EllaLink

Connecting Latam & Europe

New Route, High Rate & High Speed

Infieri 2023

"Jules Verne and the 20.000 Leagues of Subsea Cables: **A true tale about submarine cables"**

Agenda

- Telecoms World briefing
- Subsea Cables
- The EllaLink cable Impact
- Latency is the new currency
- Questions

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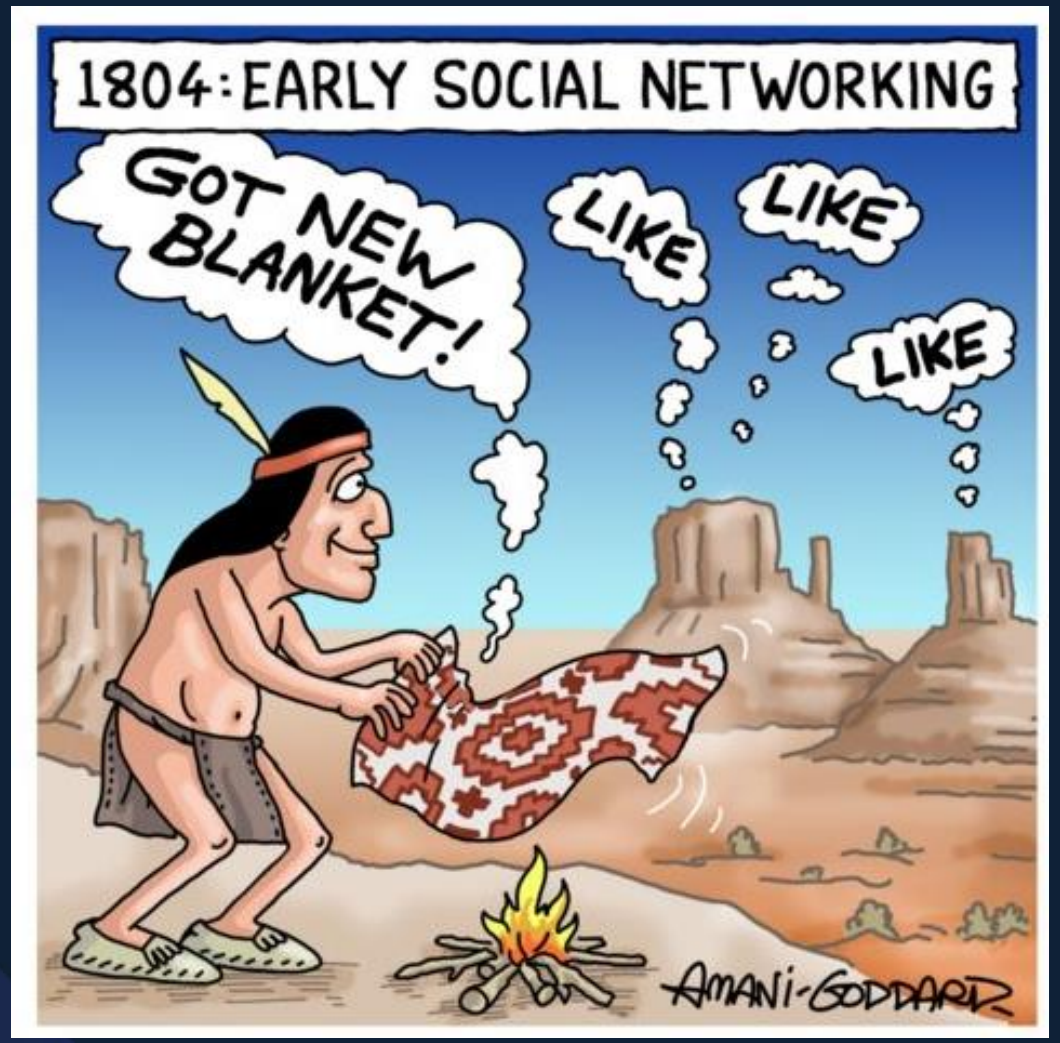
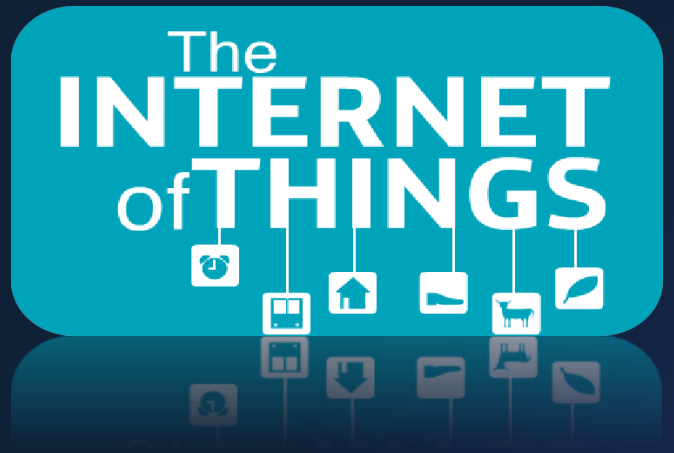


From M2M World to Internet of Everything

200 million M2M connections in 2012



20.000 million connected devices in 2020 (Gartner)

Satellites and its applications

Use In Telephony And Television
Use In Meteorology
Scientific Uses

Astronomic Research
Use As G.P.S.
Radiation Measurement
Study Of Magnetism

Satellites and its applications

GEO – Hybrid

35.405 km

GEO – HTS (High Throughput Satellites)

MEO

10.400 km

LEO

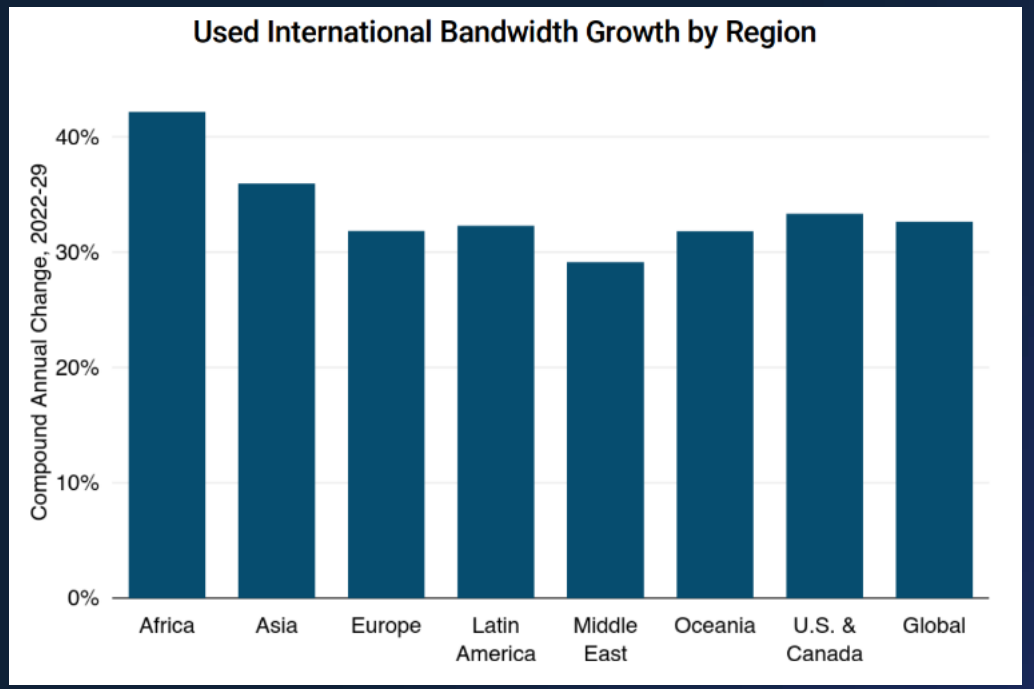
between 500 and 1200 Km

Strong demand growth globally

Globally, used international bandwidth is expected to grow at a 33 percent CAGR from 2022-29.

- This rate of growth implies a doubling roughly every 2.5 years.

- International links connected to Africa are expected to have the fastest growth, increasing at a 42% CAGR

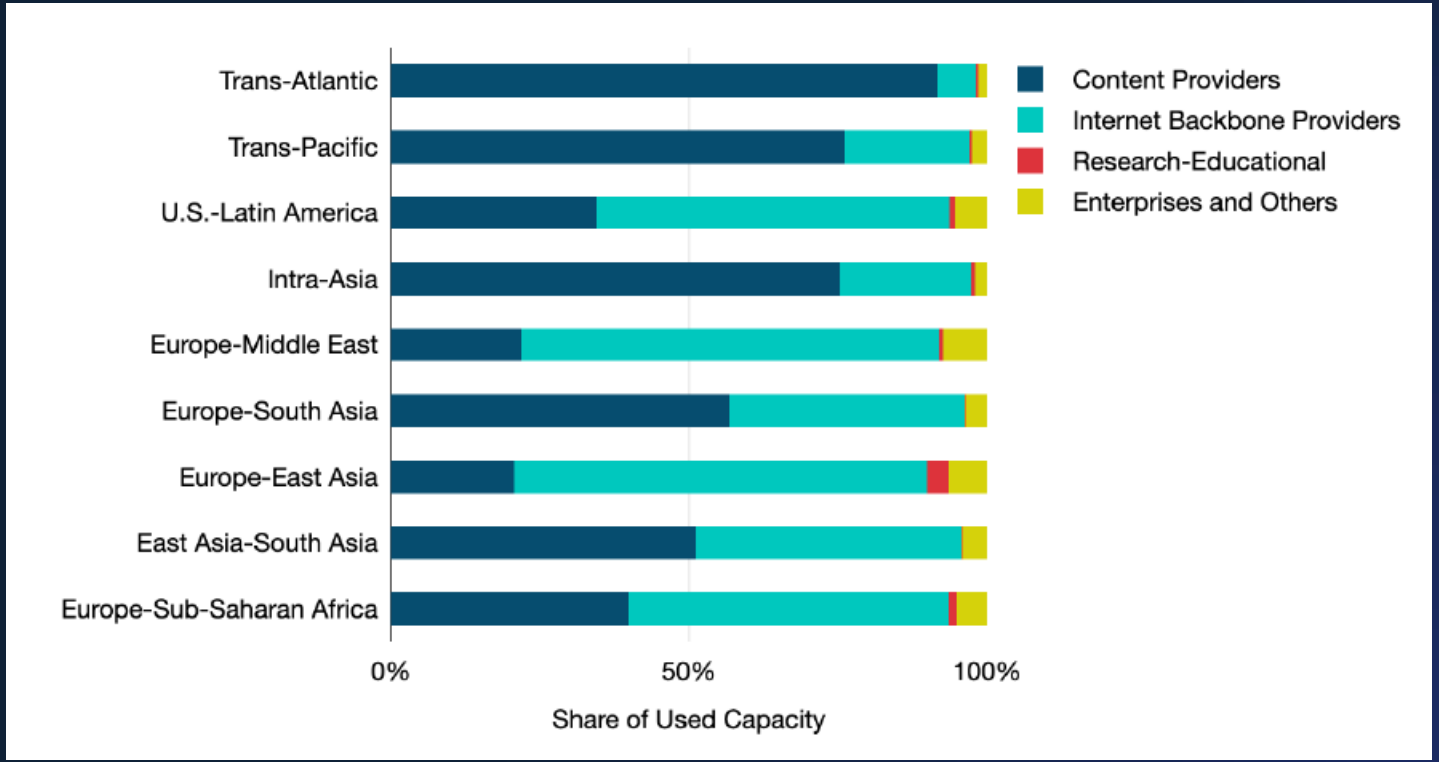


Source: Telegeography

Who is consuming the bandwidth?

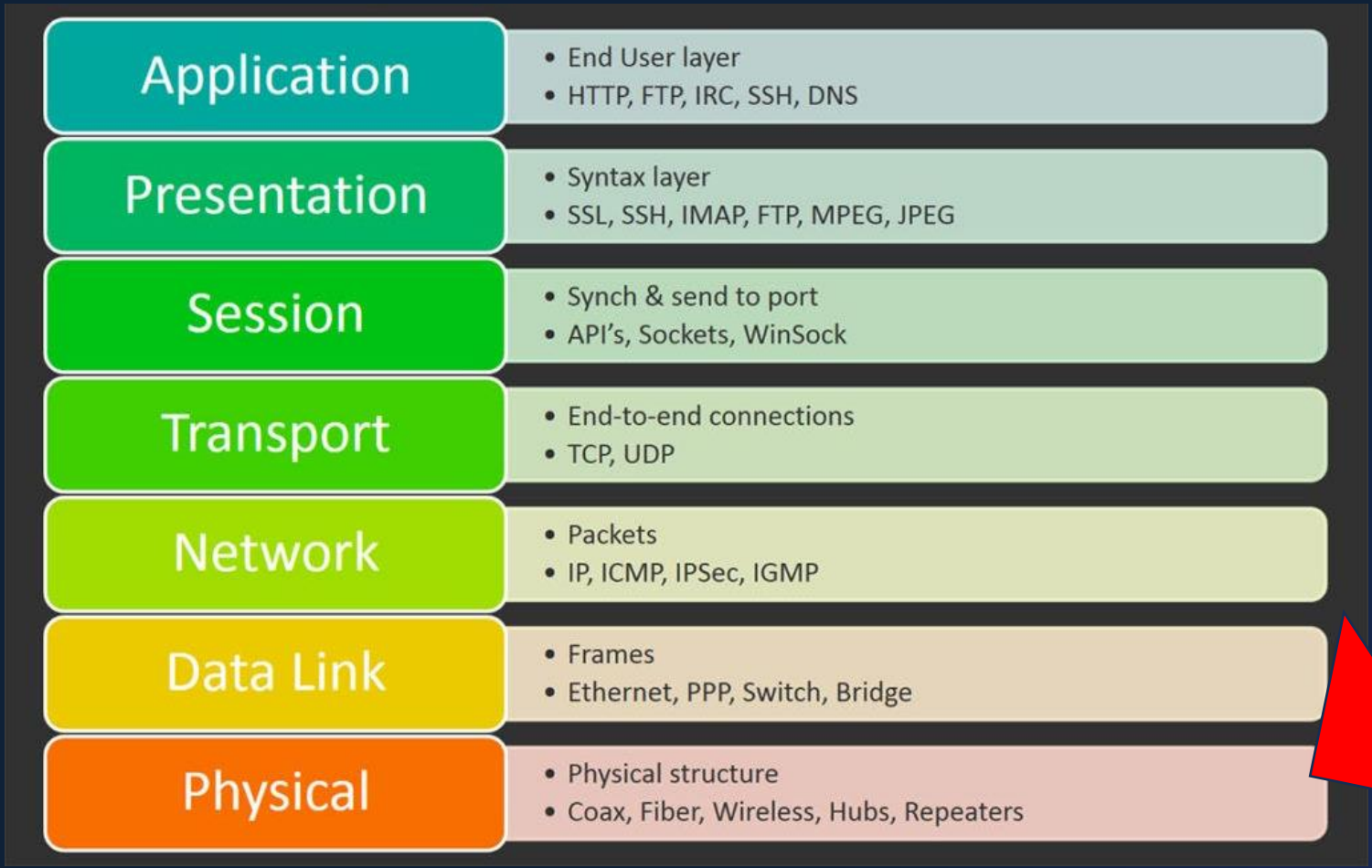
Content providers account is expected to rise to 79% by 2029.

• On the Trans-Atlantic route it was 92% in 2022. On the Europe-Middle East & Egypt route it was 22%



Source: Telegeography

OSI Network Stack



Agenda

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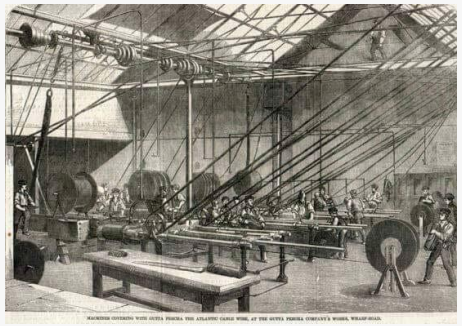
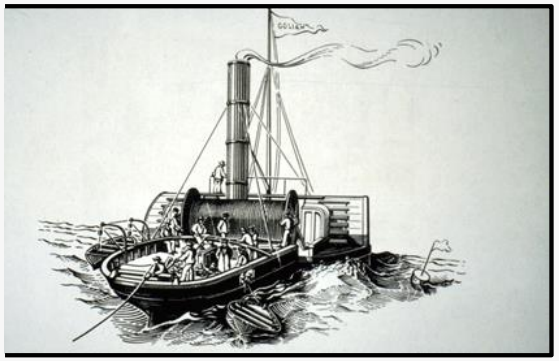
- **Subsea Cables**
- The EllaLink cable Impact
- Latency is the new currency
- Questions

A Brief History – Part I

Pallaquium GuBa
Source: Google



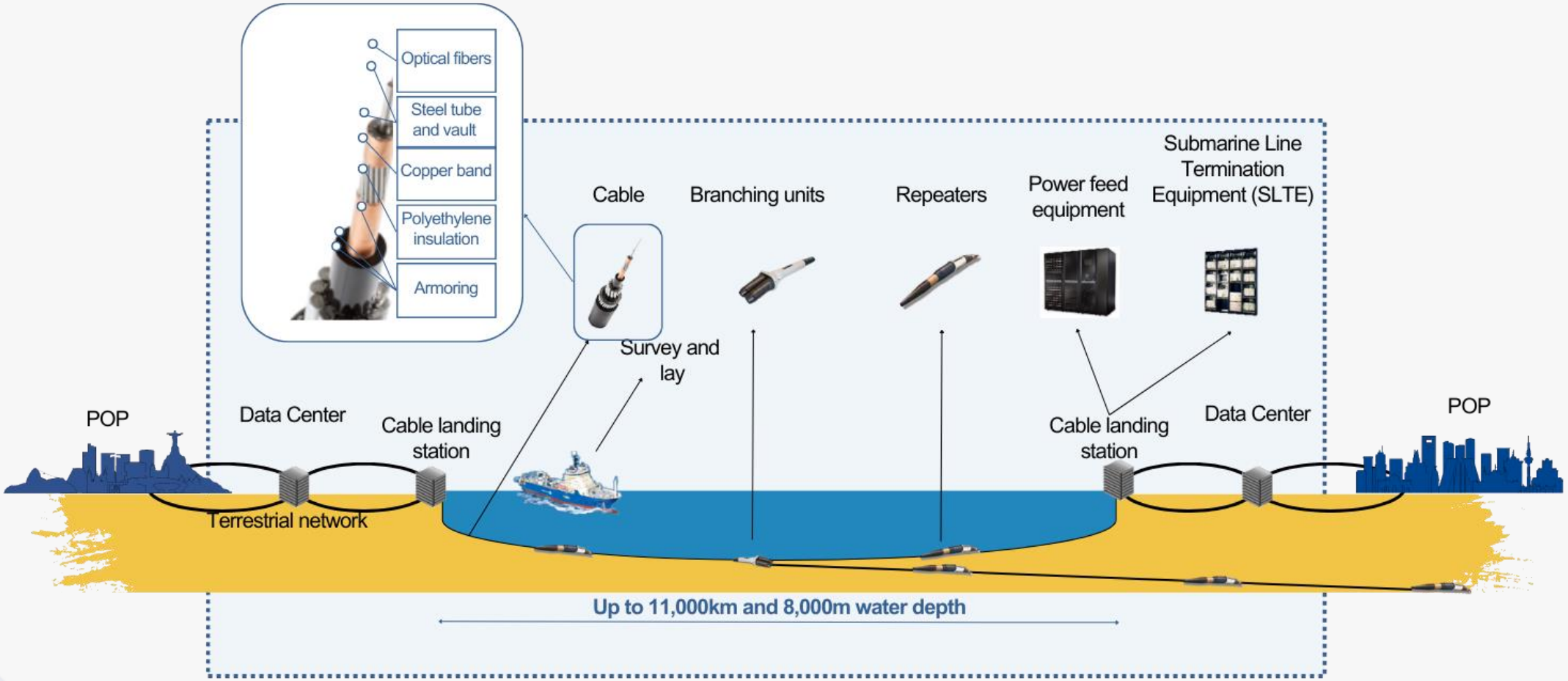
Compagnie du GuBa-Percha
Source: Reynald Leconte, Subsea OFC



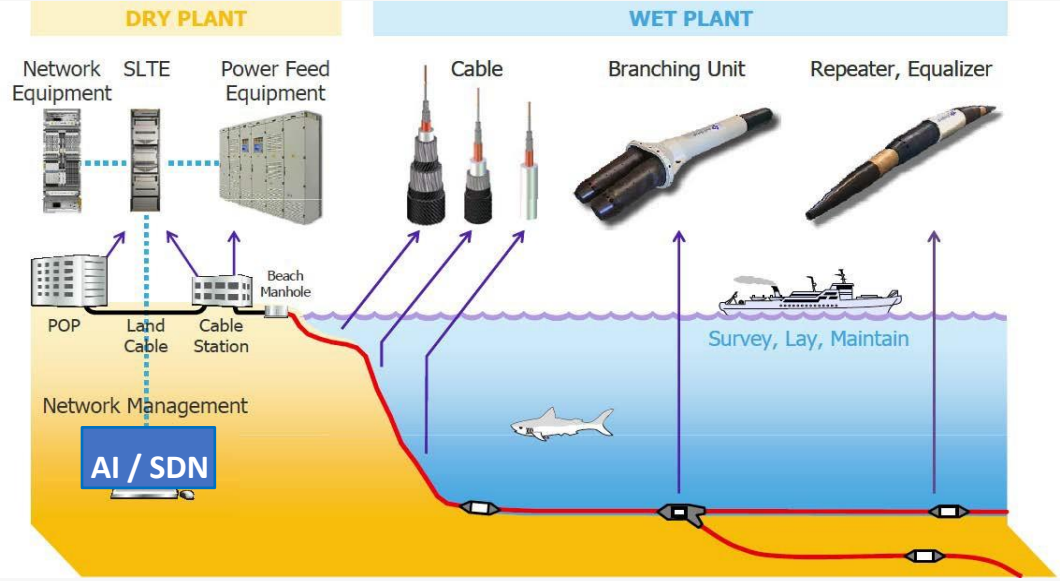
Goliath: lays 1st International Cable, UK – France, 1850-1851
Source: Reynald Leconte, Subsea OFC

- 1840: Telegraph cables start to be laid across rivers and harbours, but initially had a limited life
- 1843-1845: GuBa-percha (a type of gum found in a Malaysian tree) was brought to Britain and starts to replace other materials that were used for electrical insulation, thus extending the life of the cable
- 1850: 1st international telegraph cable laid between UK and France, followed by a stronger cable in 1851
- 1858: 1st transatlantic cable laid between Ireland and Newfoundland by *Great Eastern*. This failed after 26 days and another was laid in 1866

Main Components of a Subsea Cable System

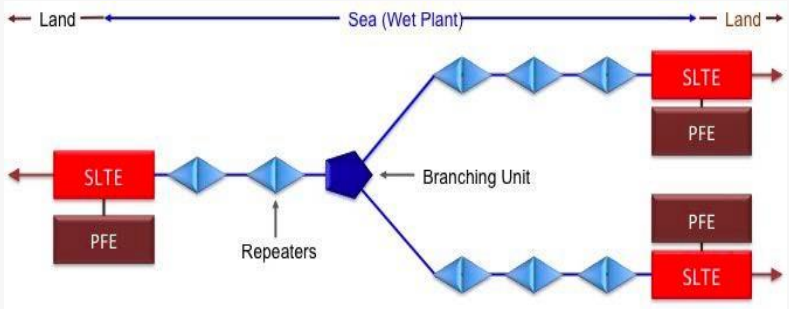


Typical Submarine Cable System



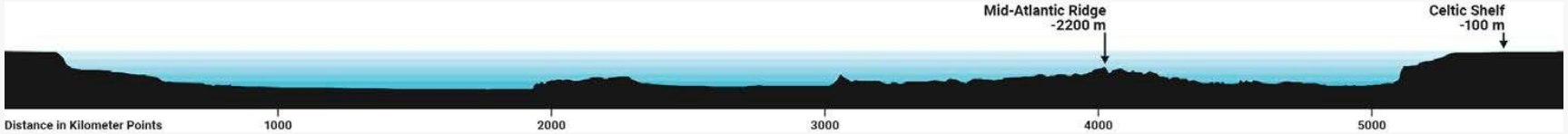
Traditional model of architecture and connection of subsea cable

Source: ICPC



Subsea cable high level design

Source: Ciena

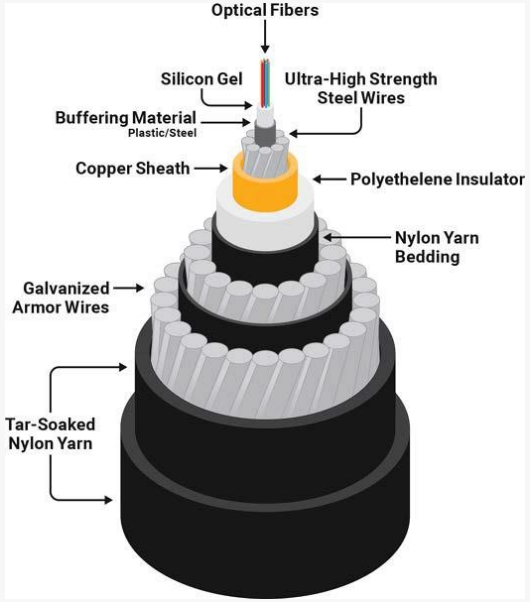


Example Trans-Atlantic cable route seabed profile

Source: TeleGeography

Submarine Cable: Key Elements

Subsea Cable



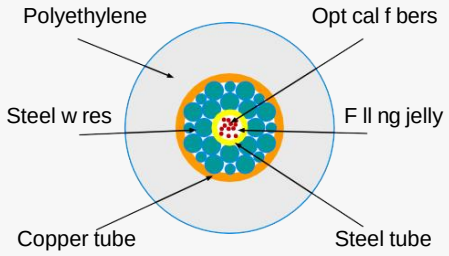
2020 **1858**

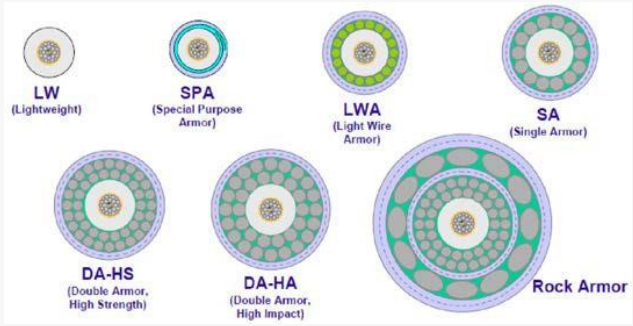
Traditional model of architecture and connection of subsea cable

Source: Michael Francois, Subsea OFC

Submarine Cable: Key Elements
Subsea Cable

- **Function**
  - Protect the optical fiber
  - Power repeaters
- **Properties**
  - Optical
  - Mechanical strength
  - Pressure
  - Abrasion
  - Voltage
  - Design life 25 years





Cables type and structure
Source: Google

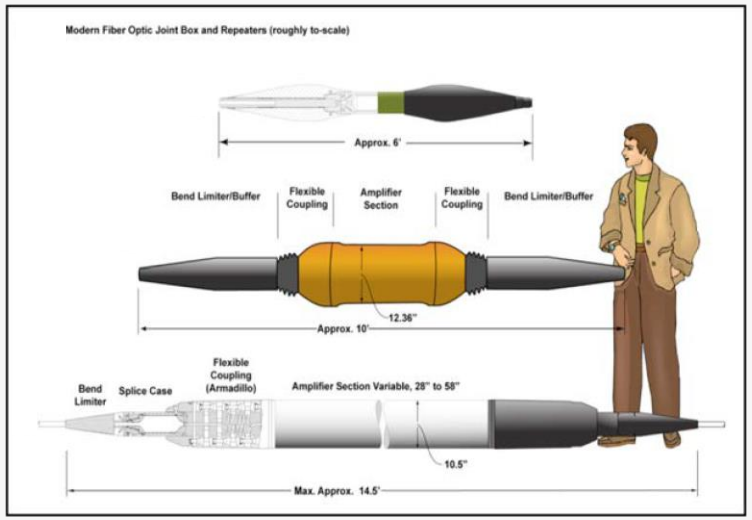
Submarine Cable: Key Elements
Repeater

Wet Plant

- **Function**
  - Amplify optical signal
  - After attenuation through fiber
- **Properties**
  - Optical
  - Mechanical
  - Pressure
  - Voltage
  - Water ingress with difficulty of mobile fiber penetrators
- **Active equipment**
  - Semiconductor Optical pump lasers
  - Specific qualification for 25 years design life

Repeater

Source: Subop+c.org

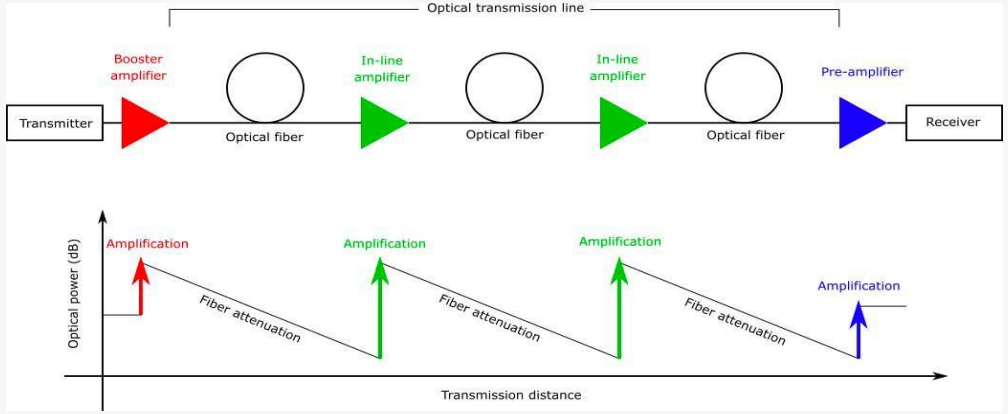


Submarine Cable: Key Elements
Repeater (EDFA)

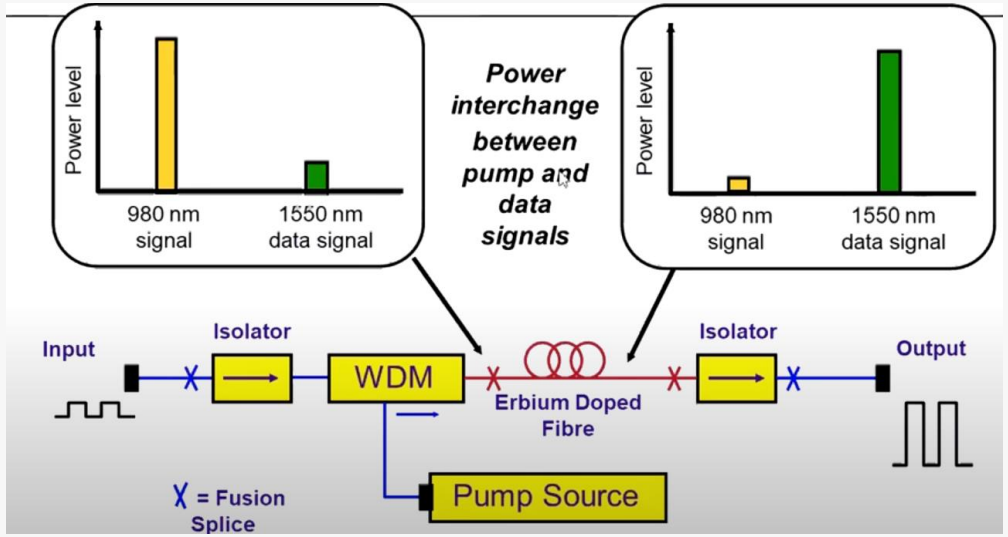
Wet Plant

EDFA (Erbium Doped Fiber Amplifier)

- **EDFA introduced in 1994**
- **Few change since**
  - Transparent
  - Enabling WDM
  - Reliable
- **Continuous evolution**
  - Higher power
  - Pump <framing>
  - C + L band (?)
  - Raman (?)
  - SOA (?)



Repeater (EDFA)
Source: Fiber Labs

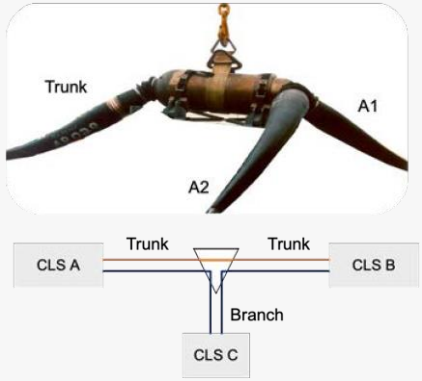


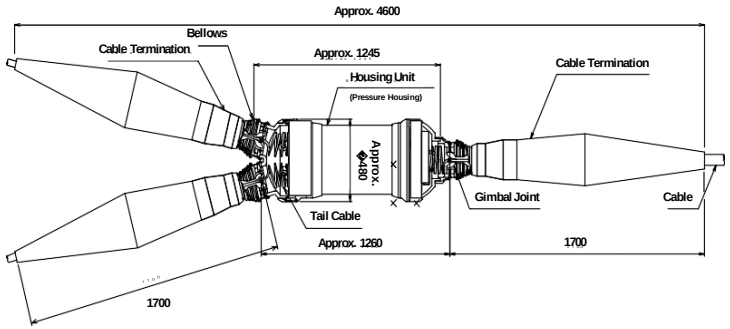
Repeater (EDFA)
Source: Dr. Vivek Upadhyaya

Submarine Cable: Key Elements
Branching Unit (BU)

Wet Plant

- **Function**
  - Split fiber path between 3 directions
- **Properties**
  - Optical
  - Mechanical
  - Pressure
  - Voltage
  - Water ingress with difficulty of mobile fiber penetrators
- **Active equipment**
  - Modern BU switch wavelengths and fibers
  - The more complex wet plan equipment

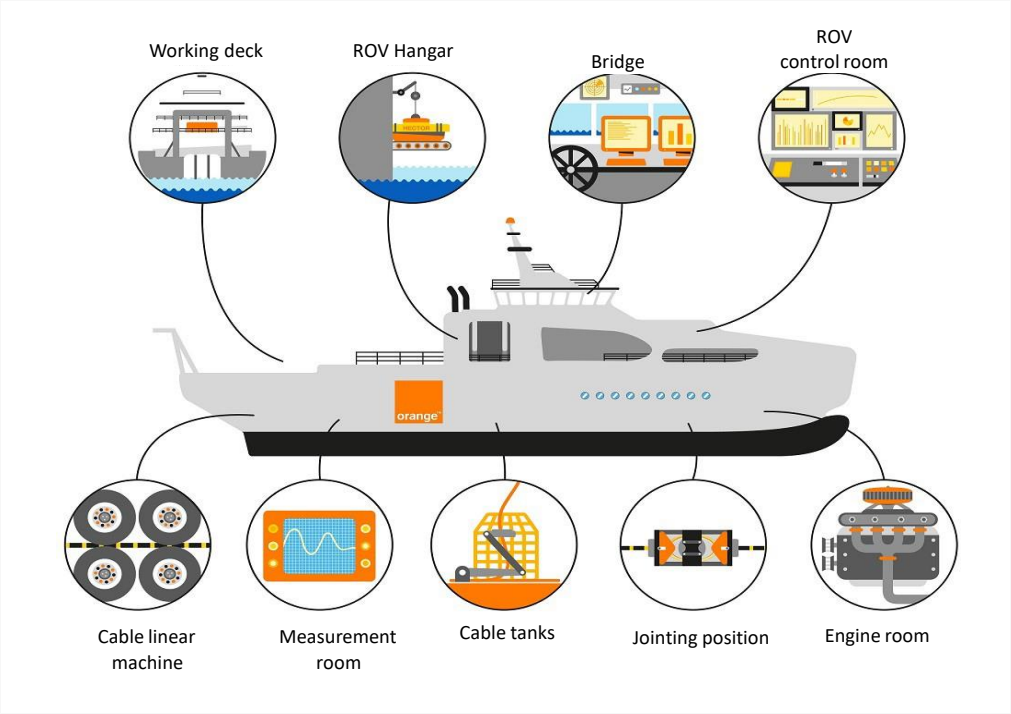




Submarine Cable: Key Elements
Cable Ship

Wet Plant

- **Modern Cable Ship**
  - Multi-function cable lay vessel
  - World wide operations
  - Range: 25,000nm or 60 day endurance
  - Berthing for 80 personnel
  - Overall length: 140m
  - Molded beam: 21m
  - Deep draft: 8.4m
  - Install, bury, repair and maintain cables



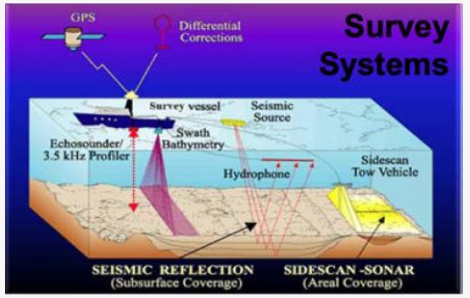
Cable ship

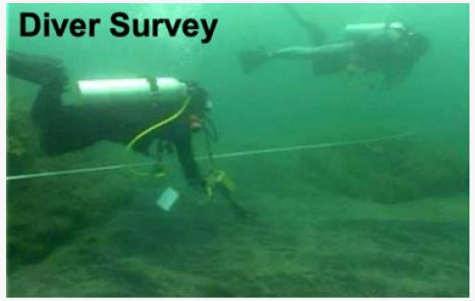
Source: Orange Marine

Submarine Cable: Key Elements
Survey

Wet Plant

- **Marine Operations: Survey**
  - Data collection, bathymetry, geotechnical, sub-bottom, and side scan data to support route engineering, cable selection, installation and burial
  - Analysis of results like, revised RPL & SLD, cable armouring & protection, burial conditions, recommendations for installation procedures

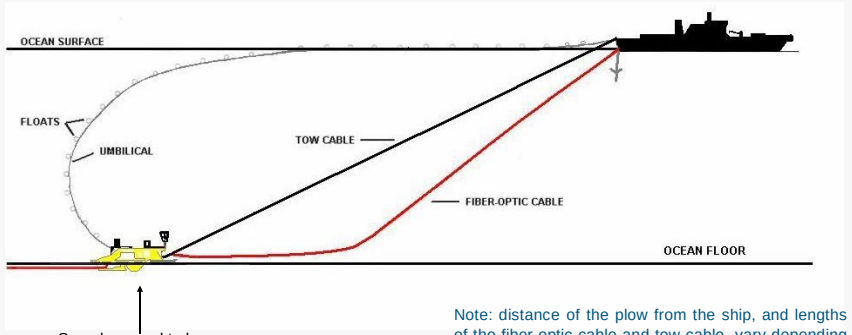




Submarine Cable: Key Elements
Cable Burial Systems (ROVs & PLOWs)

Wet Plant

- **Marine Operations: ROVs and PLOWs**
  - Cable burial remains the most effective and economical method of protection
  - Towed cable plows remain the industry standard for cable burial (1m to 3m typical)

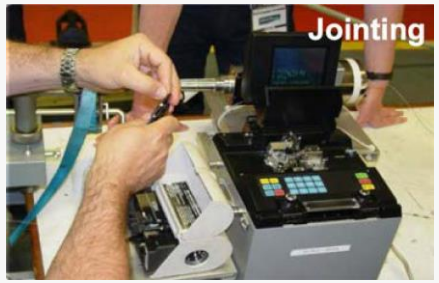


Note: distance of the plow from the ship, and lengths of the fiber-optic cable and tow cable, vary depending principally on sea-floor depth.

Submarine Cable: Key Elements
Maintenance

Wet Plant

- **Marine Operations: Maintenance**
  - Cable maintenance, recovery and operation



WACS Cable (shunt fault – 2020) in Africa

Submarine Cable: Network Security

- **I've heard that sharks are known for biting cables. Is that true?**

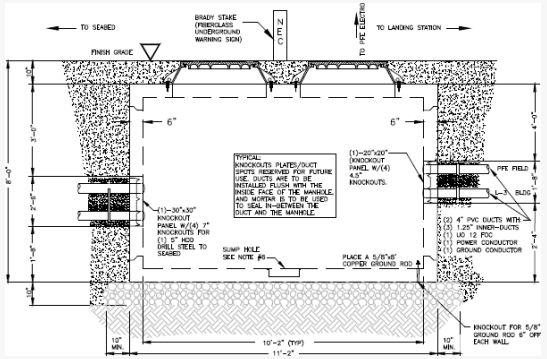
- This is probably one of the biggest myths that we see cited in the press. While it's true that in the past sharks have bitten a few cables, they are not a major threat
- According to data from the International Submarine Cable Protection Committee fish bites (a category that includes sharks) accounted for zero cable faults between 2007 and 2014
- The majority of damage to submarine cables comes from human activity, primarily fishing and anchoring, not sharks.

Submarine Cable: Key Elements

Beach Manhole (BMH)

Dry Plant

- **BMH**
  - Traditionally the point where the transition between the subsea cable and terrestrial cable occurs.
  - A chamber is constructed near the landing point and the beach joint ins constructed inside.
  - The cable is often also anchored at the BMH.



Submarine Cable: Key Elements
Cable Landing Station (CLS)

Dry Plant

- **Cable Landing Station (CLS)**
  - Terminates an subsea cable
  - Provides powering for the subsea cable
  - Provides a location for the Submarine Line Terminating Equipment (SLTE)
  - Provides a location for domestic and/or international interconnection

Submarine Cable: Key Elements

Submarine Line Terminating Equipment (SLTE)

Dry Plant

- **Submarine Line Terminating Equipment (CLS)**
  - Transponders and power management for cable
  - Use latest technology to get the most out of the cable
  - Cycle SLTE every ~5 years as technology advances (cable has 25 year lifetime)
  - Cycle multiple SLTE over life of cable

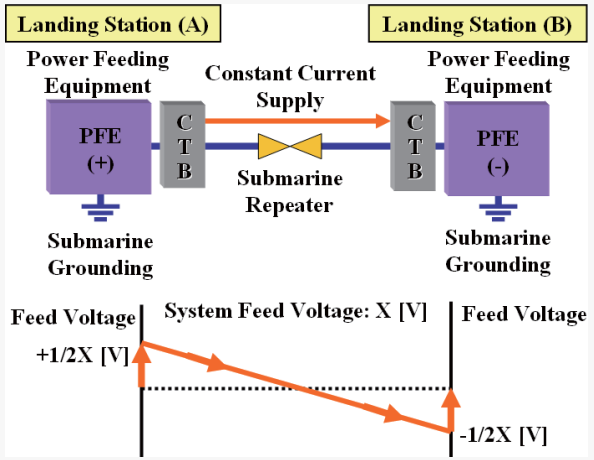
	1st Gen Coherent	2nd Gen Coherent	3rd Gen Coherent	4th Gen Coherent
Year	2010	2012-2015	2016-2019	2020+
Data Rate	40G	50G / 100G / 150G / 200G	100G – 400G	200G – 800G
Baud Rate	~11 Gbaud	~28-35 Gbaud	~40-60 Gbaud	~62-95 Gbaud
Highest Order Modulation	QPSK (& BPSK)	16QAM (&BPSK, QPSK, 8QAM)	32QAM (& below)	64QAM (& below)
Key New Technologies	Coherent CD & PMD Comp	1st Gen Features plus: SD-FEC Tx CD pre-dispersion	2nd Gen Features plus: 4D/8D mod formats, custom modulations, Nyquist shaping Improved FEC NCG	3rd Gen Features plus: Const. Shaping (PCS) improved FEC NCG, variable baud rates, Nonlinear comp (NLC), more…
Silicon Process	90nm	28-64nm	16-28nm	7nm

Submarine Cable: Key Elements

Power Feeding Equipment (PFE)

Dry Plant

- **PFE**
  - PFE supplies constant current (CC) to subsea repeaters via submarine cable.
  - To improve system power supply reliability, PFE assemblies capable of supplying all system voltage requirements are installed in the CLSs at both ends of the systems. The voltages to be supplied to subsea repeaters are allocated to provide PFE at both ends.
  - Generally, each of the two CLSs supplies both positive and negative voltage corresponding to ½ of the total system voltage
  - If any of the PFEs fail, the opposite CLS will supply the full system voltage to allow a constant current supply to the submarine repeaters.
  - This system redundancy is intended to improve system reliability



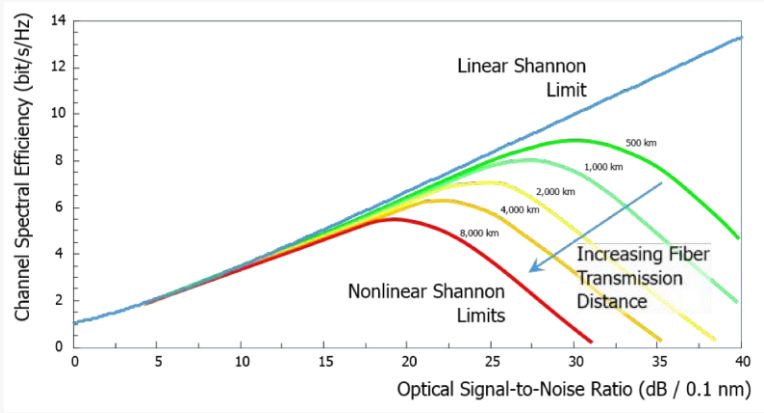
Submarine Cable: Cable Capacity

- **Cable Capacity = (Spectral Density) X (Fiber Bandwidth) X (No. Fiber Pairs)**
- **Spectral density (bits/s per Hz)**
  - Has increased rapidly by increasing channel bit rate
- **Fiber bandwidth**
  - Determined by the Erbium spectrum of EDFA
- **No. of Fiber Pairs**
  - Number of fiber pair was typically 4FP to 6FP, max 8FP
  - SDM cables enable 12, 16, 24 FP

Shannon Limit Factor

$$C = B \log_2(1 + \mathrm{SNR})$$

Channel capacity — Bandwidth — Signal to noise ratio



Submarine Fiber type: It can be a Corning Vascade EX2500

The most modern fiber today for submarine cable is 0.148db/km @1550 nm and has another common feature which is the largest affective área 200 µm, allowing to launch the signal with a higher power without cause linear effects.

Main aspects of a Subsea Cable project

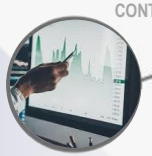
Pre-Construction
Business Case


TECHNICAL FEASIBILITY


SUPPLIERS CONTRACTS


PLANNING


ANCHORS CONTRACTS


FINANCIAL PLANNING

Construction phase: generally 12 to 24 months

Design + Pre-Build Phase


ARCHITECTURE ENGINEERING


OPTICAL DESIGN


DESIGN


PERMITTING & LICENSING

MARINE SURVEY


SURVEY VESSEL


ROUTE PLANNING & CABLE ENGINEERING

Cable Deployment Phase


DRY PLANT


MANUFACTURE


WET PLANT


CABLE LANDING STATIONS


INFRASTRUCTURE


OUTSIDE PLANT


WET PLANT


DRY PLANT


LOGISTICS & IMPORTATION


INSTALL & TEST

MARINE INSTALLATION

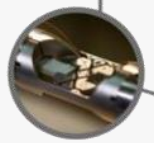

TOOLS


CABLE SHIP

25 Years operation

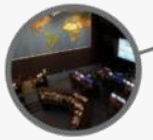

GIS

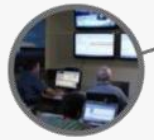

CLS OPERATIONS


JOINTING SERVICES


NETWORK OPERATIONS


MAINTENANCE MARINE

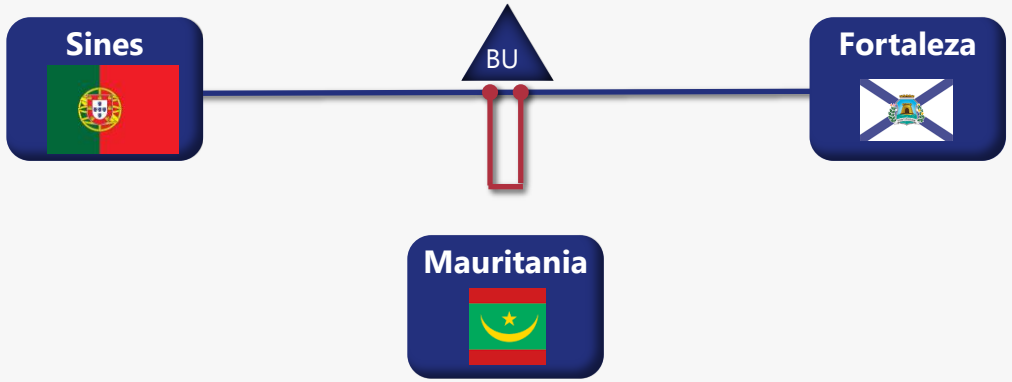

NOC OPERATIONS


GTSC

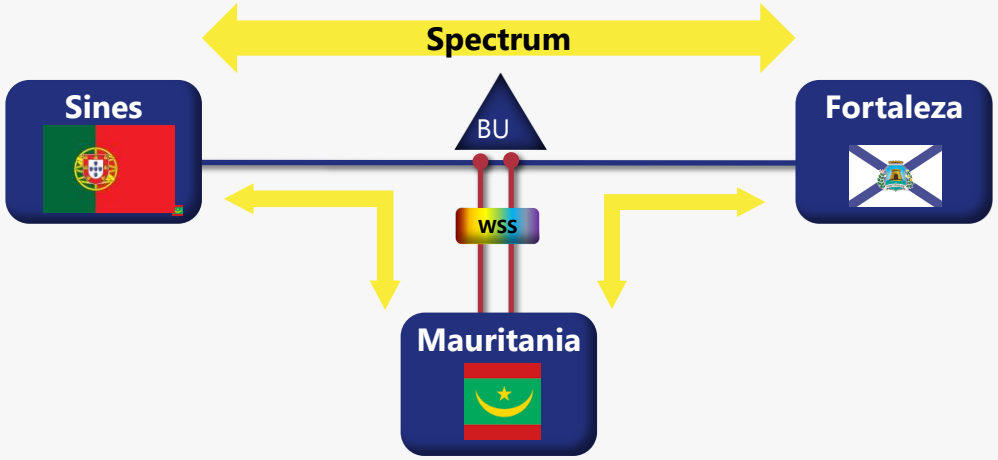

MARINE MAINTENANCE

Branch Unit Connectivity (with WSS)

PHASE 1: BU INSTALLATION



PHASE 2: BRANCH CONSTRUCTION



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- Subsea Cables
- **The EllaLink Cable impact**
- Latency is the new currency
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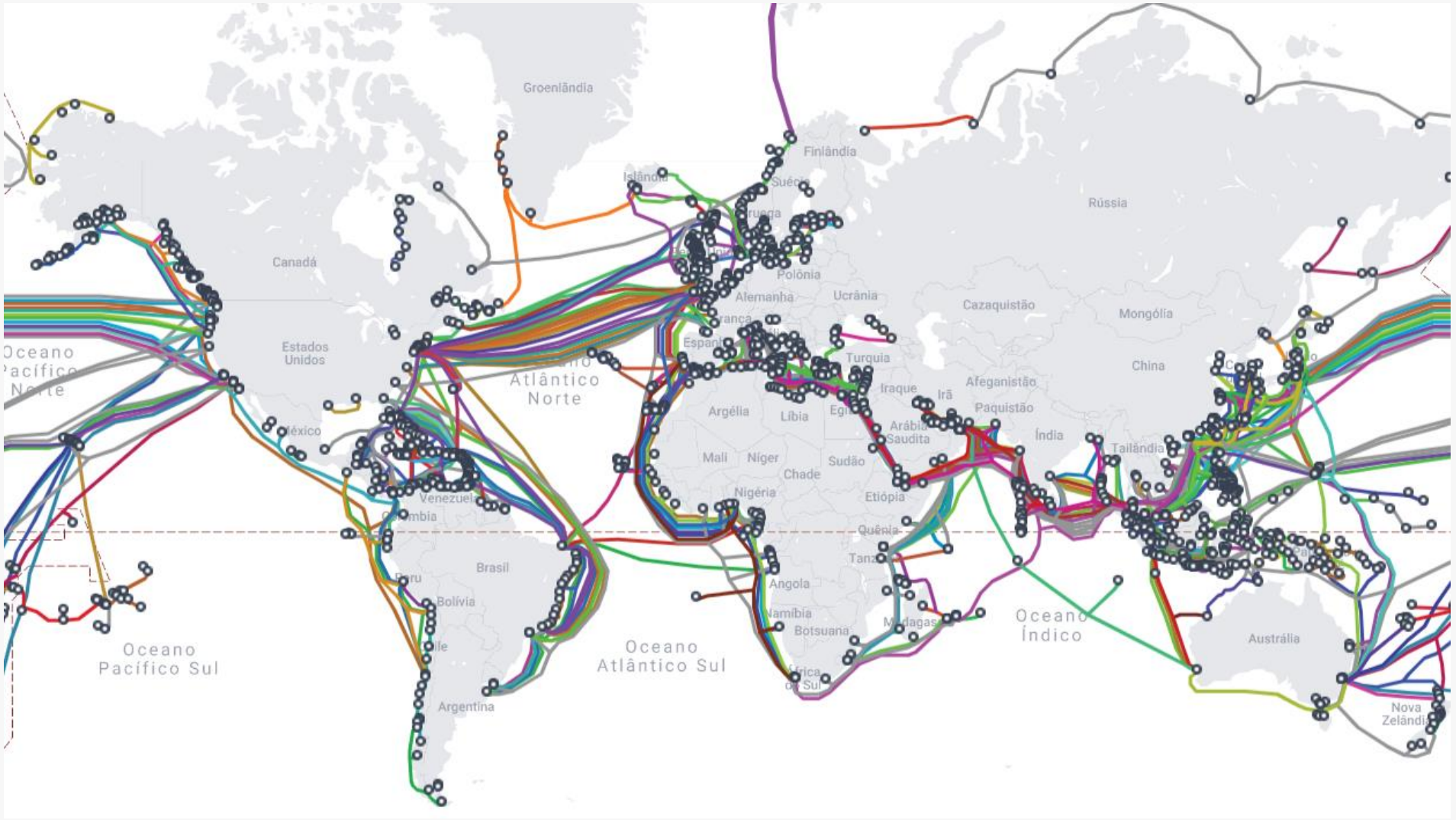
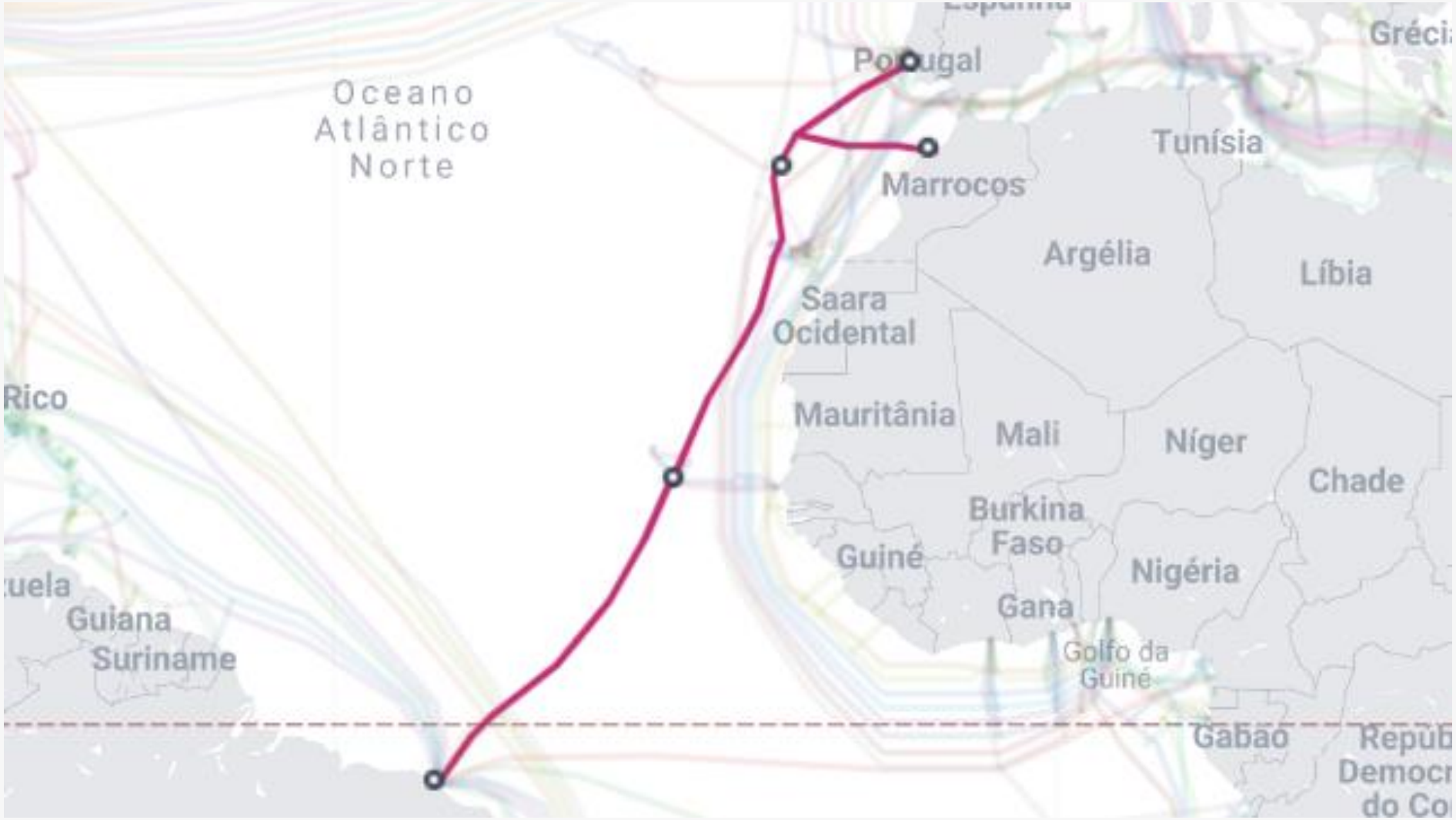




Infrastructure Customers

MAY 2018 | EMACOM (part of EEM) signed a €13M contract for dedicated fiber pair linking Madeira to the mainland Portugal

AUG 2018 | EllaLink signed €25M contract from the Bella Consortium (GEANT and redCLARA)

DEC 2018 | $25M agreement with Cabo Verde Telecom signed for branch to Cabo Verde

JUN 2019 | The GVT of Mauritania signed an agreement for a branching Unit fronting Nouadhibou

OCT 2019 | Capacity and cable landing station agreement in Fortaleza

JUN 2021 | EllaLink Ready for Service

MAR 2022 | 2 fiber pair construction from Lisbon to Casablanca

Building the European Digital Highway

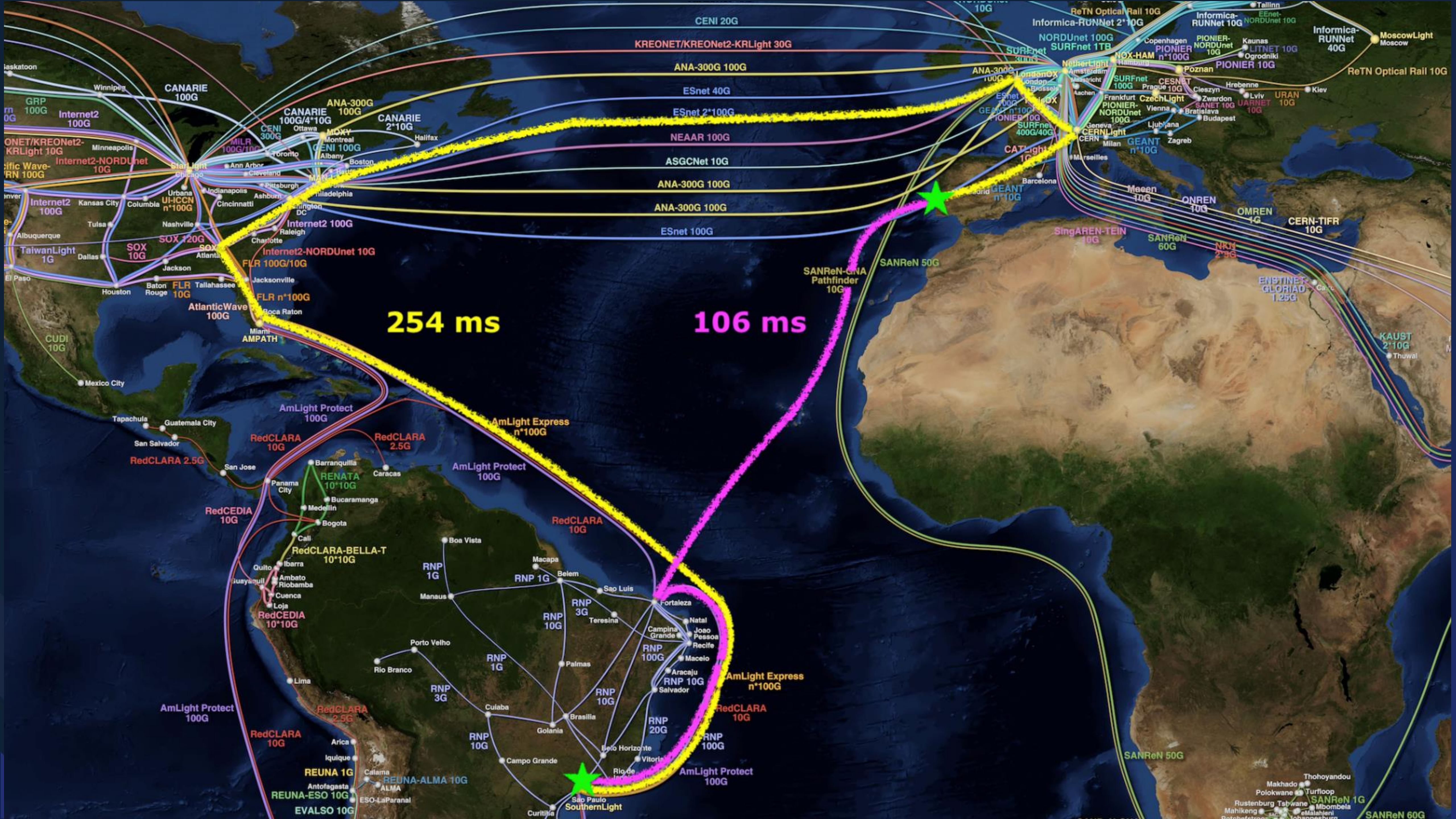
The opening ceremony of EllaLink in Sines marked the start of the EU 2030 Digital Decade.
EllaLink is strongly committed to supporting the EU's goals of making Europe more digital, developing secure, high-performance and low-latency connectivity solutions and supporting other non-European countries to be better connected.
EllaLink has received funding to develop the construction of the only cable connecting the research and education communities on both sides of the Atlantic:

BELLA Programme

Connecting Europe Facility (CEF Digital)

"EllaLink is more than a cable!
It symbolizes our renewed partnership with Latin America. EllaLink means even more to us. It will be a digital highway for joint research and education between Europe and Latin America."
Ursula von der Leyen, President of the European Commission

Co-financed by the Connecting Europe Facility of the European Union



254 ms
106 ms
CENI 20G
KREONET/KREONet2-KRLight 30G
ANA-300G 100G
ESnet 40G
ESnet 2*100G
NEAAR 100G
ASGCNet 10G
ANA-300G 100G
ANA-300G 100G
ESnet 100G
Informica-RUNNet 2*10G
ReTN Optical Rail 10G
NORDUnet 100G
SURFnet 1TB
MoscowLight
Moscow
ReTN Optical Rail 10G
NetherLight
LondonOX
CERNLight
CERN
GEANT n*10G
SANReN-GNA Pathfinder 10G
SANReN 50G
SingAREN-TEIN 10G
SANReN 60G
CERN-TIFR 10G
ORIENTplus
OMREN 1G
ONREN 10G
ENSTINET-GLORIAD 1.25G
KAUST 2*10G
Thuwal
CANARIE 100G
CANARIE 100G/4*10G
CANARIE 2*10G
ANA-300G 100G
MOXY
StarLight
Chicago
MAN LAN
Internet2 100G
Internet2-NORDUnet 10G
FLR 100G/10G
FLR n*100G
AtlanticWave 100G
Miami
AMPATH
SOX 120G
SOX 10G
TaiwanLight 1G
CUDI 10G
Mexico City
AmLight Express n*100G
AmLight Protect 100G
AmLight Protect 100G
AmLight Protect 100G
RedCLARA 10G
RedCLARA 2.5G
RedCLARA 2.5G
RedCLARA 10G
RedCEDIA 10G
RedCEDIA 10*10G
RENATA 10*10G
RedCLARA-BELLA-T 10*10G
Fortaleza
Natal
Recife
Salvador
Brasilia
Sao Paulo
SouthernLight
AmLight Express n*100G
RedCLARA 10G
RNP 100G
AmLight Protect 100G
REUNA 1G
REUNA-ALMA 10G
REUNA-ESO 10G
EVALSO 10G
SANReN 50G
SANReN 1G
SANReN 60G

Online Comparing Test

Network latency - LIP ⇔ SPRACE

Production link (through U.S.)

- RTT from LIP to SPRACE: ~254 ms

1 172.16.203.254 (172.16.203.254) 0.437 ms
2 172.16.100.1 (172.16.100.1) 0.346 ms
3 Router63.Lisboa.fccn.pt (193.137.1.233) 0.698 ms
4 Router30.Lisboa.fccn.pt (194.210.6.112) 0.617 ms
5 Router1.Lisboa.fccn.pt (194.210.6.103) 0.752 ms
6 fccn.mx2.lis.pt.geant.net (62.40.124.97) 0.407 ms
7 ae4.mx1.mad.es.geant.net (62.40.98.97) 9.513 ms
8 ae7.mx1.gen.ch.geant.net (62.40.98.67) 44.189 ms
9 ae6.mx1.par.fr.geant.net (62.40.98.183) 36.771 ms
10 ae5.mx1.lon2.uk.geant.net (62.40.98.178) 43.299 ms
11 ae6.mx1.lon.uk.geant.net (62.40.98.36) 44.102 ms
12 internet2-gw.mx1.lon.uk.geant.net (62.40.124.45) 118.094 ms
13 ae-1.4079.rtsw.atla.net.internet2.edu (198.71.45.6) 131.068 ms
14 et-3-0-0.4079.rtsw.jack.net.internet2.edu (162.252.70.43) 136.614 ms
15 198.71.45.189 (198.71.45.189) 148.902 ms
16 ae0-2005.rt04.ce.ampath.net (190.103.185.11) 257.684 ms
17 143-108-254-242.ansp.br (143.108.254.242) 253.750 ms
18 200.136.80.225 (200.136.80.225) **253.616 ms** !X

Experiment using EllaLink

- RTT from LIP to SPRACE: ~106 ms

1 172.16.203.254 (172.16.203.254) 0.382 ms
2 194.210.4.169 (194.210.4.169) 1.162 ms
3 Router30.Lisboa.fccn.pt (194.210.6.108) 0.562 ms
4 Router1.Lisboa.fccn.pt (194.210.6.103) 0.646 ms
5 fccn.mx2.lis.pt.geant.net (62.40.124.97) 0.495 ms
6 redclara-gw.lis.pt.geant.net (62.40.127.151) 62.728 ms
7 for-sao.redclara.net (200.0.204.7) 106.989 ms
8 sprace01.redclara.net (200.0.207.116) **106.452 ms** !X

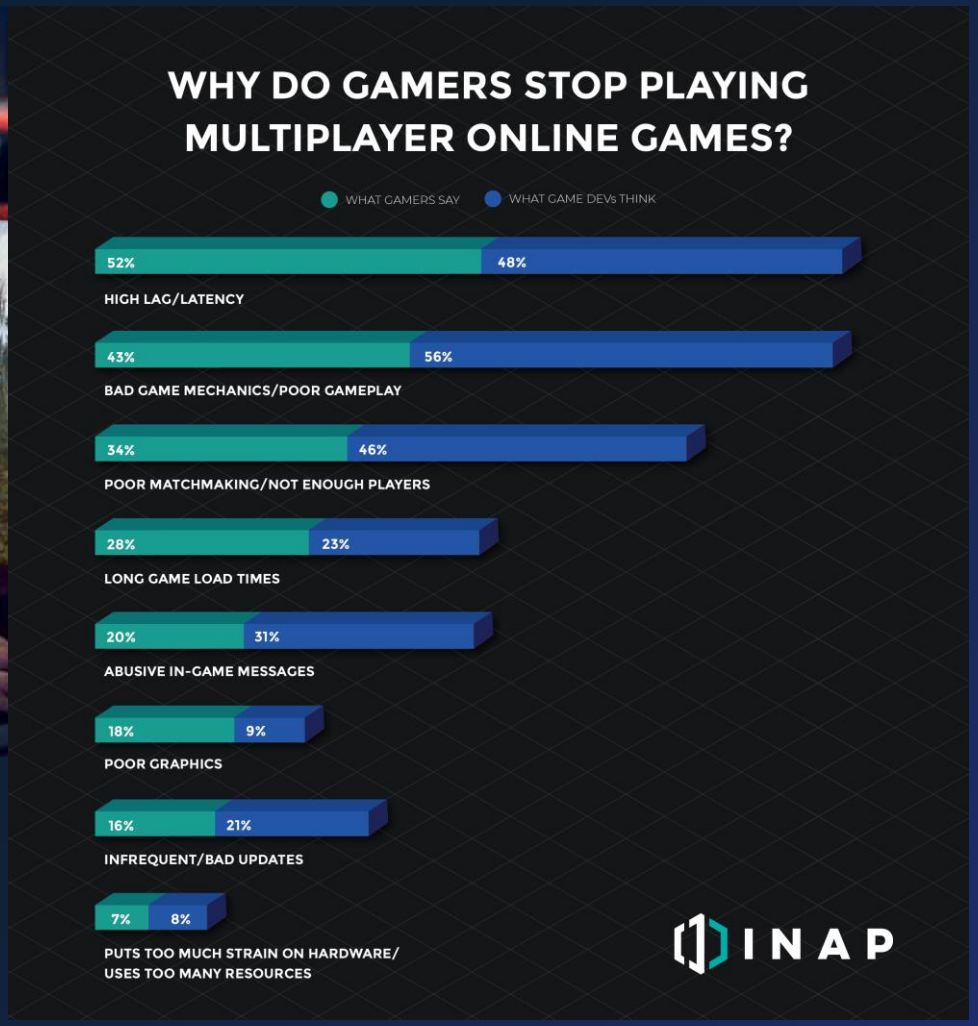
Traceroute - from Lisbon to São Paulo

Agenda

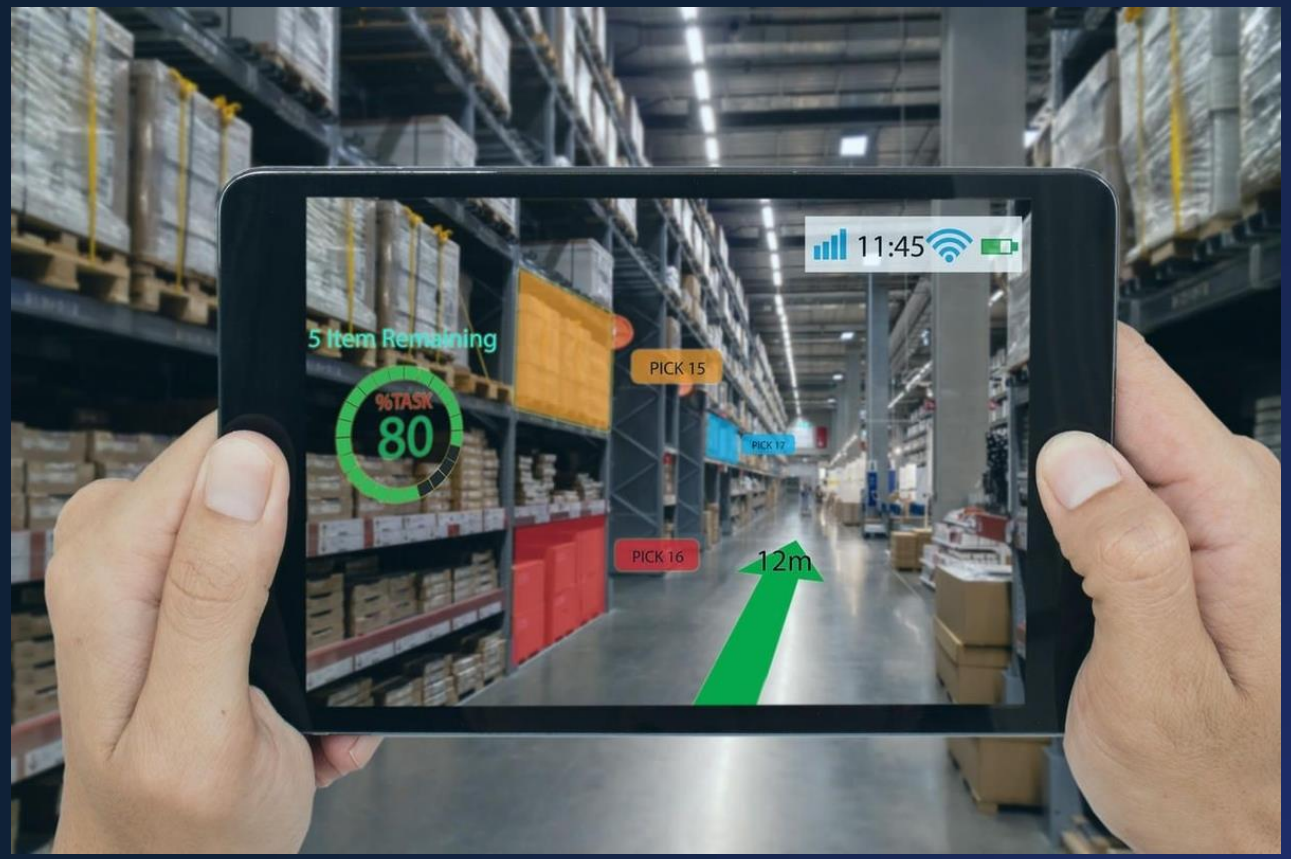
- Telecoms World briefing
- Subsea Cables
- The EllaLink cable Impact
- Latency is the new currency
- Questions

Network latency - Video and voice

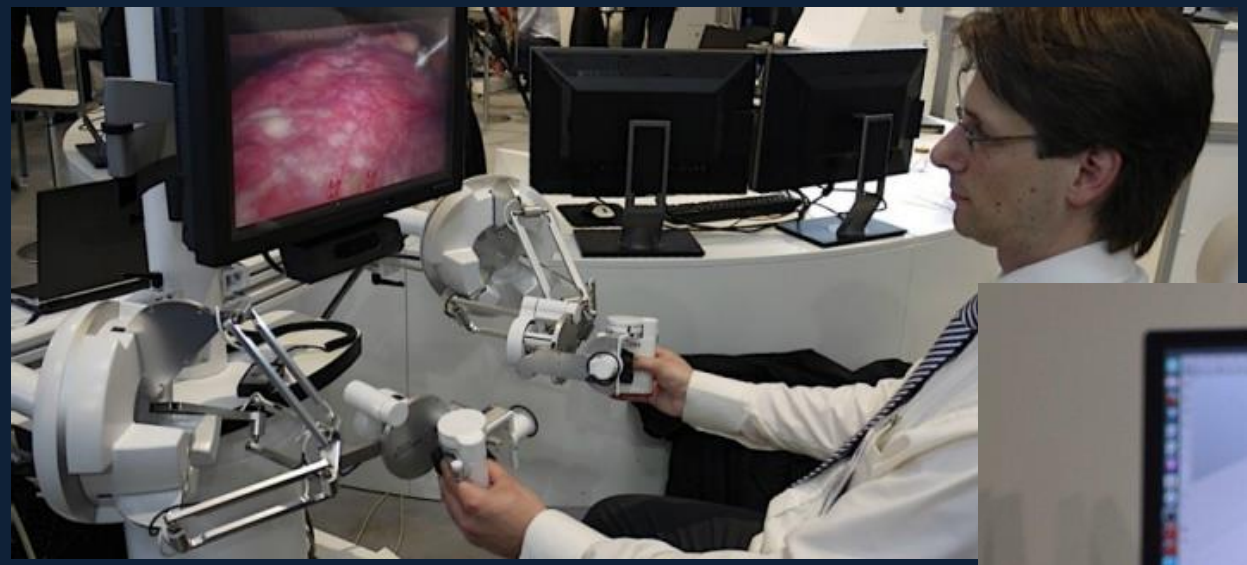
Network latency – Multiplayer gaming

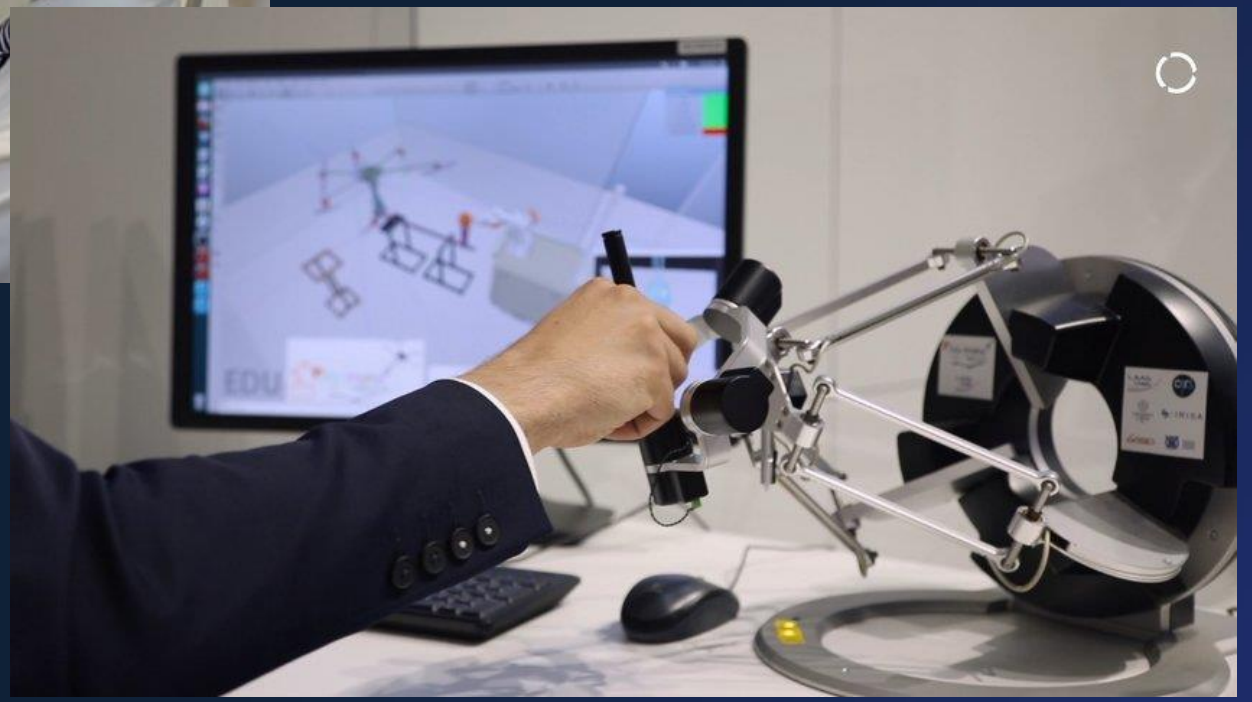


Network latency – Virtual & Aumented Reality

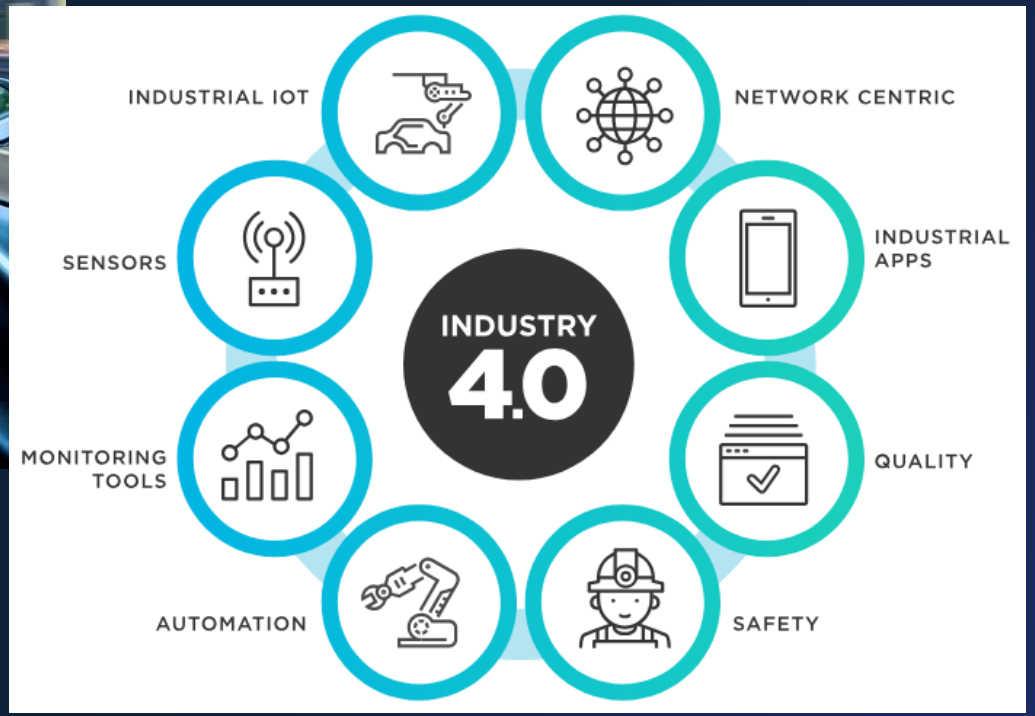


Network latency - Haptics applications

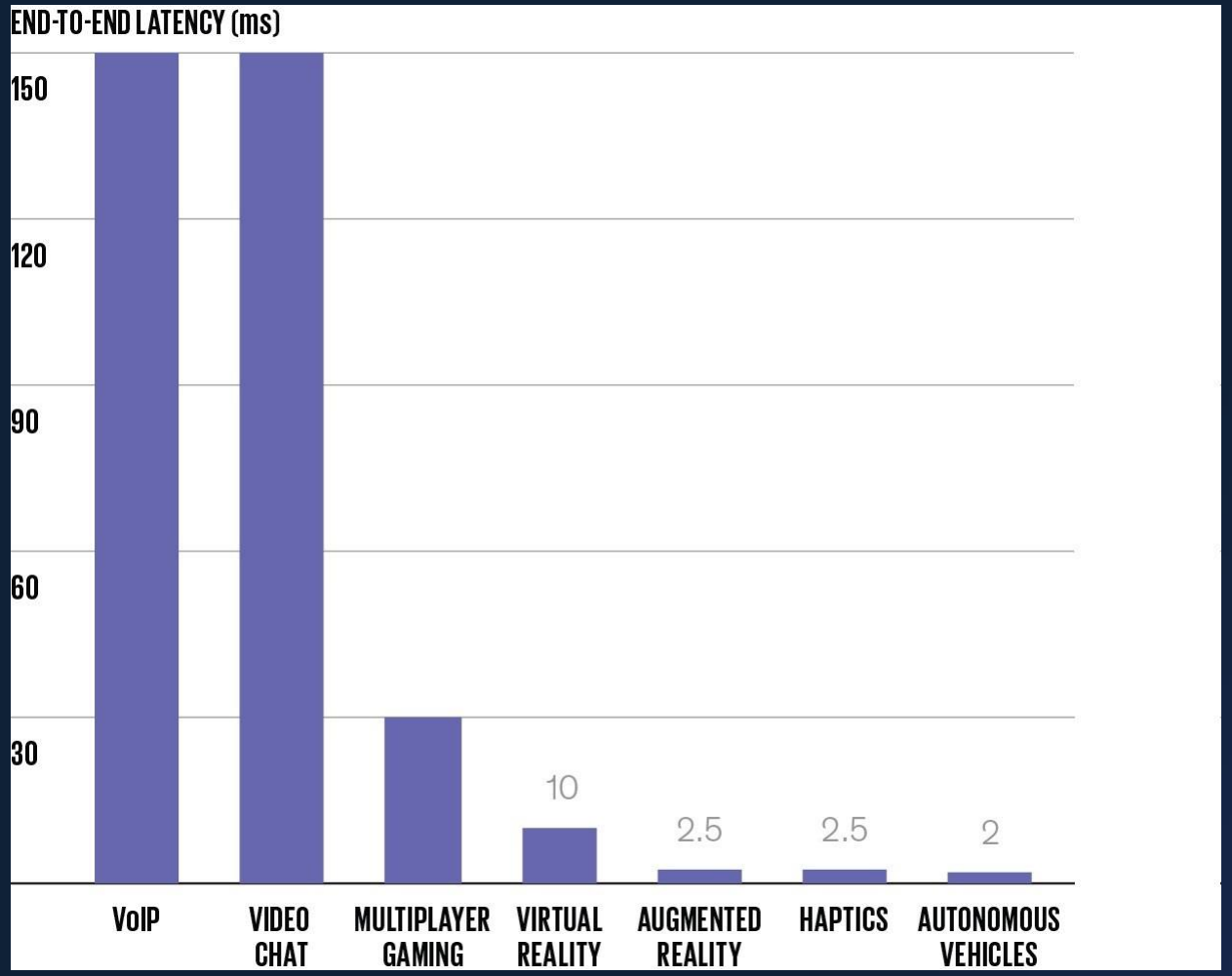




Network latency - The intelligent edge



Network latency - The Need



Agenda

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- Questions

EllaLink

SECURE

Direct access between Europe and Latin America reinforcing data privacy.

FAST

Up to 50% latency reduction between Latin America and Europe with direct City-to-City connectivity.

DIVERSE

Geographical diversity from existing submarine infrastructure.

OPEN

Carrier Neutral and Open Access operator.

European Broadband Awards 2022

EllaLink

Thank you - Gracias - Obrigado
Merci - 谢谢你 - اشكرك

+ 55 11 99461 9176

Rafael.Lozano@ella.link

ella.link