# From Foundations to Frontiers
# GÉANT's Network Evolution


## Mian Usman
HEAD OF NETWORK EVOLUTION - GÉANT


e-INFRA CZ Conference- April 29th 2024

# GÉANT: European Membership Association

**38 European National Research and Education Networks (NRENs)**

**+ NORDUnet (5 Nordic NRENs)**

**Reach:**

**over 10,000 institutions and 50 million academic users**

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027

GN4 FPA – H2020 ~8 Years (~€225 Million)

GN5 FPA (7 Years)

GN4-1 (1 Year €25 Million)

GN4-2 (2.5 Years €59 Million)

GN4-3 (4 Years €77.5 Million)

GN5-1 (2 Years €55 Million)

GN4-3N (5 Years €50.5 Million)

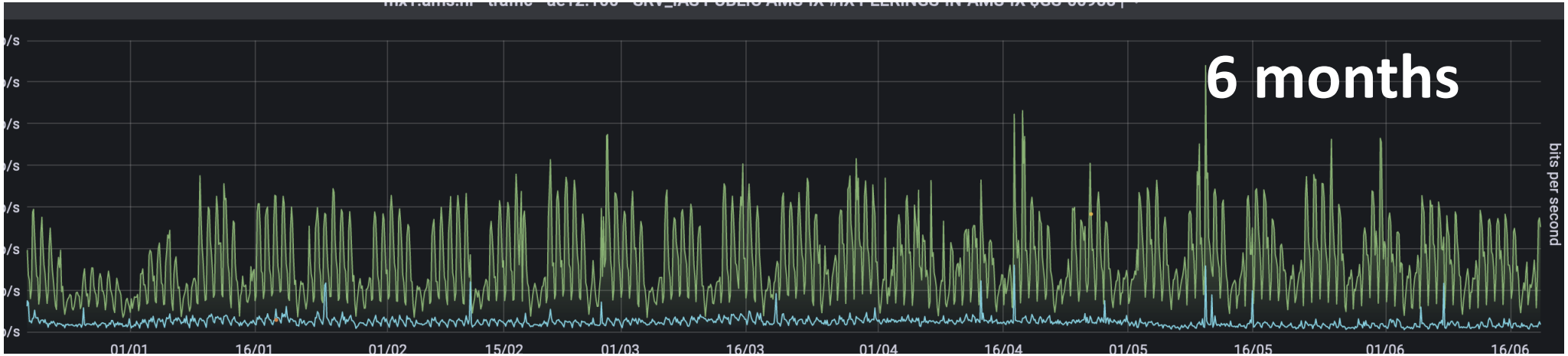
BELLA-S1 (5 Years €10 Million)

GN5-IC1 (3 Years €15 Million)

EuroHPC, Quantum, etc.

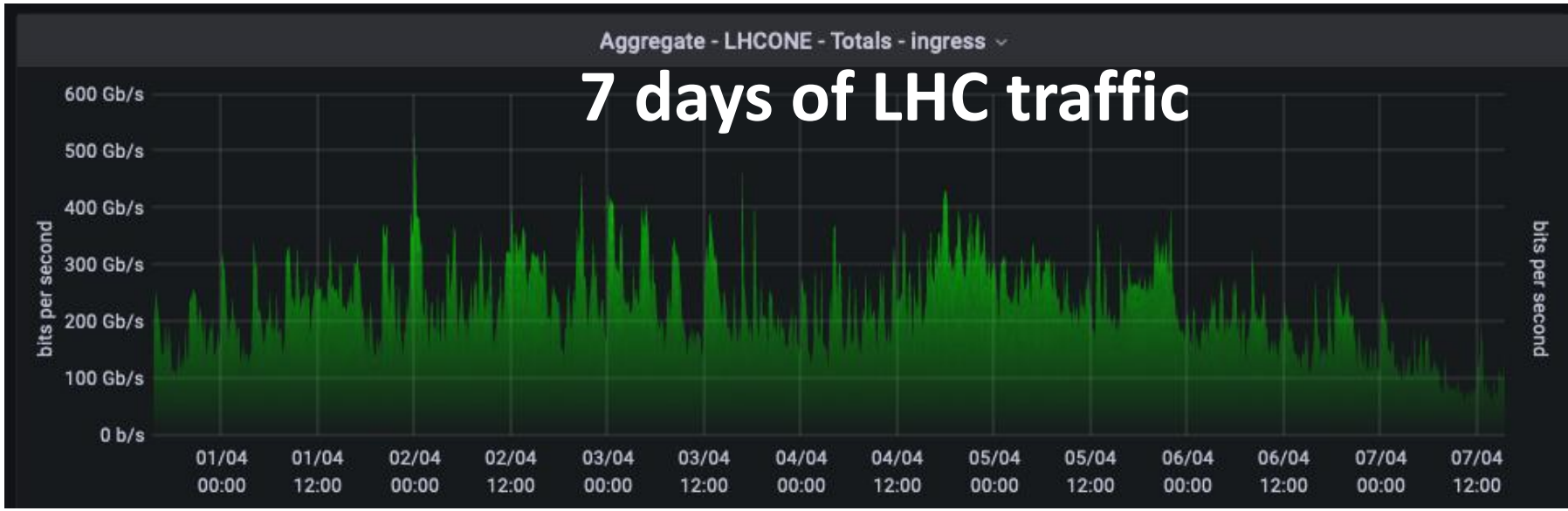
# The Foundation
# Network Infrastructure

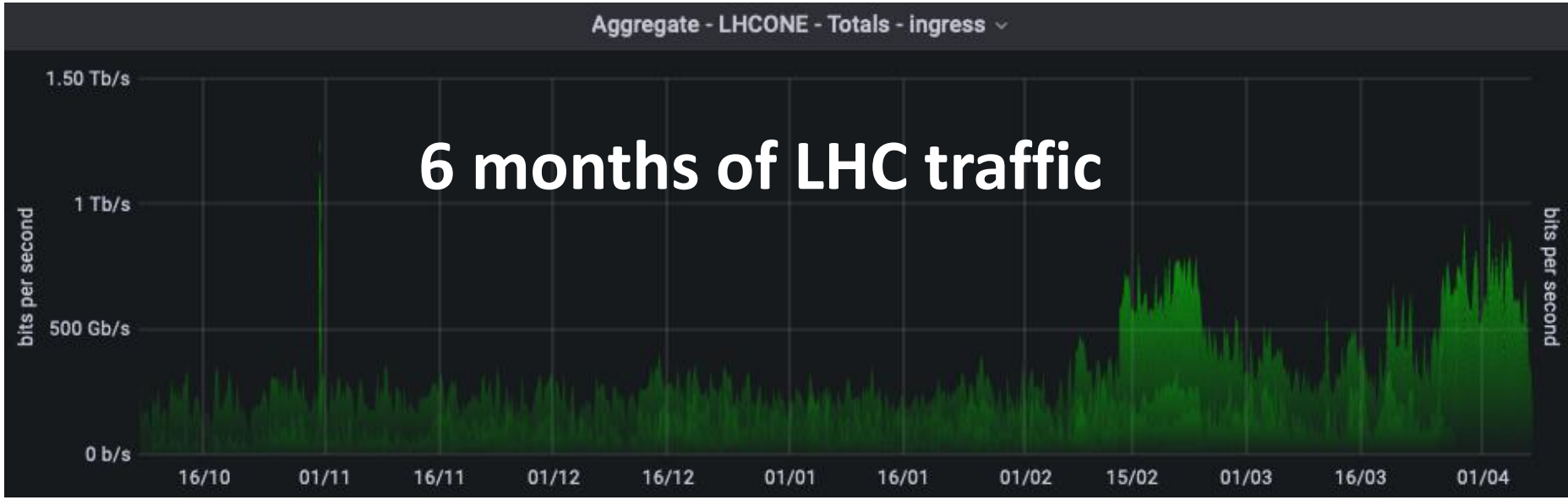
# The Challenge: Traffic

# A Harder Challenge:

# Science Traffic



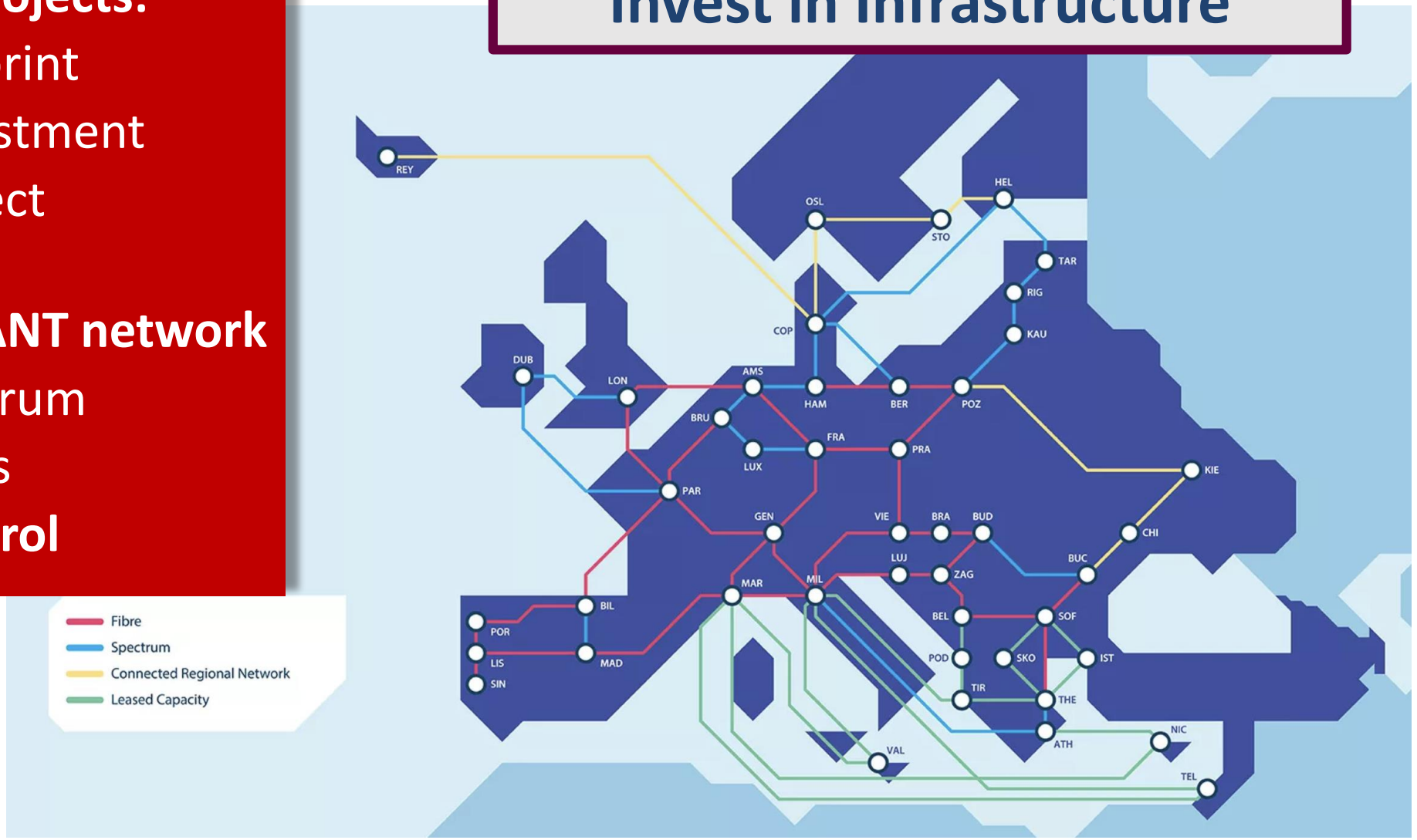
# Long Term Approach: Invest in Infrastructure

**2019 – 2023 projects:**

- European footprint
- EC-funded investment
- 50 million project

**Result: the new GÉANT network**

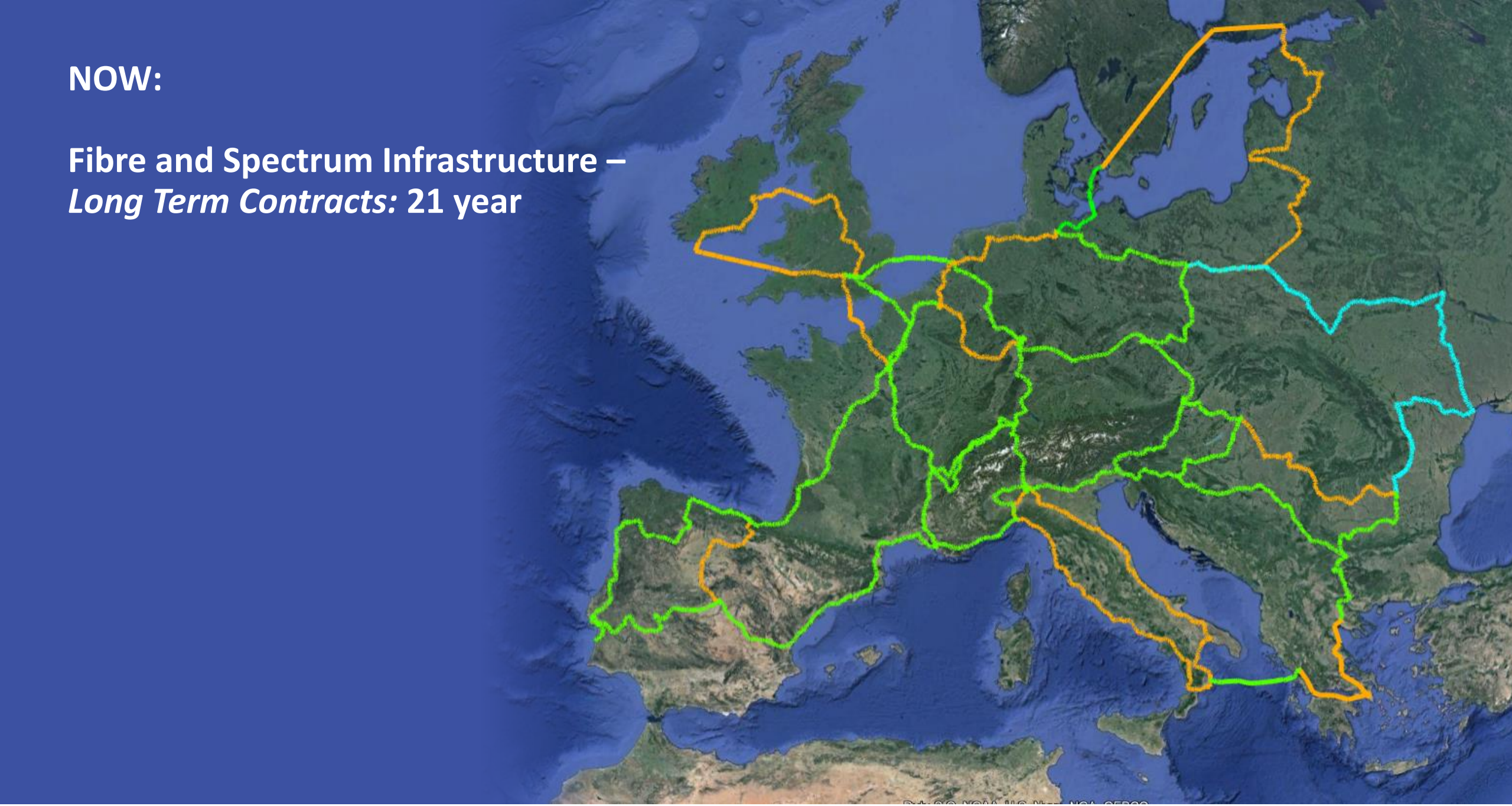
- Fiber and spectrum
- 32 + 5 countries
- **Long term control**



**Before:**
**Fibre And Spectrum Infrastructure**
***Short Term Contracts***

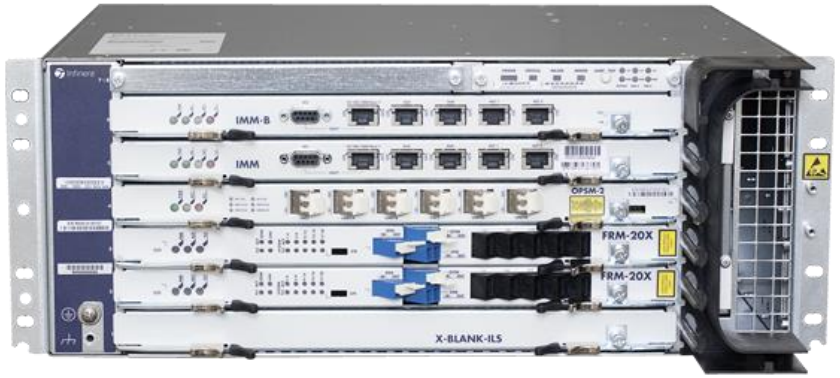
**NOW:**

**Fibre and Spectrum Infrastructure –**
***Long Term Contracts:*** **21 year**



# Optical Line System

- **Optical Line System is now deployed across the GÉANT backbone**
- **Infinera FlexILS** will remain the basis for next generation optical network for at least **a decade**
- **Framework Agreements** with four vendors available to NREN community
  - Procurement collaboration of GÉANT and a number of NRENs
- **Outcome: Modular, state-of-the art system**
- Native support for alien waves and spectrum



# Packet Layer - Optimise and improve network infrastructure

- The Juniper MX960/480 estate reached the maximum capacity of the platform at 1Tbps per slot and the last MPC10 line cards at 2 x 400Gbps have been deployed

- Successfully procured Nokia 7750 SR-7s and SR-2se for the IP/MPLS router refresh, both capable of 18Tbps per slot from initial deployment and fully redundant in both fabric and control

- The Nokia FP5 based line cards support 400G optics today and will support 800G optics when the specification is finalised and released

# Packet Layer Renewal - Delivering state of the art network infrastructure

**3-year project** started early 2022

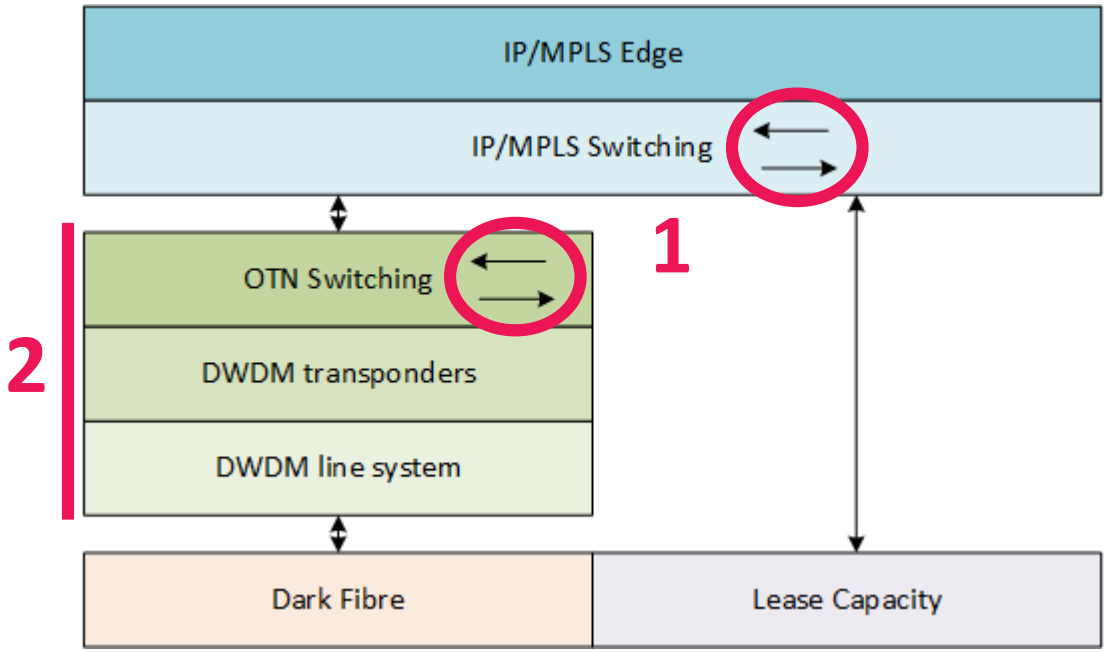
**400G availability throughout the whole GÉANT footprint**

High-speed network availability to the edges of Europe

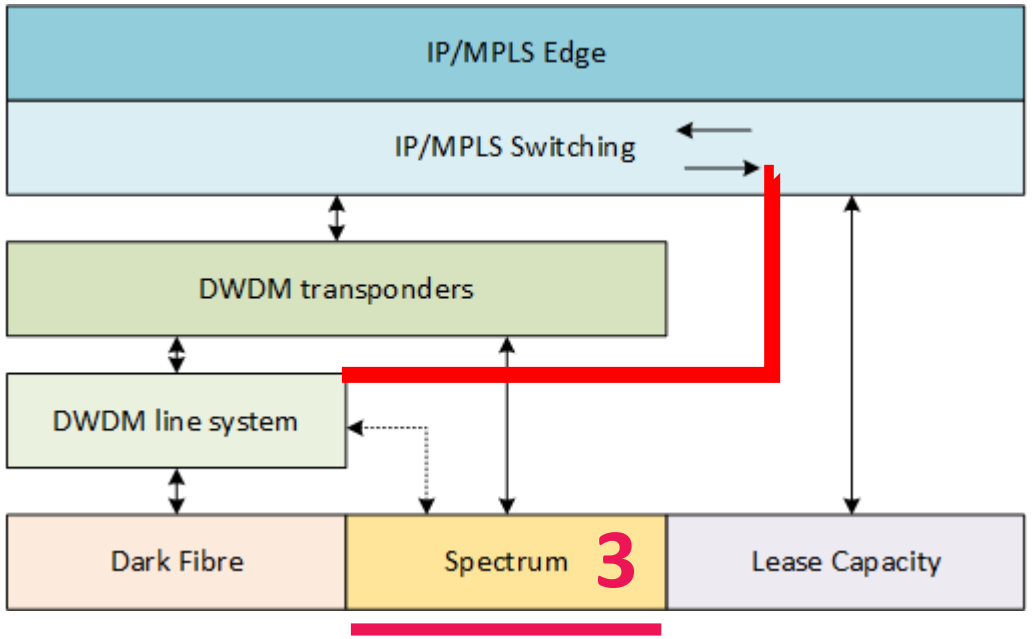
Enabling global partners to connect at or close to landing stations

# Network Stack Evolution

## Before




## After




1. Electronic Switching at MPLS layer only with removal of OTN switching
2. Disaggregation at DWDM layer between Transponders and Line System (OLS)
3. Use of Spectrum as connectivity option for the substrate

# The Frontiers

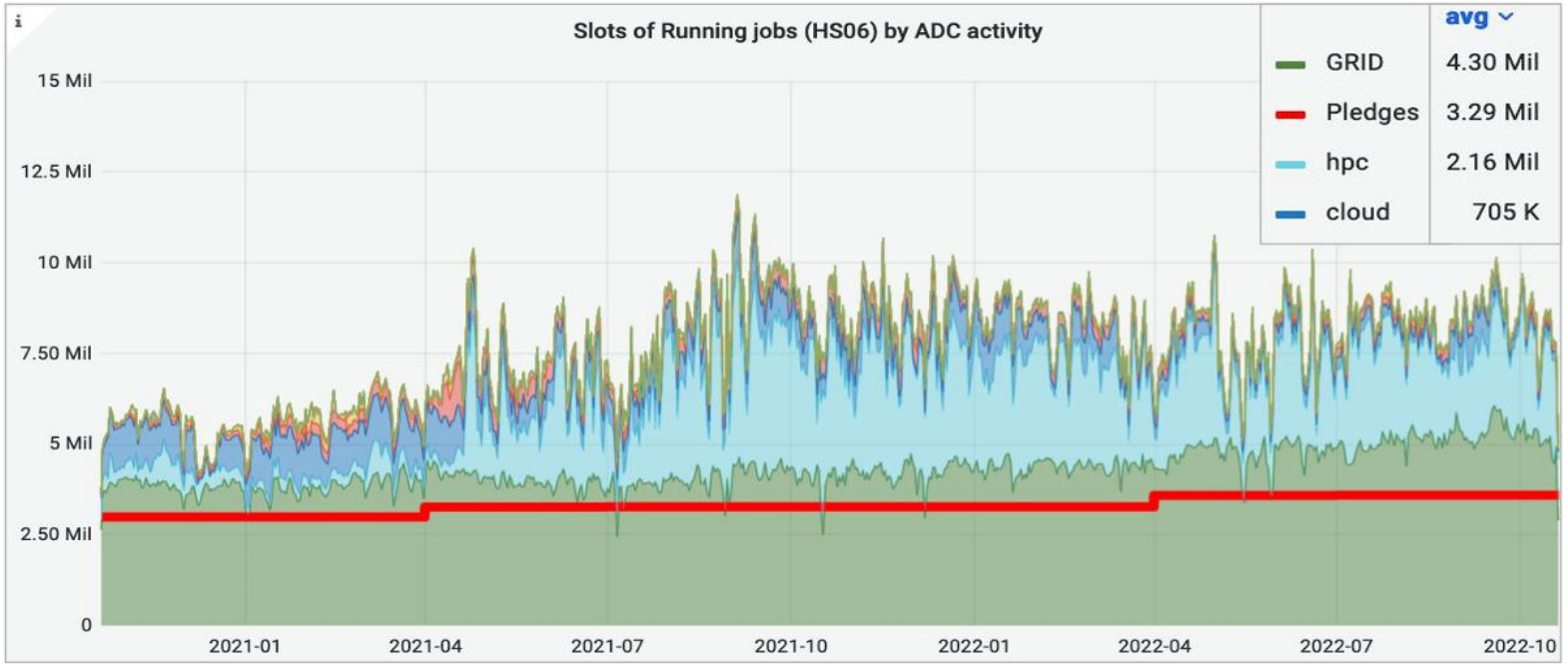
# Advancing to Next-Gen Network Solutions

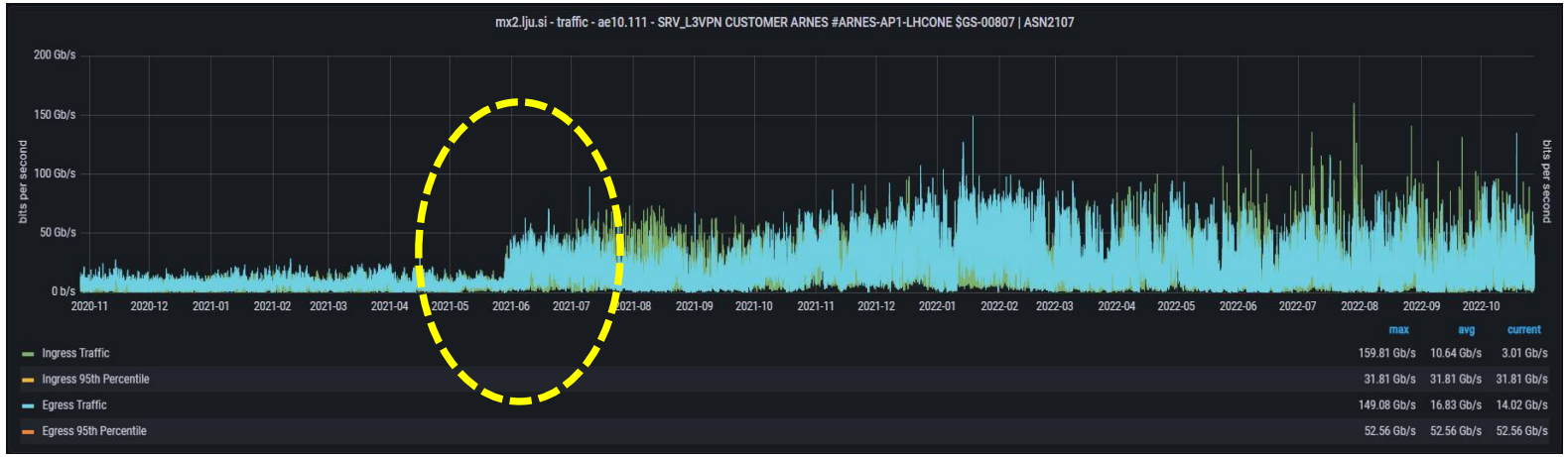
# Big Science Users and EuroHPC: Infrastructure is an Enabler

**Atlas experiment CERN** started using **Vega EuroHPC** in **Slovenia**.

Single HPC site now provides more than 50% resources and completes half the number of jobs by the WLCG (Worldwide LHC Computing GRID)

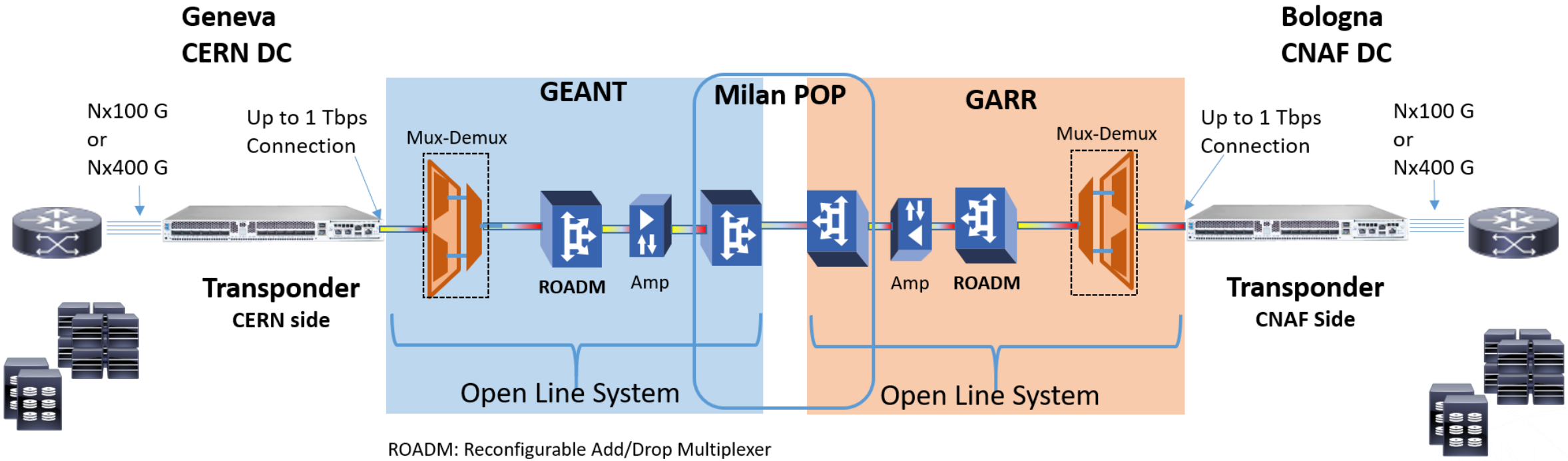
**The network was ready to take the traffic… (from 20 Gbps to 150 Gbps peak)**



# CNAF to CERN Spectrum Service

- Use Case: CNAF Tier1 to CERN Tier0 via GARR and GÉANT SCS service
- No 3R regeneration optical connection in Milan-> approx. 1000km path
- DCI equipment is housed in customer racks, but managed by GARR

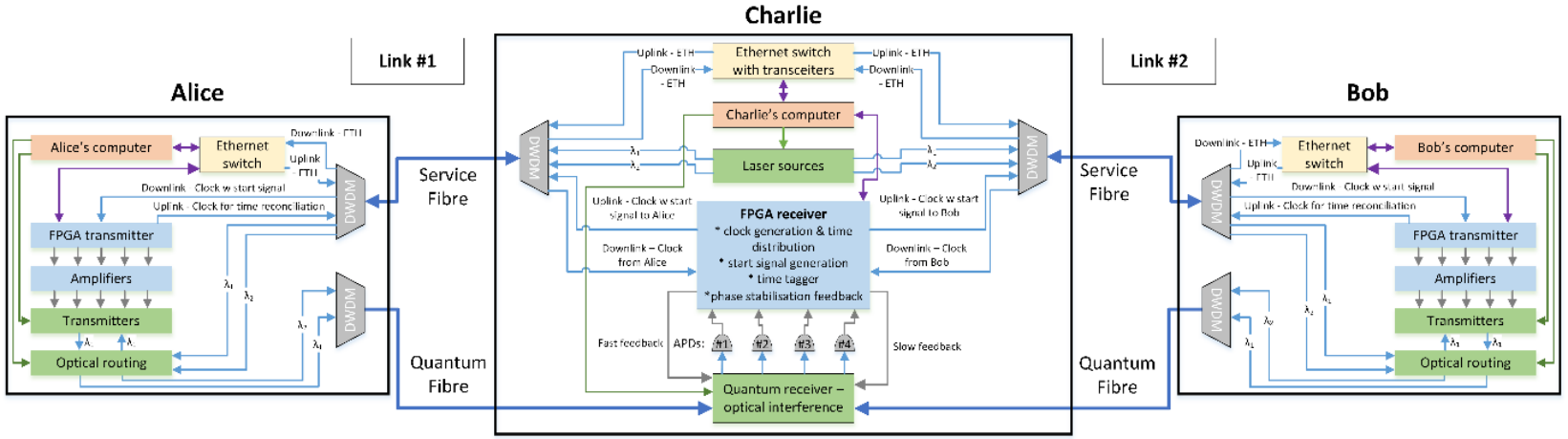




ROADM: Reconfigurable Add/Drop Multiplexer

# Long-Haul QKD Proof-of-Concept

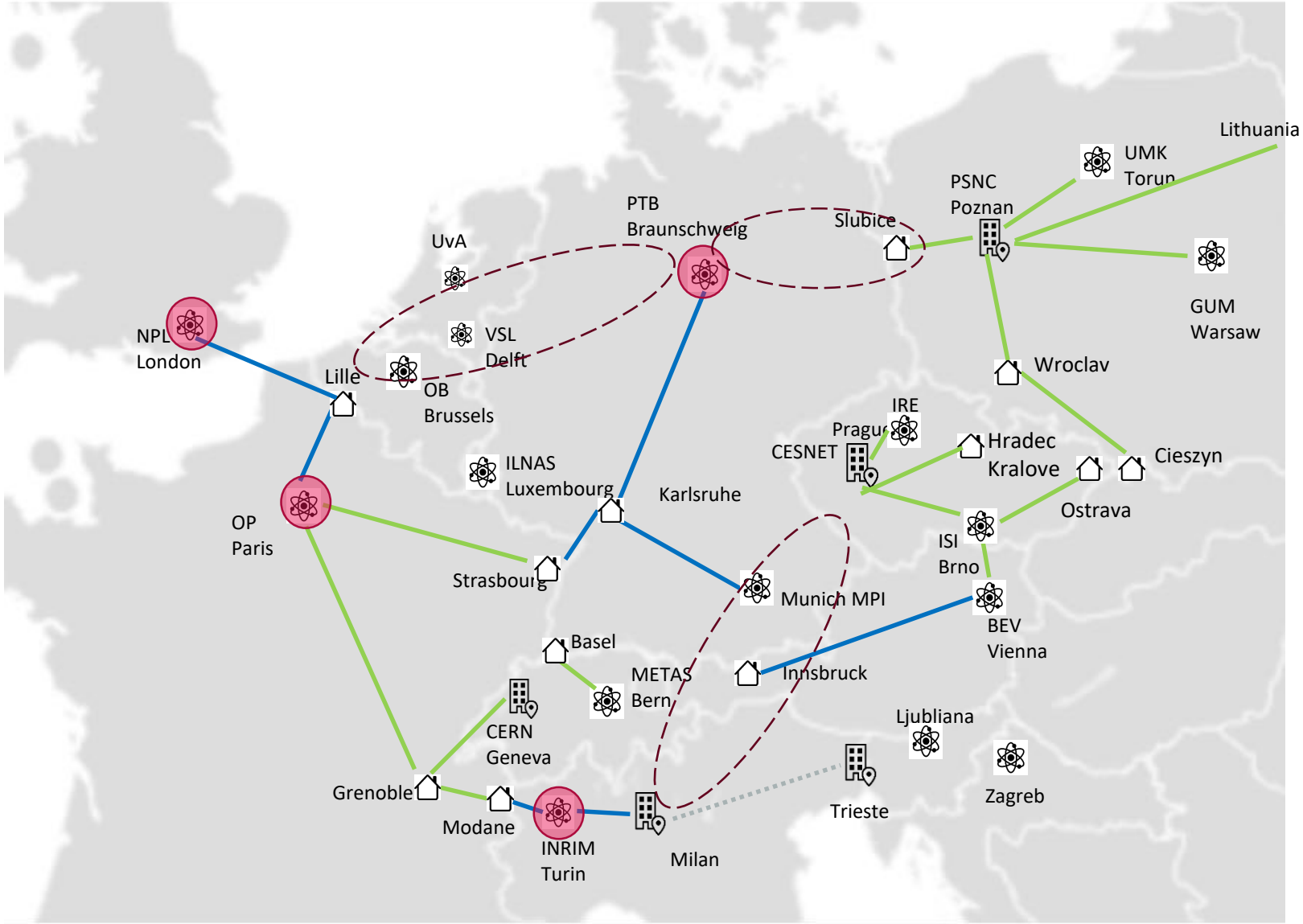
- Twin-Field (TF) QKD protocol over standard telecom facilities

- In summer 2023, GÉANT and Toshiba successfully completed the field trial
- Location for the field trial experiment was a span between Frankfurt and Kehl, Strasbourg
- Twin-Field QKD is the next generation of QKD which will double the reach compared to currently available commercial equipment


- Each node of the system (Alice, Bob) sends out a photon timed so that they arrive in Charlie at the same time
- The photons become entangled and are then measured
- Timing of the photon launch and detection is very challenging

# Time and Frequency – What is missing?




**Existing links:**

- Green links built by NRENs, Blue links built by NMIs
- Four big NMIs involved in redefining the SI second highlighted in blue

**Missing**:

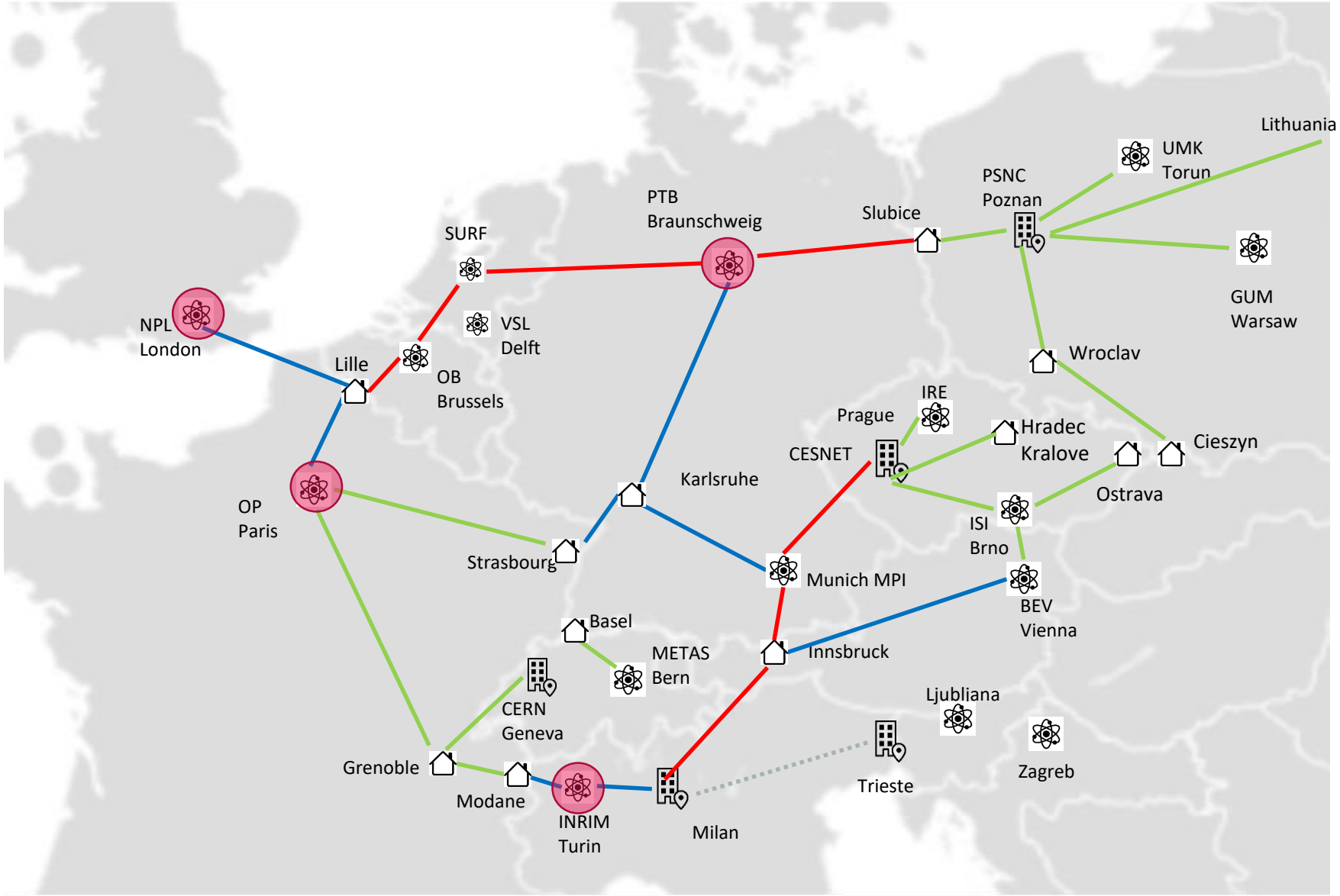
- National-based networks need to be interconnected
- Eastern and Western islands of frequency services are not linked
- A full ring/mesh of the big four NMIs will enable them to complete definition of the SI second

NMI Frequency reference

Research institute

Hut for housing RLS

# Bringing together existing national networks




**New routes**:

- New red routes are cross-border
- A northern route will connect Lille, Brussels, Amsterdam, Braunschweig and Poznan
- A southern route will connect INRIM, Innsbruck, Munich and Prague
- Expected cost of fibre is approx. EUR2.5 million over 2.5 years

NMI Frequency reference

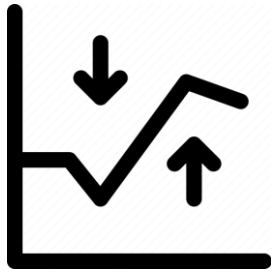
Research institute

Hut for housing RLS

**~€100 million investment** in building the next generation network

Strong **foundation** of long-term infrastructure

Bridging the **Digital divide** by expanding the networks to the edges of Europe



**Reduced dependency** on the market

**Strong collaboration with partners** is key to success

# Thank You

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