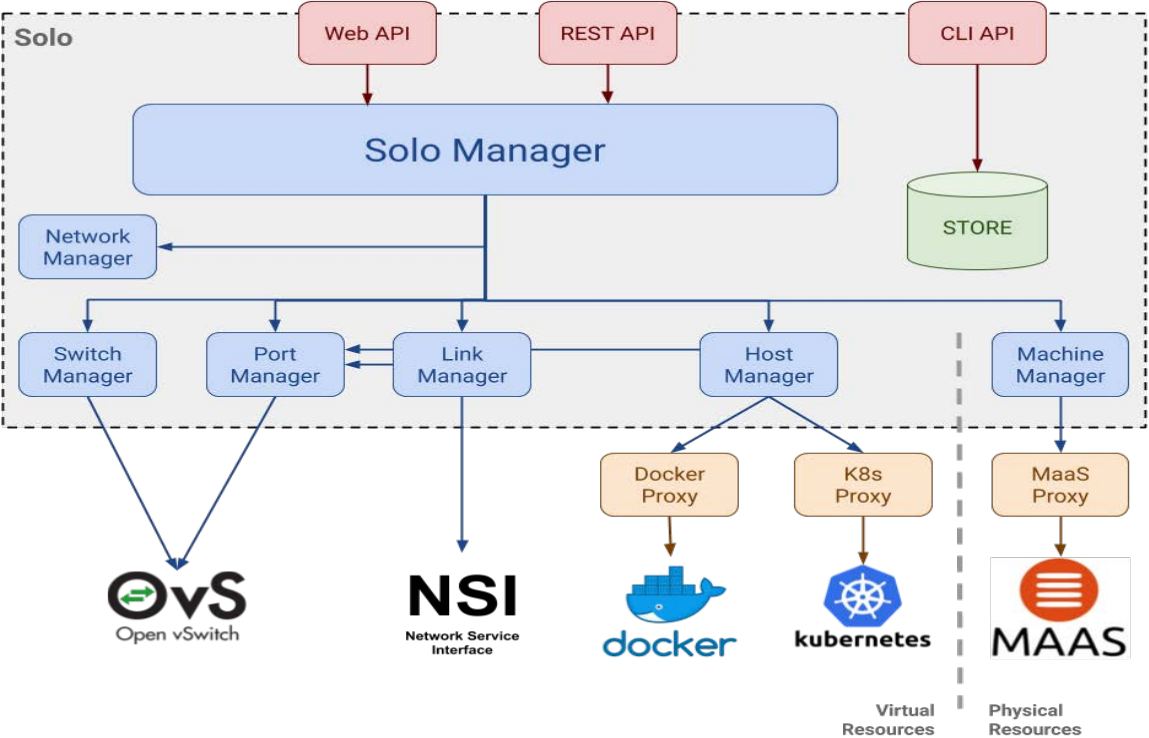
funet.fi

twaren.nchc.org

# Access circuit activation using dynamic loopback testing



# SOLO and Software Defined Infrastructure



**Thank you!**

**Questions?**

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# Agreements with the electrical power companies - Chesf, Furnas & Eletrosul (OPGW technology)

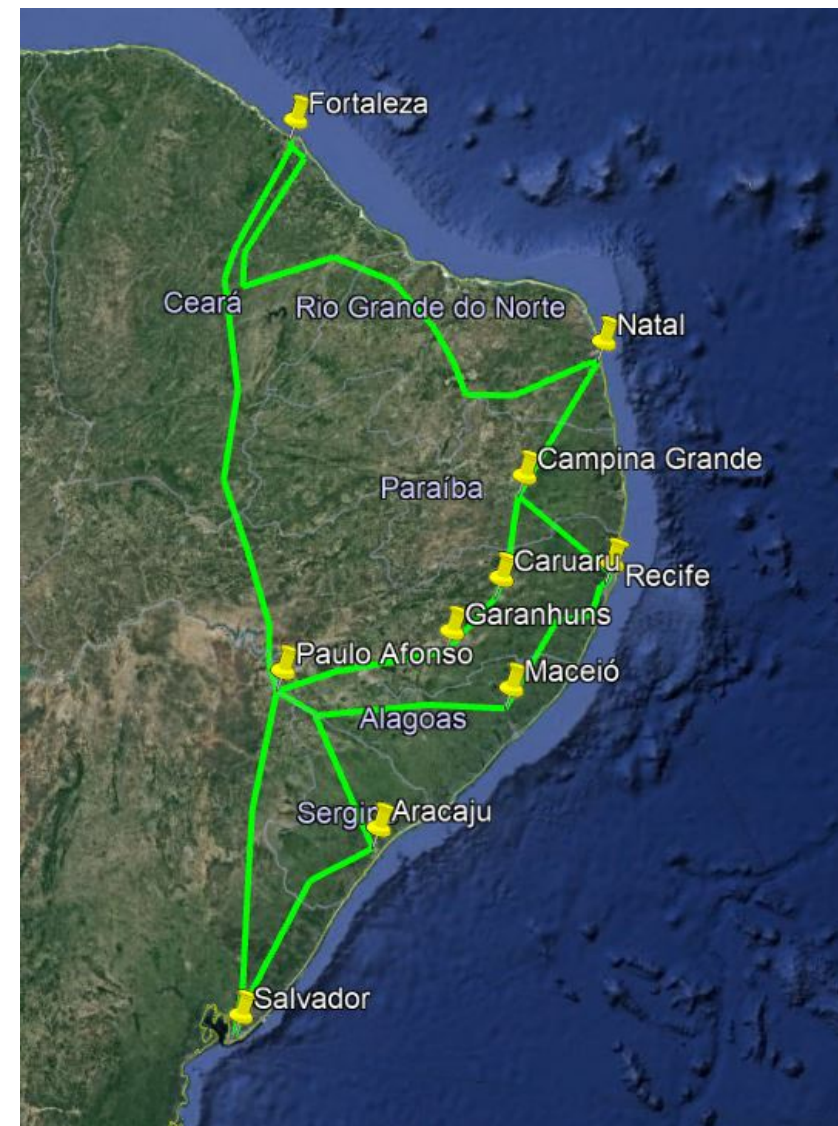
- Initially lit at 100G
- 20 optical channels, available on all routes



# Routes being installed on Chesf infrastructure



- **Phase I : green**
  - Begun in 08/2019





# Routes being installed on Furnas and Eletrosul infrastructure



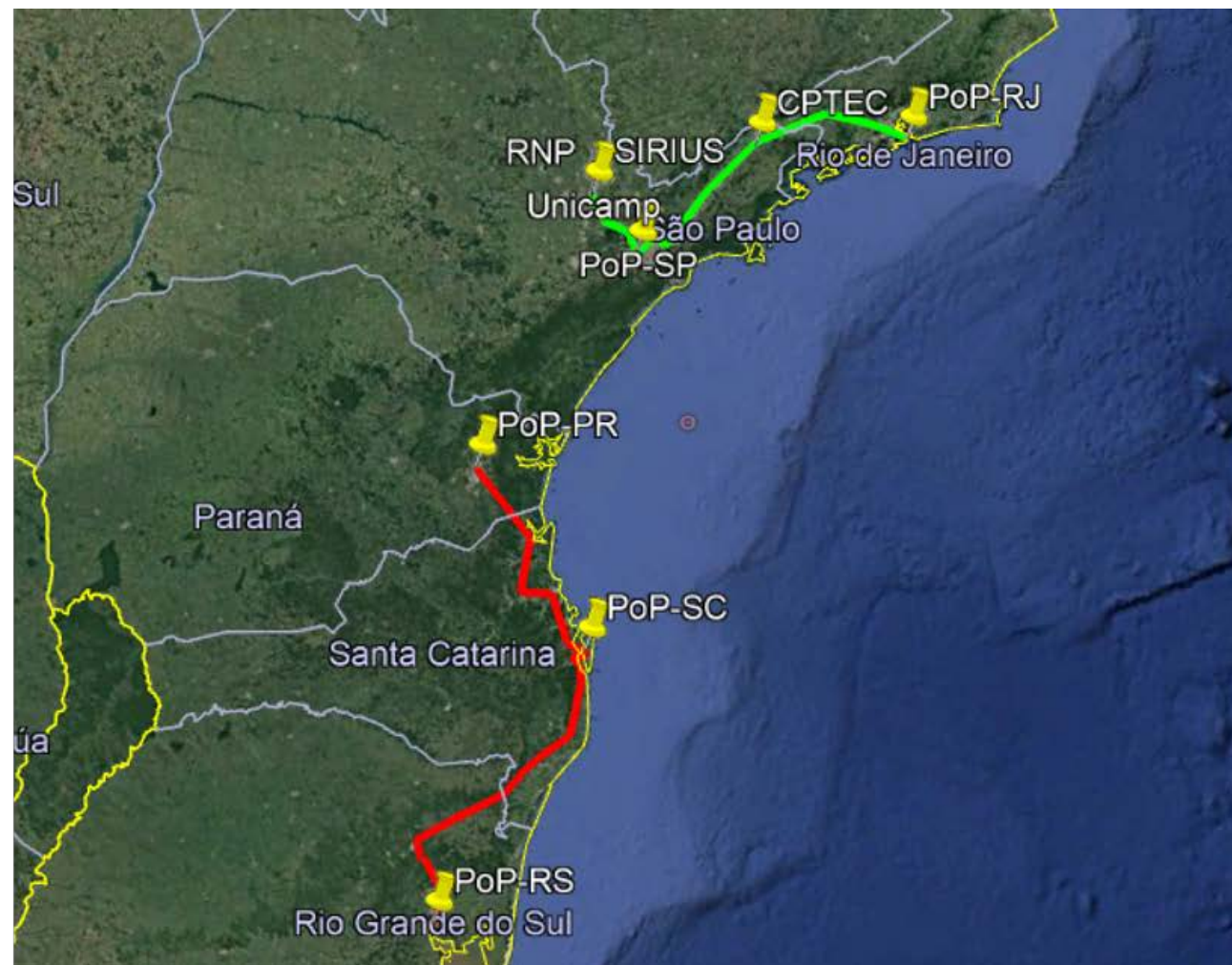
- **Furnas**

- Rio – S Paulo –  
Campinas (green)

- **Eletrosul**

- Curitiba – Florianópolis  
– Porto Alegre (red)

- **Expected completion  
date: end of 2019**



# Agreement with Taesa



- **Objective: to complement gaps and lack of redundancy in the coverage provided by the power companies network**
- **Expected operational: end 2020**
- **Initially lit up at 100G in partnership with provider**
- **Contract RNP –Taesa : agreed 05/2019**
  - At least 10 optical channels available on each route
- **Routes**
  - Camaçari (BA) – Serra da Mesa (GO)
  - Samambaia (DF) – Palmas (TO) – Colinas (TO)
  - Araraquara (SP) – Londrina (PR)

# Cables landing in Brazil and South Africa up to 2021

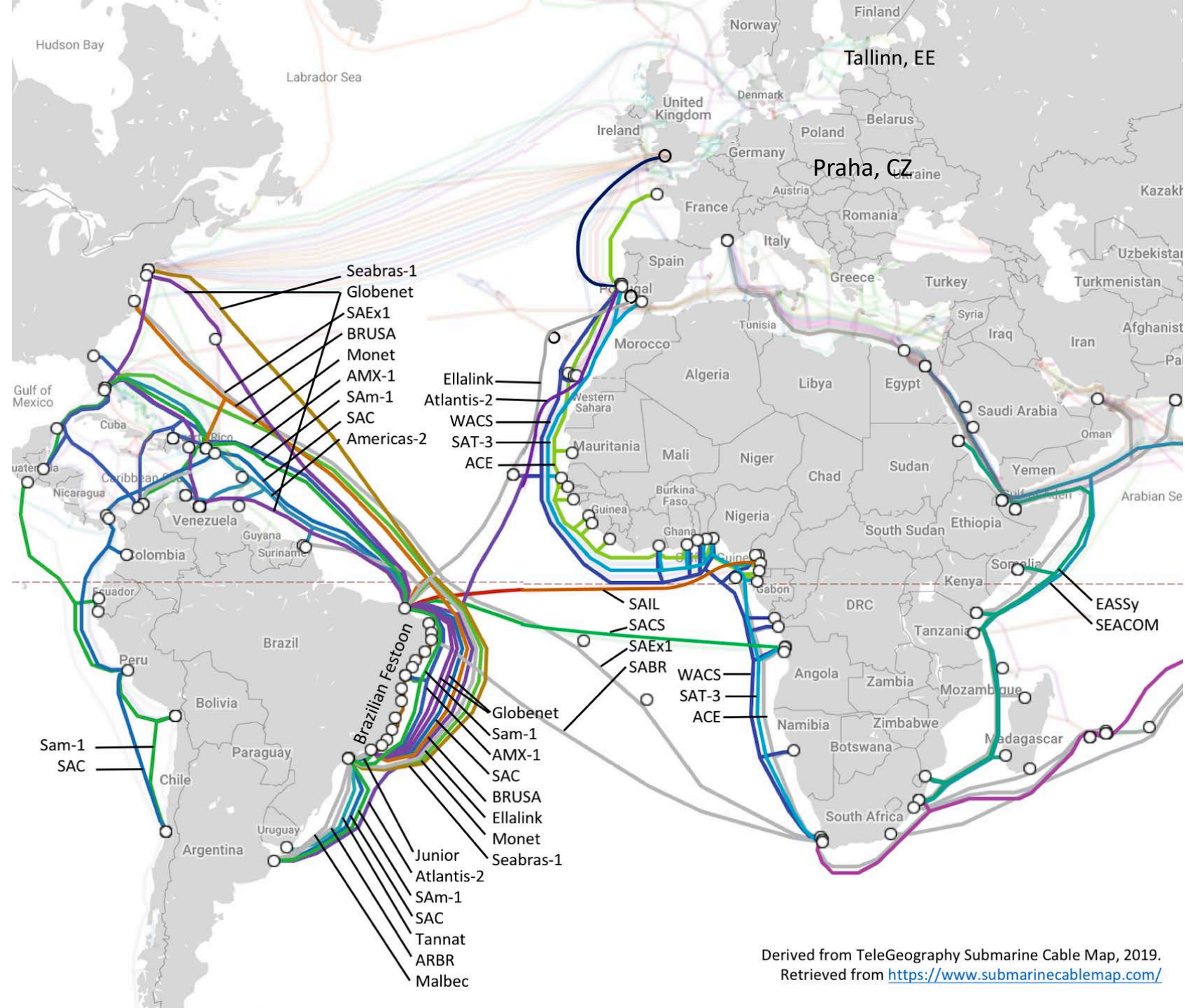
N & S America		Africa-Europe	
Name	Year	Name	Year
Americas-2	2000	SAT-3/WASC	2002
SAC	2000	SEACOM	2009
GlobeNet	2000	EASSy	2010
SAm-1	2001	WACS	2012
AMX-1	2014	ACE	2012
Monet	2017		
Seabras-1	2017		
BRUSA	2018		

## South America transatlantic

Name	Year
Atlantis-2	2000
SACS	2018
SAIL	2018
EllaLink	2020
SABR	2021
SAEx1	2021

## South America (internal)

Name	Year	N-S Cable extended
BR Festoon	1996	Americas-1/2
Tannat	2018	Monet (Google, Antel)
Junior	2018	Monet (Google)
Malbec	2020	GlobeNet
ARBR	2021	Seabras-1



Derived from TeleGeography Submarine Cable Map, 2019.  
Retrieved from <https://www.submarinecablemap.com/>



# The Evolution of Connectivity in the South Atlantic

We can identify 2 parts to the story:

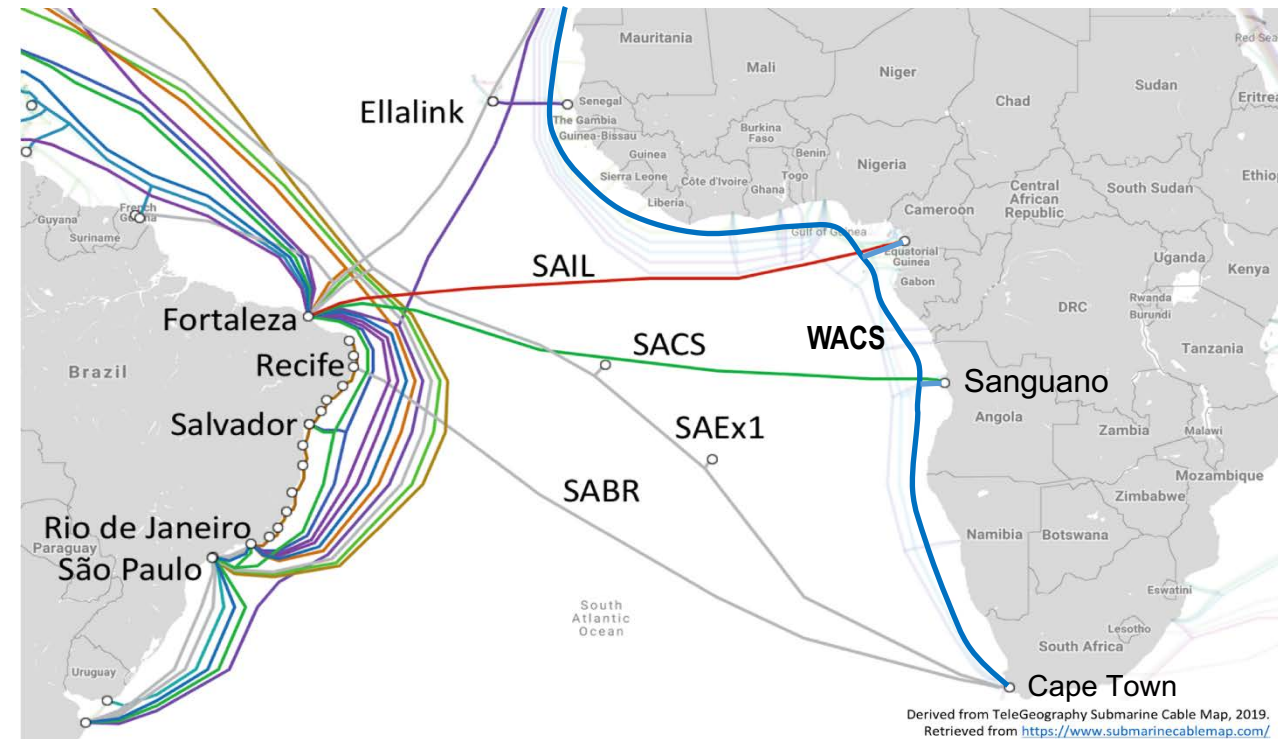
1. The development of separate cable systems around the continents on both sides of the South Atlantic: South America (SA) and Africa (AF)
2. The very recent deployment of transatlantic cables in the South Atlantic

It should be noted that 4 of the 5 new and future transatlantic cables land in Fortaleza (and the 5th in Recife), in NE Brazil.

Additionally, all except one of the 7 N. & S. American cables also land in Fortaleza

**Thus, with 10 cable landings Fortaleza is an excellent choice for interconnecting these cables**

Phase	Period	Cables	Connecting to	Bandwidth	Fortaleza?
<b>1 (SAm):</b> Only intra-Americas connections	2000-2001	SAC, GlobeNet, SAm1	N & S America (focus on Florida)	2.5 and 10G	Y
	2014	AMX-1		100G	Y
	2017	Seabras-1	N & S America	100G	N
	2017-2018	Monet, BRUSA		100G	Y
<b>1 (AF):</b> Africa - Europe	2010	EASSy	Africa - Europe (just N-S)	10G	n/a
	2012	WACS, ACE		10G	n/a
<b>2:</b> 100G	2017-2018	SAC, GlobeNet, WACS		upgrade 100G	
<b>3:</b> Also trans-Atlantic connections	2018	SACS, SAIL	Angola, Cameroon	100G	Y
	2020	EllaLink	Portugal	100G	Y
	2021	SABR	South Africa	100G	N
	2021	SAEx1	USA, South Africa	100G	Y



# NSF funding (LSST, Amlight, AarcLight)



- The US National Science Foundation (NSF) is funding the construction of this telescope in La Serena, Chile.
- RNP has an agreement to provide connectivity between São Paulo and Santiago (Chile) for LSST use. In return RNP and ANSP gain access until 2032 to several 37,5 GHz “slots” on the Monet cable from Florida to São Paulo, provided by the operator Angola Cables (AC).
- This connectivity is accessible in São Paulo and Fortaleza, where RNP is building a Global Exchange Point (GXP)

NSF is also funding the network infrastructure projects of FIU:

- Amlight Express and Protect, to connect to Brazil and Chile, providing redundant connectivity to South America
- Aarclight, to connect to Africa by means of the SACS cable between Fortaleza, Brazil, and Sanguano, Angola.
- Aarclight also permits connecting in Angola to the principal Sanren-Tenet connection between South Africa and Europe.
- This provides possible entirely new routes:
  - US-Brazil-Africa
  - South America-Africa-Europe

# Important consequences from Aarclight



- At TNC FIU and RNP presented, together with Tenet (South African NREN), a proposal to link the FIU and RNP to Tenet, making use of the SACS and WACS cables between Fortaleza, Sanguano and Cape Town.
- FIU has already obtained a long-term IRU for a single channel on SACS, and RNP will interconnect the resulting channel to Brazilian and other networks at the proposed SAX global exchange point (GXP) in Fortaleza
- It is expected that this new connection will be available before the end of 2019, and will be a game-changer for intercontinental networking due to improved connectivity.
- Video of the TNC session available at: <https://tnc19.geant.org/programme/#Wednesday>  
(Session 8A – Under the sea)

# RedCLARA – the Latin American R&E network

- Created in 2003, with support from EU
- 3 EU projects
  - ALICE 2003
  - ALICE2 2008
  - BELLA 2016
- Map shows current (pre-BELLA) membership and topology
- BELLA seeks to provide a long-term infrastructure for the region





# BELLA: a project to create long-term infrastructure connecting to and within Latin America



- BELLA, financed by the EU and Latin American NRENs, seeks to provide a sustainable long-term infrastructure to support R&E.
- It also seeks to provide a more efficient DIRECT link between Europe and South America.
- Two subprojects:
  - BELLA-S (submarine): procuring long-term access to spectrum on a direct cable to South America
  - Build a terrestrial network with access to spectrum to provide backhaul between the South American NRENs and the cable to Europe.
- Major drivers: Copernicus; ESO and ALMA observatories in Chile; LHC



[www.bella-programme.eu](http://www.bella-programme.eu)



BELLA is being implemented by a Consortium of the Regional Research and Education Networks of Europe (GEANT) and Latin America (RedCLARA) and the National Research and Education Networks (NRENs) of Brazil, Chile, Colombia, Ecuador, France, Germany, Italy, Portugal and Spain.

Funding for BELLA is provided by the European Union through three European Commission (EC) Directorates (DG-CONNECT, DG-DEVCO and DG-GROWTH) and by the Latin American NREN community.



# BELLA today

## BELLA-S:

- Large-scale spectrum (45x 37,5GHz) acquired on EllaLink cable, to be delivered by end 2020.

## BELLA-T:

- Use of own network structure by Brazil, Chile, Colombia, Ecuador
- Ongoing tender for 5 links (spectrum) for delivery in 2019

### BELLA-T links:

- A: Tulcan (EC)-Ipiates (CO)
- B: Barranquilla (CO) – Fortaleza (BR)
- C: Porto Alegre (BR) – Buenos Aires (AR)
- D: Buenos Aires (AR) – Santiago (CL)
- E: La Serena (CL) – Antofagasta (CL)

