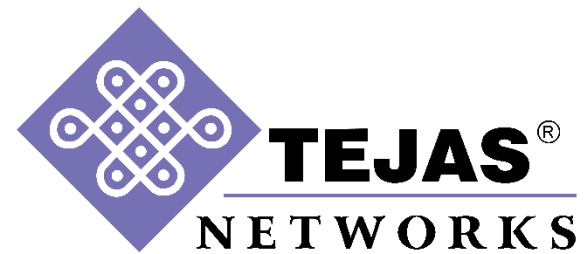




Tejas Networks Optical Products



Tejas Networks: A Snapshot



Vision: To be a Global top-tier Telecom and Networking Equipment Company

- Founded in 2000 and headquartered in Bangalore (India); publicly listed since June, 2017
- India's premier indigenous developer and manufacturer of telecom and networking equipment, both wireless and wireline
- Backed by Tata Group, India's leading multinational conglomerate



Products

End-to-End Wireless & Wireline Products

Wireless: 4G/5G RAN
(Baseband and Radios)

Wireline: FTTx, Optical
Transport and Switching



Applications

Mobile RAN and Backhaul

Wholesale & Enterprise
Bandwidth Services

Home and Business Broadband

Critical Infrastructure Networks



Business Success

Deployed in 500+ Networks
across 75+ Countries

Incumbent in all large public and
private telcos in India

Global recognition for innovation
and business excellence



People

1900+ Employees with >60%
in R&D; 440+ patents filed

Multi-disciplinary skillsets in
hardware & software

Top-3 R&D spender** among
public cos in India

Global Presence



★ Global Offices

Global Customer Success

900,000+
Systems Shipped

500+
Networks

75+
Countries

OEM Partners



Americas



EMEA



South East Asia



SAARC

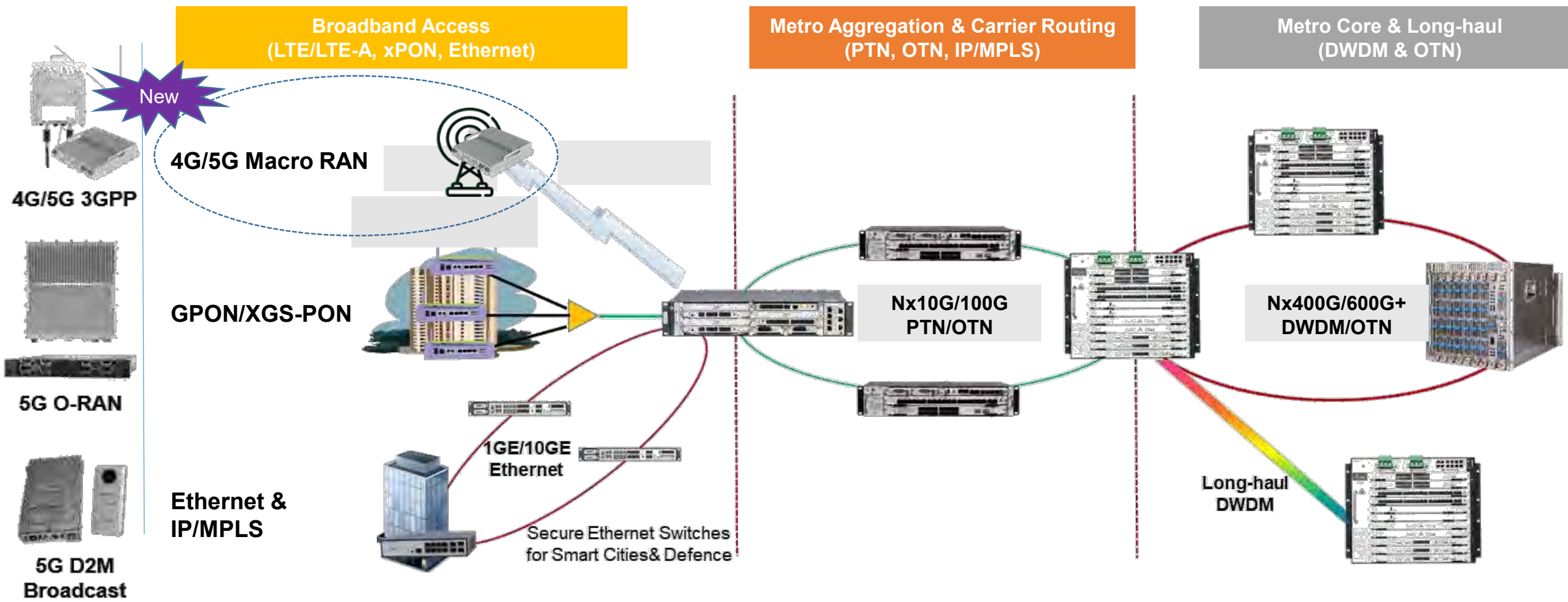


India



Product Portfolio

Universal, SDN-ready Network Management System (NMS)



- **Wireline**: Optical Transmission, Broadband Access of Fiber (FTTX), Secured Ethernet Switches
- **Wireless products**: RAN -5G, Broadcast, Satcom, 4G-LTE for Fixed Broadband and Mobile Networks

PTN Portfolio

Configuration

Feature

TJ1400P-D



4x10G + 8xGE (O) + 8xGE (E)
CEM: E1/DS1, STMn/OCn

1U, Env Hardened -40 to +65 Option
64G CE & MPLS-TP

TJ1400P-4X*



4x10G + 12xGE (O) + 4xGE (E)
CEM: E1, STMn

1U, Env Hardened -40 to +65 Option
64G CE & IP MPLS

TJ1400P-H



3x100G + 28x1G/10G
4x25G
CEM: STMn

1U, Env Hardened -40 to +65 Option
300G CE, MPLS-TP & IP MPLS

TJ1400-7



1G/10G/100G,
CEM: E1/DS1/DS3, STMn/OCn

2U, Env Hardened 0 to +60 Option
CEF4: 64G, CE, MPLS-TP
CEF8-1: 300G, xPON, CE, MPLS-TP, IP-MPLS

TJ1400-13



1G/10G/100G

5U, Env Hardened 0 to +60 Option
CEF8-1/1A: 300G, CE, xPON
CEF10: 1.2T

TJ1400-18



1G/10G/100G
CEM: STMn
200G/400G

7U, Operating Temp 0 to +50 Option
CSC1: 1T, CE, xPON, MPLS-TP, IP-MPLS
CSC2: 3.2T

Enterprise Switch Portfolio

Configuration

Feature

TJ1400P-M1



Front access 8 port 1/2 RU
Front access 16/24 port 1RU
16K MAC, Front PSU

Fully managed Line Rate L2/L3
Optical/PoE/UPOE/Non-PoE
MACSec variant
Optional Industrial Grade variant

TJ1400P-M2



24P/48P
16K MAC, PSU (FRU)

Fully managed Line Rate L2/L3
Optical/PoE/non-PoE
MACSec variant
Stackable with uplink/dedicated ports

TJ1400P-M3



24/48/24 (O) +24 (E)
4x 1/10G uplink + 4x10G Breakout
2 QSFP+ Stack Ports
2 FRU PSUs, 3 FRU Fan modules

L3 Feature set
600+ Gbps Switching Capacity
400Gbps Stacking

TJ1400P-H



28 x 1G/10G
3 x 100G

Carrier Grade Switch
L3 feature set

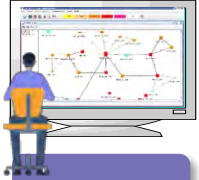
TJ1400-18



128 x 1G
50 x 10G
6 x 100G

Carrier Grade Redundant modular Switch
Long-Range 100G support
L3 feature set

xPON OLT Portfolio



UNIFIED
EMS
TJ5500

		Configuration	Feature
Small Pizza box OLT	<p>TJ1400-1-G4 TJ1400-1-G8/G16 TJ1400-1-C8/C16</p>	<ul style="list-style-type: none"> • GPON 4 port 1 RU (HD <250 mm) with 1G SNI • GPON 8/16 Ports in 1RU (HD <300mm) with 1G/10G SNI • XGSPON/Combo-PON 8/16 in 1RU (<250mm) With 10/25/100G SNI 	<ul style="list-style-type: none"> • 1U, Op Temperature 0 to +60°C • 8/16 with -40 to 65°C option • 8/16 Port redundant FRU Power supply & FRU FAN
Compact Redundant OLT	<p>TJ1400-7 OLT</p>	<ul style="list-style-type: none"> • 32 x GPON 	<ul style="list-style-type: none"> • 2U, Op Temperature: 0 to +50°C • Redundant Control & Power Card • CEF8-1 (5x10G: SNI)
Mid-range Redundant OLT	<p>TJ1400-13 OLT</p>	<ul style="list-style-type: none"> • 64xGPON • 64GPON+16XGSPON • 64COMBO PON 	<ul style="list-style-type: none"> • 5U, Env Hardened 0 to +60°C Option • Redundant Control & Power Card • CEF8-1 (5x10G SNI)
Scalable OLT	<p>TJ1400-18 OLT</p>	<ul style="list-style-type: none"> • 128xGPON • 128GPON+32XGSPON 	<ul style="list-style-type: none"> • 7U, Op Temperature: 0 to +45°C • Redundant Control & Power Card • CSC1 (20x10G, 2x100G SNI with 2xCSC1)

xPON ONT Portfolio

GPON

Small Residential

Single Band G001110-N300
1xGE, 1xFE, 1xPOTS,N300

SFU 12B2:1x1GE

SFU (12A / G010000)
1x2.5GE

Premium Home

G002000-AC1200: 2x1GE, AC1200
G002010-AC1200: 2x1GE, 1xPOTS,
AC1200
G004000-AC1200: 4x1GE, AC1200
G004011E-AC1200: 4x1GE, 1xPOTS,
1xUSB, AC1200
G004010M-AC1200: 4x1GE, 1xPOTS,
AC1200, LTE SIM Slot

G004011-AX3000
4x1GE, 1xPOTS, 1xUSB, AX3000

Industrial/Enterprise

20PS (8x1GE POE), -48V DC PSU
20PS4 (4x1GE POE), -48V DC PSU

G004000: 4x1GE

G004001R: 4x1GE, 1xUSB, Type-C

G004000ER: 4x1GE, Type-C, IP53

SFP

10 SFP ONT

XGSPON

32E / x104021
1x10GE, 4x1GE, 2xPOTS, 1xUSB

X104011-AX6000
1x10GE, 4x1GE, 1xPOTS, 1xUSB, AX6000

X104000ER
1x10GE, 4x1GE, Type-C, IP53

32S SFP ONT

Features

ZTP

TR069

QOE

POE

Type C

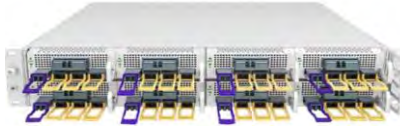
MBH Support

OTN/WDM Portfolio

TJ1600-2



TJ1600D-AE01



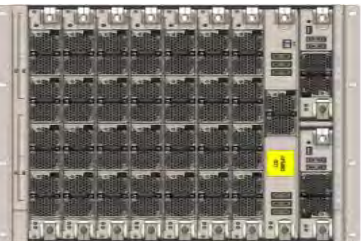
TJ1600-6



TJ1600-11



TJ1600-S/I



Configuration

2.4Tb Shelf Capacity
Client:1GE/10GE/100GE/FC/STMn/OCn
Line: 100G, 200G, 400G, 600G, 1.2T
400G Integrated OTN XC

6.4T Shelf Capacity
Client : 10G/100G/400G
Line: 100G/200G/400G

4.8Tb Shelf Capacity
Client:1GE/10GE/100GE/FC/STMn/OCn
Line: 100G, 200G, 400G, 600G, 1.2T
400G Integrated OTN XC

10Tb Shelf Capacity
Client:1GE/10GE/100GE/FC/STMn/OCn
Line: 100G, 200G, 400G, 600G, 1.2T

Client:1GE/10GE/100GE/FC/STMn/OCn
Line: 100G, 200G, 400G

Feature

2RU, 19" Wide, 300mm deep
Muxponder/Transponder
DWDM Amplifiers – ILA, WSON
Full Front Access

2RU, 19" Wide, 480mm deep
Muxponder/Transponder
AC+DC

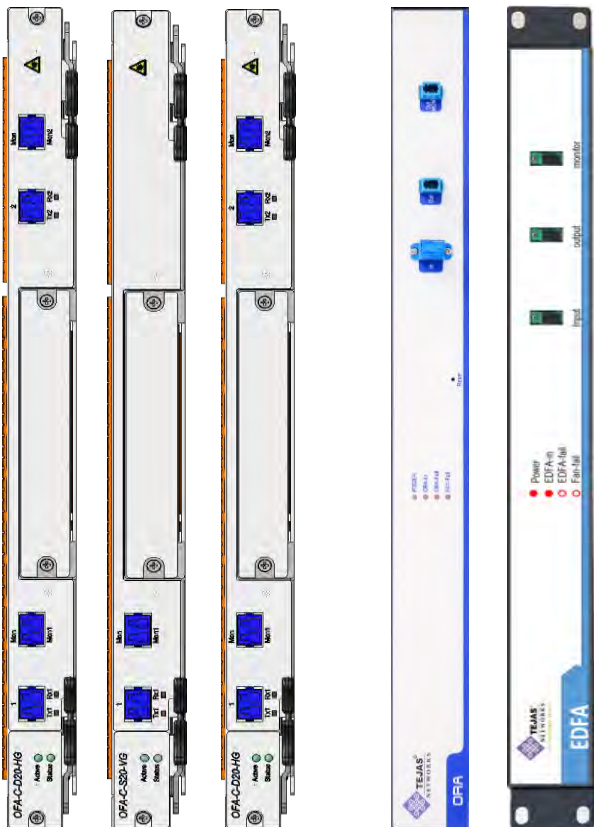
4RU, 19" Wide, 300mm deep,
Muxponder/Transponder
DWDM, Multi-degree CDC-F, WSON
Full Front Access

9RU, 19" Wide, 300mm deep,
Muxponder/Transponder
DWDM, Multi-degree CDC-F,
WSON
Full Front Access

800G, 1.6T, 8T, 16T OTN
DXC
L1-ASON

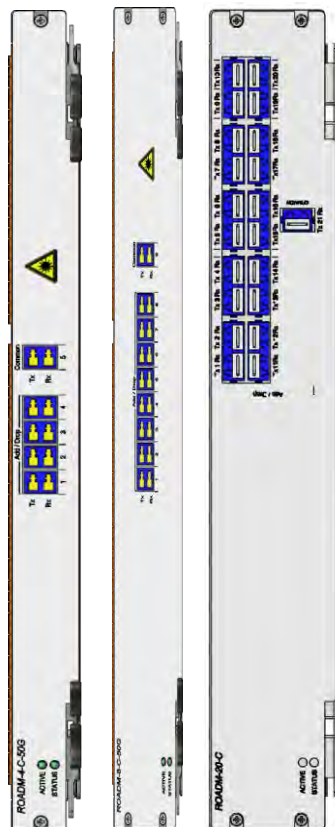
Photonics Layer

Amplifiers – EDFA / RAMAN



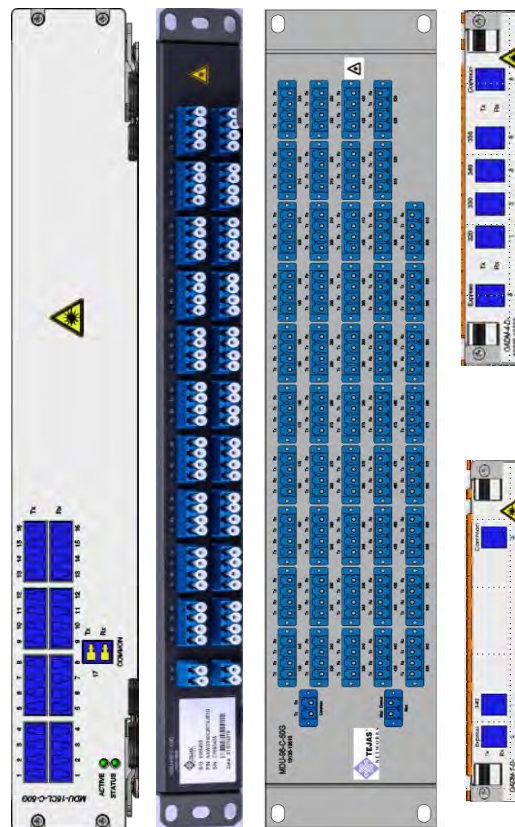
VG LG MG Raman Booster

ROADMs



4° 9° 20°

Add/drop Filters



Flex / Fixed

FPU



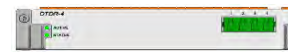
VOA



OPM



OTDR



OSC Filter



PSCM



DCM

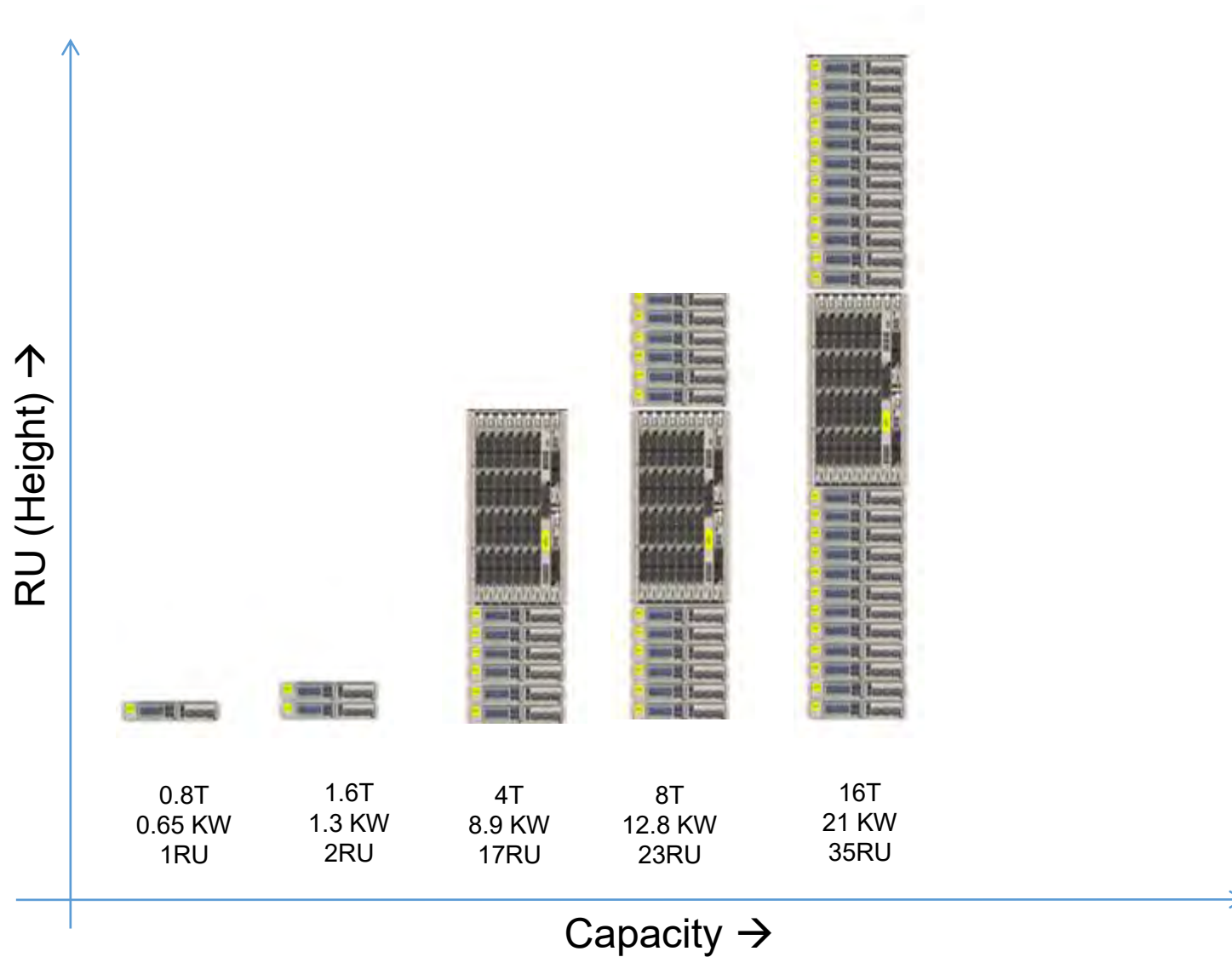


DCU



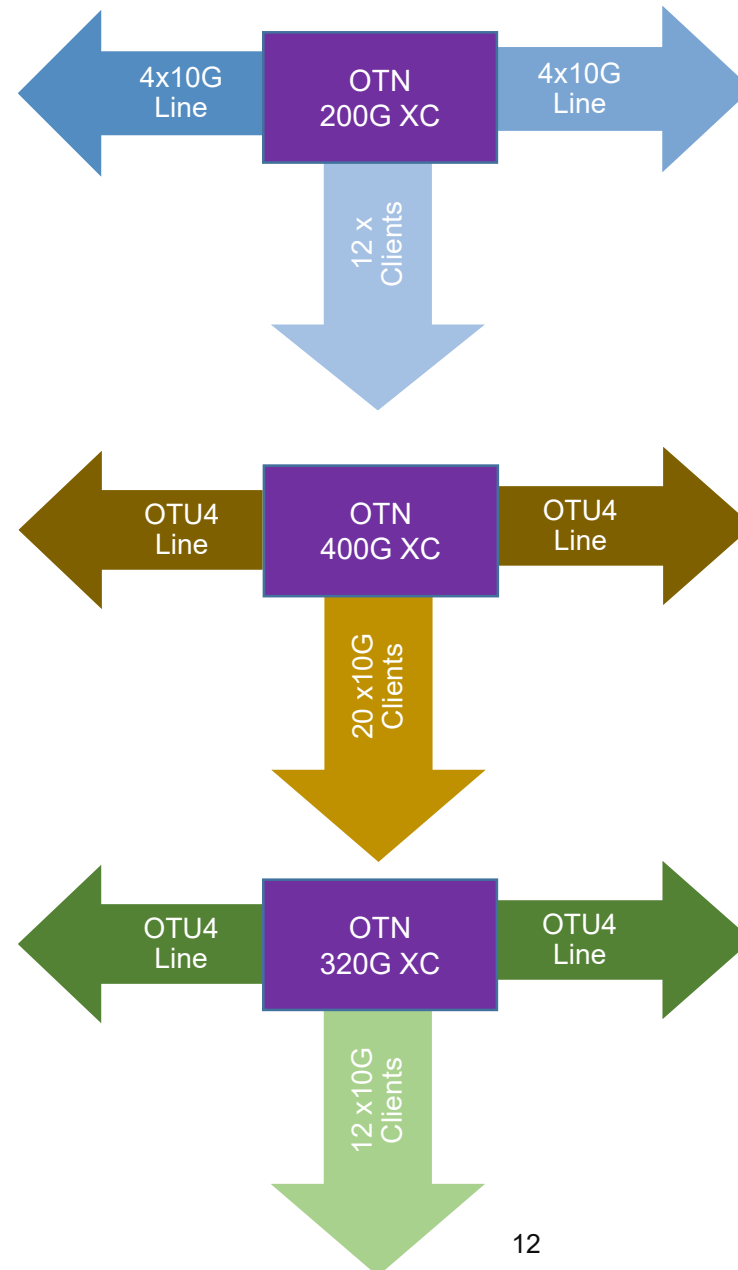
COLORLESS – DIRECTIONLESS – CONTENSIONLESS – FLEX GRID

TJ1600 I/S Platform Scalability



0.8T	1 x Interface Shelf
1.6T	2 x Interface Shelf
4T	6 x Interface Shelf w. FS
8T	12 x Interface Shelf w. FS
16T*	24 x Interface Shelf w. FS*

Multiple OTN configs on same Hardware: TJ1600-2



200G XC Mode: 2xHCPS modules

- 4 OTU2/2e line ports per card
- gFEC/ eFEC supported on line ports
- 10GE ODUFlex supported
- 12 client ports which supports
 - 10GE/1GE
 - STM-64/ STM-16/ STM-4/ STM-1
 - OC192/ OC48/ OC12/ OC3
 - FC100/FC200/FC400/FC800
- ODU cross connects supported: ODU0/ ODU1/ ODU2/2e/ ODUFlex

400G XC Mode: 2xHCPS modules

- 100G ports: 2 x OTU4
- Client Side ports: 20 x 10G Client Mapper Ports
- 10G Payloads: OTU2/2e/STM64/10GE/OC192/FC8G
- Coherent CFP and non-coherent CFP supported
- FEC on 100G grey and 100G coherent. GCC supported
- ODU cross connects supported: ODU2/2e

320G XC Mode: 2xHCPS modules

- 2 x OTU4 ports
- 10GE ODUFlex supported
- Coherent CFP and non-coherent CFP supported
- 12 client ports which supports
 - 10GE/1GE
 - STM-64/ STM-16/ STM-4/ STM-1
 - OC192/ OC48/ OC12/ OC3
 - FC100/FC200/FC400/FC800
- ODU cross connects supported: ODU0/ODU1/ODU2/2e/ ODU4/ODUFlex

2 Line Card Slots

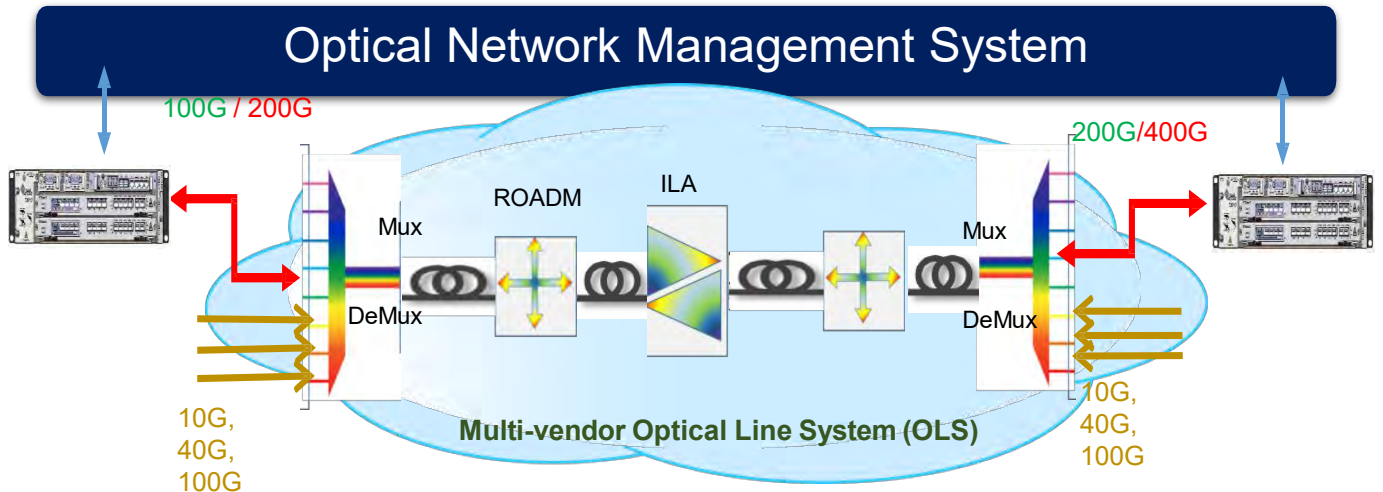
HCPS (1xOTU4 + 10x10G)



Config modification:

- Change of these config modes doesn't require any Hardware change
- Config change is executed thru a selection on software

100G/200G Alien Wave Solution



Vendor	Network Design	Existing lit channels	Distance	Region
Adva	80 x 10G	40 lit	200km	SA
Adva	80 x 10G	57 lit	1600 km	SA
Adva	80 x 10G	40 lit	900 km	SA
ZTE	40 x 10G	15 lit	465 km	SA
Huawei	80 x 100G	10 lit	1400 km	SA
Huawei	80 x 100G	20 lit	1500 km	SA
Coriant	40 x 10G	20 lit	200 km	Asia
Huawei	40 x 10G	20+	650 km	Americas
ZTE	40 x 10G	-	600 km	Asia
Nokia	8 x 10G	4	150 km	India
ADVA	40 x 10G	10	850 km	India
Cisco	40x 10G	20	670 km	Asia
Ciena	1x200G	Nx10G	200 km	India

Customer

- Global Tier-1/Tier-2 operators upgrading existing 10G DWDM network to 100G/200G/400G
- Reuse spare 10G channels available to launch new 100G/100G+ wavelengths

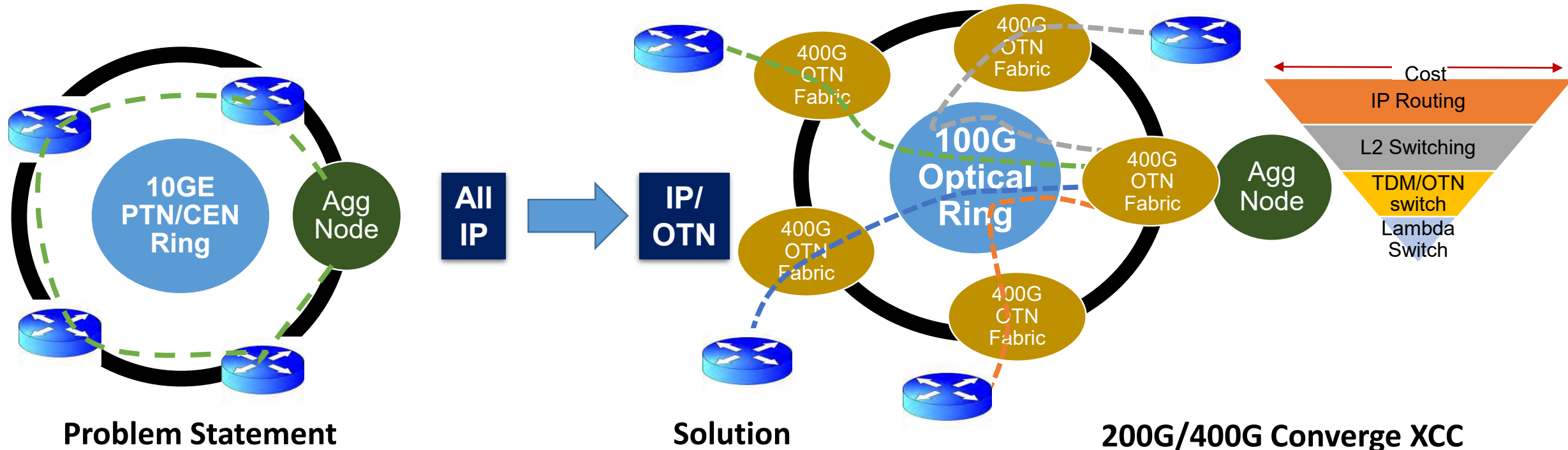
Challenges, we solve

- No change in existing photonic layer (OLS); only end-points to be changed
- Interop with third-party optical OEMs
- Agile network planning and service provisioning across "alien hardware"

Our USPs

- No guard bands for 100G/200G, maximizes available 10G spectrum reuse.
- Proven interop with 7 optical vendors; Restful-APIs, TMFs for NMS integration
- Automated templates to plan & implement

Micro-OTN Switch: Router-bypass for Enterprise traffic



Problem Statement

- How to increase 10G Ring capacity?
- Statistically Multiplexed 10G Ring; Limited Scalability beyond 10G
- Each Router processes & learns packets/addresses of other Routers
- Expensive and Higher Power Consumption

Solution

- Hub-and-Spoke architecture; Scalable to 100G and beyond
- Traffic not destined for an IP Router bypassed on the OTN layer
- Cost effective than nx10G lambda approach, no link budget challenge
- Easy to manage single 100G grey link

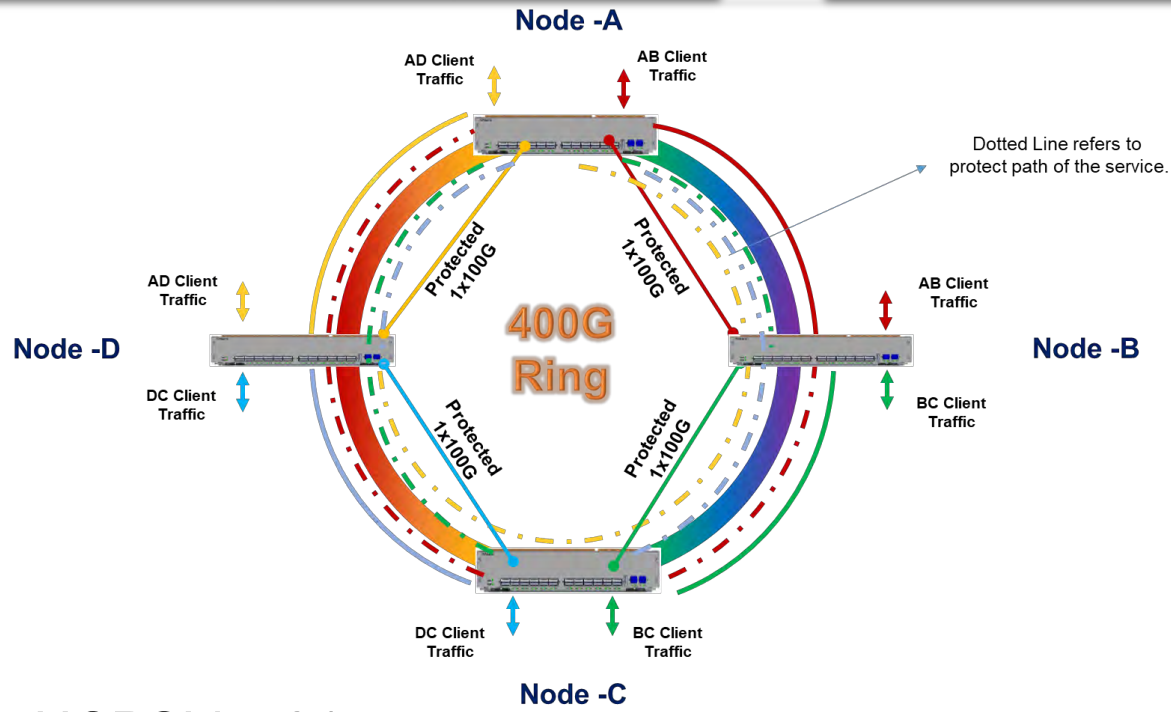
200G/400G Converge XCC

- 2RU TJ1600-2 converged POTP, OTN/DWDM Cross-connect
- Sub Lambda(λ) grooming using OTN
- Any client: FC2/4/8/10G, 10/100GE, OTU2/4
- 2.4Tb in 2U form factor. Uplink available 200G/400G/600G

Deployment Use-Cases

Ring Topology

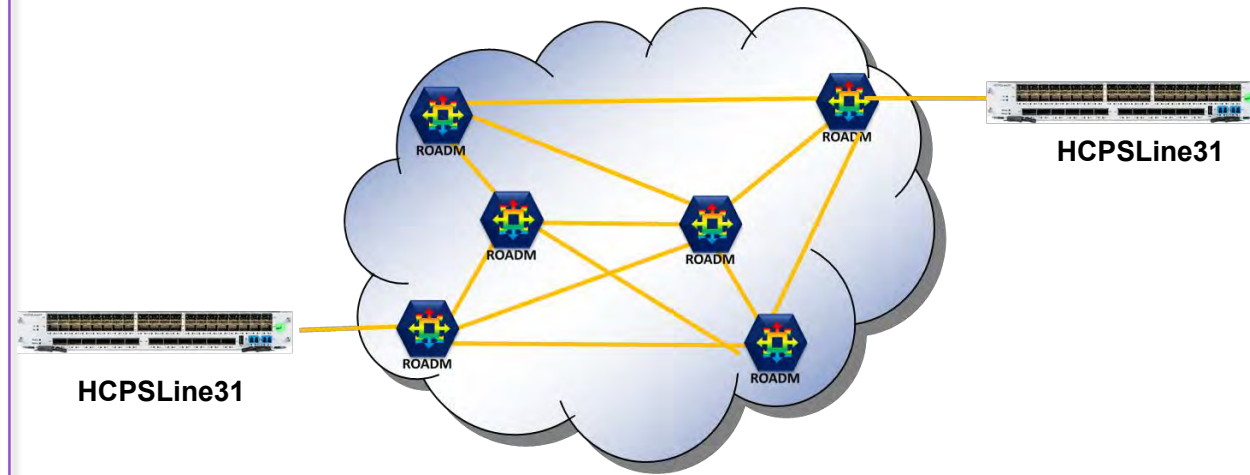
Dolphin Nigeria



- HCPSLine31
- Ring protection (sub 50-ms switching)
- Any-to-Any traffic
- n x 600G rings

Mesh Topology

Summit Com.

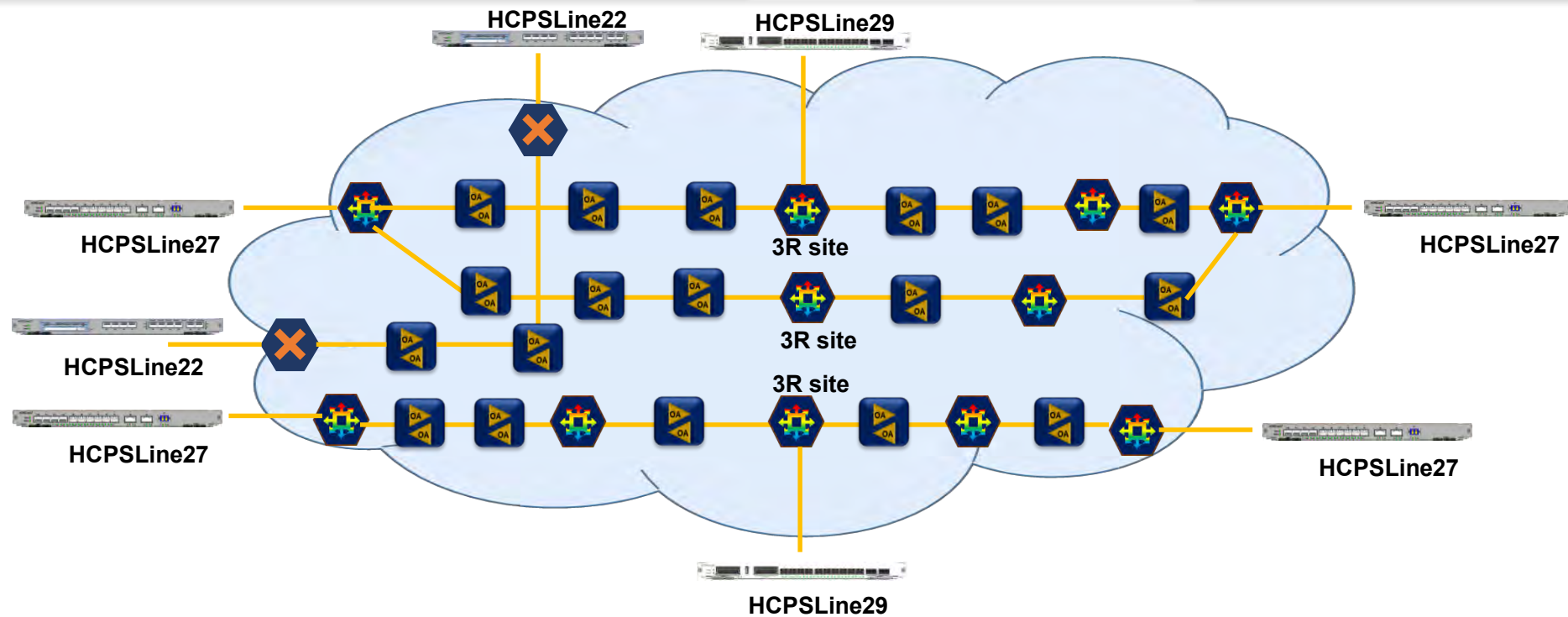


- 1+1 NPP protection w/ WSON restoration
- Alien-wave/native wave support

Deployment Use-Cases

Unified Solution with Txp, Mxp, 3R, DXC, WSON, DWDM

PGCIL



- 200G/100G channels traversing 1000s of km with 3R regeneration at intermediate sites
- L0 GMPLS (WSON) protection
- Few sites equipped with DXC using HCPLine22
- 62,000 route km, 450 locations
- C-D-F based Design

World's first Ultra Converged Broadband Platform

Fiber Broadband Access



Enterprise Data Services



Fixed Wireless Access



Network Modernization



GPON/
XGS-PON

Carrier Ethernet
E-Line, E-LAN
L2, MPLS-TP

LTE 4G,
upgradable to 5G

SDH/
SONET/
PDH

TJ1400



Nx10G/100G Packet
Optical Transport



Award Winning Product in USA, Europe, Asia



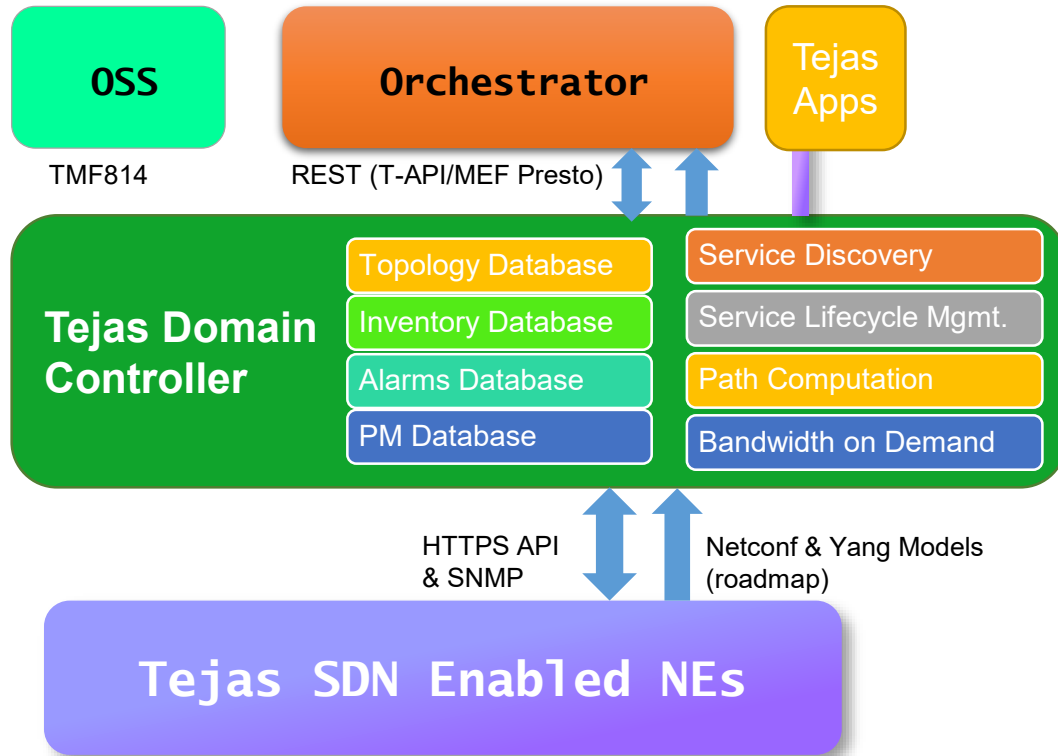
ON ROADMAP*

- L3 Enterprise Services
- Mobile Wireless

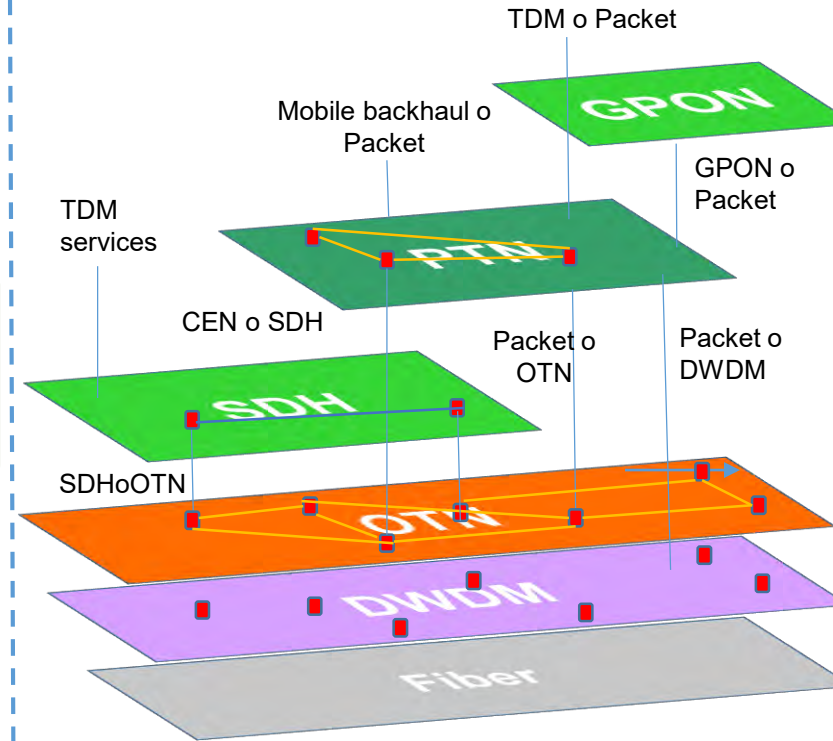


Tejas SDN

Open platform, APIs



Integrated Management Platform for multiple layers



Successful OSS integrations

- NetCracker's NetP
- NMSWorks
- HP's OpenView
- TE-MIP
- Agilent's CNMS
- IBM – Tivoli / Netcool
- MyCOM
- CDOT-NMS
- HOBS

- Multi-Technology, automated end-to-end-service provisioning
- New Contemporary GUI (mega-menus & ribbons)
- SDN Ready Domain Controller (NBI for full FCAPS, BW on-demand, BW calendaring, service activation through NBI)
- REST NBI for integration with SDN Life Cycle Orchestrators

Data Analytics

Data Optimization

- Pick only relevant attributes or objects
- Per Object Policies for Data Retention

Streaming Telemetry

- Real time analytics

Historical Trends

- Averages for last 1/7/30 days
- Long Term trends (6 months, 1 year, 2 year)
- Best/Worst Performances

Grouping, KPIs & Dashboards

- By Region/Customer/Service Types etc
- Visualization: Line/Pie charts/Frequency Distributions

Threshold Crossing Alerts

- TCAs (with configurable thresholds)
- TCA Actions (Alarms/Email/Protection Switch)

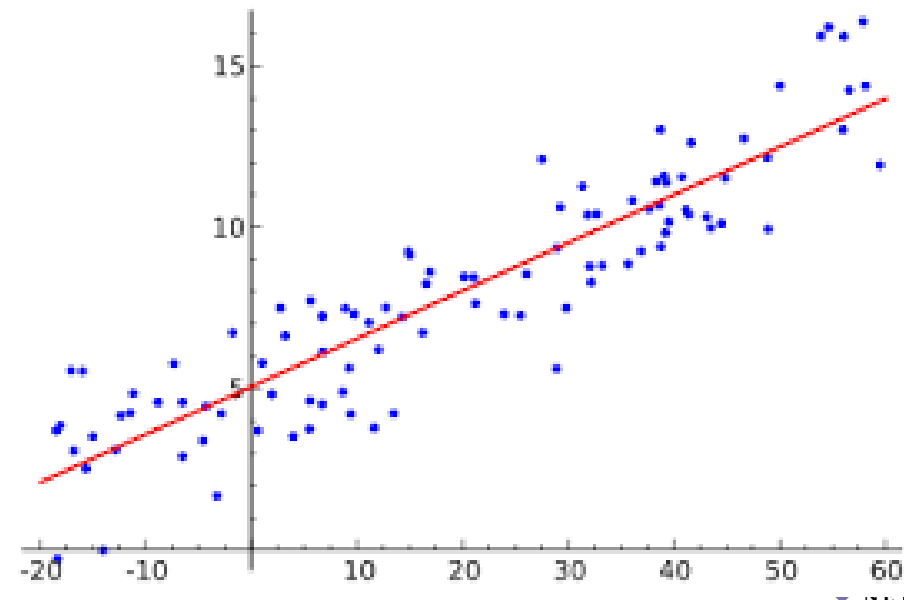
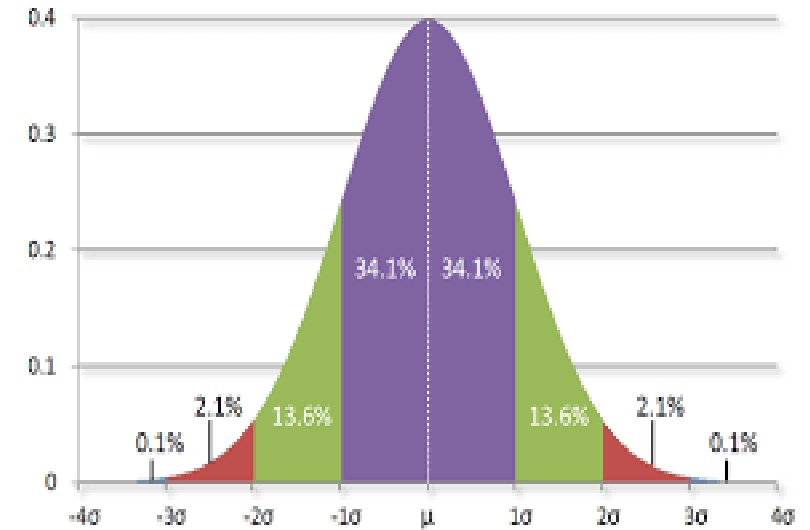
Regression Analysis

- Line of Best Fit (Linear Regression)

Reports & Pivots

- Advanced Filtering Options
- Grouping & Pivots

All Technologies



AI assisted Predictive Analytics

Anomaly Detection

- Single or Multi-variable
- Predict faults before they happen
- Flag security incidents

Time to Hit Thresholds

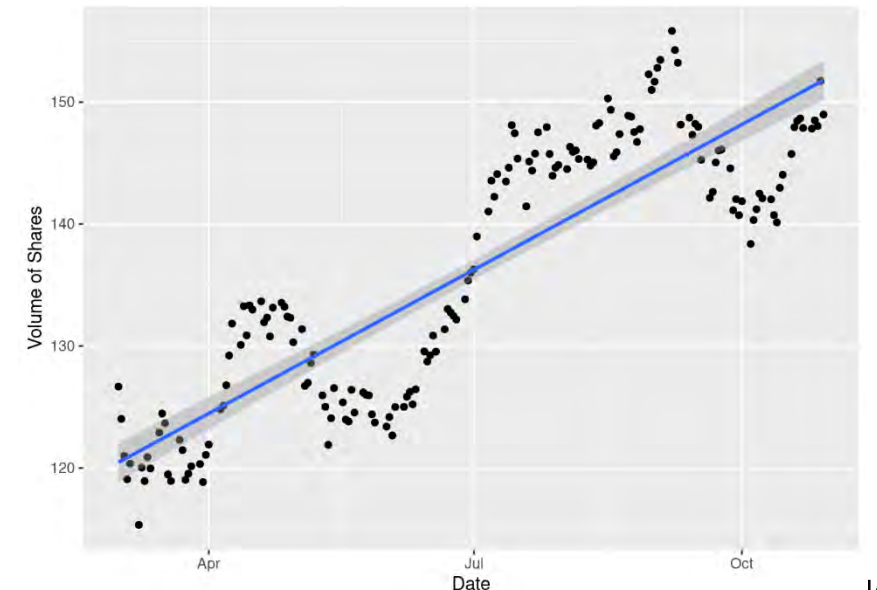
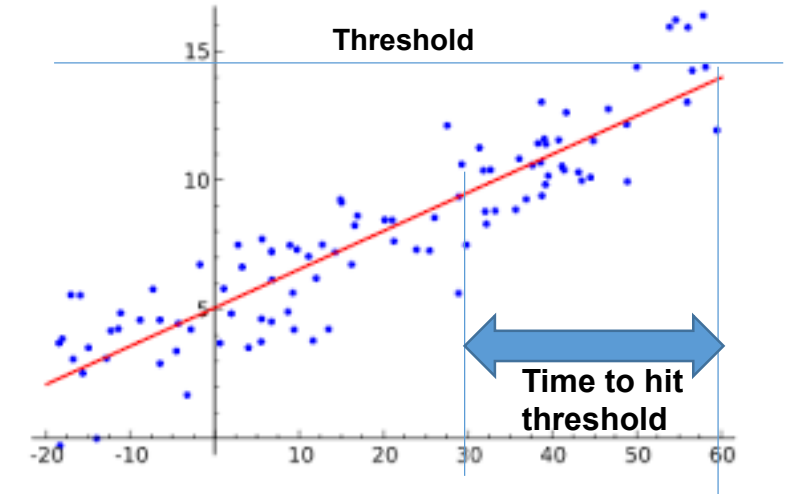
- Predict congestion
- Predict remaining life of resources

Long term trends

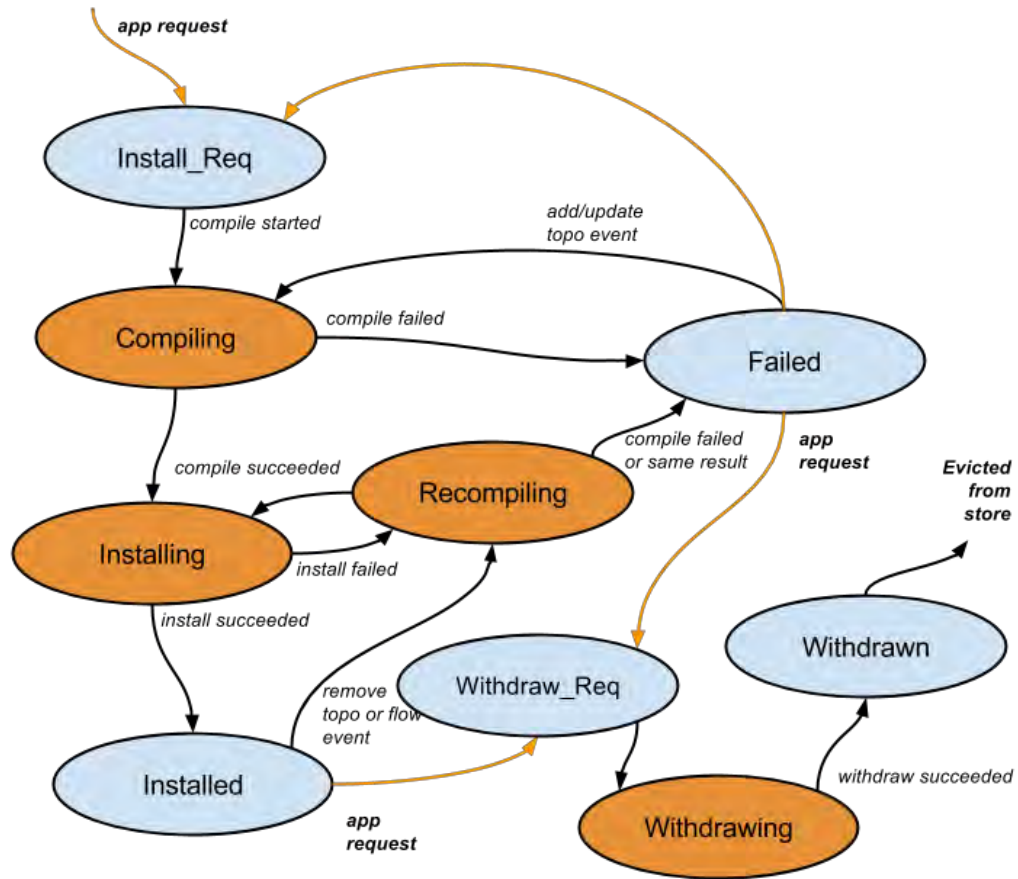
- Linear / Polynomial / Periodic

Ripples or Periodicity

- Identify ripples or periodicity in the data



Intent based Services & Closed Loop Automation



Intent Parameters

- Network Resources
- Constraints (eg Include/Exclude/SRLG)
- Goals / SLAs

Intent Lifecycle

- Install Request
 - Compiling / Installing
- Recompile
 - Triggered by certain events
- Installed / Failed
- Withdraw Request
 - Withdrawn

Nested Intents

- If an intent at higher layer fails, then it's possible for it to trigger another intent at lower layer

Integration Capabilities

REST

- T-API/Presto
- JSON data exchange

Kafka

- Kafka notification channel
- Multiple producers & consumers

XML/JSON Import/Export

- Export of NE configs as XML or JSON
- Export of NMS Data (eg Circuits) as XML or JSON
- Import of XML from Planning Tools
 - DWDM/OTN/GPON/IP-MPLS

CLI

- IP/MPLS integration
- GPON CLI

Netconf/Yang*

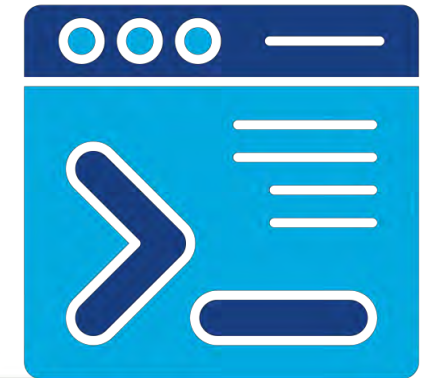
- IP/MPLS : Segment Routing , Router management
- OpenRoadm: Disaggregation

Telemetry*

- gRPC / gNMI



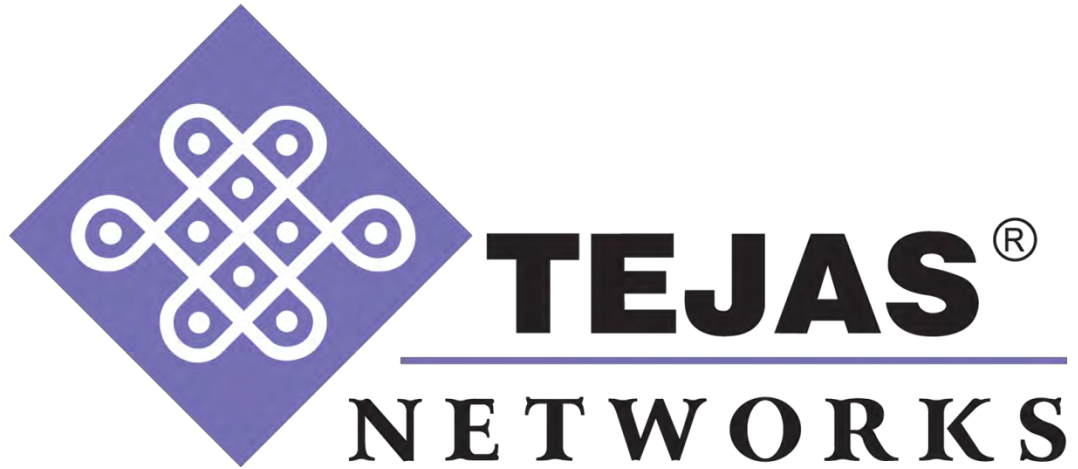
{ REST }



YANG

```
container community-sets {  
  description "Container for community sets";  
  list community-set {  
    key community-set-name;  
    description "Definitions for community sets";  
    leaf community-set-name {  
      type string;  
      description "name of the community set";  
    }  
    leaf-list community-member {  
      type string {  
        pattern '([0-9]+:[0-9]+)';  
      }  
      description "members of the community set";  
    }  
  }  
}
```





Thank you!

Gordhan Singh Rathore
Director Sales
gordhansr@tejasnetworks.com