Advances in Long-haul Submarine Optical Transmission Infrastructure

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Outline

- LATAM/Brazil Bandwidth Market
- Subsea Infrastructure Design and Technology Update
- Unified Global Networks



LATAM/Brazil Bandwidth Market

TeleGeography's LATAM Bandwidth Review



"Strong regional demand, comparatively high prices, and a small number of competitors on existing systems have driven strong interest in new Latin American connectivity projects over the past few years".

BANDWIDTH PRICING REPORT DECEMBER, 2015: LATIN AMERICA BANDWIDTH REVIEW

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Supply and Demand

Submarine Networks

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Bandwidth Demand

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Latin American International Bandwidth Usage, 2010-2014



BANDWIDTH PRICING REPORT DECEMBER, 2015: LATIN AMERICA BANDWIDTH REVIEW

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Terrestrial Networks

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Pricing Trends

Latin American International Bandwidth Usage, 2010 to 2014



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Latin American International Bandwidth Usage, 2010 to 2014



Submarine cable operators added 6.6 Tbit/s of lit capacity in 2014 between LATAM and USA.

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Latin American International Bandwidth Usage, 2010 to 2014



In 2014, connection to North America accounted for 87% of the LATAM's total used bandwidth.

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10G Wave Price Q1 2011 to Q4 2015





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10G Wave Price Q1 2011 to Q4 2015





TeleGeography

10G Wave Price on Miami – São Paulo, Q3 2012 to Q3 2015





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10G Wave Price on Miami – São Paulo, Q3 2012 to Q3 2015





More Competition on Brazil – USA Route



- Existing cable systems:
 - AMX-1
 - GlobeNet
 - SAC
 - SAM-1
- Announced new cable systems:
 - Monet
 - Seabras-1
 - BRUSA

New Connectivity São Paulo to New York – Direct



Seaborn Networks completes total funding of US\$500 million for Seabras-1

Manufacturing commenced on first direct point-to-point subsea cable between New York City and São Paulo

Boston, MA, January 11, 2016 – Seaborn Networks announced today the completion of its US\$500 million project funding for Seabras-1, a new transoceanic subsea fiber optic cable system directly connecting points of presence (POPs) in New York City (US) and São Paulo (Brazil). All conditions to this project financing have been fully satisfied; debt and equity funds have been drawn.

Seabras-1, owned jointly by Seaborn and global private markets investment manager Partners Group, uses next-generation coherent technology to deliver high-capacity and low latency telecommunications for one of the fastest-growing transoceanic routes in the world.

New Route Brazil to Africa



Japan's Banks Provide Finance for Angola-Brazil Submarine Cable

Published on Saturday, 02 April 2016 08:33

According to Reuter news, the Japan Bank for International Cooperation (JBIC) said on Thursday it had signed a loan agreement with Angola's state-run development bank to finance the construction of an optical submarine cable system between Angola and Brazil, the South Atlantic Cable System (<u>SACS</u>).

The SACS spans 6,200 km (3,850 mile), connecting Sangano in Angola and Fortaleza in Brazil. The submarine cable system will be supplied and laid by NEC Corp.

JBIC and Sumitomo Mitsui Banking Corporation (SMBC) will provide \$109.7 million loan jointly. JBIC will provide \$65.8 million, SMBC the rest.

The SACS project was launched by Angola Cable. In Nov. 2014, Angola Cable <u>announced</u> it has signed supply contract with NEC to build the SACS. Due to tremendous drop on oil price in the past two years, oil-rich Angola faced difficulties to finance the SACS project. And the SACS project was been suspended.

New Route Brazil to Europe



TELEBRAS AND ISLALINK SIGN SHAREHOLDER AGREEMENT OF THE JOINT VENTURE THAT WILL BUILD THE SUBMARINE CABLE BETWEEN BRAZIL AND EUROPE

🕓 01 July 2015

🗣 Press Release 🛛 🗣 EQT Infrastructure II 🛛 🗣 IslaLink

Madrid, July 1st, 2015

Telebras S.A. and IslaLink S.L signed yesterday a shareholder agreement to create the joint venture that will be dedicated to launch and operate a submarine cable that will link directly the South American and European continents.

This joint venture is a Brazilian company which will be 35% owned by Telebras, 45% owned by IslaLink and 20% owned by a third Brazilian shareholder, which will be defined after the constitution of the company and before the construction of the cable.

The Project

International traffic demand in the region is growing at annual rates of over 40%, being the traffic to United States several orders of magnitude higher than that which goes straight to Europe. This is because today there is only a single cable connecting directly the two continents, which is already running out of capacity. The new cable will support the need for a high-capacity, direct connection between Europe and South America.

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Subsea Infrastructure Design and Technology Update

[Capacity – Reach] in Unrepeatered Links







6 1 9 100 Gbit/s 6 2 0 + km **6 1 9 +** km **1**

Trials With State Grid of China





World leading unrepeatered transmission demos: • 100G over 627 km / 101 dB • 10G over 645 km / 104 dB

Unrepeatered Technologies Also For Terrestrial Networks



Power Grids: Infrastructure Suitable for Optical Networks

- OPGW cable between transmission towers
- Not a telco network:
 - Long distances between intermediate ODF sites
 - Telecom sites maybe off the power grid
 - → Very long spans

Optical Repeater for Subsea Cable Systems Launched at Sub



Innovations: Mechanical Electrical **Optical**

Marine grade titanium. Compact, light and strong. Improved powering enabling Raman amplification. Modular optical design. Optical bandwidth increased by 50%. **Manufacturability** Flexible and simplified manufacturing process.

Optical Benefits from Raman in Repeaters



Better noise performance

- Lower nonlinearities
- Broader spectrum

Optical synthesizer for active gain tilt controller

Longer repeater spacing, longer reach
 Wider spectrum for higher capacity

Raman Repeater Bandwidth, Tilt And Noise Figure



- Bandwidth
 - Today: 50+ nm
 - Wider soon
- Tilt of ±2 dB possible

 Effective noise figure lower than 4 dB



Repeater Manufacturing (1/2)







Repeater Manufacturing (2/2)









Cable termination

Gimbal

Bend-limiter

Amplifiers

Housing

Wide Spectrum Repeater Loading

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Wide Spectrum Repeater Deployment

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Branching Unit Sea Trial

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New Technologies Enabling New Design/Functionality



Coherent technology in the dry plant:

- High spectral efficiency
- High line capacity (for both upgrades and new builds)
- Modular/adjustable parameters (modulation format, channel spacing, etc.) for meeting customers requirements more easily and faster
- High tolerance to PMD (key for upgrading old cable systems)

New Technologies Enabling New Design/Functionality



Repeaters

- New material (titanium), smaller form factor and lighter
- Wider spectrum, more dynamic behavior, better noise performance

Branching units

- Routing not only fibers, but also waves
- Reconfigurability for capacity configurations (required with higher focus on content delivery) and fault recovery



Unified Global Network

Are Terrestrial and Submarine Fundamentally Different?



- Technology has converged dramatically over the past few years... FEC, coherent, modulation format...
- Optical transmission is fundamentally the same. Actually, tranmission is easier over a wet fiber plant:
 - Uniform fiber type/vintage
 - Uniform span length
 - Zero optical connector loss
 - Lower margins
- The submerged equipment technology is specific.
- Operational aspects have differences.

One First Basic Requirement for Unified Network: Global Portfolio!

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Raman Reach and Capacity Across Core Networks



Multi-Purpose Optical Networking Platform

- Terrestrial backbone networks
 - Long reach, long spans
 - High capacity (Raman spectrum)
- Unrepeatered links
 - Ultra-long span
 - Land or subsea applications
- Repeatered subsea cable systems
 - Raman based repeaters for wide spectrum, long span, dynamic gain equalization









PoP-to-PoP Concept First Step of Convergence



- Direct, unified PoP-to-Pop, or DC-to-DC, connection.
- What is achievable today: optical network going PoP to PoP with 150 channels at 100G per fiber pair.



PoP-to-PoP Concept First Step of Convergence



Motivations

- #1, #2, ...: Cost of bandwidth! 2 interface cards instead of 6.
- Simplified operations
- Simplified management (one integrated network)
- Minimized latency
- Increased possibilities (e.g. OTN switching)

Three phases

- Additional performance to reach the PoPs/DCs
- Seamless optical and systems integration between terrestrial and subsea
- New wavelength functionalities

Convergence Terrestrial-Subsea



• The new World we live in:



- Only **ONE** core network
- Convergence of technologies for Hardware <u>and</u> Software

Convergence is Beyond PoP to PoP Interconnection



Terrestrial/Subsea Network Controller



- Convergence in features
 - Flexibility in subsea and terrestrial... networking is global.
 - Bandwidth in both... no bottleneck at a "border".
- Convergence in technology
 - Interface cards, coherent, FEC, etc.
- Need for volume to match cost point

New traffic patterns (e.g. east west between data centers) Unpredictable traffic demands and patterns

New players (e.g. OTTs)

Summary

- Global restoration scheme / strategy
- Subsea/terrestrial convergence needs:
 - Coherent technology (high channel rate over long reach)
 - Wide spectrum amplifiers over land and under water
 - Advent of ROADM under water
- Good for volume to match cost point!

• Subsea/terrestrial convergence required due to:





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Xtera will exhibit at SubOptic www.suboptic.org 2016



Maximizing Network Capacity, Reach and Value Over land, under sea, worldwide

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