Transforming next-gen optical networks with TIP's Cassini solution

Come learn how the industry collaboration deployment for the first disaggregated optical networks in Latin America. In the webinar, we'll introduce how telecommunication providers can increase its network capacities for major cities by deploying the new software-defined IP network based on the industry's first open optical packet transponder – Edgecore hardware with OcNOS® from IP Infusion, led the first trial by Whitestack in Latin America.

Speaker Introduction

TELECOM INFRA PROJECT

Dave Hutton
Chief Architect

Edge-corE NETWORKS

Matt Roman
VP of Product Management and Marketing

ipinfusion

Srikanth Krishnamohan
Director of Product Marketing

whitestack

José Miguel Guzmán
Sr. Network Consultant

Agenda

TIP Overview

Hardware Overview - Edgecore

Software Overview - IP Infusion

Deploying Cassini in the Real World - Whitestack

Q&A

TELECOM INFRA PROJECT

Together We Build, Test and Deploy

Telecom Infra Project

David Hutton

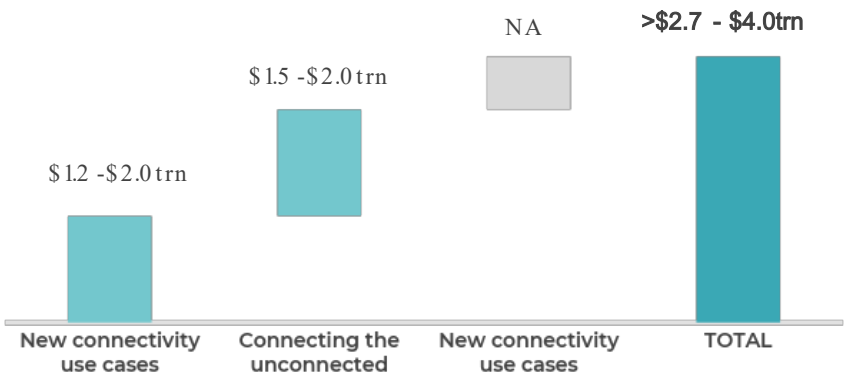
Chief Engineer, TIP

THE OPPORTUNITY

Improving connectivity will unlock substantial economic value

Connectivity has the potential to unlock substantial value

Impact of "advanced connectivity" on global GDP (2030E)[1]



4 selected domains :

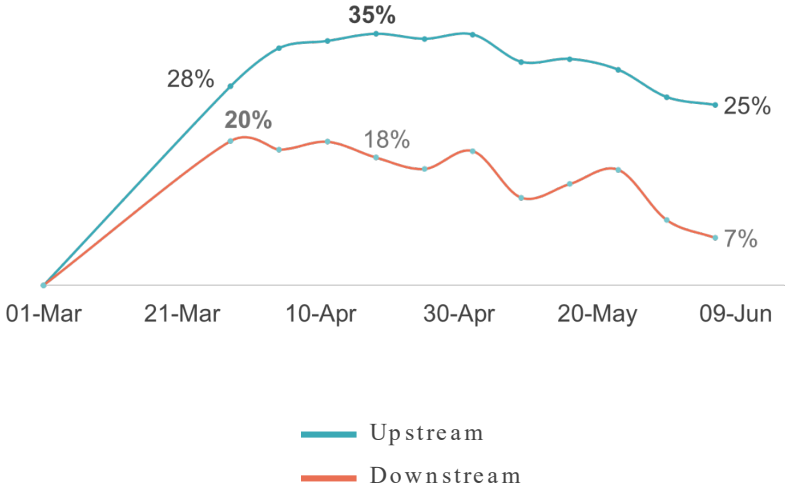
- Healthcare
- Manufacturing
- Mobility
- Retail

Enabling 1bn people to gain better access to digital information, tools & services

Other domains

COVID -19 is accelerating the need for better connectivity

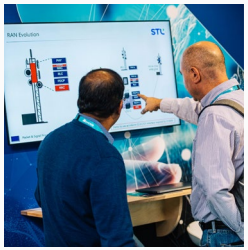
Growth in US consumer internet traffic (Mar-Jun 2020)[2]



1. Source: McKinsey Global Institute; 2. Source: NCTA







What is TIP?

Founded in 2016, TIP is a community of diverse members that includes hundreds of companies - from service providers and technology partners, to systems integrators and other connectivity stakeholders.

We are working together to develop, test and deploy open, disaggregated, and standards -based solutions that deliver the high quality connectivity that the world needs - now and in the decades to come.

Together We Build, Test & Deploy.

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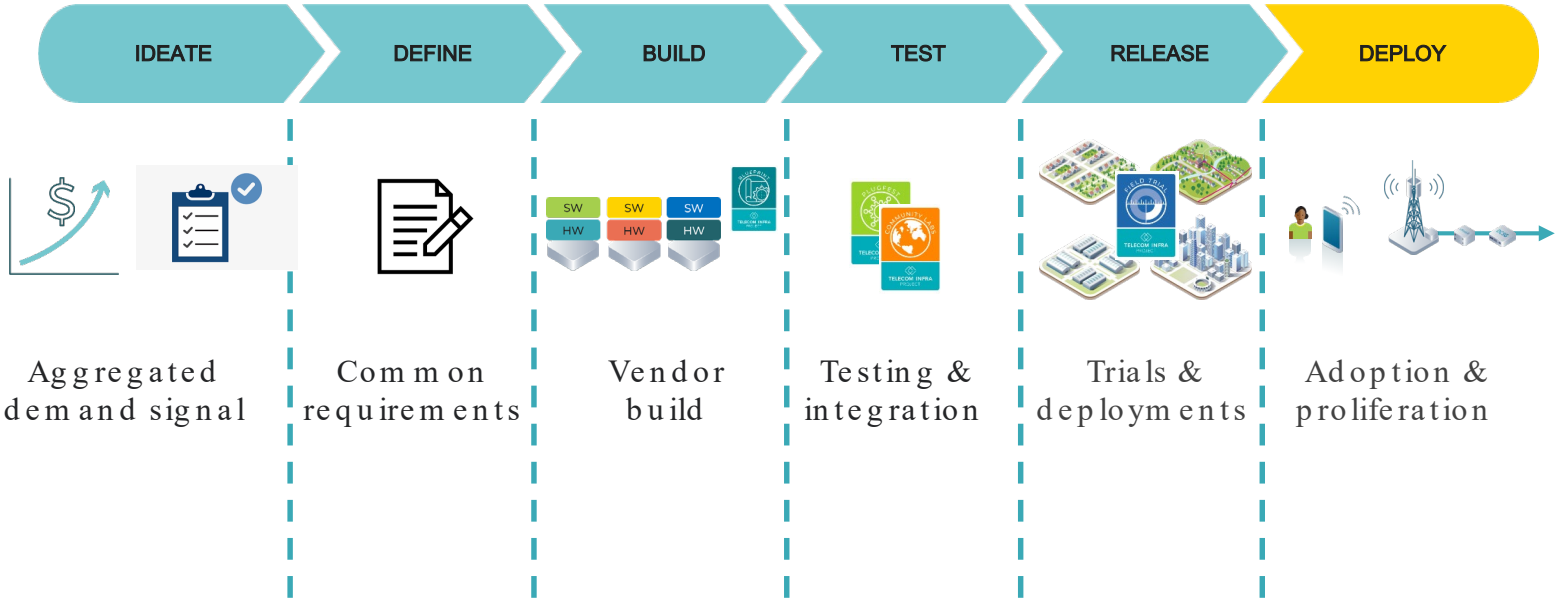
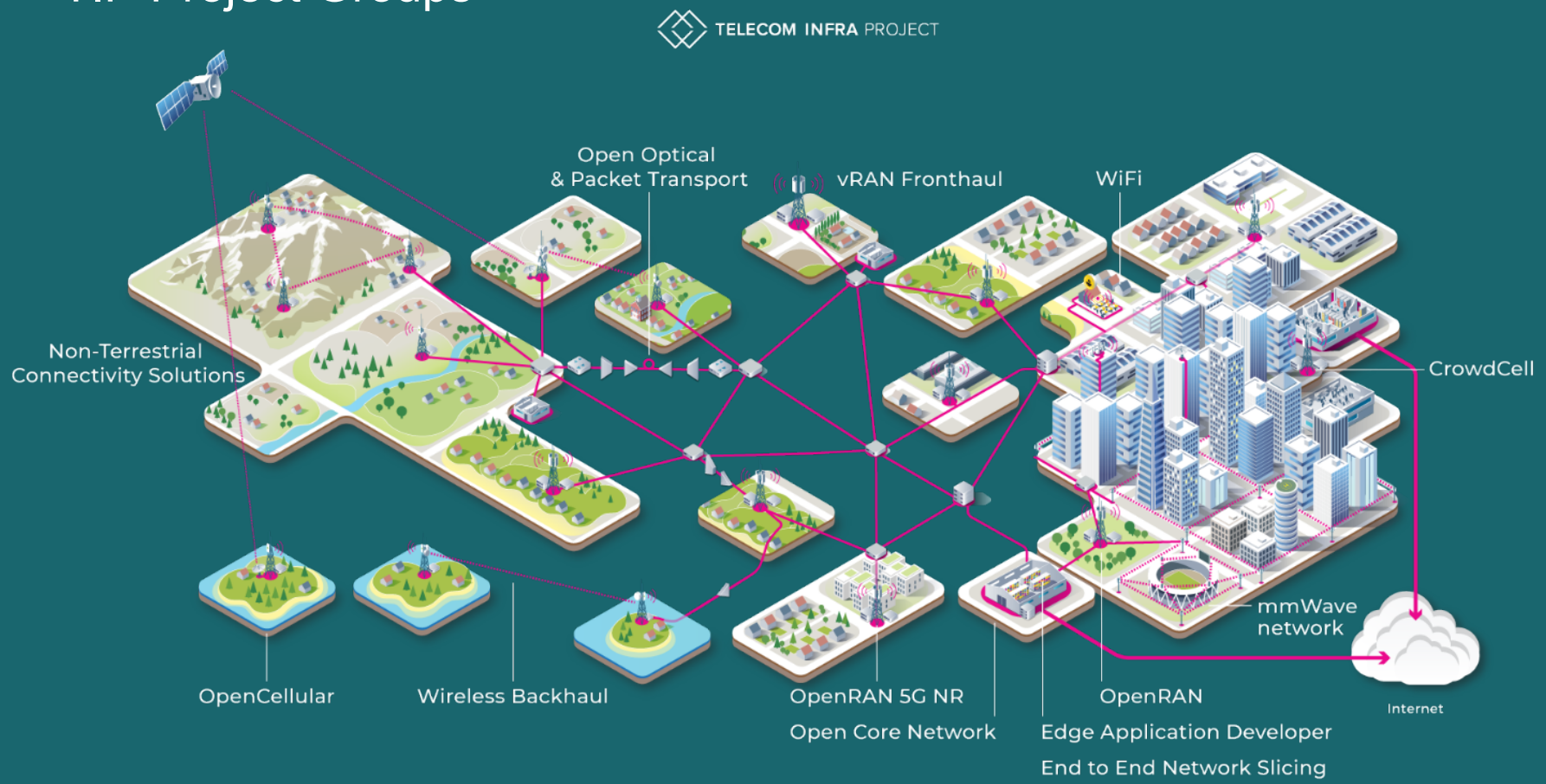
WHAT WE ARE BUILDING TOGETHER

To eliminate barriers and accelerate, we are working across all phases of the product lifecycle



TIP Project Groups



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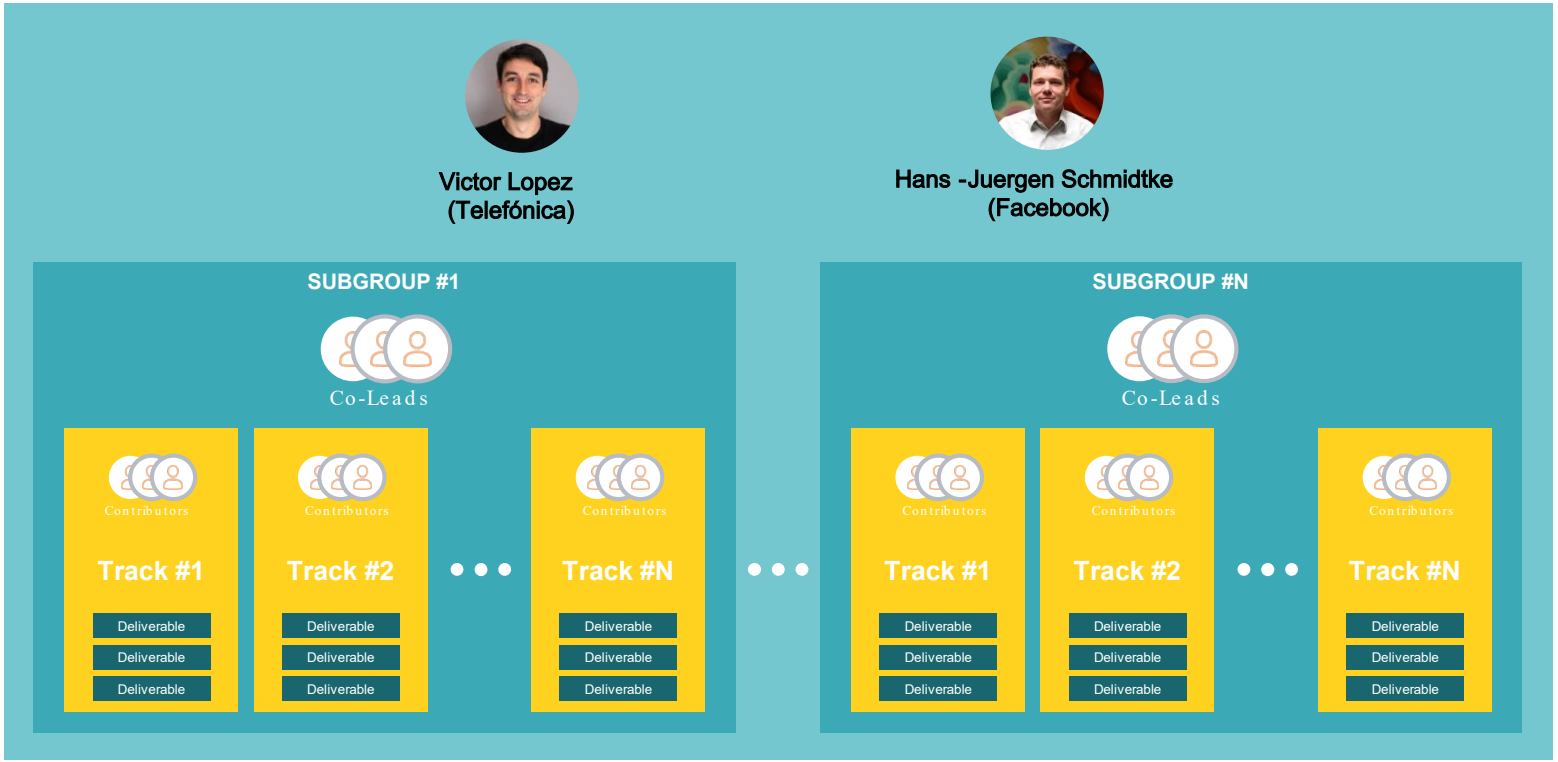
Open Optical & Packet Transport

Project group Structure



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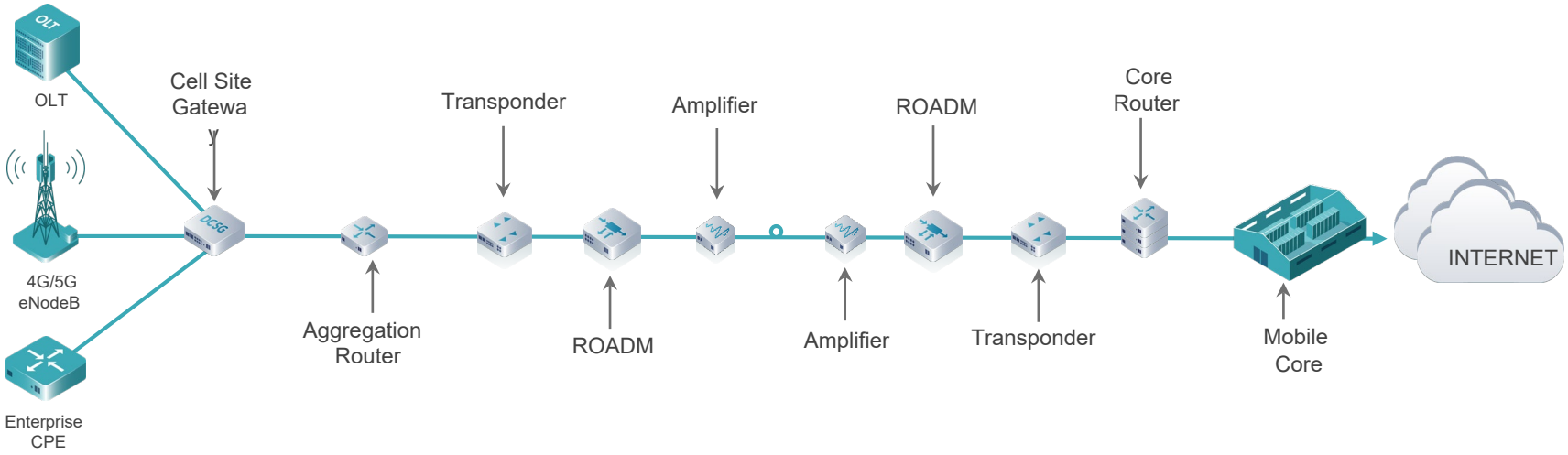
Open Optical & Packet Transport

Project group Scope



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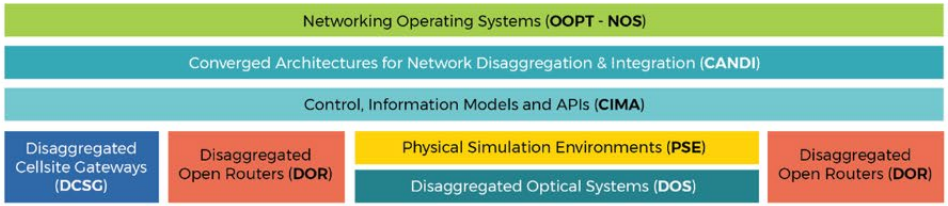
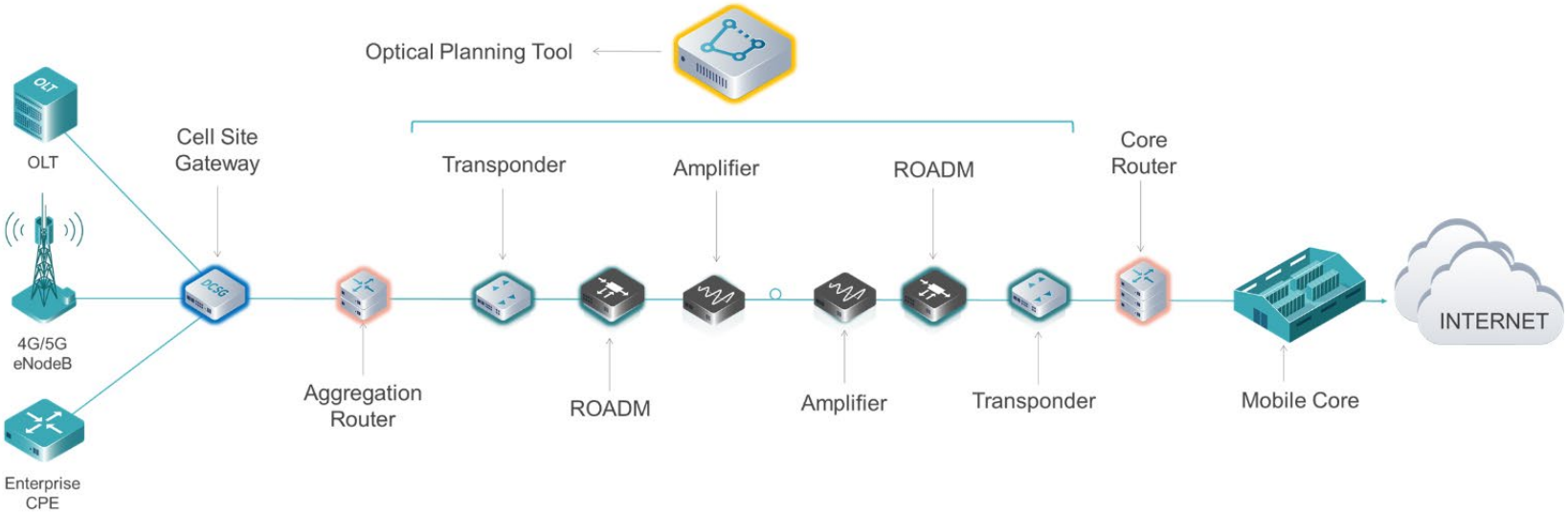
Open Optical & Packet Transport

Subgroups Overview



Current structure of the OOPT Project Group



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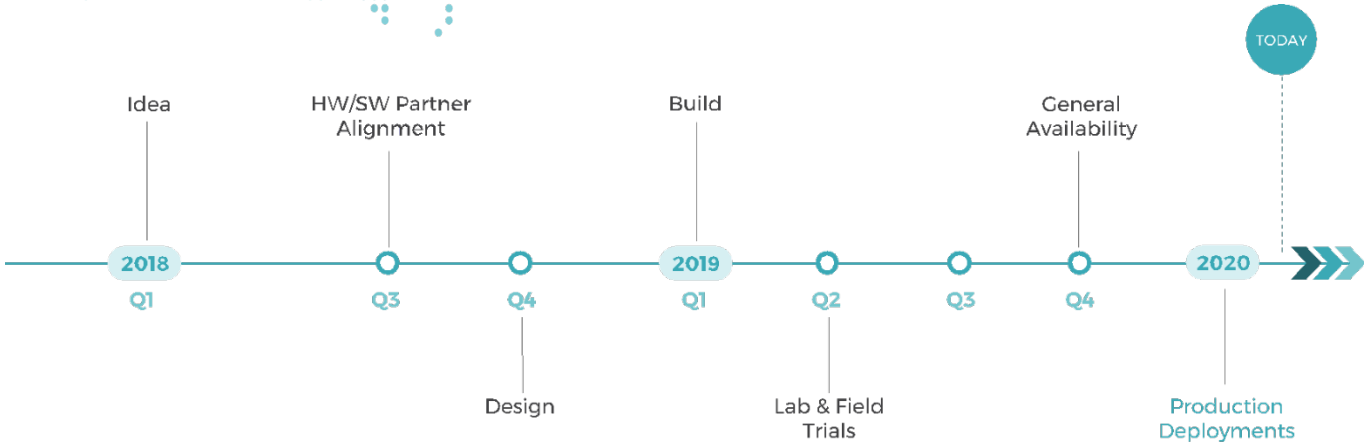
Cassini Open Packet Optical Transponder

The plan and Activities



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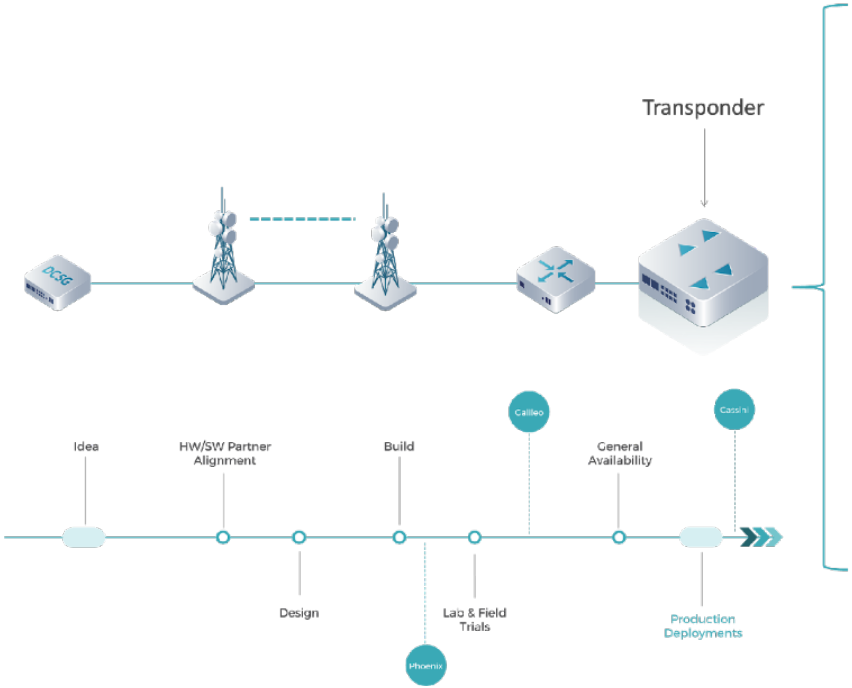
Disaggregated Optical Systems

Open and Disaggregated Transponders



CASSINI

GALLILEO

PHOENIX

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Cassini Hardware Overview

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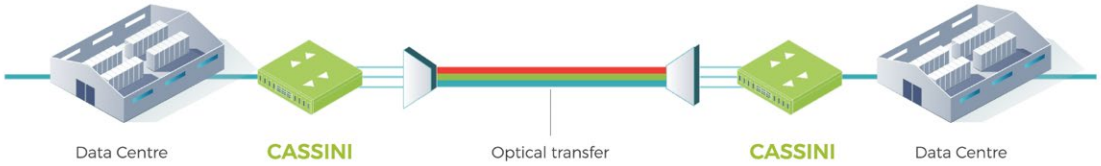
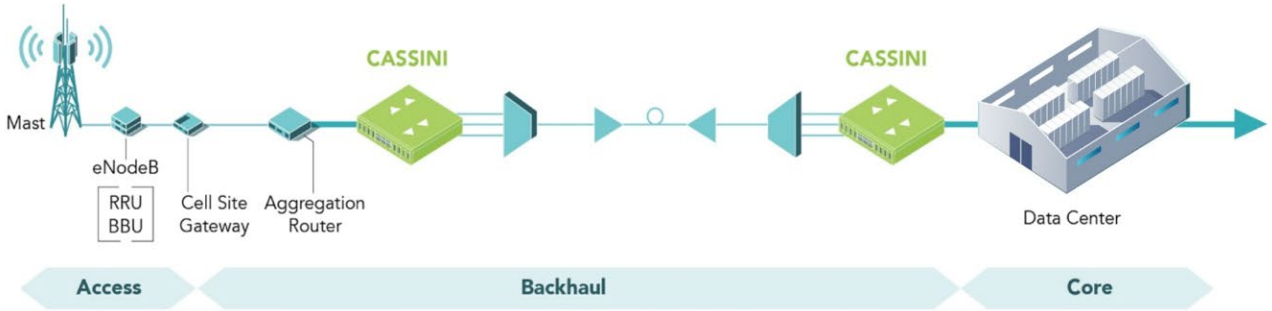
Cassini Use Cases

Data Center Interconnect



Service Provider Backhaul



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What is Cassini?

- Open Disaggregated Packet Optical Transponder
- High Performance Ethernet Switch with Coherent Optical Modules
- Modular “Pay as you Grow” Design
- Choice of CFP2 Optical Technologies from Multiple Vendors
- Choice of Commercial and Open Source Software Options
- Designed and Contributed to TIP by Edgecore

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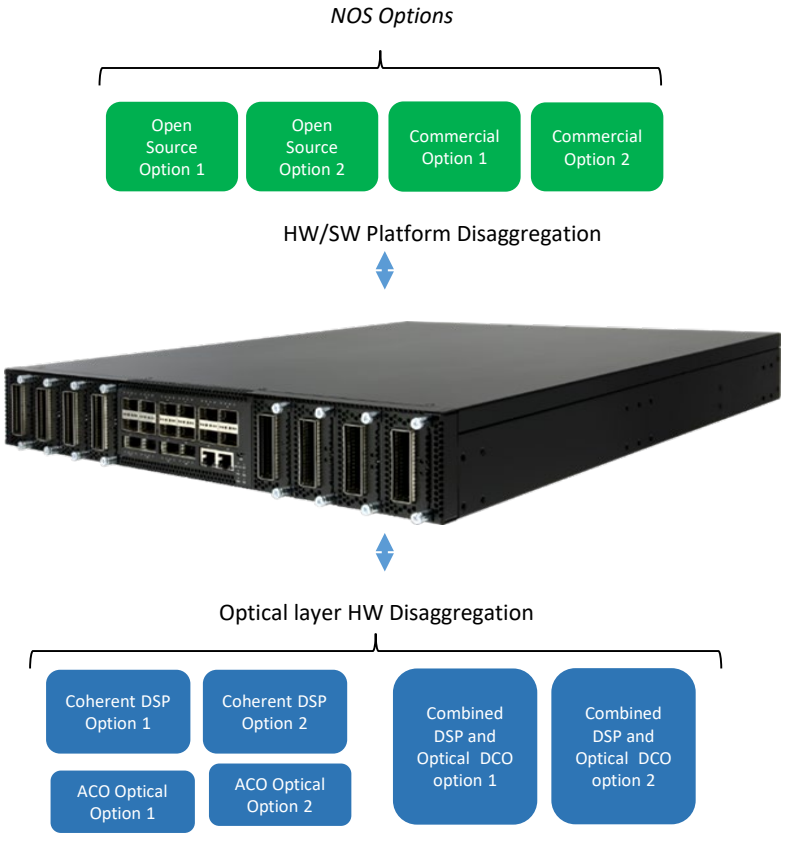
Cassini Overview

Cassini Disaggregation



Disaggregation between the hardware and NOS also disaggregation in the optical layer

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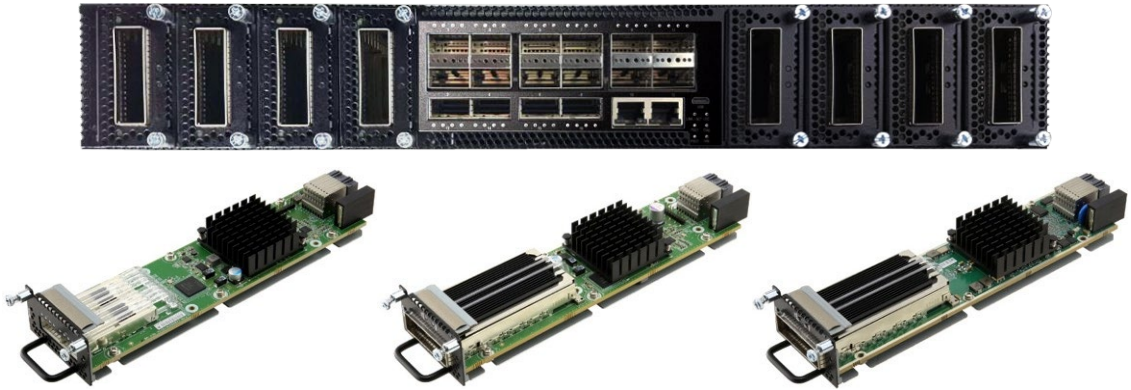
Cassini AS7716-24SC

- Integrated Switching and Layer 1 Optical transport functions
- 3.2 Tbps Ethernet Switch ASIC
- 16 100G Ethernet fixed ports
- 8 Module Slots for Ethernet QSFP28, DCO, or ACO Coherent Optics Line Cards
- x86 CPU



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Cassini Architecture

Broadcom XGS 3.2Tb/s Switch ASIC

Intel Broadwell-D1518 4-Core CPU
16GB DDR
32GB SSD Storage

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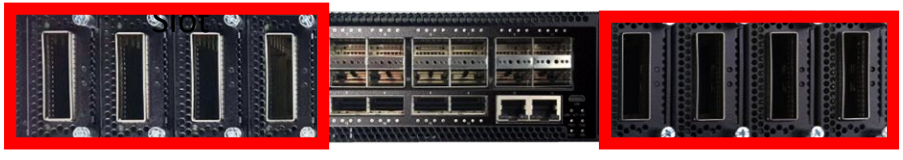
Cassini AS7716-24SC

50-Watt Power Budget per Line Card



3+1 High Power Redundant Fans
1+1 Redundant 1000W Power
AC and DC Options
0℃ to 45℃ Degree Celsius Operation
44.25 x 55.0 x 6.6 cm

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Cassini Client Side

- 16 x 100G QSFP28 Ports
- Each 100G QSFP28 Interface Supports
  - 1x100G
  - 4x25G
  - 1x40G
  - 1x40-to-4x10G

Client Side

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Cassini Line Side

- Dual 100G Ethernet with MACSEC
- 100G/200G CFP DCO with MACSEC
- 100G/200G CFP2 ACO
- Field Upgradeable
- Hot-Swap

Line Side

Line Side

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Cassini Line Cards

Ethernet Line Card
- 2x100Gbe
- MACSEC PHY with AES 256 Bit Encryption

Digital Coherent Optic (DCO) Line Card
- 1x 100G/200G CFP2
- MACSEC PHY with AES 256 Bit Encryption
- Optics - Lumentum

Analog Coherent Optic (ACO) Line Card
- 1x 100G/200G CFP2
- NTT Electronics ExaSPEED 200 DSP
- QPSK mode/100Gbps for maximum 1000KM
- 16QAM mode/200Gbps for maximum 200KM

CFP2 Pluggables
- Acacia
- Lumentum
- Fujitsu

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Cassini AS7716-24SC Software

- Ships with
  - ONIE
  - ONL/ONLP running with Broadcom SDK and NEL SDK
- NOS Options

OcNOS®

Stratum

Goldstone

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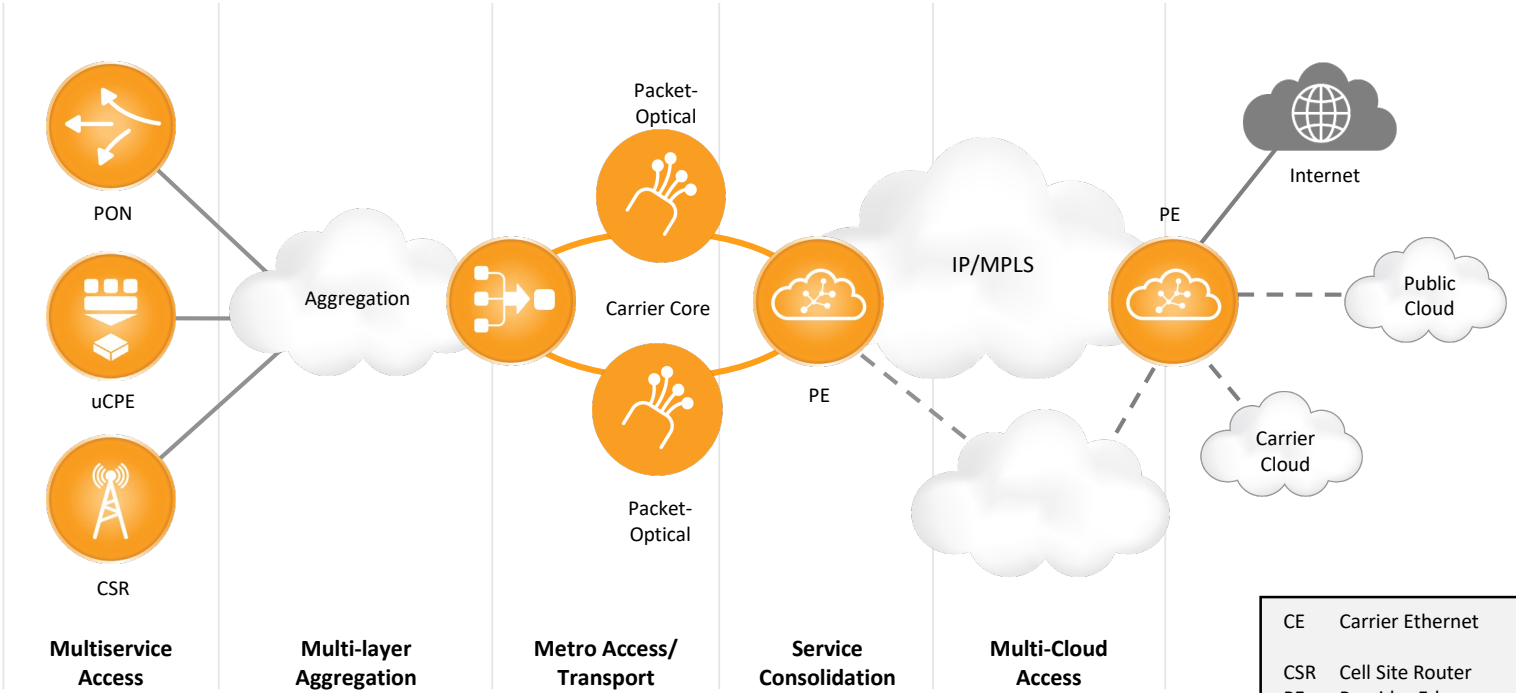
ipinfusion™
Accelerating Network Disaggregation

DISAGGREGATED PACKET TRANSPONDERS BASED ON TIP-CASSINI

IP Infusion: Common Platform, Variety of Use Cases



CE	Carrier Ethernet
CSR	Cell Site Router
PE	Provider Edge
PON	Passive Optical Network
uCPE	Universal CPE

IP Infusion Use Case

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Network Transformation and Trends

Trends & Challenges

On-demand, any-to-any connectivity
With 5G up to 1G bandwidth to every device

Network Edge is key to the transformation
Investing for higher bandwidth to the users

DCI Expansion and growth
Double digit bandwidth growth

Successful transformation requires efficient scaling of network capacity and better automation to reducing OPEX

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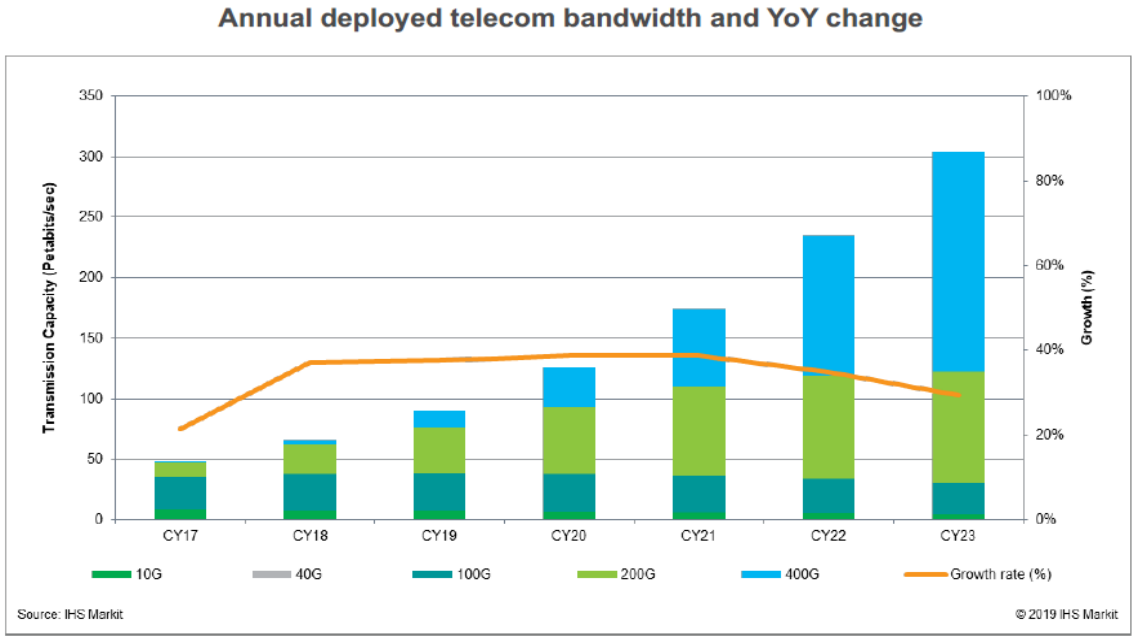
Bandwidth Growth

Telecom transceivers as proxy for bandwidth demand growth

- Historical YoY growth from 20–50% per year
- Modeling even conservative 20–40% growth drives need for 400G+ technologies to efficiently manage future network requirements
- 400G+ forecast to support ~ 50% of the deployed bandwidth by 2022
- 400G+ needed to reduce the cost per bit for coherent transport



Source: IHS Markit | Technology, now part of Informa Tech, Telecom Optics & Components Market Tracker; October 2019

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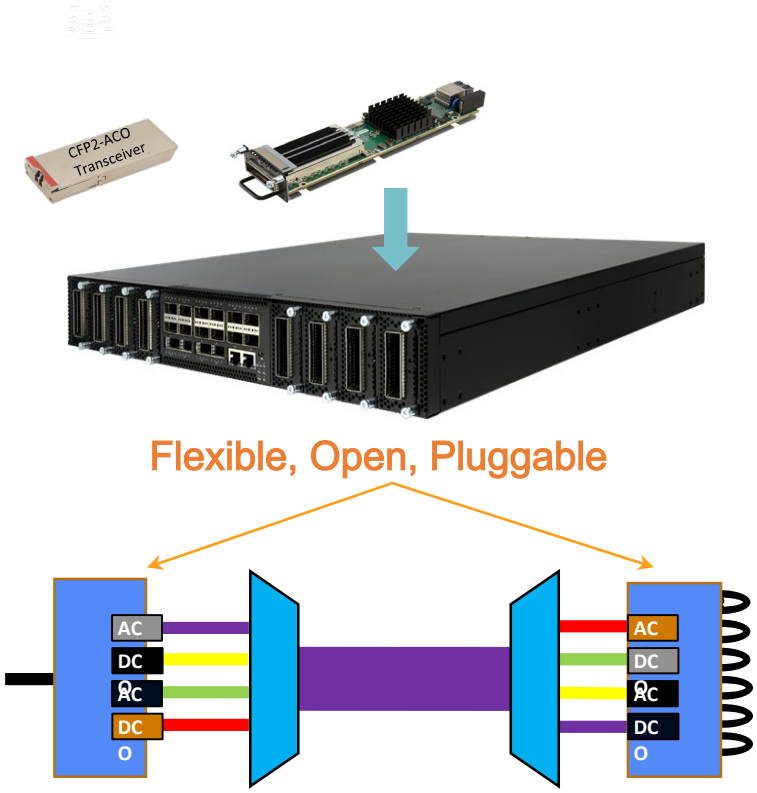
Disaggregated Optical Transport Solution – Ecosystem



Solution Ecosystem

Design and Validation: TELECOM INFRA PROJECT

Network Operating System: ipinfusion

Cassini Hardware: Edge-corE NETWORKS

Coherent Optics: LUMENTUM, ACACIA, FUJITSU FUJITSU OPTICAL COMPONENTS

System Integrator(s): whitestack

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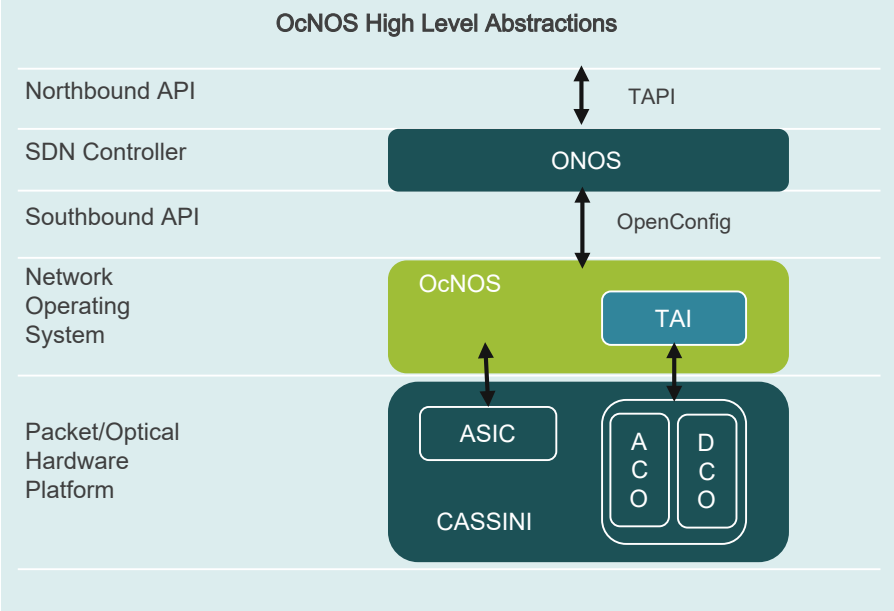
OcNOS: Optical Transport Network (OTN) – Solution Overview

- Optical transport for the following use case:
  - Data Center Interconnect
  - Backhaul of access edge services
  - Metro Ethernet services
  - Long haul using ACO with appropriate DSP
- Feature Overview
  - L1 cross connect for transponder use case
  - L2/L3 switch for packet transponder applications
  - Configuration, monitoring and debug of optical line
  - Open API and management interfaces
- Software SKUs
  - **OCNOS-OTN-IPBASE:** L2/L3 switching with transport
  - **OCNOS-OTN-XCONNECT:** L1 cross connect for transponder use case
  - **OCNOS-OTN-CFP2-WDM:** Pay-as-you-grow model



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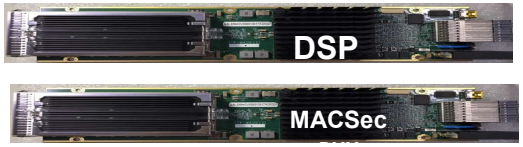
OcNOS OTN Key Features

Description	Features
Form factor	Modular chassis with Coherent pluggable cards. Choice of ACO or DCO optics. 200G or 100G DWDM
Distances	Metro to Longhaul 100Km to 1000Km+
NOS Features	OcNOS with comprehensive L2/L3/Multicast/VXLAN features or a L1 transponder design
Configuration	Modulation: DP-16QAM, DP-8QAM, DP-QPSK Output power (dBm) Frequency (Hz)
Monitoring	Current pre-FEC BER (bps), current post-FEC (bps) Current input power (dBm), current output power (dBm) Current frequency (Hz) Chromatic Dispersion and DGD counter on the OTN side
Debug and Alarms	PRBS – generator and checker Loopback – hostif and networkif PM Counters
Management and Automation	ZTP, Netconf/Openconfig, Telemetry
Supported CFP2 vendors	Lumentum, Fujitsu, Acacia

A Disaggregated Packet Optical Solution Offers Significant Value



REQUIREMENTS	FEATURES/Benefits
Performance and Footprint Optimized	• DSP • Photonic integration
Pluggable	• Pay-as-you-grow (PAYG) consumption model; defers capex when required • Allows service agility
Flexible	• Configurable operating modes: Modulation, FEC, output power, spectral shaping (Nyquist) • Application and capacity agility: 100G or 200G, metro, LH
Programmable	• Interface, API, Architecture • Standards-based, mature, commercially available hardware and software solutions • Reduces integration time and complexity; avoids proprietary vendor equipment locked-in
Interoperable	• Conformance to standards assures operators have multi-vendor, multi-source, supply continuity • Competition drives innovation and keeps costs in check

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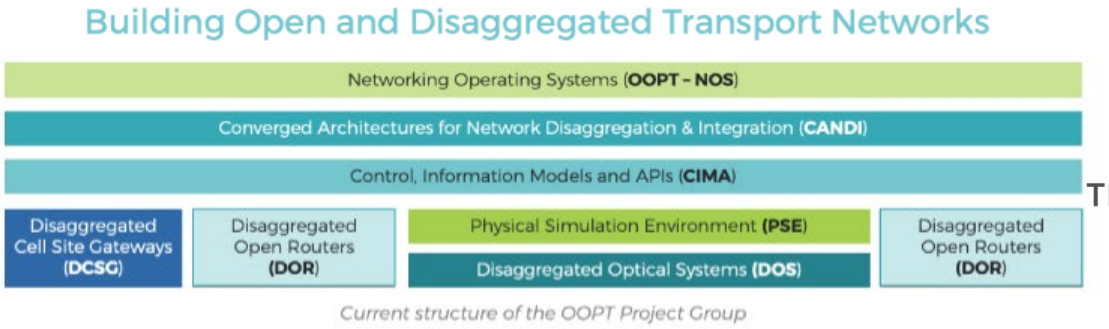
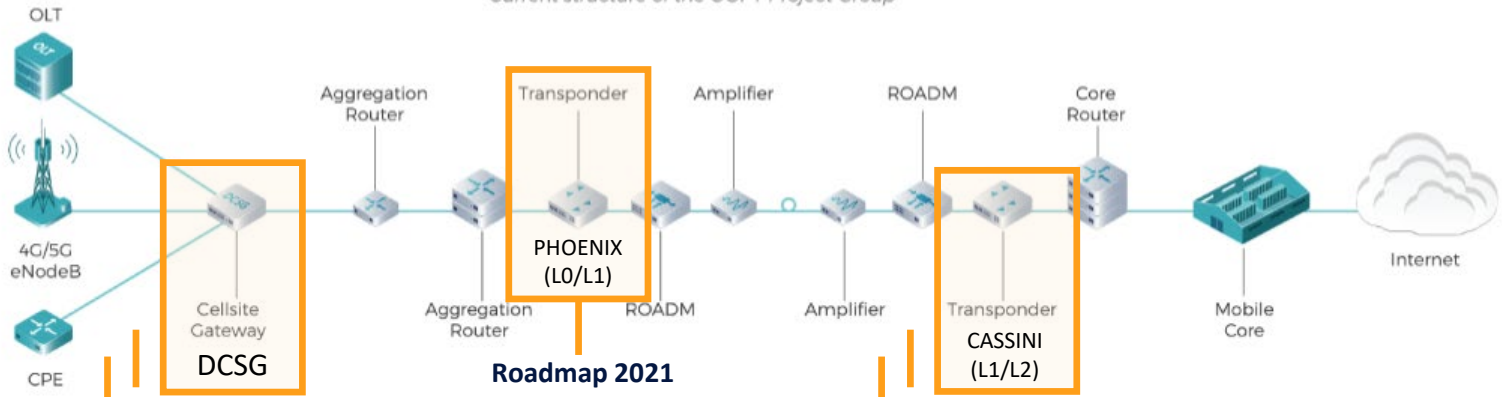
IP Infusion Contributions to TIP



TELECOM INFRA PROJECT



Fully compliant with DCSG specifications (Disaggregated Cell Site Gateway)

Roadmap 2021
Phoenix (400G Optical Transponder)

First production-ready NOS for Cassini (Packet-Optical Transponder)

IP Infusion Contribution

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Summary

- Growing bandwidth demand for new services will be increasingly met by optimized 100G+ WDM platforms.
  - DCI, enterprise services, fixed access, and mobile transport are all underlying drivers for optical transport investment
  - 100G will be the dominant speed by 2020, with 200G and 400G wavelengths ramping up quickly
- Operator driven initiatives to drive the roadmap towards partial and full disaggregation
  - Initiatives such as the OOPT from TIP driven by service providers
  - Move towards open standard interfaces for operational simplicity
- Take advantage of innovations on the photonics and coherent optical transport in a pluggable form factor
  - Modular optics enable Pay-as-you-grow (PAYG) consumption model; defers capex when required
  - Allows service agility

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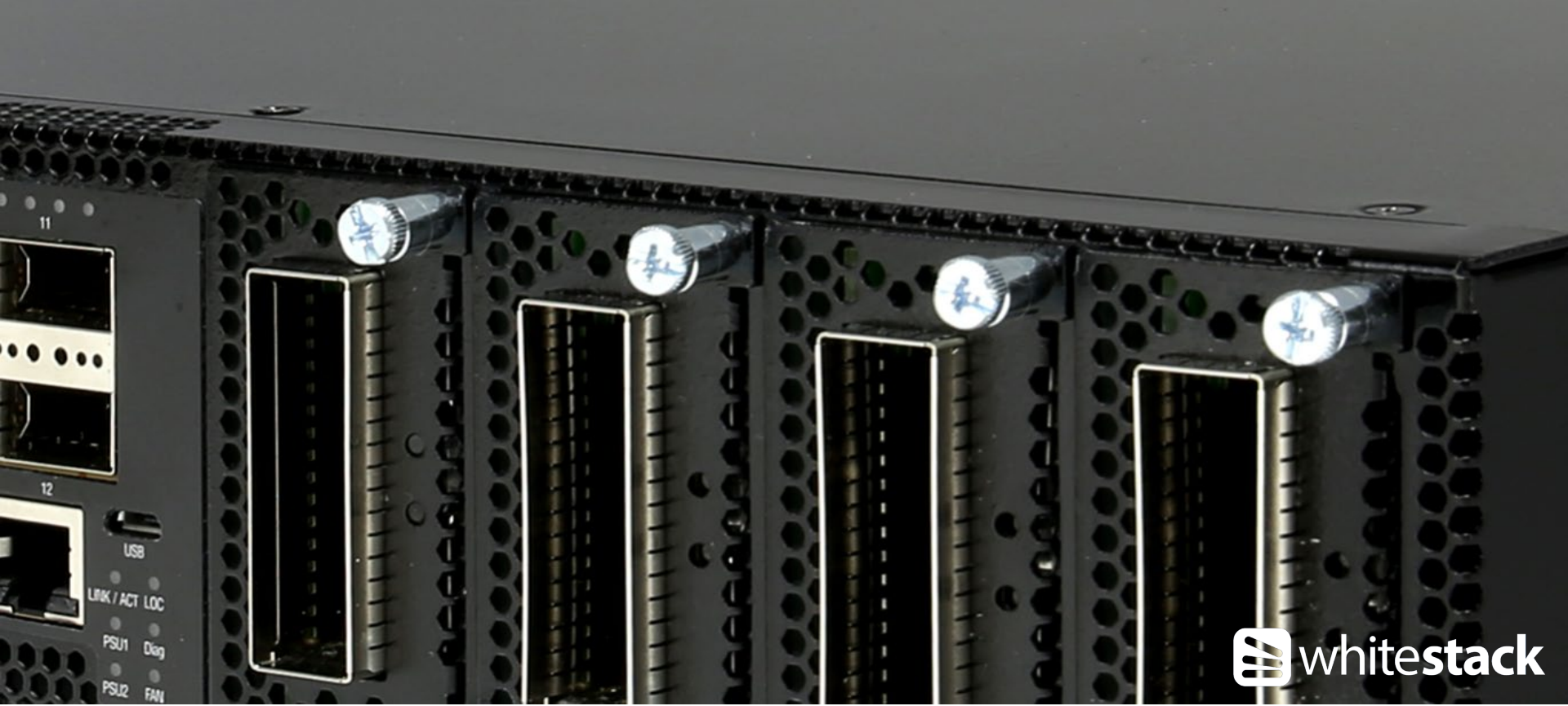
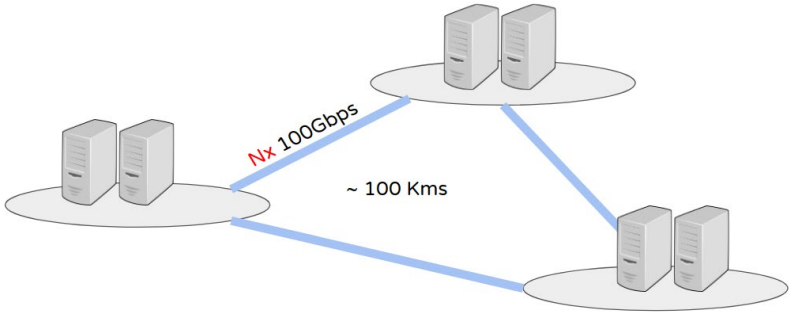


Deploying Cassini in the Real World

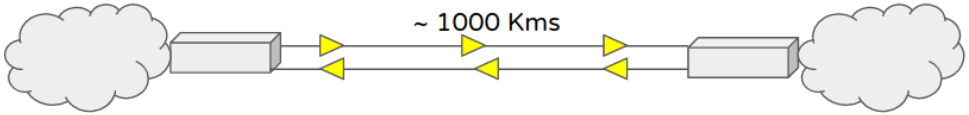
Takeaways from the first nationwide deployment

Use Cases

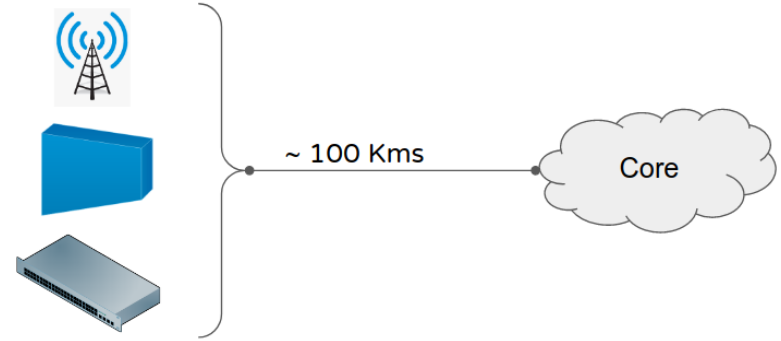
Metro Data Center Interconnect



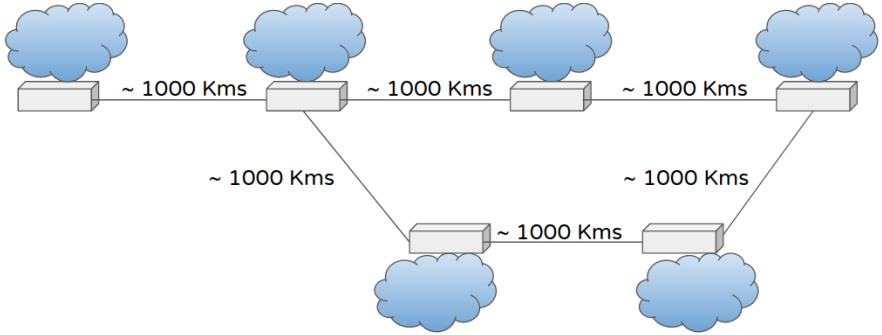
Long Haul



Backhaul



IP Backbone



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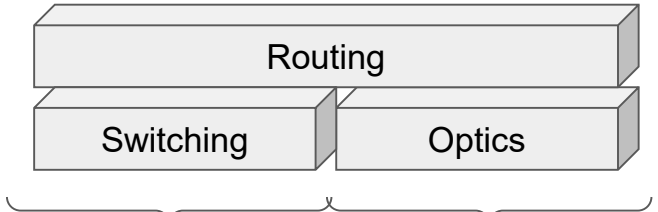
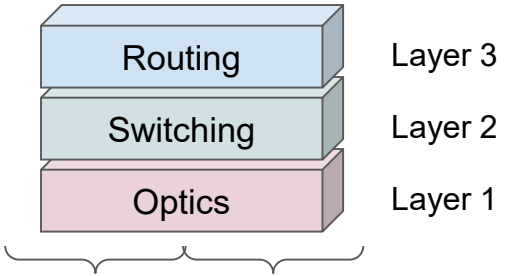
Collapsing the Network Layers

Traditional Multi Layer Model



Collapsed Model



3.2 Tbps

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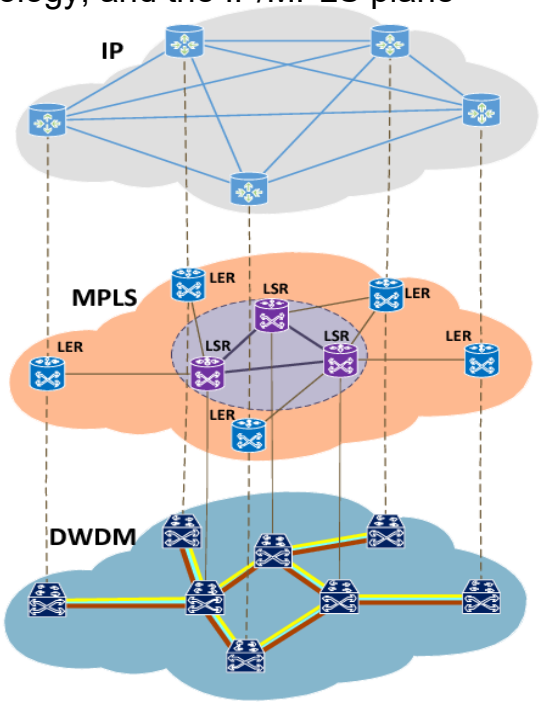
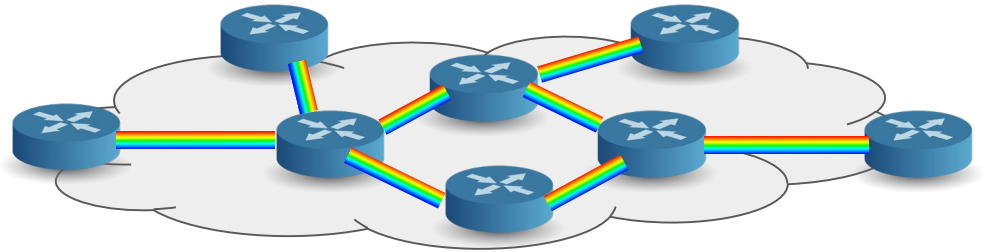
Benefit: Multi -Layer Optimization

In Traditional Networks, it is difficult to make routing decisions taking in account the Optical Topology, and the IP/MPLS plane



Evolution

By Collapsing the Layers, there is a single network, that can route based on traditional routing criteria.



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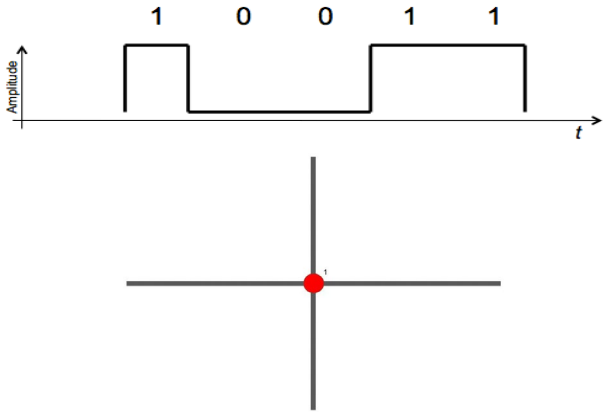
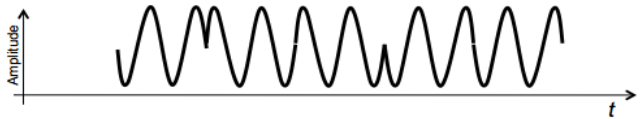
New Technology: **Coherent Optics**

Traditional NRZ Optics

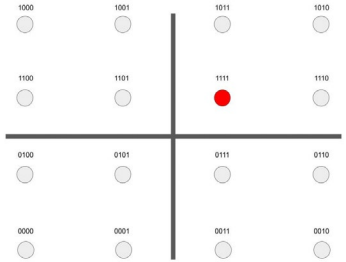


Evolution

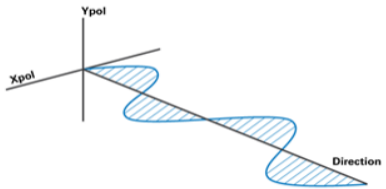
Coherent Optics



QPSK
8-QAM
16-QAM

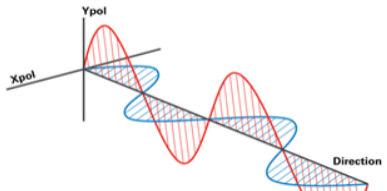


Single Polarization Signal



QPSK : 1 Baud = 2 Bits
16QAM : 1 Baud = 4 Bits

Dual Polarization Signal



DP-QPSK : 1 Baud = 4 Bits
DP-16QAM : 1 Baud = 8 Bits

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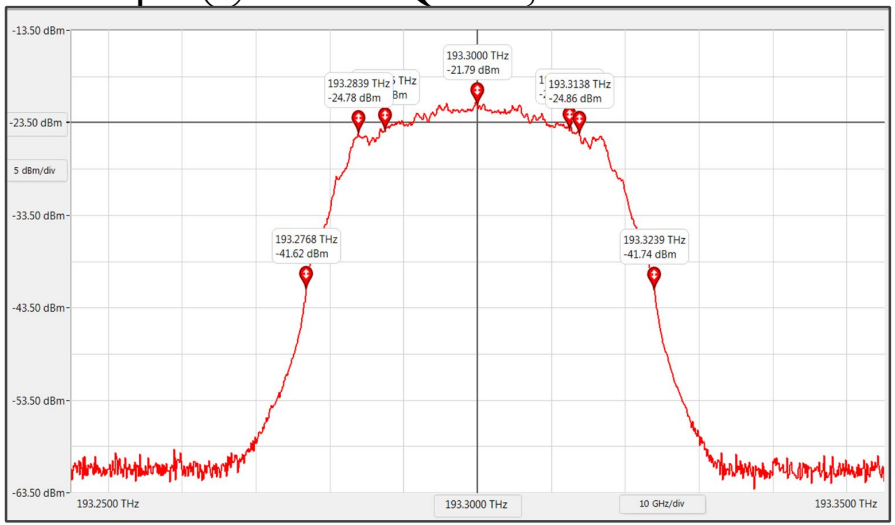
Higher Spectral Efficiency

200 Gbps @ DP-16QAM, within 50 Ghz



191.25 THz
. . .
196.10 THz

19.4 Tbps
Theoretical
Capacity

Modulación	DP-QPSK	DP-8QAM	DP-16QAM
Capacidad	100 Gbps	200 Gbps	200 Gbps
Bits/Baud	4	6	8
Bauds	34.5 GBaud	45 GBaud	34.5 GBaud
Bits/Hz	2.5	3.5	5.2
Ancho de Banda	40 Ghz	57 Ghz	38 Ghz

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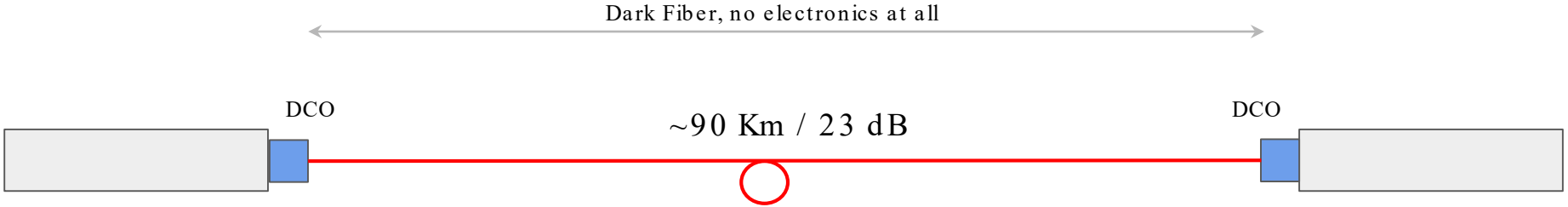
Real Case: Point -to -Point Dark Fiber

No Amplification



Modulation-format	:	dp-8-qam	Modulation-format	:	dp-8-qam
TX-Output-Power	:	3.00 dBm	TX-Output-Power	:	3.00 dBm
Current PRE FEC BER	:	**2.623478e-04**	Current PRE FEC BER	:	**2.623478e-04**
Current Input Power	:	**-19.97 dBm**	Current Input Power	:	**-19.14 dBm**
Current OSNR Estimate	:	38.50 dB	Current OSNR Estimate	:	38.50 dB
Current Q-Margin	:	3.90 dB	Current Q-Margin	:	3.90 dB
Current Uncorrected Block-count	:	0	Current Uncorrected Block-count	:	0

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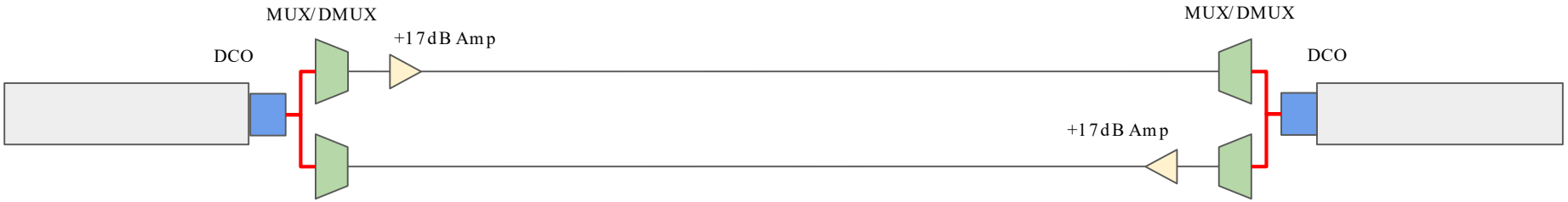
Real Case: **Amplified / Multiplexed**

Larger Distances



Modulation-format	:	dp-8-qam
TX-Output-Power	:	**-3.00 dBm**
TX-Laser-freq	:	**193500000 MHz**
Current PRE FEC BER	:	**1.083477e-03**
Current Input Power	:	**-11.81 dBm**
Current OSNR Estimate	:	**31.20 dB**
Current Q-Margin	:	2.80 dB
Current Uncorrected Block-count	:	0

Modulation-format	:	dp-8-qam
TX-Output-Power	:	**-5.00 dBm**
TX-Laser-freq	:	**193500000 MHz**
Current PRE FEC BER	:	**7.966043e-03**
Current Input Power	:	**-10.89 dBm**
Current OSNR Estimate	:	**34.40 dB**
Current Q-Margin	:	2.90 dB
Current Uncorrected Block-count	:	0

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Real Case: **Productive DWDM Network**

Network with Amplifiers and MUX/DMUX, shared with prod traffic

Tests on the Telefónica Network were published in a Paper.

Disaggregated Packet Transponder field demonstration exercising multi-format transmission with multi-vendor, open packet optical network elements

Geraldine Francia[1], Ryoji Nagase[2], Wataru Ishida[2], Yoshiaki Sone[2], Srikanth Krishnamohan[4] and Victor Lopez[3]

[1] *Telefónica del Perú S.A.A, Jr. Domingo Martínez Luján 1130, Lima, Peru (geraldine.francia@telefonica.com)*
[2] *Fujitsu Optical Components (FOC) America, Inc. 1280 East Arques Avenue, MS350 Sunnyvale, California 94085-4701, USA, (rnagase@us.fujitsu.com), [3]NTT Electronics America Inc., 250 Pehle Ave., Suite 706 Saddle Brook, NJ 07663, USA, (ishida@nel-america.com, sone@nel-america.com), [4]IP Infusion, 3965 Freedom Circle, #200, Santa Clara, CA (srikanthk@ipinfusion.com, lalit.kumar@ipinfusion.com, yogi.harsh@ipinfusion.com, [5] Telefónica Global CTIO, Ronda de la Comunicación 2, 28050 Madrid, Spain (victor.lopezalvarez@telefonica.com)*

Abstract: We demonstrate a field trial of 100G/200Gbps alien wavelength transmission and management onto a deployed line system (Telefónica del Perú nationwide field network) with disaggregated packet transponder, adopting multi-vendor CFP2-ACO / CFP2-DCO transceivers.

1. Introduction

Open networking and disaggregation are common trends in the industry. Open Compute Project (OCP) [1] and Telecom Infra Project (TIP) [2] are the two main activities that are impacting the industry. While OCP started with more focus on the data center, TIP is focused on TELCOs environments. Within the Open Optical & Packet Transport (OOPT) working group in TIP the Disaggregated Optical Systems sub-group has defined the network elements to achieve the goal of disaggregation offering wider choice to operators. The definition of packet/optical white boxes such as Voyager and Cassini enables the creation of a vendor neutral abstraction framework such as Transponder Abstraction Interface (TAI) [3], where pluggable manufacturers can test and integrate their solutions. Building on this foundation is the NOS layer which provides a uniform control, management interface for end-end service management.

Coherent optics for metro and long haul transmission traditionally have been integrated almost exclusively into proprietary network equipment manufacturers (NEM) systems, from L0/L1 optical transport systems, to L2/L3 Ethernet/IP switches/routers. As the trend continues towards commercially available packet optical network

3. Field Trial Results

Fig. 3 shows the summary of transmission test results for each configuration. RFC 2544 test was passed for 100G DP-QPSK 1250km transmission and 200G DP-16QAM 640km transmissions.

Site	Application	Module	Reach	Mod Format	Baud Rate	Tx OSNR	Rx OSNR	pre FEC BER	RFC 2544
WA2	LH - 100Gbps Protection Path	ACO	1250km	QPSK	33 Gbd	30.5 dB	15.8 dB	4.20E-04	Pass
TRU						31.5 dB	18.9 dB	1.05E-03	Pass
WA2	LH - 200Gbps Working Path	DCO	640km	8QAM	42 Gbd	30.5 dB	20.5 dB	6.50E-03	Pass
TRU						31.5 dB	20.1 dB	6.60E-03	Pass

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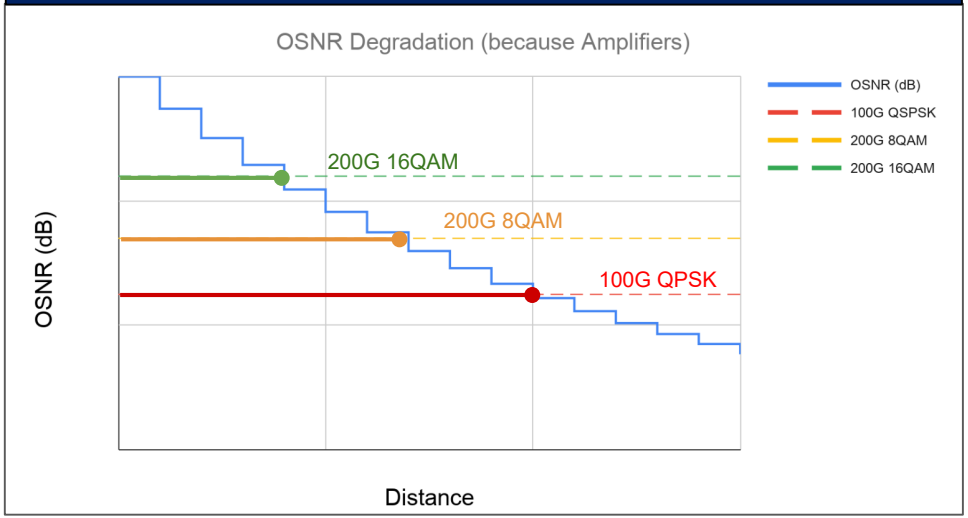
Long Haul Links, with no regeneration!

It is a matter of Signal Quality (OSNR)

You can Amplify the signal (let's say, indefinitely)

but, each amplifiers introduce Noise, that degrades the signal quality.



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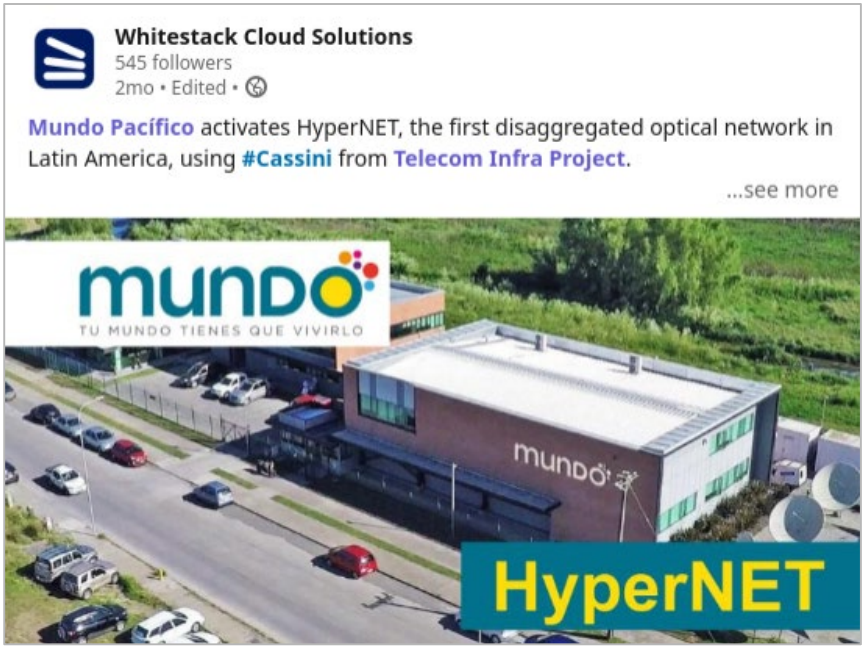
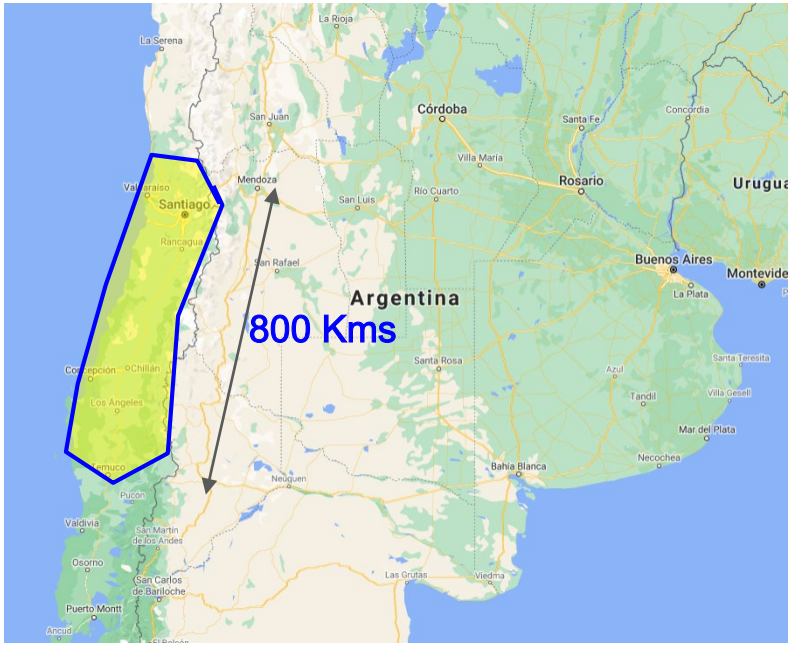
Deploying the Largest Cassini Network

Building the Next -Generation Mundo Pacifico Network, in Chile





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The components

ipinfusion™

ACACIA COMMUNICATIONS, INC.

LUMENTUM

CASSINI

DCO PIU

DC PSU

Edge-corE NETWORKS

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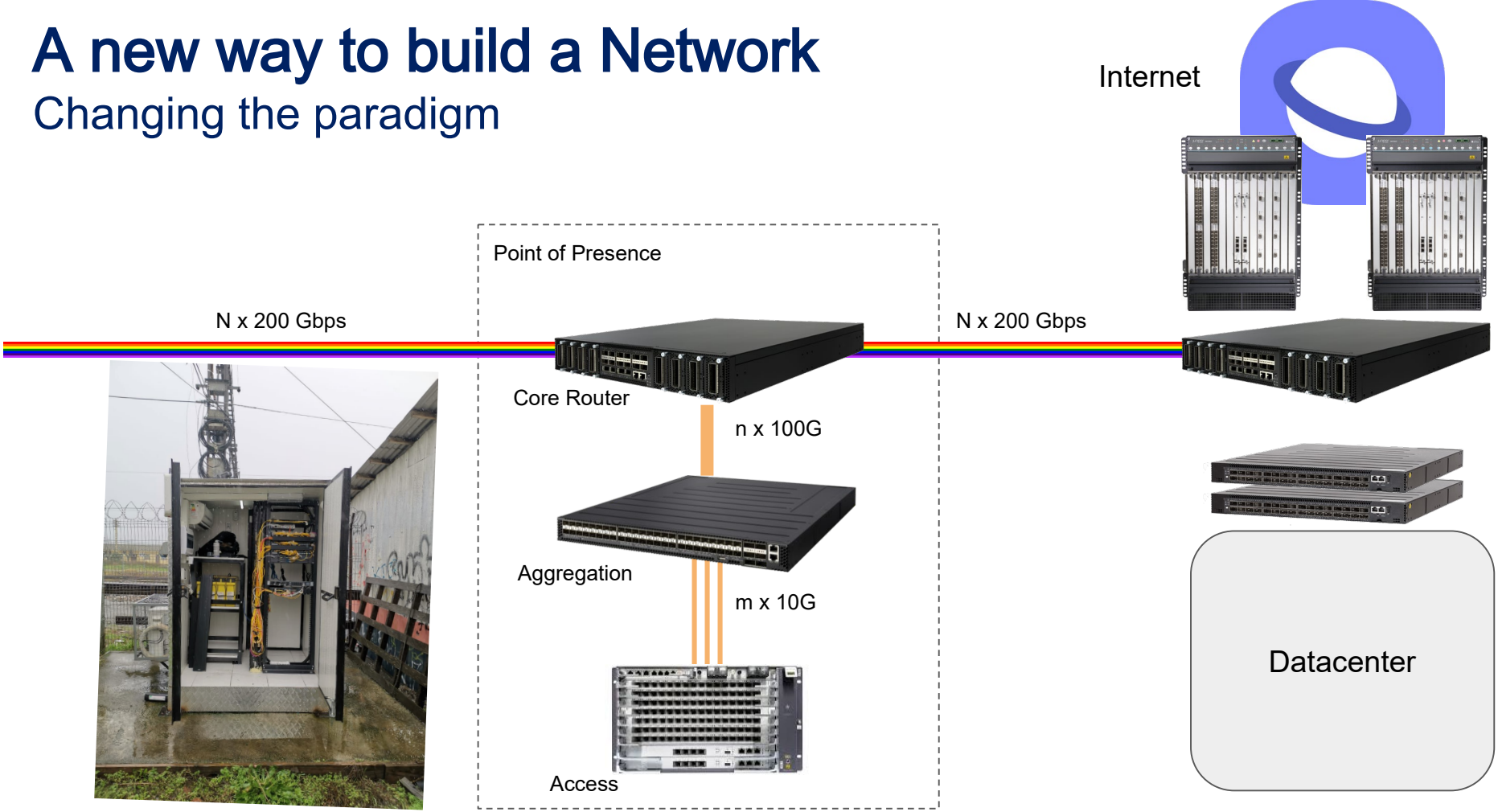
A new way to build a Network

Changing the paradigm



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Challenges!

Overcoming the obstacles!

Change of Paradigm

- Operators think in terms of layers!
- They are realizing the benefits of collapsing layers.

Technical Challenges

- Learning Optics (Power, BER, OSNR, ..)
- Optical Links auto recovery & monitoring

Logistics (during COVID times) - Initial delays

- Component Factories were closed!
- Airports were closed!
- Mobility Constraints!

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Summary

- **It works**
  - Open Networking, works in a production network!
  - Disaggregated Optics, works in a production network!
- **It is more efficient**
  - Energy
  - Space
  - Operationally
- **Not a Box, but an Strategy**

  Upcoming boxes:
  - Galileo
  - Phoenix

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Gracias!

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Q&A

Please use Question/Chat Box.

Thank you for joining us today