



JUNIPER  
NETWORKS

# JUNIPER DAY

16 октября 2018 | Москва

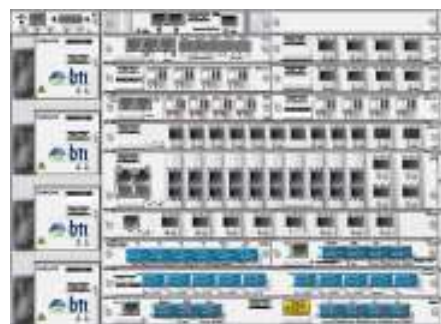
Новое в оптической продуктовой  
линейке

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# BTI 7000 & 7800 ПОРТФОЛИО

## 7000 серия

BTI 7200 (20 slots)



2.5G / 10G  
Транспондер



Мультиплексор



BTI 7060 (2 slots)



ROADM



BTI 7020 (1 slots)

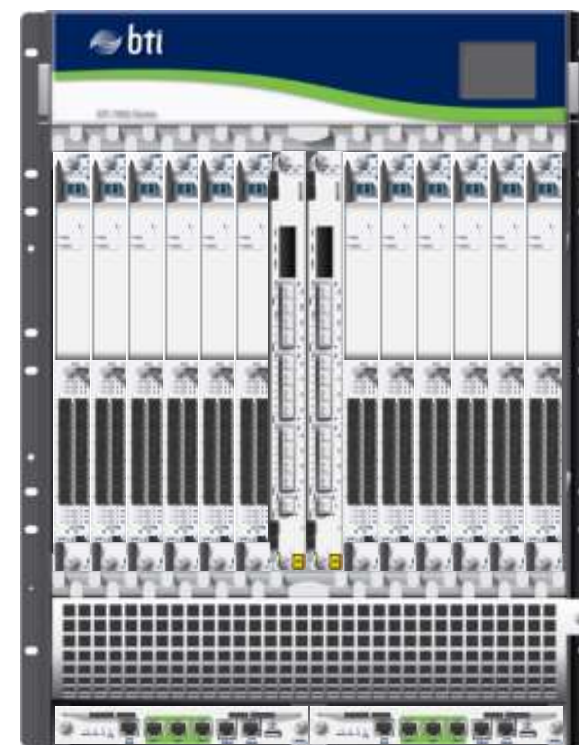


DWDM  
мультиплексор



## 7800 серия

BTI 7814 (14 slots)



BTI 7802 (2 slots)



BTI 7801 (1 slot)



DWDM мультиплексор



UFM3



UFM6



# КАРТЫ DWDM ДЛЯ MX & PTX

## PLUGGABLE COHERENT DWDM INTERFACES

### CFP2-ACO



**MPC3/3-NG:** 1x100G/slot  
**FPC3:** 10x100G/slot

### CFP2-DCO

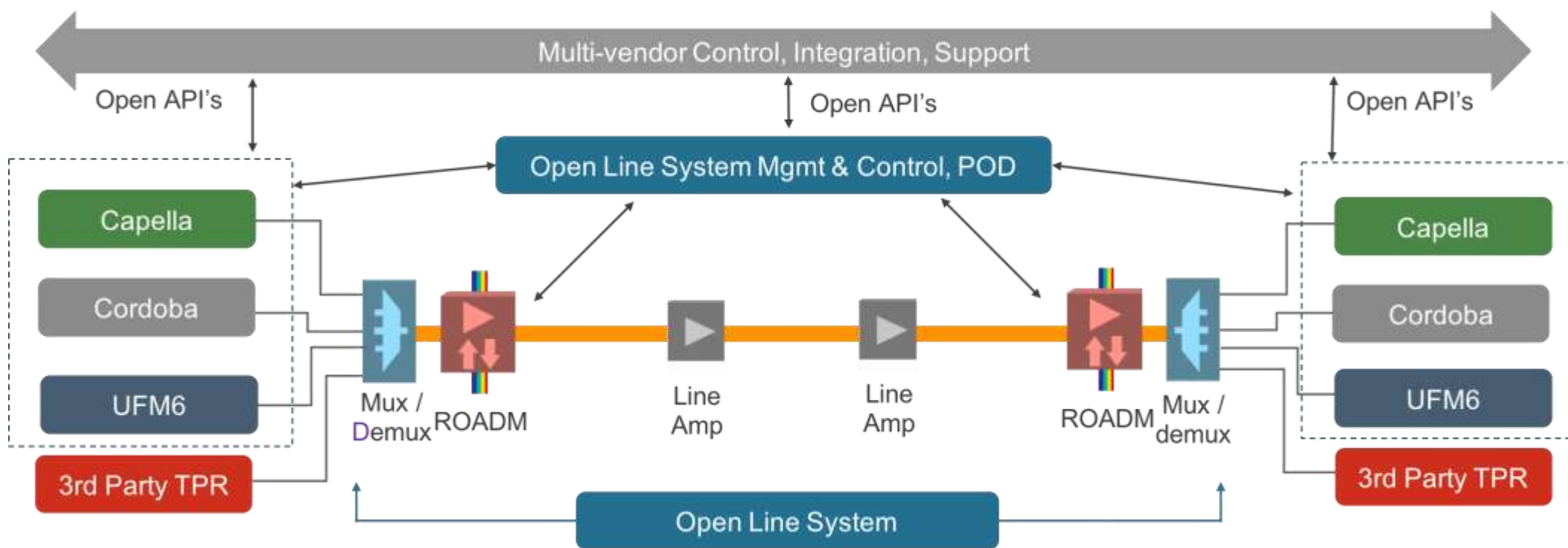


**MPC5/6:** 2/4x100G/slot  
**FPC2/3:** 8x100G/slot

Integrated DWDM line cards for MX and PTX:

- Pluggable 100G coherent DWDM interfaces
- Fully tunable across the C-band (up to 96 x 100G)
- Up to 2500 km transmission over DWDM line systems
- Up to 150 km transmission over dark fiber
- Support for SD-FEC and HG-FEC (MPC3 only).
- Managed over CLI & SNMP.

# ТСХ1000 ДЛЯ ТРАНСПОРТНОЙ СИСТЕМЫ

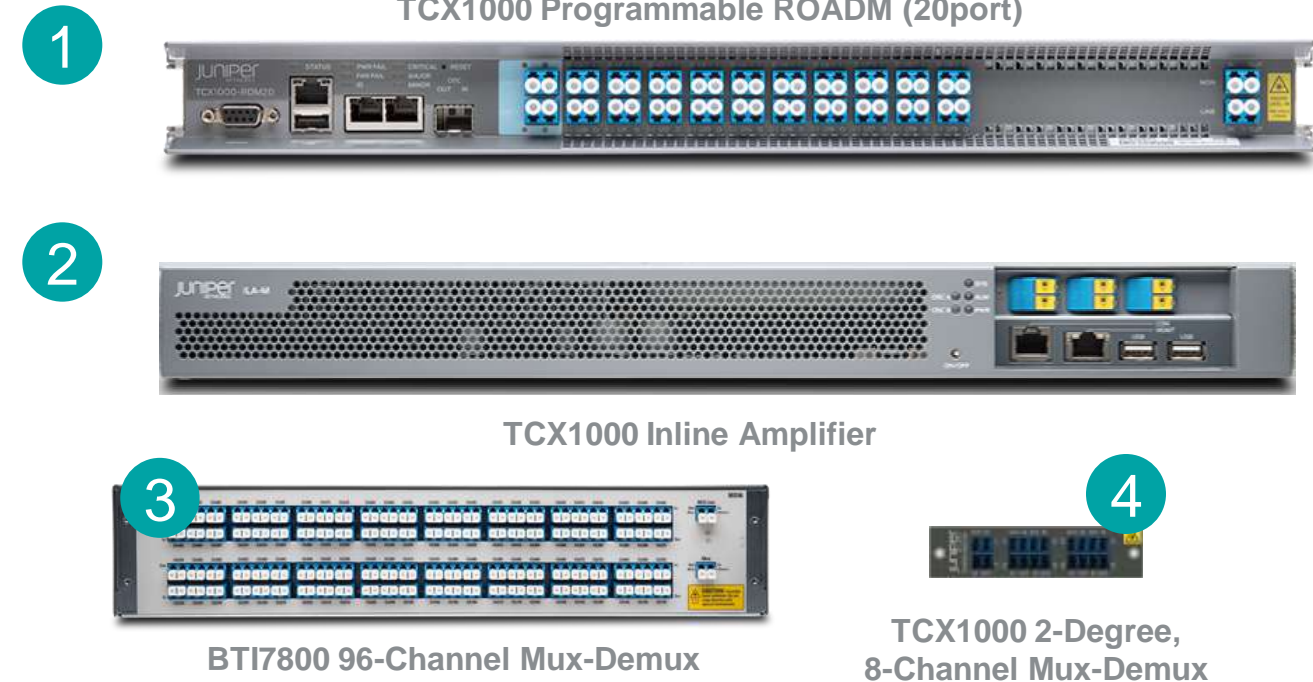
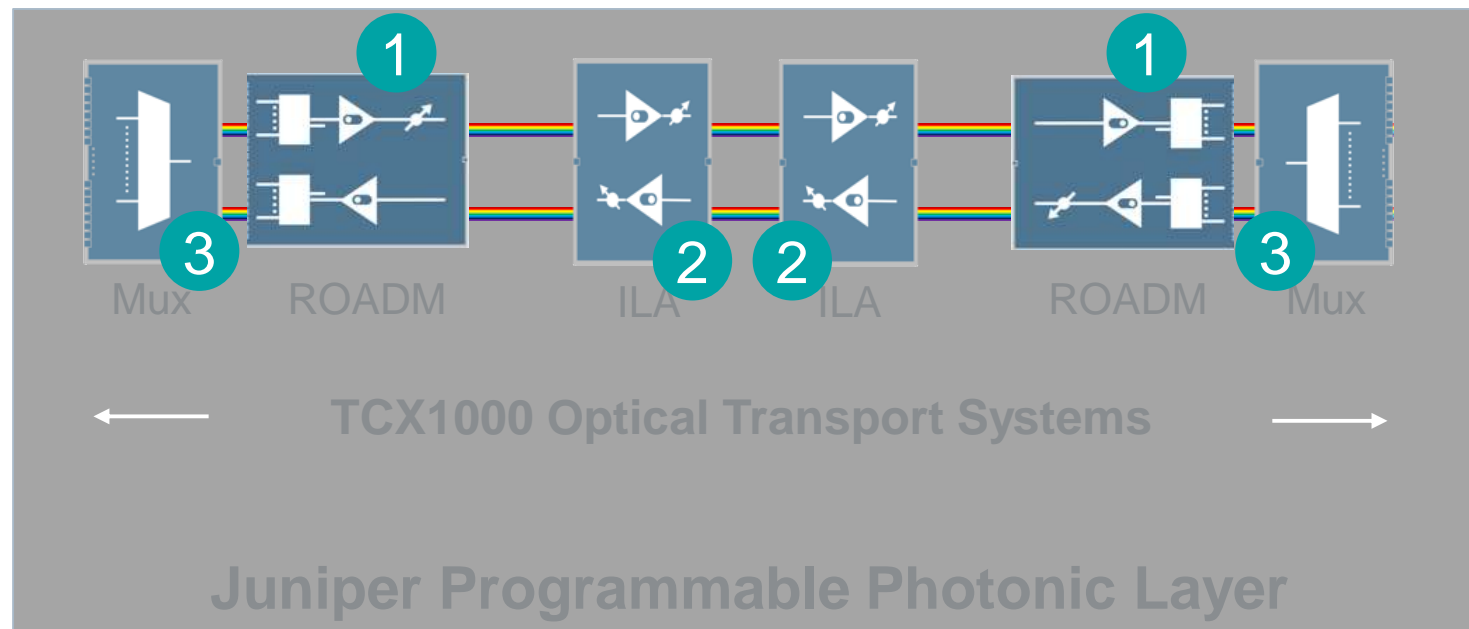


## OPEN

- Eliminates vendor lock in
- Integrated end to end management
  - Extensible to multi vendor equipment support via standard interfaces
- Alien wavelength transport and management
  - No RTUs or PS services required – Lowers barriers to entry
- Standard REST APIs for 3<sup>rd</sup> party OSS/BSS integration and orchestration

# OPEN OPTICAL LINE SYSTEM

## DISAGGREGATED DWDM ОПТИЧЕСКИЙ ТРАНСПОРТ



### 1 TCX1000 ROADM

- 1RU 20 Degree ROADM
- Colorless, directionless & flex grid
- Integrated WSS, EDFAs, OSC and OTDR support
- Automated turnup, provisioning, and operations

### 2 TCX1000 ILA

- 1RU Bi-Directional WDM Amplifier with OSC support
- Fully automatic with 0-33dB dynamic gain range
- 128 Channel in the C band with 37.5GHz channel spacing support

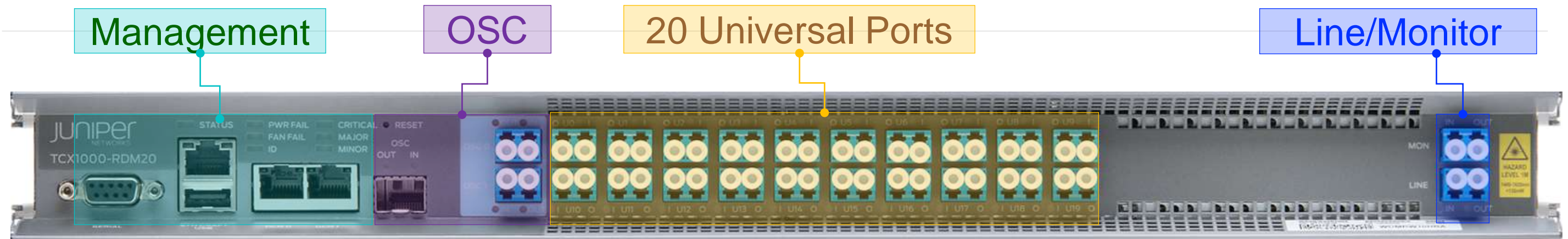
### 3 96 Channel Mux/Demux

- 2RU 96 Channel 50GHz Mux/Demux
- Supports channels up to 40GBaud i.e. 100G and 200G capable
- Fully passive equipment

### 4 TCX1000 2D8CMD

- 2 Degree 8-Port Directionless Flex Grid Mux/Demux
- 128 Channel in the C band with 37.5GHz channel spacing support
- 3 x 2D8CMD in 1RU chassis

# TCX1000 PROGRAMMABLE ROADM



## Open Programmable ROADM

- Colorless, directionless & flex grid
- Integrated WSS, EDFAs, OSC and OCM
- Automated turnup, provisioning, and operations

## 20 Universal Ports

- Direct add/drop
- Multiplex port
- Degree interconnect
- Combination of above

## Compact Design

- Disaggregated 1 U platform
- 19", 21", and 23" standard rack-mountable; 600mm deep

## Power and Cooling

- Power efficient 150-250W
- Field replaceable AC/DC PSs and CUs
- Redundant, front-to-back air cooling; NEBS compliant

# MULTI-DEGREE OPEN ROADM

## 20-port ROADM provides:

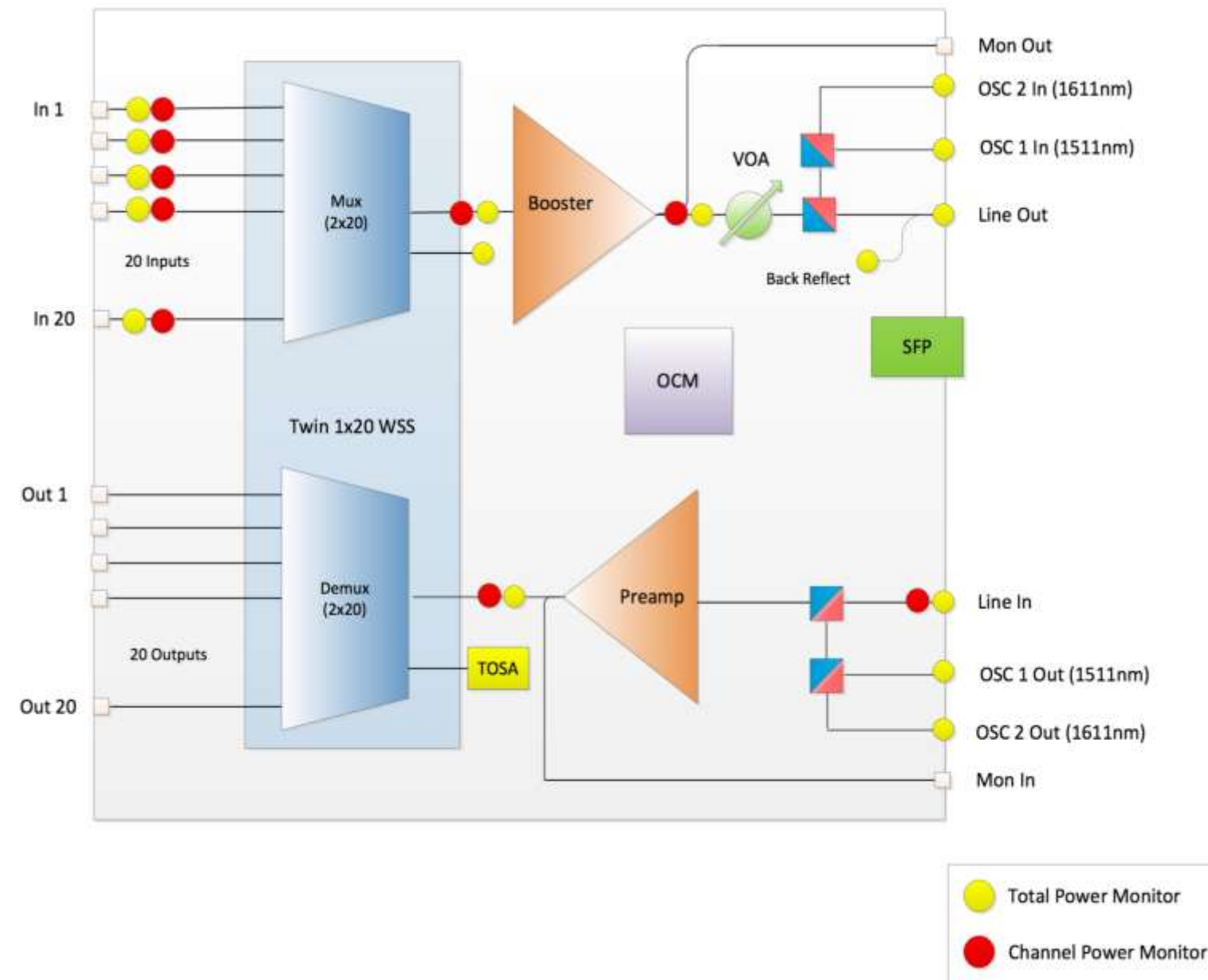
- Route and Select WSS with 20 node side “universal” ports
- Integrated EDFA line amplification (Booster and Pre-amp)
- Integrated spectral and total power monitoring
- Integrated Ethernet optical supervisory channel (OSC)

## “Split” ROADM Configuration

Maximum robustness and resiliency

## 20 Universal Ports enable different use cases:

- Simple (1D) terminal with a fixed mux/demux, to
- 1D Terminal with up-to 128 channels of colorless MD, to
- 20D switching node





# TCX1000 ILA ОБЗОР

## INLINE DISAGGREGATED AMPLIFIER (ILA)

- Bi directional WDM amplification in single 1RU package
- Fully automatic with 0-34dB dynamic range
- 128 channels in the C band with 37.5GHz channel spacing
- Telco grade
  - NEBS compliant with front to back airflow
  - Redundant hot swappable AC/DC power supply and fan modules
  - Hazard Level 1M
- Line in/out and optical monitor ports
- DCN and local craft terminal ports
- 19", ETSI and ANSI compatible
  - 300mm deep
  - Optical/management ports on front
  - Power connectors on rear
- 80W Max power consumption
- Embedded OSC channel
  - 100M / 1511nm
- OOB and IB management
- Can cascade up to 4 ILAs between ROADMs equalization stages
- Central optical loop control



# 96-КАНАЛЬНЫЙ MUX/DEMUX (BT8A78MD03)

2U 96ch 50GHz mux/demux

Fully passive existing 7800 solution

High density - low cost per channel

Supports channels up to 40 GBaud i.e. 100G and 200G capable

Uses one Ux port

## Channels Can Be:

- A disaggregated transponder e.g. BTI UFM6
- An integrated Coherent interface e.g. Voodoo, Cordoba
- Alien e.g. third-party transponder
- Optical channel protection using OPS/WPS



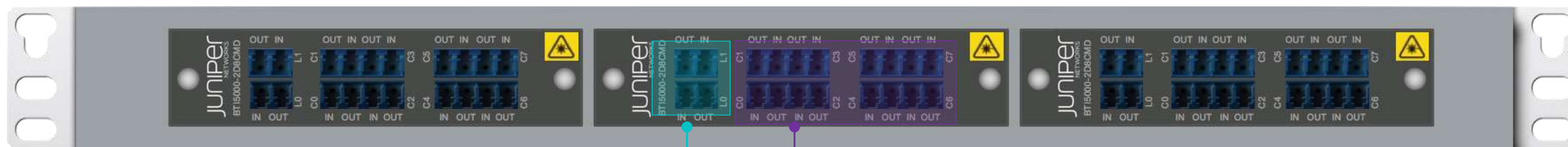
# TCX1000 2-DEGREE 8-КАНАЛЬНЫЙ MD ОБЗОР

## Disaggregated Mux Demux

- 2-degree 8-port directionless flex grid mux demux
- 3 2D8CMDs in a 1U chassis (RCK-1)
- 19, 21 and 23 in. standard rack mountable

Parameter	Value
Form factor (W x H x D)	2.85 x 12.95 x 16.2 mm (1.12 x 5.10 x 6.36 in)
Connector Type	Duplex LC/UPC
Wavelength Range	1525-1570nm
Insertion loss	<10.5dB
Directivity	>55dB
Return Loss	>45dB

1U Rack

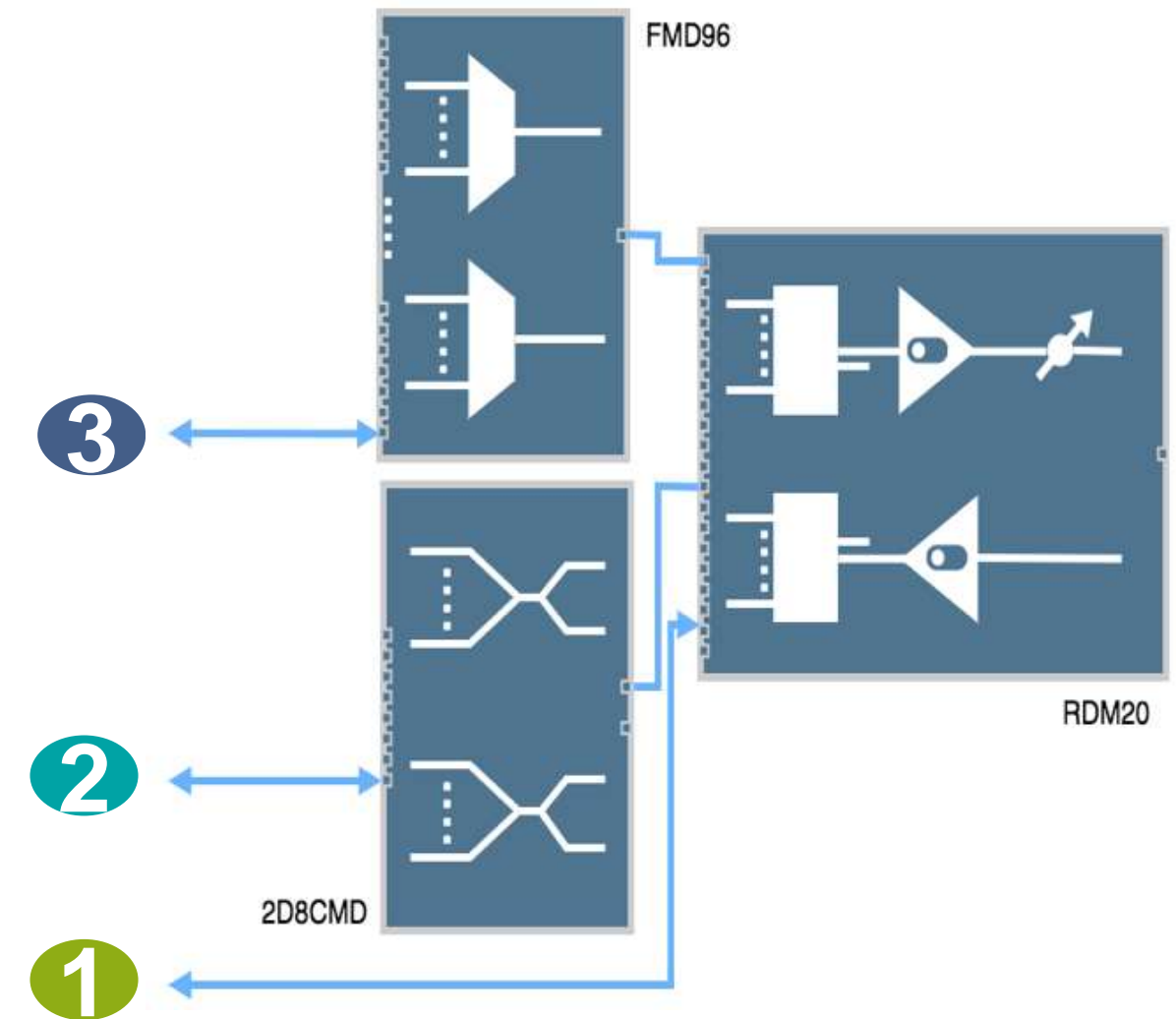


2 Line (Direction) Ports

8 Add/Drop Ports

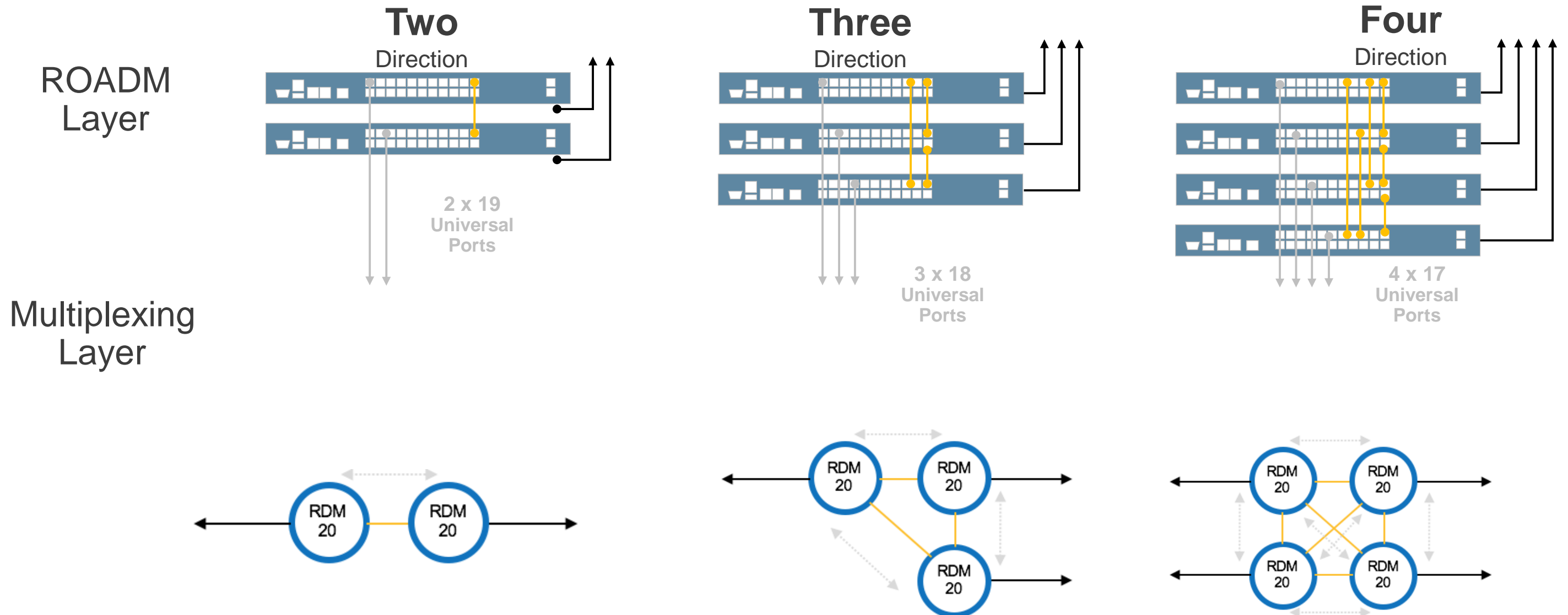
# ГИБКОЕ МУЛЬТИПЛЕКСИРОВАНИЕ БЕЗ ПРАВИЛ, ЛЮБЫЕ КОМБИНАЦИИ

<p><b>1</b></p> <p><b>DIRECT ADD/DROP</b></p>	<p>Native Juniper TPRs          Alien wavelength          Alien multiplex source          Up to 20 colorless flex grid channels:          100G/200G/400G+</p>
<p><b>2</b></p> <p><b>MULTIPLEX via 2D8CMD</b></p>	<p>8 colorless flex grid channels per module          100G/200G/400G+          E.g. 96 TPR connections by using 12x2D8CMD          modules and 12 RDM20 ports (leaves 8 ports free          to enable a 9 degree node)</p>
<p><b>3</b></p> <p><b>MULTIPLEX via FMD96</b></p>	<p>Fixed color single direction          96 50 GHz channels          Channels: 100G/200G          Keeps max # of ports on ROADM free</p>

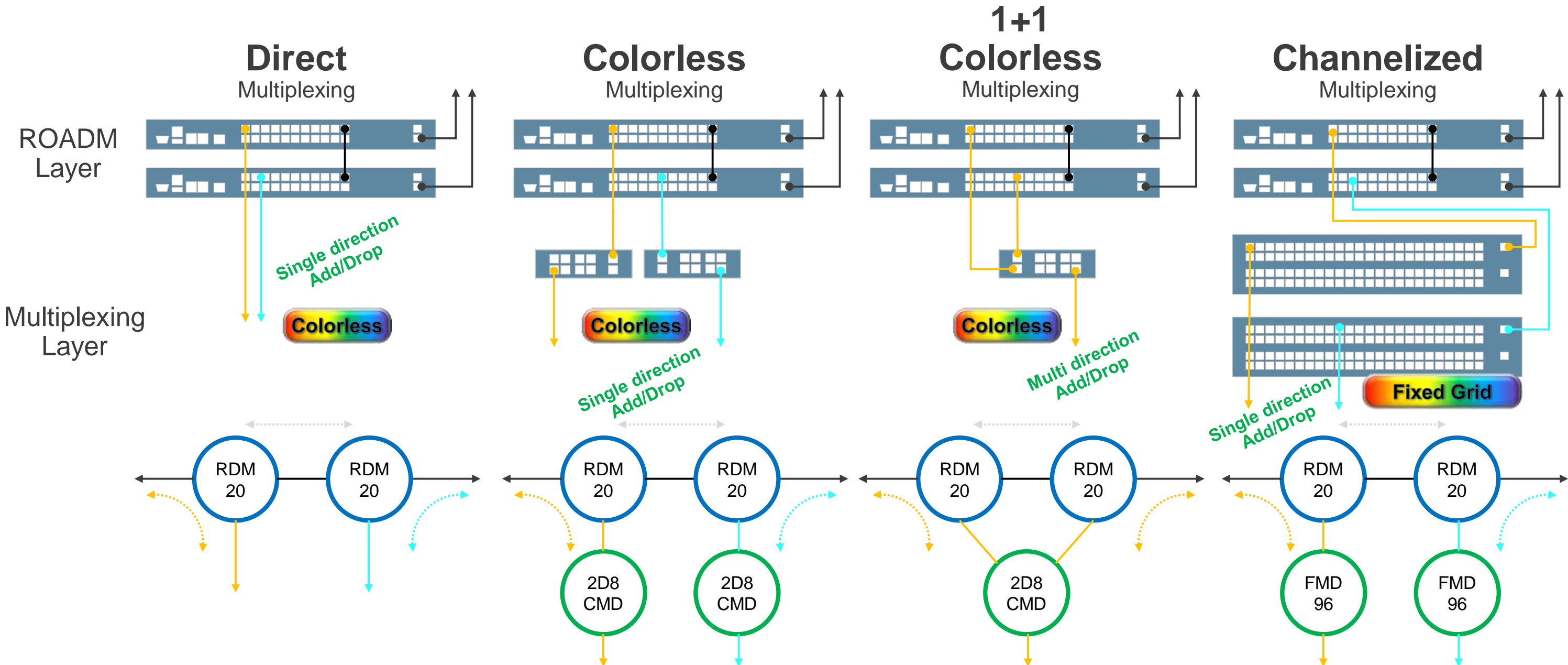


Start with direct connect channels and expand with external multiplexers as traffic growth is confirmed

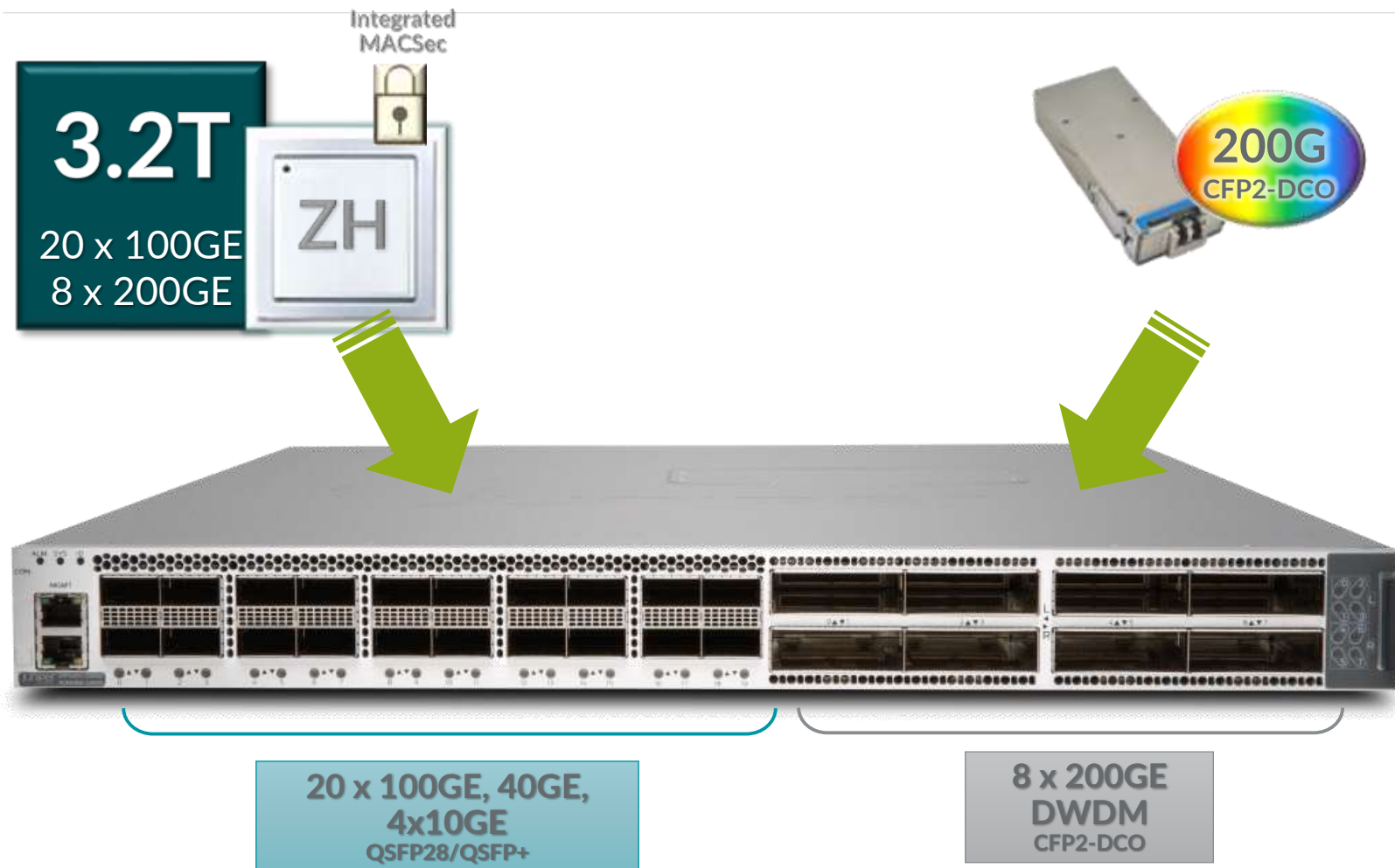
# МАСШТАБИРОВАНИЕ САЙТА ...1 DEGREE...



# ГИБКОЕ МУЛЬТИПЛЕКСИРОВАНИЕ И МАСШТАБИРОВАНИЕ



# ACX6360: МАРШРУТИЗАТОР



- 1 RU, Stackable, 19" rack, depth <= 27.0"
- 100G/200G Per-Port Coherent Capacity, CFP2-DCO
- 1.6T Max Slot Optical Capacity: 8x 200G
- 8 Coherent Ports: 100G-QPSK; 200G-8/16QAM
- 20 Client Ports: QSFP28
- MACSec Line-Side, AES-256, (100G Logical Interfaces)\*
- Host Router Pre-FEC BER signaling to Host Router

**PAY AS YOU GROW**

Stackable + Pluggable optics + Licenses

**OPEN & PROGRAMMABLE**

Any Optical Infra with \*HGFEF/100G

**SECURITY & DEMARCATION**

100G MACSEC for Optical Network & Client Links

**FLEXIBLE**

Port - Port Mapping Or Router Mode (PFE)

# АСХ6360: ПОДДЕРЖКА CFP2-DCO

## 100G: QPSK

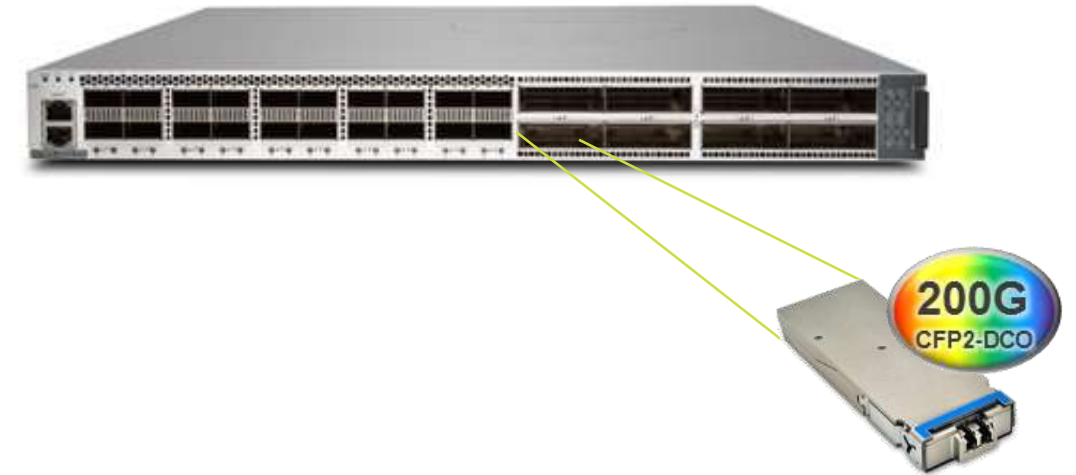
- 32Gbd
- 50Ghz & 37.5Ghz flexgrid spacing
- SD-FEC
- Max 133 channels supported
- ~3,000KM reach

## 200G: 8QAM

- 45Gbd
- 50Ghz spacing
- SD-FEC
- Max 100 channels
- ~1,200KM reach

## 200G: 16QAM

- 32Gbd
- 50Ghz & 37.5Ghz flexgrid spacing
- SD-FEC
- Max 133 channels supported
- ~600KM reach





# ACX6360 - В РЕЖИМЕ МАРШРУТИЗАТОРА

## SOFTWARE FEATURES & SCALING

Features		Scale	
Features @ FRS	Features Post-FRS (t.b.c.)		Scale @ FRS
Protocols BGP, ISIS, MPLS, RSVP, LDP	L2 COS	Ports per AE	64
ZTP	LLDP	AE interfaces per system	128
Port Mirroring	MC-LAG	ECMP paths per system	32
256AES MACsec	Multicast – PIM-SM/SSM	IFLs per PFE/system	60K
JTI Optical/OTN sensors	IGMP, MSDP, PIM	VoQs	384K
LDP Synchronization	sFlow	IPv4 / IPv6 FIB capacity	480K
BGP-LS	FBF	RIB capacity	5M
LAG / LACP	GRE	Filters MPLS label stack	No Limit
FRR (link and node)	6PE	Max imposed / pop / swap labels	8
Virtual router (VRF-lite)	P2MP	Max ingress / transit / egress LSPs	48K/128K/48K
Filters – Port ACLs (ingress), Routed ACLs (ingress/egress)	Filters – Port ACLs (egress), VLAN ACLs (ingress/egress)		
L3 QOS – classification (DSCP only), rewrite, queuing			

# ACX6360 (ROUTER MODE)

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- ACX6360 Router Mode is enabled by a Junos software load that provides routing and switching functionality.
- In router mode, any-to-any port connectivity is enabled providing statistical multiplexing advantages. Client interfaces can route to any other client interfaces or line side interfaces and vice versa.
- Support for full routing protocol, IP/MPLS, QoS support, etc., applications such as Optical DCI IP underlay and Packet Optical routing applications such as Metro Aggregation, Metro Core routing and LSR applications can be addressed
- On the client side, ACX6360 optical interfaces can be configured as 100G, 40G or breakout mode (4x10G)

## Routing features

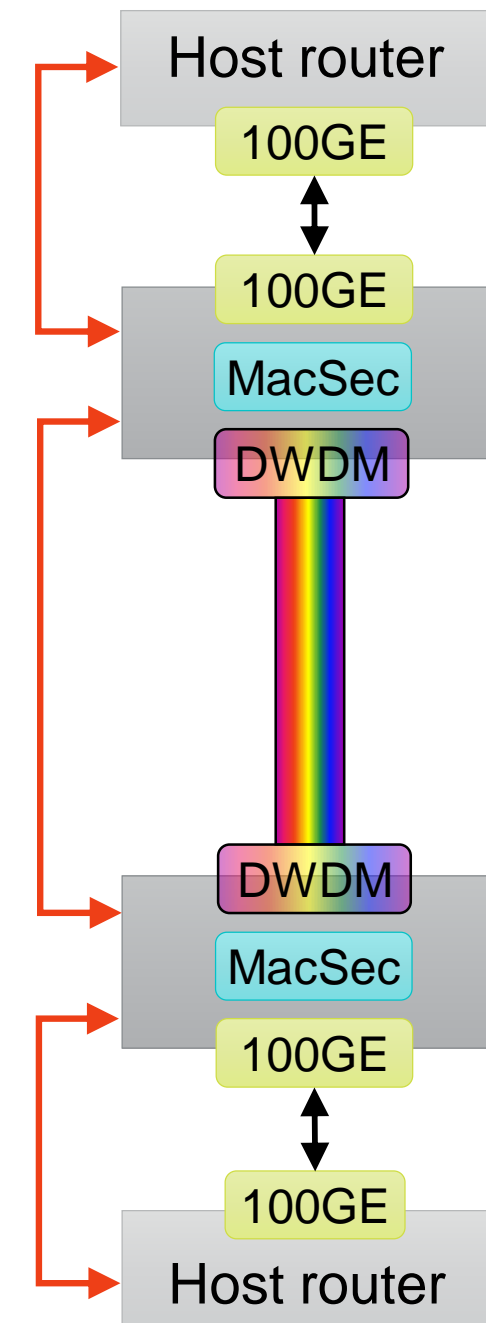
- 256k MPLS labels & 512k host routes
- 8K filters & 32k terms (single PFE)
- 2 billion pps
- Line rate at 205 byte packets
- 256-way ECMP
- 100 us (shallow) buffer
- FRR local to Argus-Optical box

## L3 Features:

- IP (BGP/OSPF/ISIS)
- BGP LU
- SR ISIS/BGP
- MPLS (RSVP/LDP)

# ФУНКЦИОНАЛ АСХ6360 (В РЕЖИМЕ ТРАНСПОНДЕРА)

- ACX6360 Optical Transponder Mode is enabled by a Junos software load
- 1:1 client to line side interface mapping
- **Transponder Mode is NOT a fully transparent transponder (UFM3/6)**
- Transponder Mode does not do any look up or learning on the MAC header (or any other data within the Ethernet frame)
- **all L2 and L3 PFE lookup is turned-off and based on the cross-connect status these packets from client ports are forwarded to line side**
- L2 control packets transparently pass-through the circuit
- Supports fault propagation and LLDP snooping
- Very low-latency (~1us)



# ACX 6180 OPENROADM TRANSPONDER



2 x 100GE/OTU4 QSFP28

CFP2-DCO (100G/200G)



## 800G PROGRAMMABLE TRANSPARENT TRANSPONDER

- 1 RU stackable platform
- 19, 21 and 23 rack mountable; 600 mm deep

### Capacity

- 800Gbps DWDM lineside capacity
  - 4 x 100G (QPSK); 200G (8/16QAM)
  - CFP2 DCO pluggables
- 800G client capacity 8 x 100GE

### Operation Mode:

- Managed via POD
- OpenROADM Compliant

### Power and Cooling

- Field Replaceable AC/DC Power & Cooling
- Front to back air-cooling
- NEBS

Optically Compatible with ACX6360, MX/PTX CFP2-DCO and PTX/QFX DWDM solutions

# RIO: ACX5448-D УНИВЕРСАЛЬНЫЙ МЕТРО МАРШРУТИЗАТОР

## 100GE COST OPTIMIZED FOR THE METRO APPLICATIONS



ACX5448



32 x 1/10GE (SFP+) + 2 x 100GE (QSFP28) + 2 x 100G/200G DWDM (CFP2-DCO)

**Universal** Mobile backhaul, Residential and MEF services platform

**Flexible** Services, Timing , Protocols with JUNOS

**1 RU**, Stackable, 19" rack, chassis depth 22"

**4x100G** QSFP28 Interfaces

**800G** Max Capacity: 32 x 1/10GE (SFP+) + 2 x 100GE (QSFP28) + 2 x 100G/200G DWDM (CFP2-DCO)

**Enhanced Temperature Support:** Max 55c

**Power Typical** 300W

### PAY AS YOU GROW

PAYG via Pluggable Optics  
PAYG via Stackable Hardware  
PAYG via IP Feature Level

### UNIVERSAL

Supports Ethernet Business, Residential Fiber, and Mobile Backhaul Usecases

### ENVIRONMENTAL

Designed for for CO, PoPs, and DC Cloud Environments with Enhanced Temperature Support

### FLEXIBLE

Supports All MEF and IP VPNs Services, Timing Synchronization, Junos Automation Toolkit

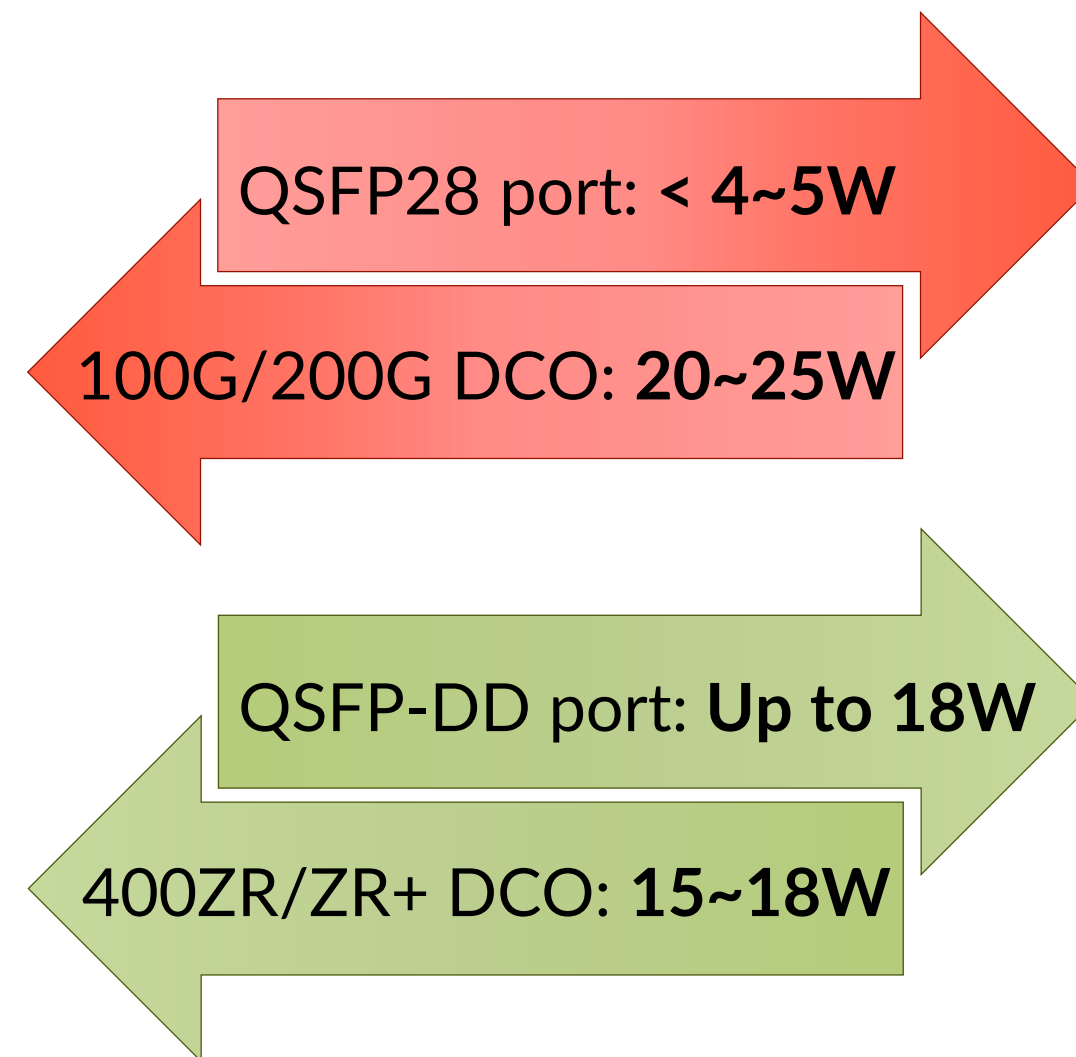
# 400ZR COHERENT DWDM ДЛЯ QSFP ЭКОСИСТЕМ

## QSFP28 is today the universal form factor of choice:

- QSFP28 ports are generally designed for a power consumption < 4~5 W.
- 100G/200G DCO have a 20~25W power consumption, requiring a CFP2 form factor

## QSFP-DD is the next-generation universal form factor:

- Designed to support higher power consumption (< 12~14W).
- Innovation in coherent DWDM technology is now focused on small form factor pluggables → 400G DCI market.
- The same pluggables will also support 300G / 200G / 100G modes to address access, metro and regional markets.



**Differentiation between client and line interfaces will largely disappear once the form factors become identical and you can mix-and-match on the same line card**

# 400G DWDM QSFP-DD

## TARGET OPTICAL MODES & OPTICAL PERFORMANCE



Preliminary  
analysis

Data Rate (Gb/s)	Modulation format	Application	Baud Rate (Gbaud/s)	FEC	Encoding	Target Reach (km)	Typical OSNR (dB)	Target Power (W)
400	DP-16QAM	OIF 400ZR	60	C-FEC	Non-Diff	120 / 300*	23	<= 15
400	DP-16QAM	Metro	62	SDFEC	Non-Diff	400	22	<= 16
300	DP-8QAM	Regional	62	SDFEC	Non-Diff	800	19	<= 16
200	DP-QPSK	Long-haul	62	SDFEC	Non-Diff	2000	14	<= 15
200	DP-8QAM	Regional	42	SDFEC	Non-Diff	1200	17	<= 15
200	DP-16QAM	Metro	31	SDFEC	Non-Diff	1000	18	<= 14
100	DP-QPSK	Long-haul	31	SDFEC	Non-Diff	>2000	11	<= 13
100	DP-QPSK	Interoperable	28	HG-FEC	Diff	>2000	13.5	<= 12.5

\* The OIF 400ZR IA targets up to 120 km reach on a single amplified fiber span, longer reach is feasible on a more optimal multi-span link

**Pluggable coherent DWDM QSFP-DD modules will address applications across DCI, access, metro, regional and long-haul markets**

# INPHI COLORZ

## 100G DWDM B QSFP28 FORM ФАКТОРЕ

### 100G QSFP28-DDO optimized for high-capacity point-to-point interconnects up to 80 km:

- Direct detection receiver, as a 100G coherent receiver is not feasible in QSFP28 form factor.
- Non-tunable, 40 SKUs to cover full C-band.
- ColorZ needs a dedicated line system:
  - 40 channel Mux / DeMux.
  - High-power optical amplification with pre- and booster amplifiers.
  - Accurate (tunable) dispersion compensation.
  - Automated optical tuning (link loss, dispersion) without knowledge of fiber infrastructure.



Maximum reach	Up to 80 km
Modulation	2 $\lambda$ x 56.25G PAM4
Wavelength grid	100 GHz
Power consumption	< 5 W
Tx power / lane	-11 to -8 dBm
Rx power / lane	-2 to +6 dBm
OSNR requirement	31 dB
CD tolerance	+/- 100 ps/nm

<https://azure.microsoft.com/en-us/blog/lighting-up-network-innovation/>  
<https://www.inphi.com/products/colorz/resources/>



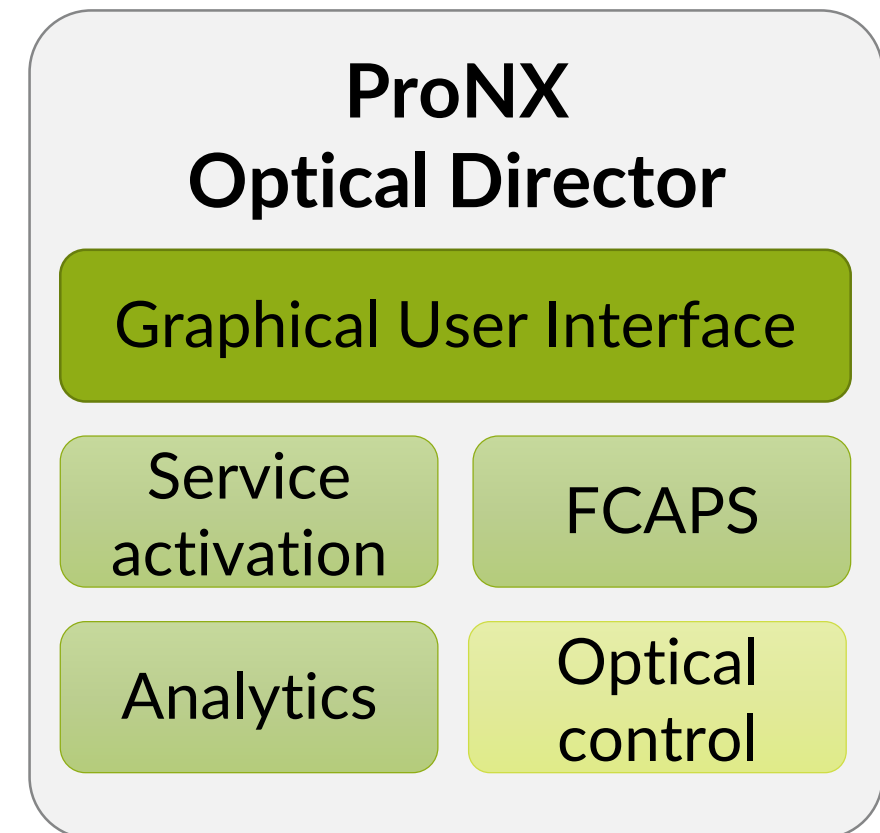
# PRONX OPTICAL DIRECTOR (POD) КОНТРОЛЛЕР ОПТИЧЕСКОЙ СЕТИ

## NMS platform with full FCAPS functionality:

- Web based user interface for topology visualization, point & click activation of transport services and performance monitoring.
- Facilitates network automation through open APIs with focus on OpenROADM and OpenConfig APIs

## Virtualized optical control for ROADM networks:

- Implements strict separation of control and transport layers for optical transport networks.
- Optical link control implemented in the network controller instead of the network elements.
- Enables easier integration of 3rd party NEs.



# PRONX OPTICAL DIRECTOR (POD) FRAMEWORK

## Microservices architecture:

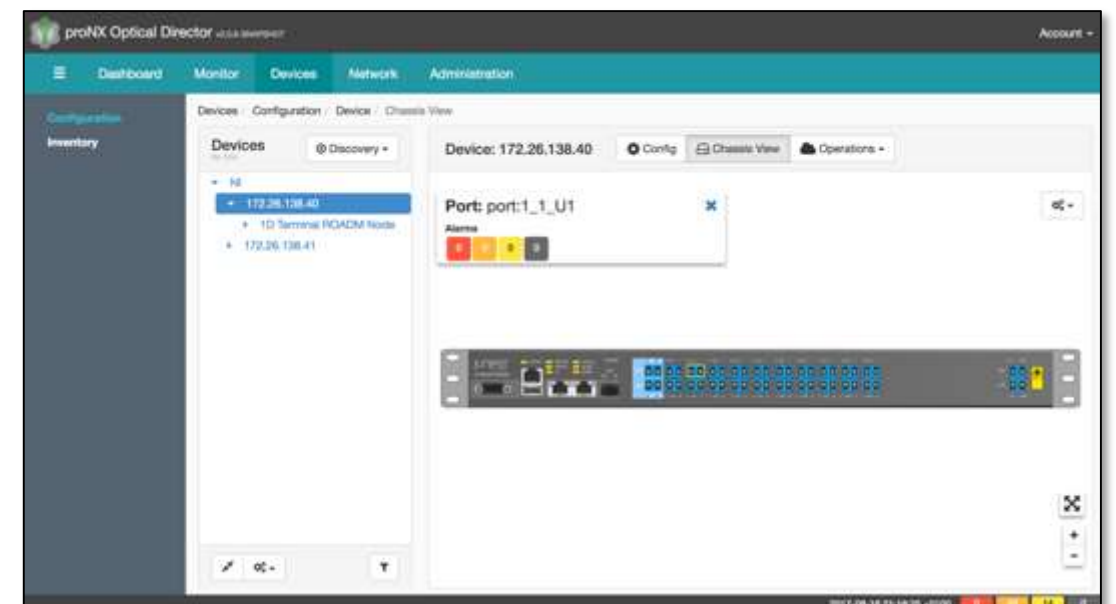
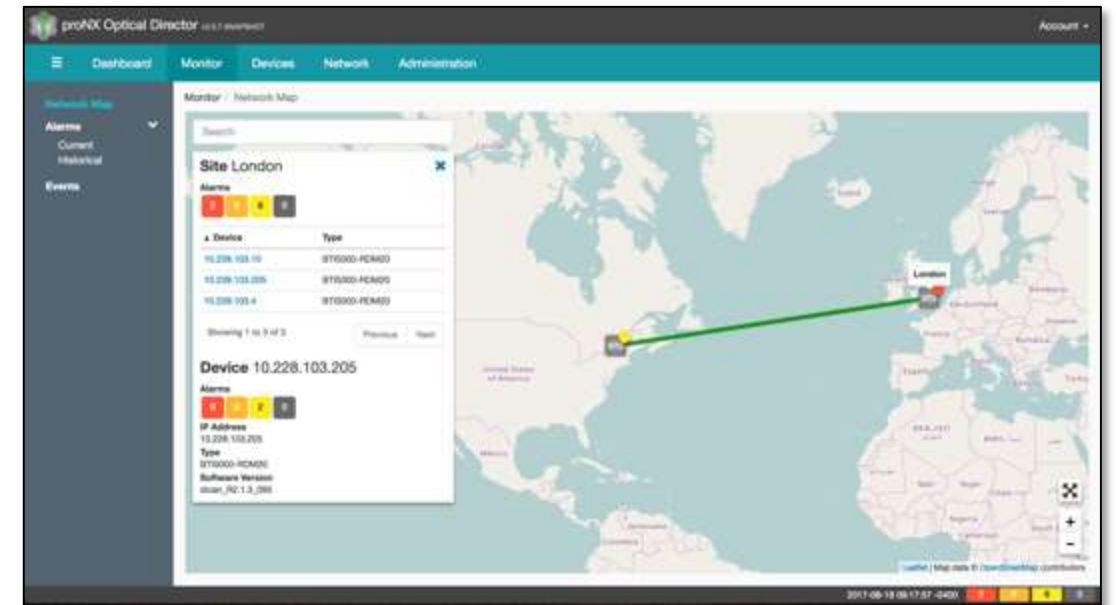
- Asynchronous message transport infrastructure to transparently scale-up new service instances.

## Build on top of a modern software infrastructure:

- Builds on LDK (Linux-Docker-Kubernetes) software stack, which provides compute, storage and networking services.
- Native clustering enables high-availability and geo-redundancy for all applications.
- Running on commodity (COTS) hardware.

## Deployed as a highly available, highly scalable transport network controller:

- HW can be introduced with zero down time
- SW can be programmatically scaled up and down. Architecture supports any size of network.

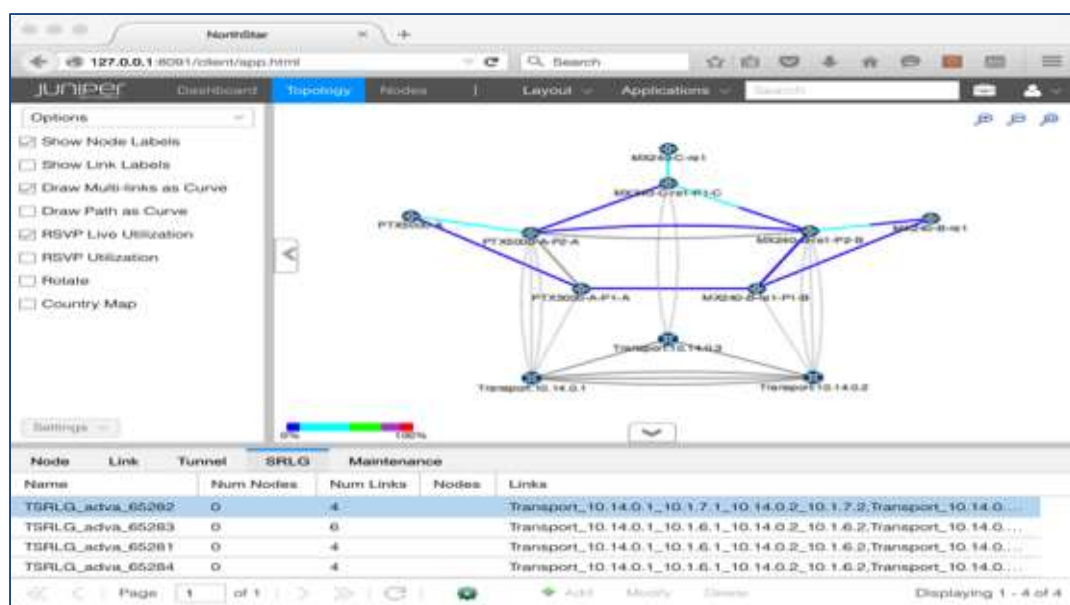


# MULTILAYER OPTIMIZATION PRONX OPTICAL DIRECTOR & NORTHSTAR



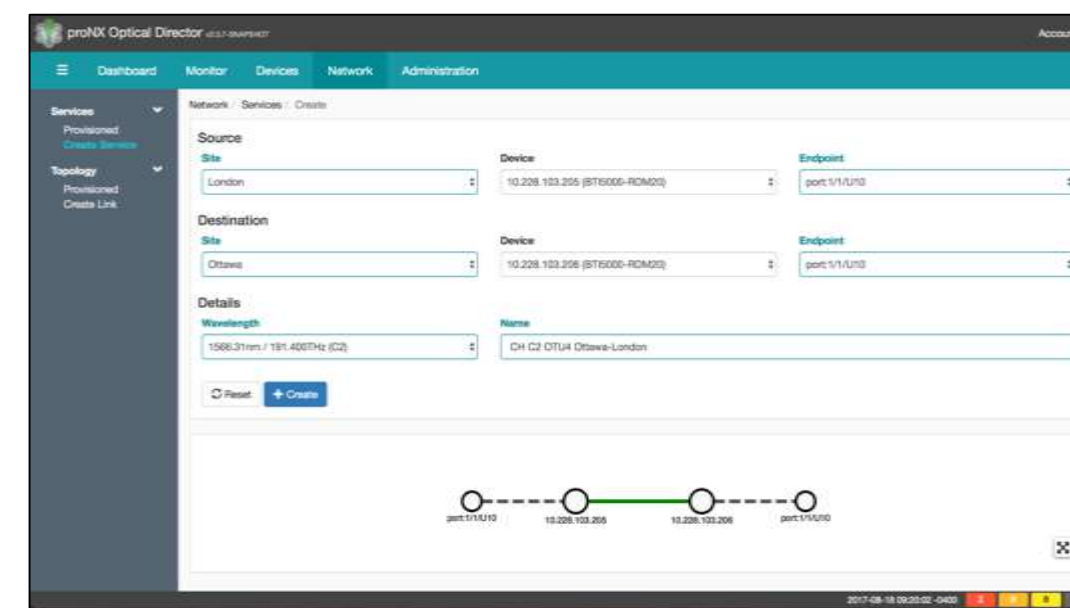
Planned for  
**2H2018**

## NorthStar Controller



REST/  
RESTCONF  
↔  
Topology  
Exchange

## proNX Optical Director



- Technology-agnostic YANG data model based on draft-ietf-teas-yang-te-topo-05.
- Dynamic learning of abstracted node & link topology through REST/RESTCONF interface
- TE metric, SRLG, protection, and delay attribute exchange with dynamic LSP re-optimization to ensure LSP constraints are met.
- Proven end-to-end Juniper solution, as well as with 3<sup>rd</sup> party transport controllers.

# СПАСИБО

За уделенное вами время