Оптические сетевые решения для организации связи повышенной безопасности между ЦОДами

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Agenda

1. Introduction ADVA
2. Datacenter Interconnectivity (DCI) and DWDM
3. Overview of ADVA's DWDM Hardware
4. Examples and Solutions
5. Security

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1. Introduction ADVA
2. Datacenter Interconnectivity (DCI) and DWDM
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Our History – DWDM Family

1994 2000 2005 2010 2015 2020

OCM 4

FSP-II

FSP 2000

FSP 3000

FSP 3000 CC

Connecting for more than 25 years

ADVA Optical Networking today

Our CUSTOMERS

Hundreds of carriers
Thousands of enterprises

Product portfolio overview

Cloud interconnect

FSP 3000

Open optical networking solutions based on wavelength division multiplexing (WDM) technology to deliver scalable bandwidth for access, metro and long-haul networks; high levels of open interworking, programmability and ease-of-use;

Connect Guard™

Micro Connect™ | True Time™ | Open Fabric™ | Cloud Connect™

ADVA Optical Networking

Cloud access

FSP 150 and Ensemble

Carrier Ethernet access and network functions virtualization (NFV) solutions that enable communication service providers to deliver software-defined, differentiated and performance-assured wholesale, mobile backhaul and business services;

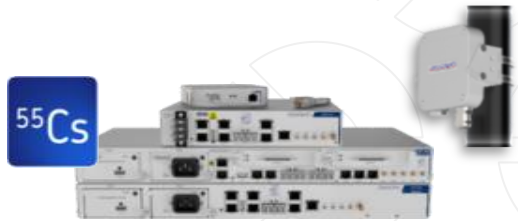
Empowered Edge™ | Connect Guard™ | Ensemble (A Division of ADVA Optical Networking)

ADVA Optical Networking | MRV

Timing excellence

Oscilloquartz

Primary reference sources (atomic clocks) and distribution solutions to deliver accurate and scalable time and frequency synchronization for mobile network infrastructure, utilities, financial services, distributed data bases and meteorology;



Sync Jack™

ADVA Optical Networking | OSCILLOQUARTZ (An ADVA Optical Networking Company)

Our multi-technology and future-proof portfolio

Open optical transport

FSP 3000

Synchronization

OSA

Ensemble

Multi-technology network management, control and orchestration

FSP 150

Packet edge with NFV

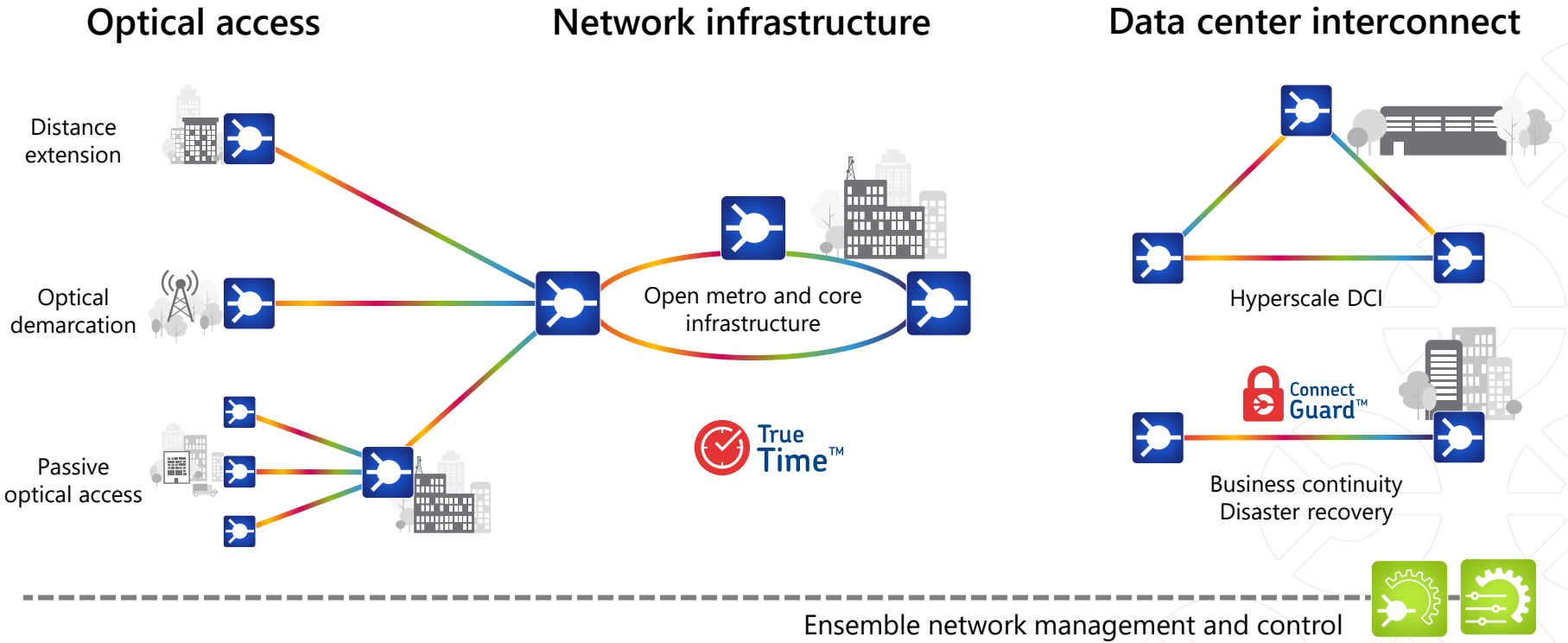
ALM

Fiber monitoring and assurance

Our solutions

It’s all about the network

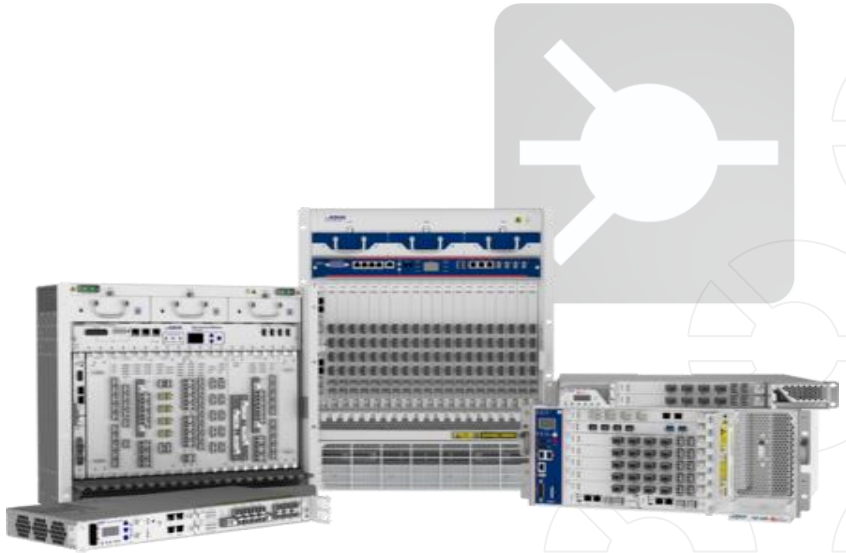
Open optical networking



Redefining cloud connectivity – open and secure terascale networking

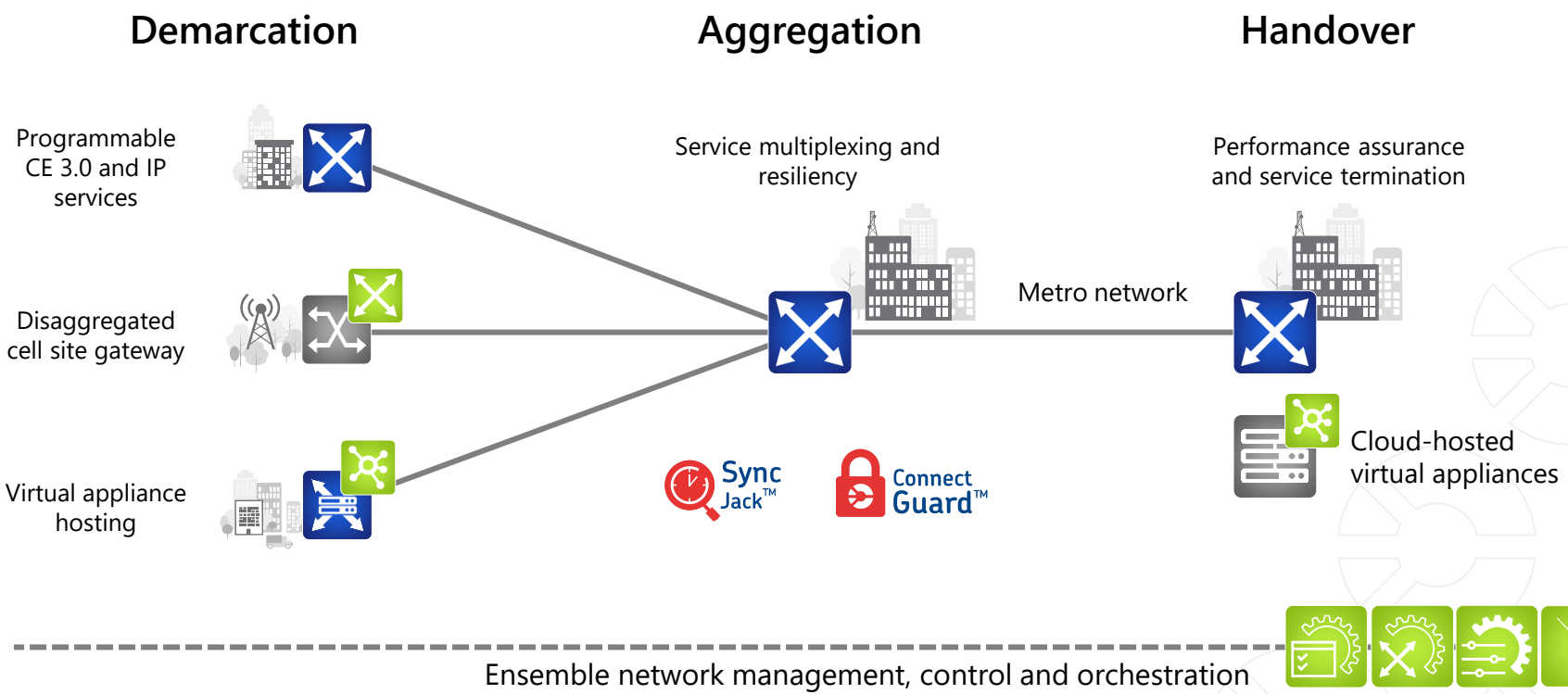
FSP 3000

- Open architecture and YANG-based software design
- Easy integration into any SDN environment
- ConnectGuard™ optical encryption for ultimate security
- Operational simplicity through low-touch provisioning
- Lowest power consumption and smallest footprint
- Qualified by all storage system vendors



Redefining cloud connectivity – open and secure terascale networking

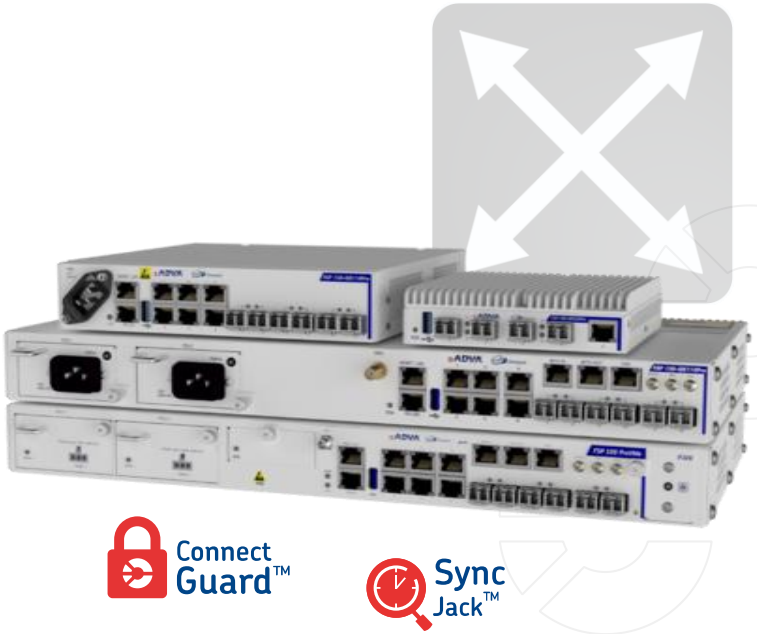
Packet edge demarcation and aggregation



Empowering the network edge – secure, zero-touch service delivery

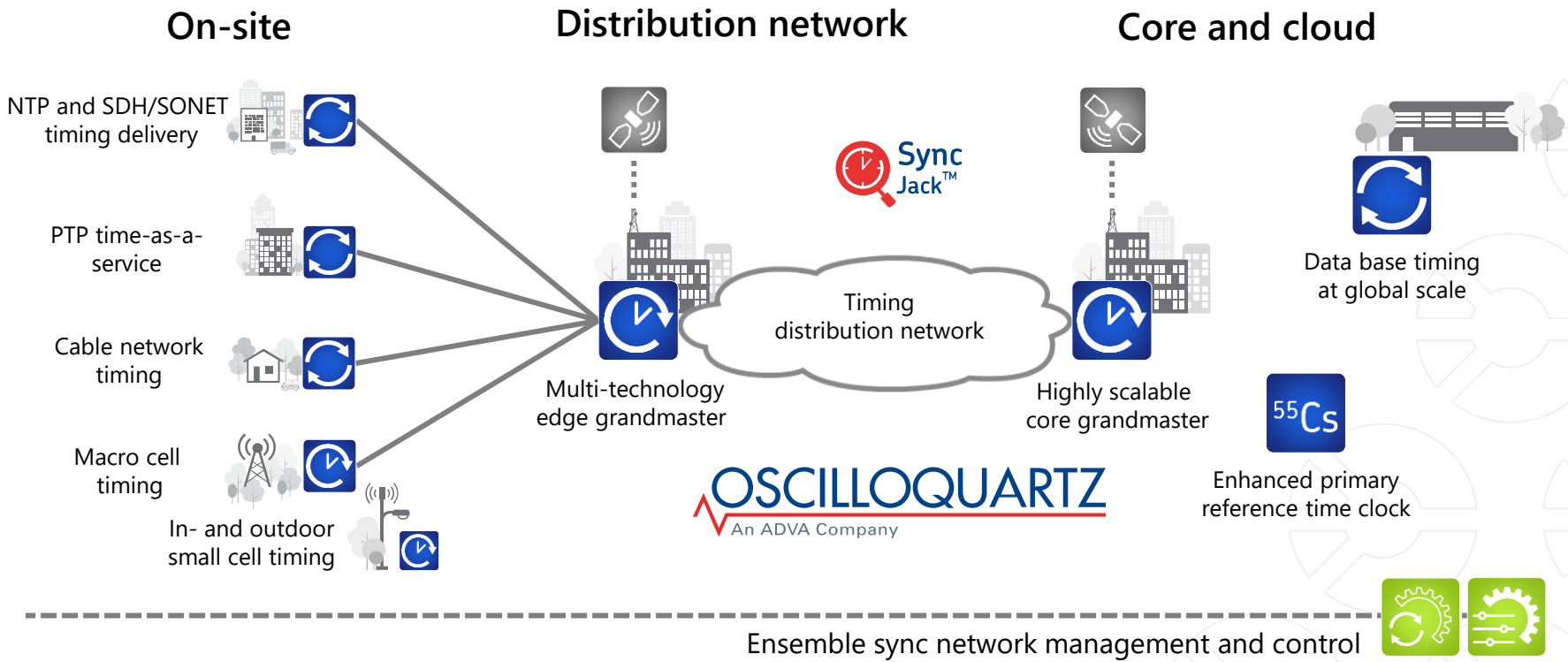
FSP 150

- Ethernet and IP services up to 100Gbit/s
- Programmable multi-layer technology
- Hosting of virtual network functions
- Zero touch provisioning for automated service activation
- ConnectGuard™ Ethernet encryption for ultimate security
- Syncjack™ technology for precise synchronization



Empowering the network edge – secure, zero-touch service delivery

Synchronization delivery and assurance



Assured precision timing – scalable time and frequency synchronization

OSA line

- End-to-end synchronization solutions
- Modular, scalable and high-availability architecture
- Extended holdover performance
- Installation simplicity indoor and outdoor
- Syncjack™ technology for in-service assurance
- Ensemble Sync Director for efficient large-scale deployment

Assured precision timing – scalable time and frequency synchronization

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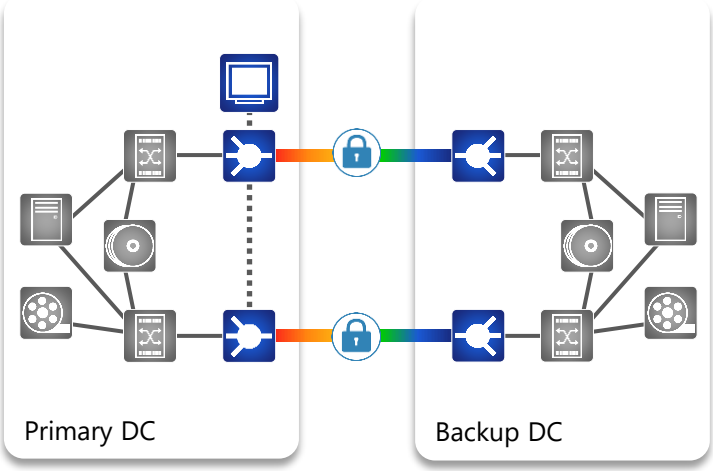
Our Main Target Application: DCI SAN

Market Verticals

- Government
- Finance & Insurance
- Healthcare
- Transport & Logistic
- Energy
- Manufacturing
- Utilities



- From Cloud Access to Terabit/s connectivity
- Partner Qualifications (IBM, Brocade, EMC²)
- Feature Set including 100G-600G Encryption

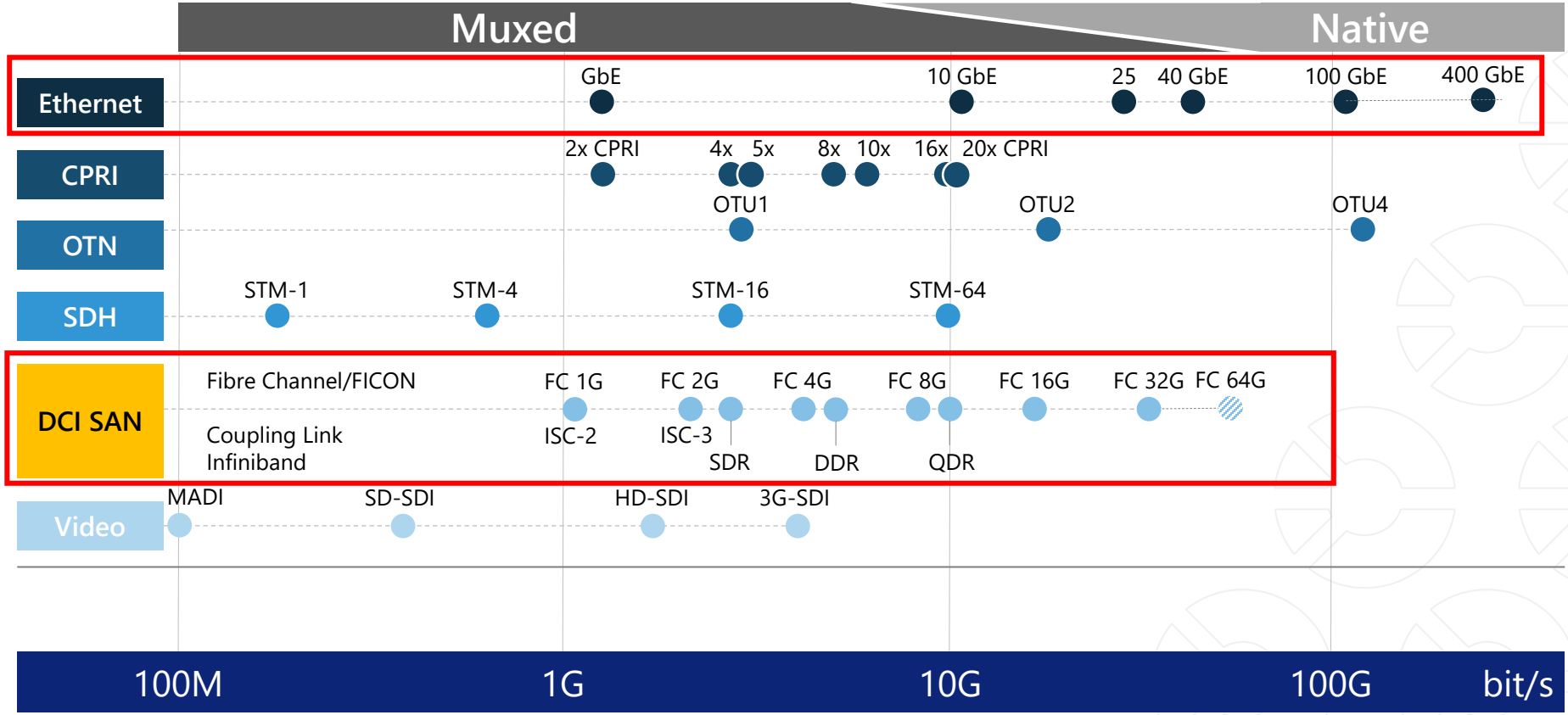
Connect Guard™

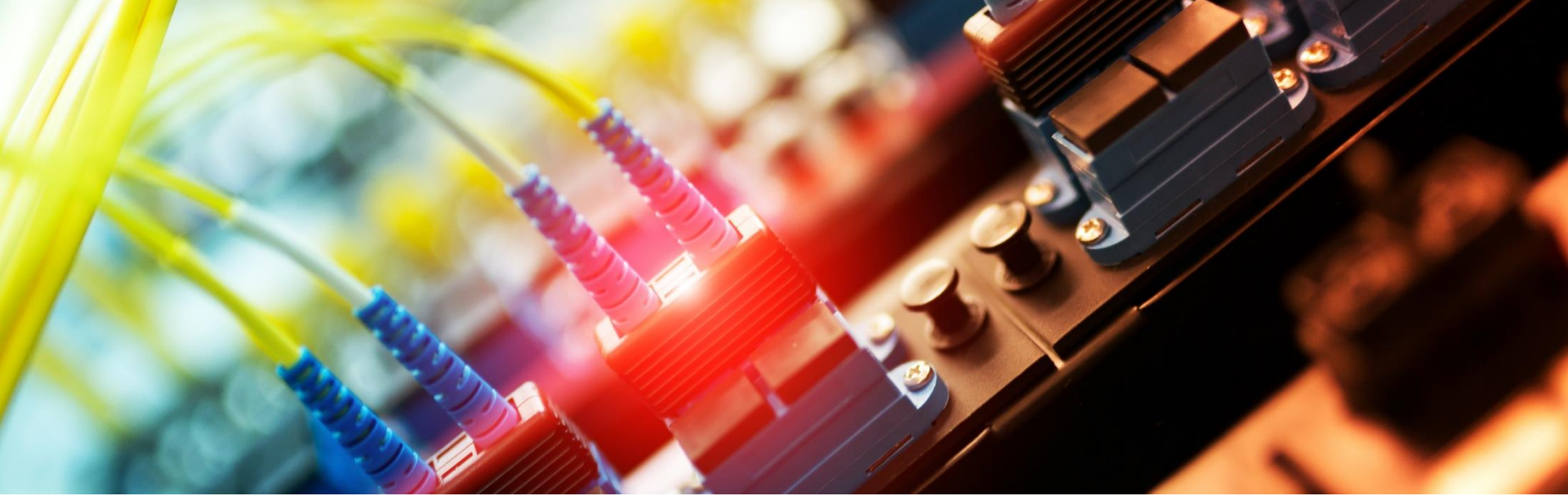
Why ADVA?

- Best Performance
- Max. Security
- Certifications
- Lowest Latency
- Scalability
- Multiprotocol support

Innovation for high-performance Data Center Connections

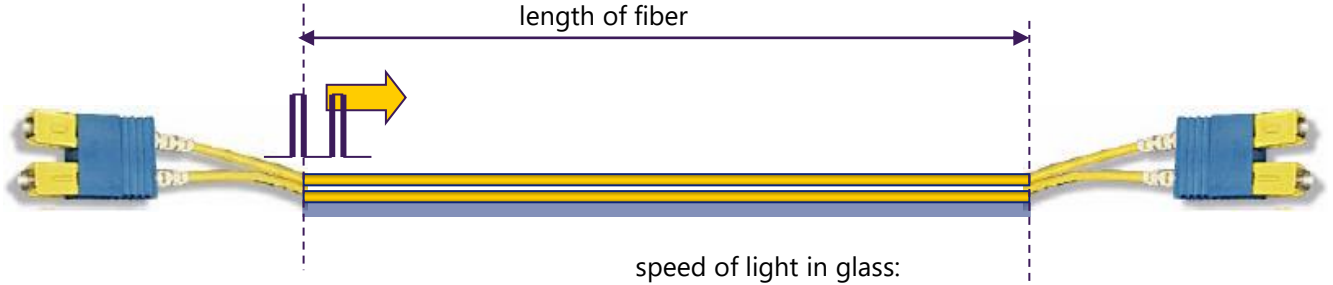
ADVA's Multiservice offerings





Some Physics

Some physics

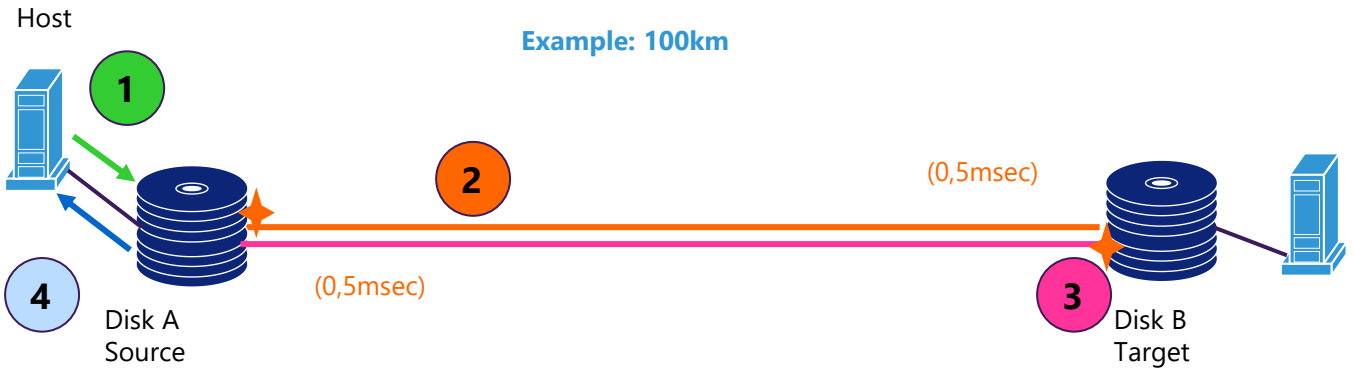


speed of light in glass:

length	in km	delay in microsec	in msec
1	km	5	0,005
10	km	50	0,05
50	km	250	0,25
100	km	500	0,5
150	km	750	0,75
0,02	km	0,1	0,0001

$$s = c \cdot t \quad with \quad c = 2 \cdot 10^8 \frac{km}{s} \quad \Rightarrow \quad 1\mu s \cong 200m$$

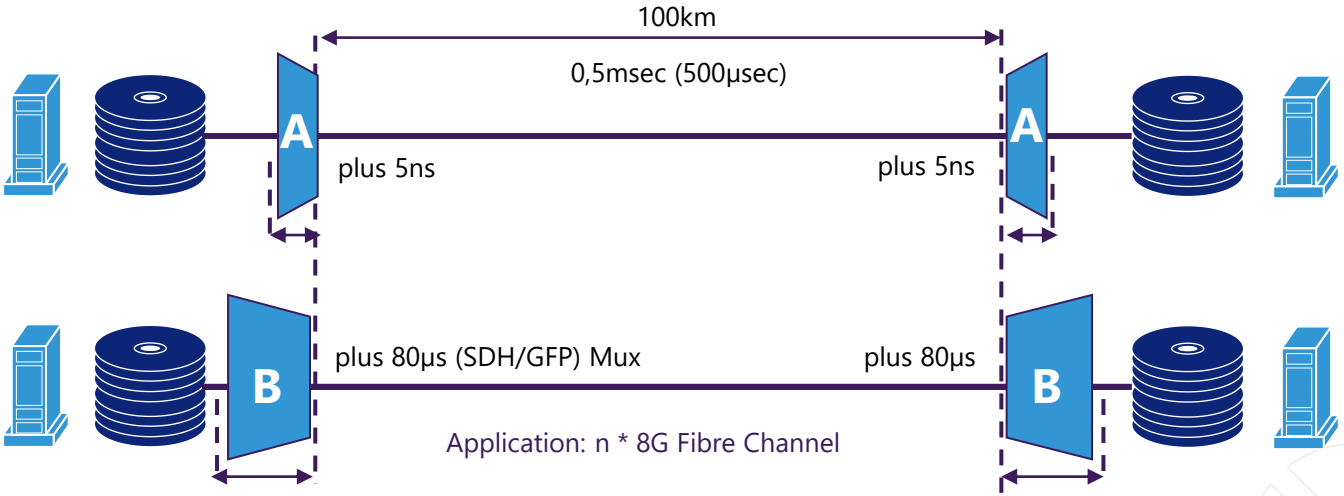
Disk mirroring: the most important storage application



1. write I/O from host to source
2. I/O is transmitted to the target
3. Receipt acknowledgment is provided by target back to the source
4. Ending status is presented to host

Low latency leadership

Example: 5WCA card



Result: both ADVA multiplexers will add an additional "virtual" lengths of 2 meters versus 32km

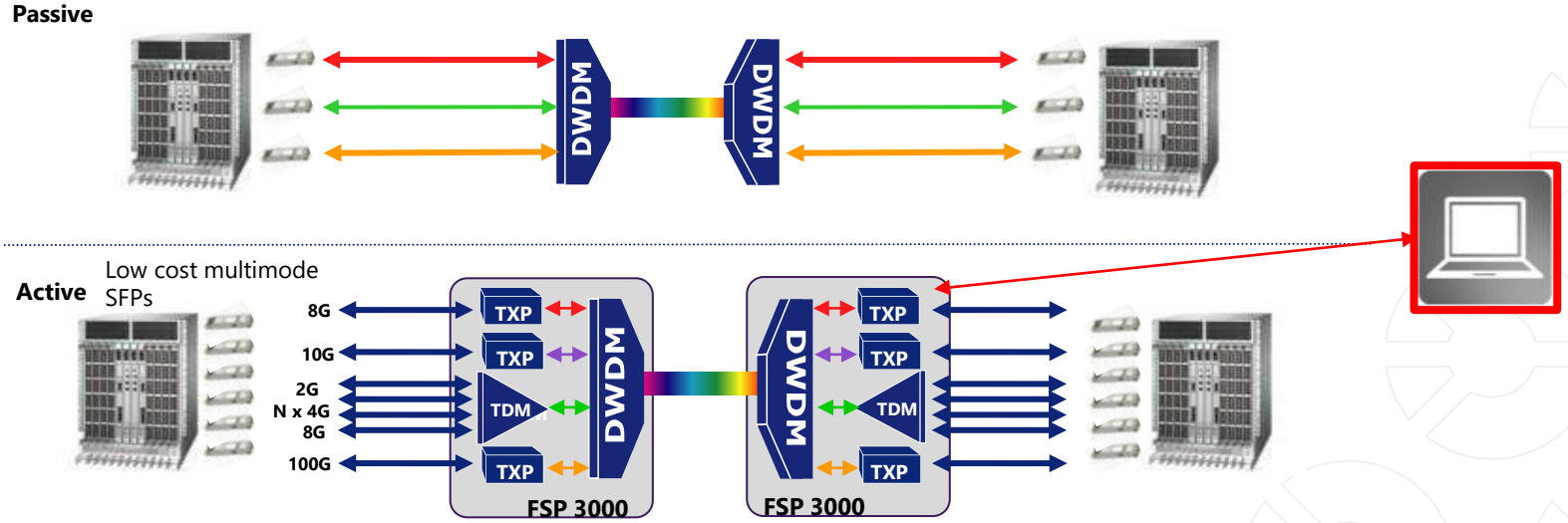
ADVA round trip: (1m+100km+1m+1m+100km+1m) = 200,004km

Competitor round trip: (16+100+16+16+100+16)km = 264km

ADVA™
Optical Networking

DWDM solution for sensitive Storage applications

Passive WDM vs. active WDM solutions



Higher capacity (more channels per fiber)

Higher aggregate bandwidth (up to 100G per wavelength)

Higher distance (up to 200 km without mid-span amplifier)

More secure (automated fail over, NMS, optical monitoring tools, embedded encryption)

10G Data Center Channel Card

5WCA-PCN-16GU

Quint-Transponder, ultra-high density, lowest cost per bit

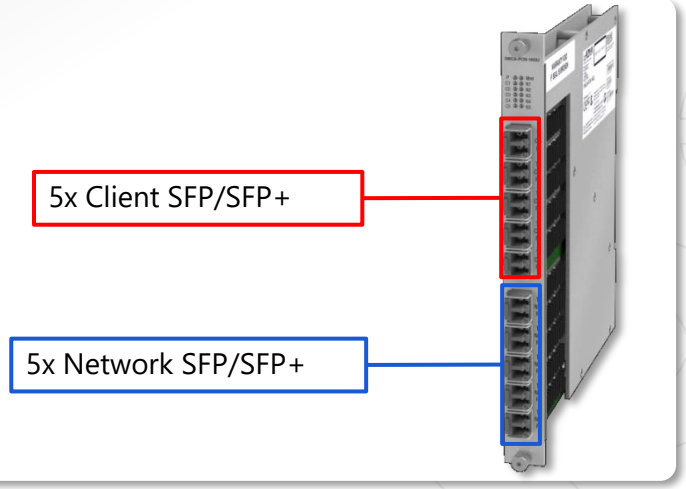
Multi-service

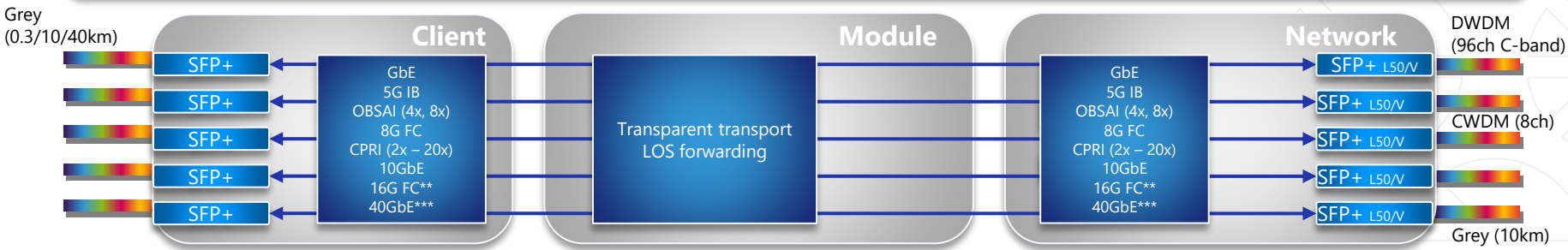
- 5G IB, 8G FC, 16G FC
- **GbE,** 10GbE, 40GbE (SR4, **LR4** via break out cable)
- **CPRI from 1228.8 Mb/s to 10137.6 Mb/s**
- **OBSAI 3072 Mb/s and 6144 Mb/s**

Optimized for Data Center and Mobile Backhaul

Low latency

Client Channel Card Protection*





CWDM (8ch and 40GbE LR4)
DWDM (96ch C-band)

* Except 40GbE
** Dedicated 16G FC SFP+
*** Via break out cable, supports SR4, LR4 clients

10G Data Center Channel Card

5WCA-PCN-16GU

Supported services and pluggable transceiver

Client Data Rate / Service	Client SFP / SFP+	Network SFP / SFP+
1250.0 Mb/s: GbE	SFP/GBE/850I/../TIN SFP/GBE/1310S/../TIN SFP/GBE/1310L/../TIN	SFP/GBE/1310L/../TIN SFP/3GU/BCxxxxL/../TIN SFP/2G5U/CxxxxV SFP/2G5U/Dxxxx.xxU
1228.8 Mb/s: CPRI (2x) 2457.6 Mb/s: CPRI (4x) 3072.0 Mb/s: CPRI (5x), OBSAI (4x)	SFP/4GU/850I SFP/4GU/1310S	SFP/3GU/BCxxxxL/../TIN
4915.2 Mb/s: CPRI (8x) 6144.0 Mb/s: CPRI (10x), OBSAI (8x) 9830.4 Mb/s: CPRI (16x) 10137.6 Mb/s: CPRI (20x)	SFP+/11GU/850I SFP+/11GU/1310S SFP+/11GU/CxxxxV SFP+/11GU/DCTV	SFP+/11GU/1310S SFP+/11GU/CxxxxV SFP+/11GU/DCTV
5000.0 Mb/s: 5G IB 8500.0 Mb/s: 8G FC 10312.0 Mb/s: 10GbE	SFP+/11GU/850I SFP+/11GU/1310S SFP+/11GU/CxxxxV SFP+/11GU/DCTV	SFP+/11GU/1310S SFP+/11GU/CxxxxL* SFP+/11GU/CxxxxV SFP+/11GU/#19xxxL50* SFP+/11GU/DCTV *No 5G IB
8500.0 Mb/s: 8G FC 14025.0 Mb/s: 16G FC	SFP+/16GFC/850I SFP+/16GFC/1310S	SFP+/16GU/#19xxxL50
40GbE (SR4, LR4 as 4x 10GbE)	SR4: 4x SFP+/11GU/850I w/ J/MM50/MPO12-LC08 LR4: 4x SFP+CDR/11GU/CxxxxS w/ 2x J/SM/4CS-#C1270-#C1330	4x SFP+/11GU/CxxxxL 4x SFP+/11GU/CxxxxV 4x SFP+/11GU/#19xxxL50 4x SFP+/11GU/DCTV

100G Enterprise & Metro/Regio Muxponder 10TCE-PCN-16GU+100G

Ultra-high density 100G muxponder

Pluggable interfaces on client and network (grey, 4x 28G and coherent)

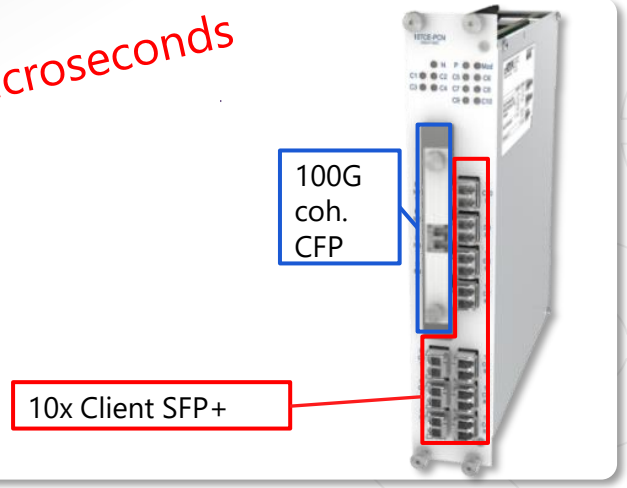
Coherent CFP (CFP/112G/#DCTC/SM/LC)

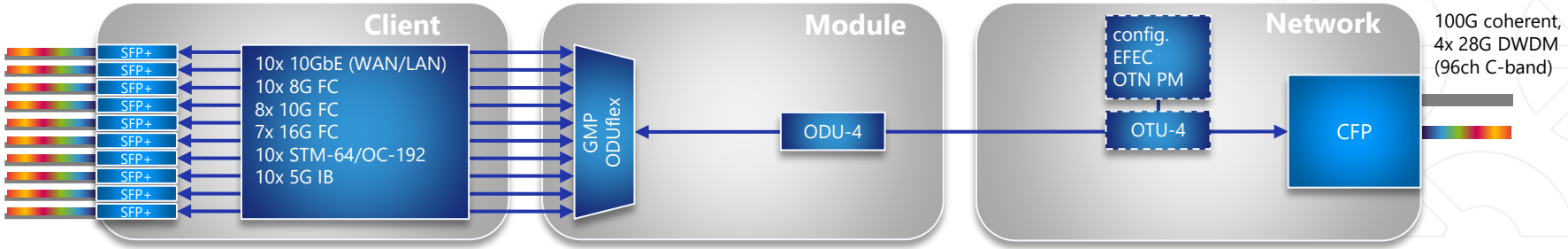
- 50GHz spacing DP-QPSK
- Integrated SD-FEC
- CD 40.000ps/nm (up to 2000 km SSMF), PMD <15ps

Up to 10 x any multi-service

- 10GE, STM-64/OC-192, **FC 8/10/16**, 5G IB
- 40GE/100GE via break out cable

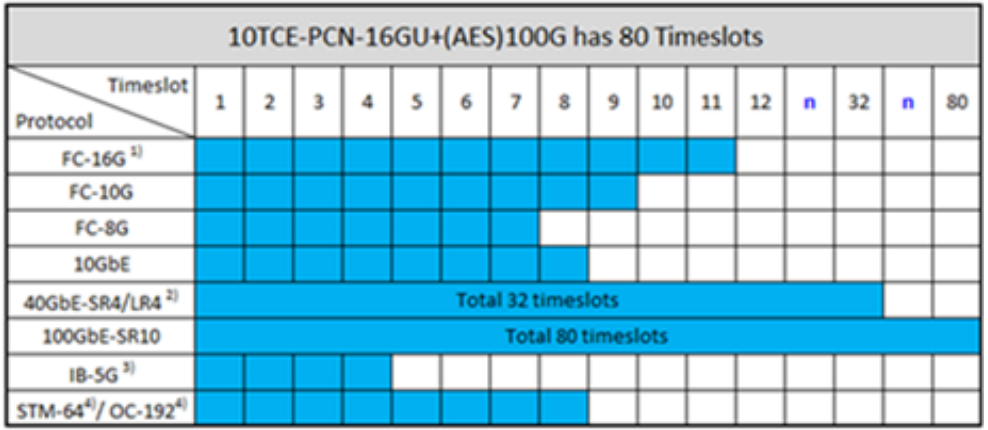
Delay: 7,5 microseconds





Grey (0.3/10km)
CWDM (8ch+4ch), DWDM (40ch C-band)

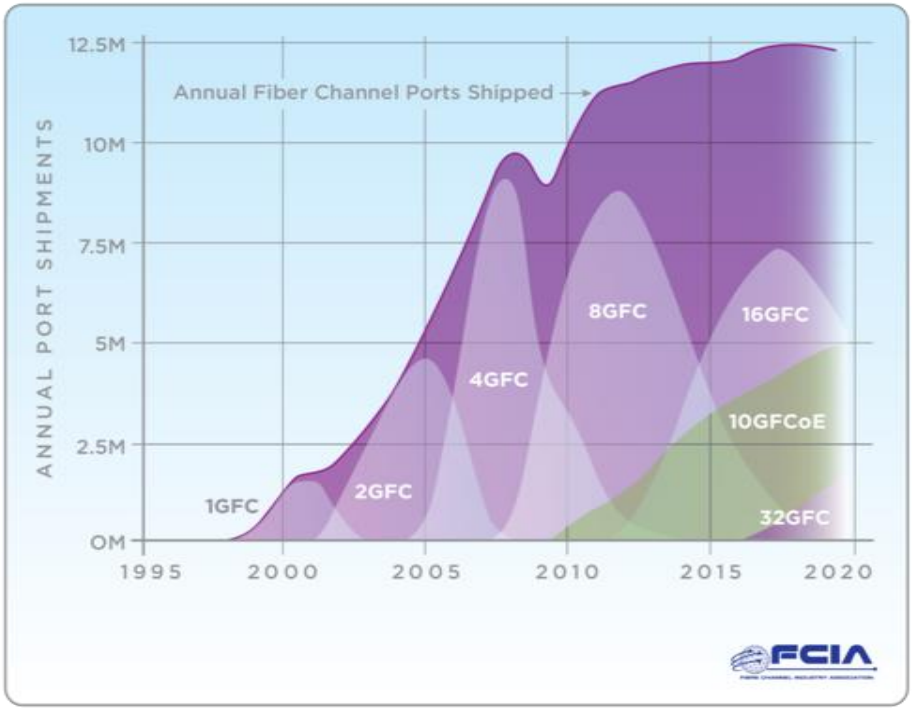
100G Enterprise & Metro/Regio Muxponder 10TCE-PCN-16GU+100G

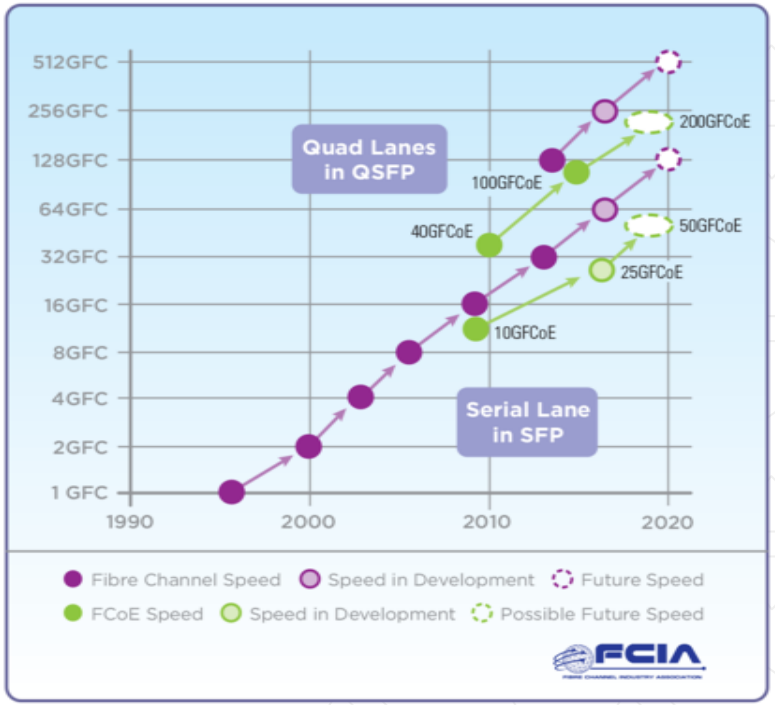


10TCE-PCN-16GU+(AES)100G has 80 Timeslots																
Protocol \ Timeslot	1	2	3	4	5	6	7	8	9	10	11	12	n	32	n	80
FC-16G [1]	■	■	■	■	■	■	■	■	■	■	■					
FC-10G	■	■	■	■	■	■	■	■	■							
FC-8G	■	■	■	■	■	■	■									
10GbE	■	■	■	■	■	■	■	■								
40GbE-SR4/LR4 [2]	Total 32 timeslots															
100GbE-SR10	Total 80 timeslots															
IB-5G [3]	■	■	■	■												
STM-64 [4] / OC-192 [4]	■	■	■	■	■	■	■	■								

Fiber Channel Alive !

DCI SAN: Fibre Channel Switch Market





Source: http://fibrechannel.org/roadmap/

Fiber Channel Roadmap – ADVA Roadmap

Source:

Fibre Channel Solutions Guide 2019

ADVA – Roadmap*:

2021: 64G FC (under dev.)

2017: 32G FC (2018 with encrypt.)

2012: 16G FC (2014 with encrypt.)

2008: 8G FC (2011 with encryp.)
2005: 4G FC
…
…
…

*** 128G FC support under analysis**

ADVA – First to market with DWDM support of new FC-protocols

Bound to enterprises – for many years

ADVA: First to market with new storage protocol qualifications

32G Fibrechannel … in the field

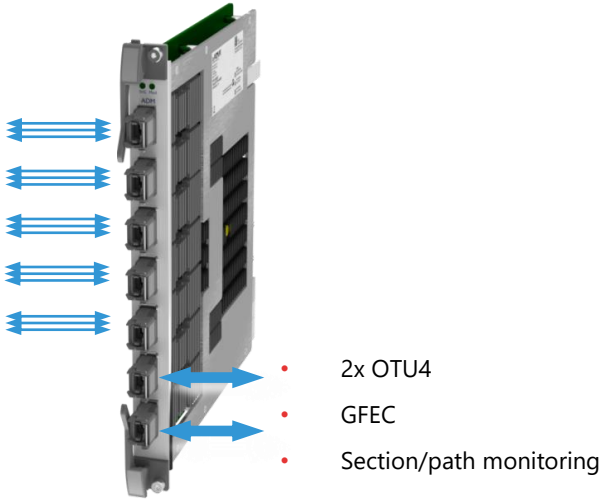
SAN Transport via Muxponder card

16G /32G FC support

- 28.05GHz service rate (matching OTU4 lane rate)
- PCS transparent transport
- Minimum skew for Brocade trunking
- Up to **6x 32G FC** or up to **12x 16G FC**
- 128G FC (later release)

Service support on Quad Pluggables

- 16G FC via fan out of QSFP14 or multi rate QSFP28/SR4 and QSFP28/PSM4
- 32G FC via fan out of dual rate QSFP28/SR4 and QSFP28/PSM4
- 3x service per QSFP

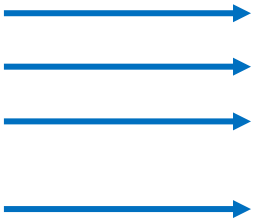


"OpenFab-SAN"

Minimal DCI Solution 32/16/8G FC

Brocade G620 Switch

n x 32G FC

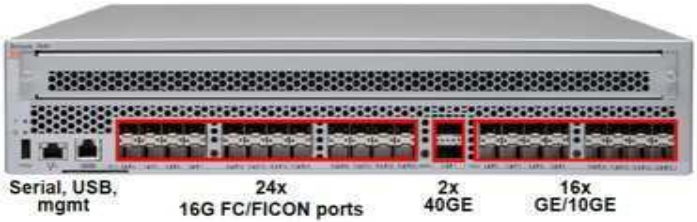


12 x 32G FC per 1HU chassis

or...

120 x 32G FC per 12HU chassis

Brocade's 7840 Extension Switch over DWDM



2 x 40G Ethernet

8 x 40GE per 1HU chassis

25GE over DWDM

NEW

n * 25G Ethernet

16 x 25GE per 1HU chassis

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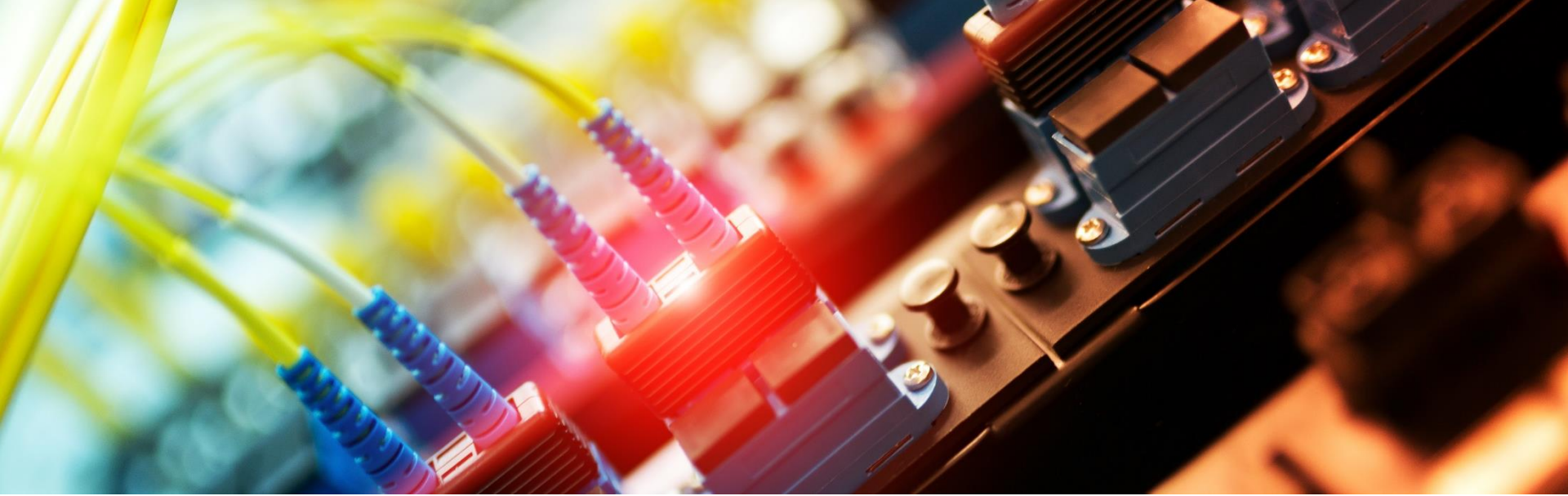
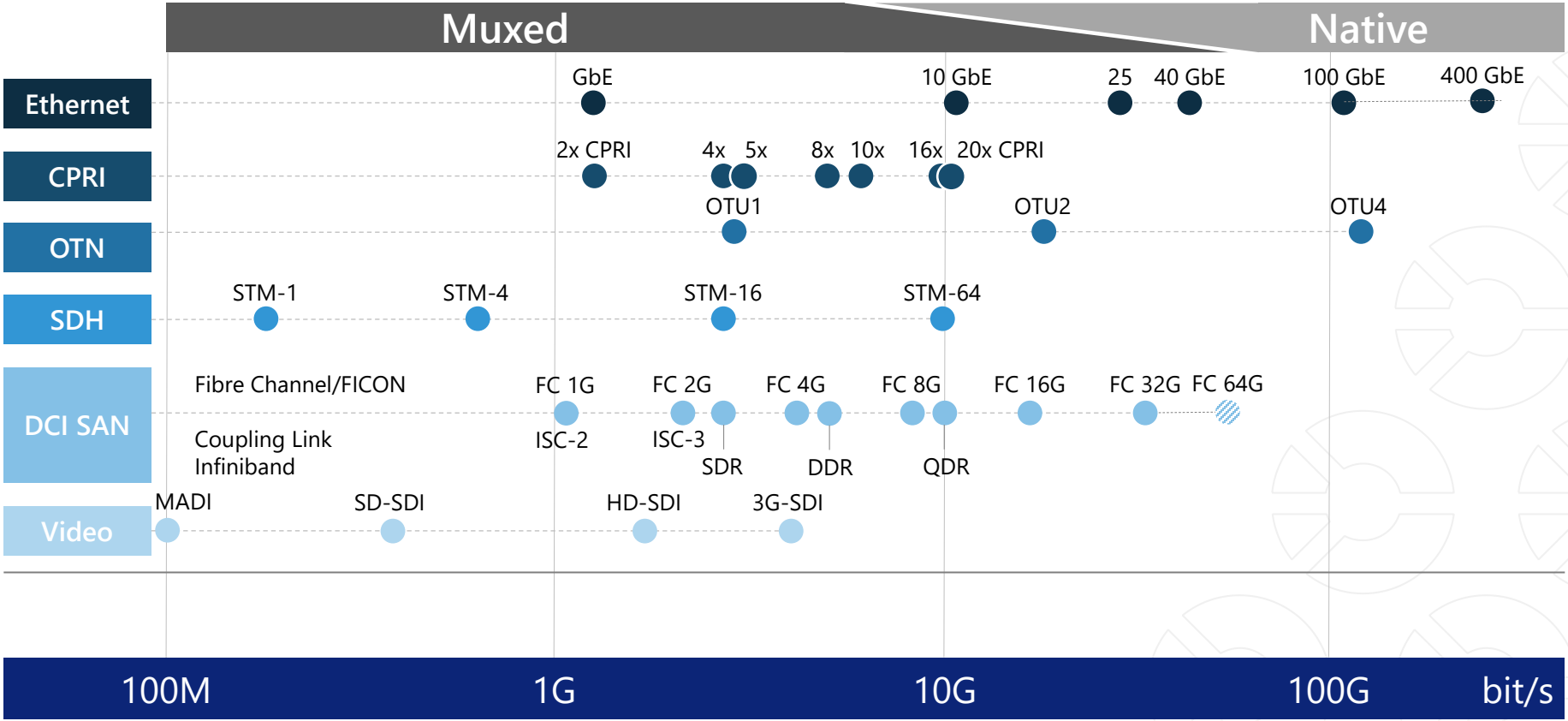


FSP 3000 system overview

Multiservice offerings



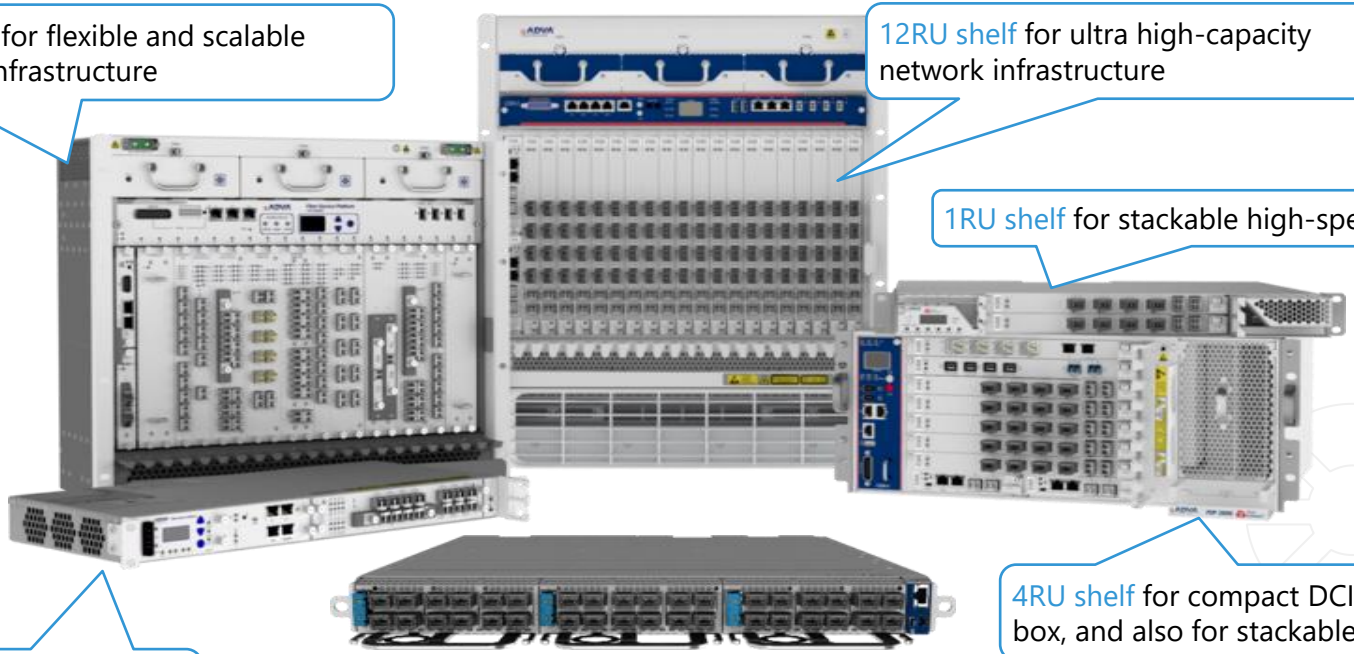
Chassis

FSP 3000 chassis options

9RU shelf for flexible and scalable network infrastructure

12RU shelf for ultra high-capacity network infrastructure

1RU shelf for stackable high-speed DCI

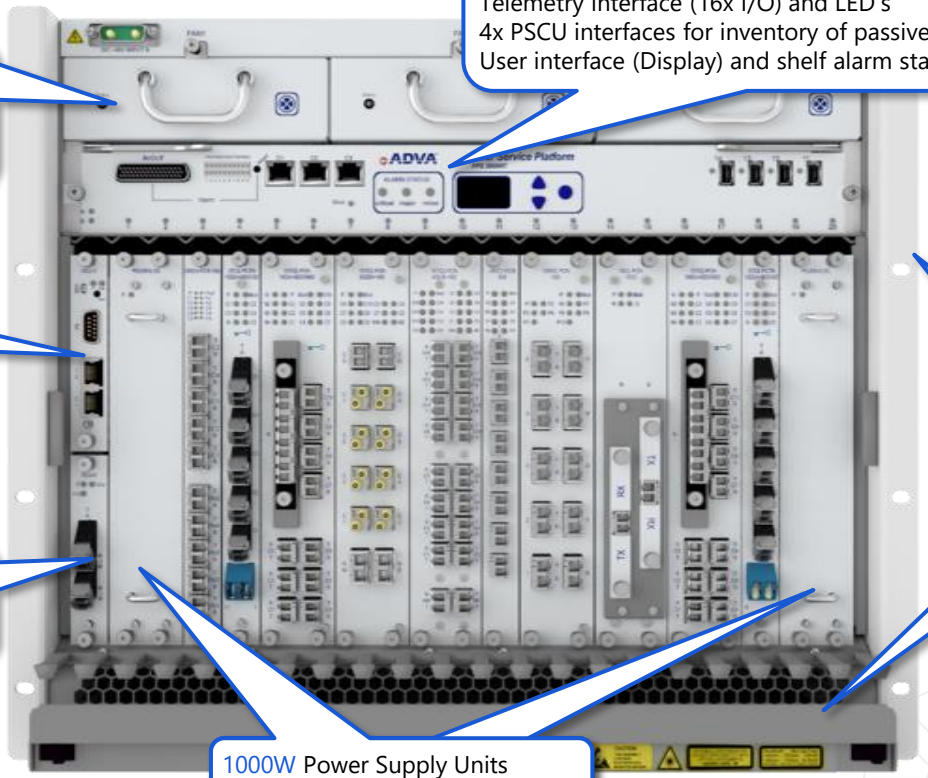


4RU shelf for compact DCI solutions in a box, and also for stackable DCI solutions

1RU shelf for compact access and metro solutions

1RU shelf for ultra-compact hyperscale DCI solutions

System Architecture
9HU High End Shelf



Central Equipment Management Panel
3x RJ45 Ethernet
Telemetry interface (16x I/O) and LED's
4x PSCU interfaces for inventory of passive units
User interface (Display) and shelf alarm status LED's

High cooling power support by optimized air flow management and individual swappable fan units

Network Controller Unit (NCU-II) for NE Management

Shelf Controller Unit (SCU-II) optical connectivity between shelves

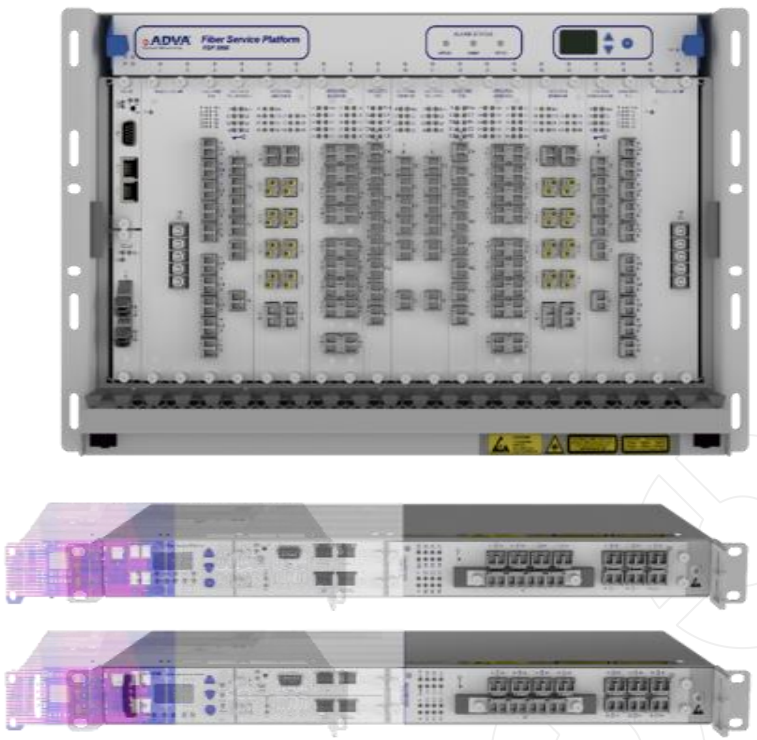
Separate electrical and optical cable management

1000W Power Supply Units (AC/DC) with Redundancy

System Architecture
7HU Common Shelf and 1HU Slimline Shelf

7HU Shelf (20 slots)
- Redundant PSU
- NCU-II, SCU-II
- OSCM + OSFM
- EDFA + DCM
- Filters + Transponders

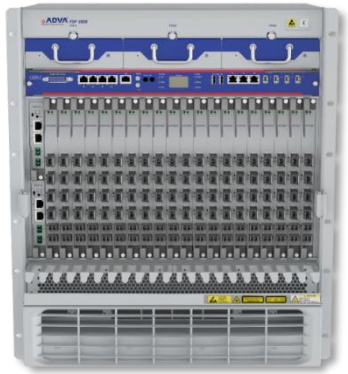
1HU Slimline Shelf (2 slots)
- Redundant DC feed or redundant AC or DC power supplies
- SCU-II, SCU-S
- NCU-II, NCU-S
- Filters + Transponders
- E-Temp variant for operating from -33 ˚C to +55 ˚C



High Density Shelves

Flexible Installation

Colocation



- 4 card slots
- 700W typ./max. 1000W

- 20 card slots
- 2900W typ./max. 3900W

Colocation & ETSI rack support (300mm)

Front traffic & management access

Power: AC front, DC front/rear

Data center

- 7 card slots
- 1100W typ./max. 1500W

- 2 card slots
- 360W typ./max. 450W

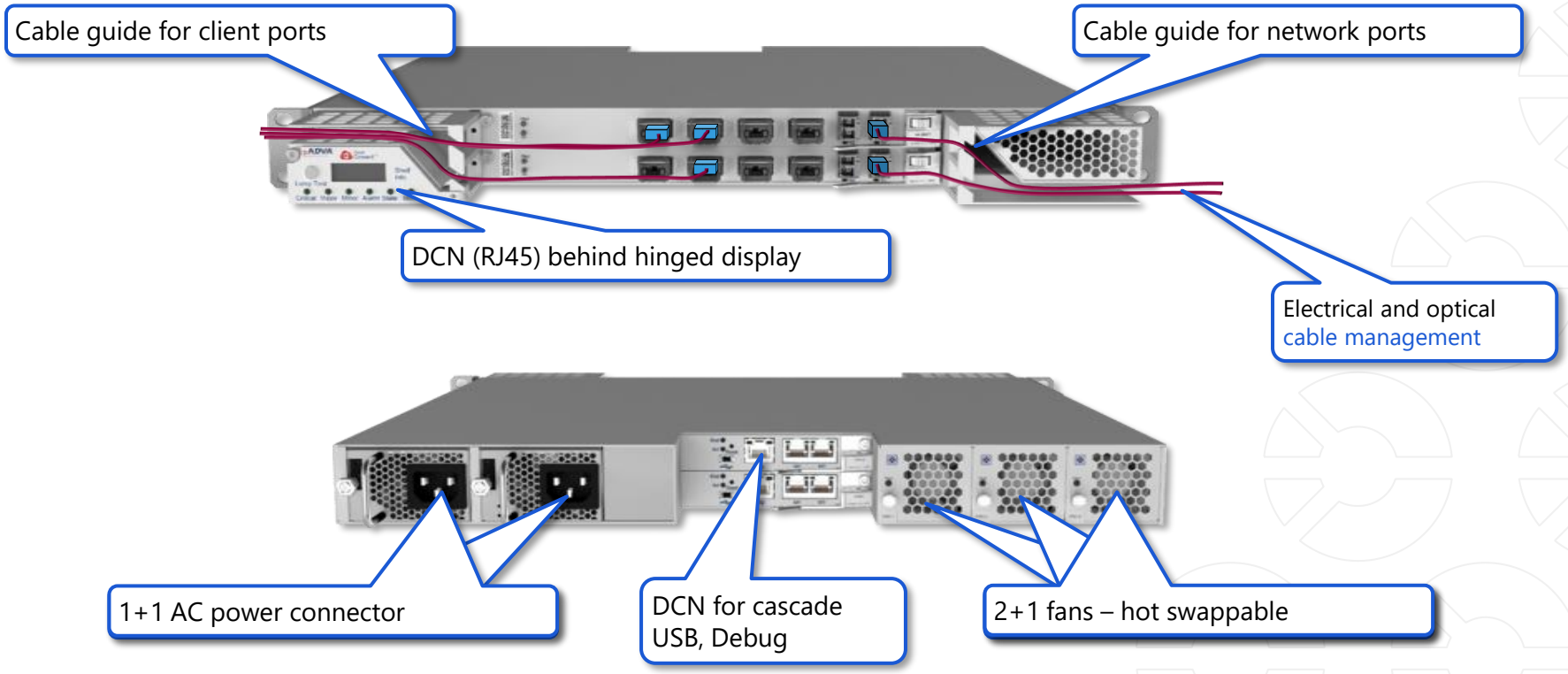
Data Center Rack support (600mm)

Front traffic, front & rear management access

Power: AC/DC rear

Application for any Rack Type

1 HU Chassis



Active Cards:
100G - 200G – 400G – 600G

100G Enterprise & Metro/Regio Muxponder 10TCE-PCN-16GU+100G

Ultra-high density 100G muxponder

Pluggable interfaces on client and network (grey, 4x 28G and coherent)

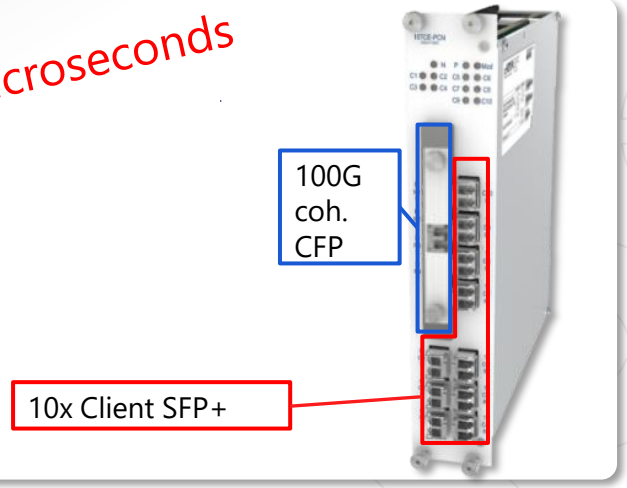
Coherent CFP (CFP/112G/#DCTC/SM/LC)

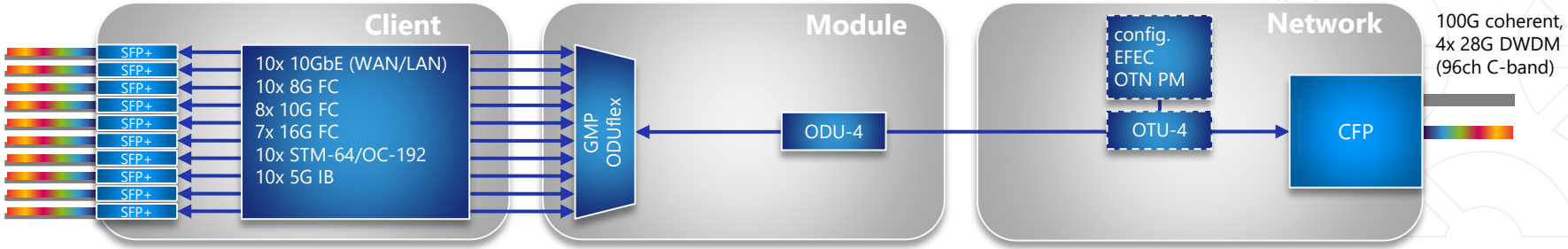
- 50GHz spacing DP-QPSK
- Integrated SD-FEC
- CD 40.000ps/nm (up to 2000 km SSMF), PMD <15ps

Up to 10 x any multi-service

- 10GE, STM-64/OC-192, **FC 8/10/16**, 5G IB
- 40GE/100GE via break out cable

Delay: 7,5 microseconds





Grey (0.3/10km)
CWDM (8ch+4ch), DWDM (40ch C-band)

FSP 3000 terminals

Fixed line capacity <=100Gbit/s

Core transponders/ muxponders

- G.709 framing
- Digital performance monitoring
- Fixed and tunable optics
- Client channel card protection

Access transponders/ muxponders

- Service transparency
- Optical performance monitoring
- Pluggable network interfaces
- Cost optimized

Enterprise transponders/ muxponders

- Application-specific
- Certified for storage applications
- Low-latency design
- Encryption/security

SW-defined optics >= 100Gbit/s

Transponders and muxponders

- Multiple coherent modulation schemes
- Up to 400Gbit/s per 1-slot module
- Up to 3.6Tbit/s per 1RU chassis
- Flexgrid support

MicroMux™

- Convert any 100GbE QSFP28 client port into 10 x 10GbE ports
- Zero footprint (QSFP28 pluggable)

OpenFabric™

- OTN service switch
- Entirely new and open design
- Multi-protocol, any mix of services
- AES256 Encryption variant (CryptoMux™)

Channel cards

Core

		Description	Usage

100G		• Full OTN / G.709 support
		• Optical reach optimized
		• Transponder / Muxponder:
		  • **WCC-PCN-100G(B)** (w/ coherent CFP)
		  • **10TCC-PCN-40GU+100G (**w/ coherent CFP)
			• OTN based multiservice 10G
			10GbE, 40GbE, STM-64/OC-192 and OTU2(e) aggregation to 100G (OTU4)
			• 100GbE and OTU4 Transponder,
			with CFP and QSFP28 client plug option

10G		• Full OTN / G.709 support
		• Optical reach optimized
		• Transponder / Muxponder / Add/Drop-Multiplexer / OTN Cross-Connect:
		  • **4WCC-PCN-10G**
		  • **16TCC-PCN-4GUS+10G**
		  • **10TCC-PCN-GSDI+10G3GSDI+10G**
			• OTN based aggregation, transport and network termination for various data rates and service types

2.5G		• Full OTN / G.709 support • Dual Transponder / Muxponder: • **2TWCC-PCN-2G7U**	• OTN access solution • Lower data rate termination

Channel cards

Access

		Description	Usage

10 G		• Multi rate Dual Transponder:
		  • **2WCA-PCN-10G** w/ XFPs on all ports
		• Multi rate Quint Transponder:
		  • **5WCA-PCN-16G** w/SFP+ on all ports
			• Multi purpose wavelength conversion and service demarcation, CWDM and DWDM
			• 5WCA with CPRI, OBSAI, low-cost 40GbE

4G		• Add/drop Multiplexer:
		  • **4TCA-PCN-4GU+4G**
		  • **4TCA-PCN-4GUS+4G**
			• TDM-based GbE ring-aggregation to 4G line rate
			• Variant with additional FC or SDH/SONET support

2.5G		• Multi rate Transponder: • **WCA-PCN-2G5**	• Low rate, multi purpose wavelength conversion and service demarcation

Channel cards

Enterprise

		Description	Usage

100G		• Transponder / Muxponder:
		  • **WCC-PCN-100G(B)**
		  • **10TCE-PCN-16G+100G**
		• AES encryption support
		  • **WCC-PCN-AES100GB(-F)**
		  • **10TCE-PCN-16G+AES100G(-F, -BSI)**
			• Datacenter connectivity
			• Secure optical transport, incl. FIPS/BSI variants
			• Low latency, cost efficient transmission
			• 100GbE service support via CFP or QSFP28
			• 10GbE, 40GbE and 8/10/16G FC aggregation

10G		• Trans-/Muxponder:
		  • **5TCE-PCN-10GU+10G**
		• AES encryption support
		  • **5TCE-PCN-10GU+AES10G**
			• Aggregation and transport of different FC rates, IB, SDH/SONET and GbE / 10GbE services
			• Encrypted services from 1 to 10G

		• Multi-Transponder with AES encryption: • **9TCE-PCN-10GU+AES10G-F**	• Quad Transponder with FIPS encryption • Transport of 10G services, 10GbE, OTU2, STM-64 or 8G FC
		• High port count Transponder: • **5WCA-PCN-16G**	• High density 5G IB/8G/16G FC and 10G/40GbE connectivity

Channel cards

Hyper-scale capacity

		Description	Usage

2x 200G Transponder		• QuadFlex
		• Single slot 400G SW defined trans-/muxponder
		• Dual network coherent 100/150/200G formats
		• FlexGrid DWDM, up to 4000km reach
		  • **MP-2B4CT**
		  • **MP-2B4CT-S**
			• High capacity DCI with low footprint and lowest power per Gbit
			• LH operation using QPSK
			• 100GbE and OTU4 service support
			• High capacity upgrade of existing networks
			• Single fiber variant (“-S”) at 100/200G

2x 100G Muxponder		• OpenFabric • Multi-service aggregation and XC function • Dual OTN-4 line output • **MA-2C5LT**	• OTN based aggregation and network termination for various data rates and service types • In conjunction with QuadFlex for high capacity multiplexing
		• CryptoMux • Multi-service aggregation and XC function • AES encryption • **MA-2C2C3LT-A**	• Secured multi service aggregation and support • Usable where OpenFabric requires data encryption

Flex Coherent Technology

NextGen DSPs & coherent technology - three generations

- First generation coherent technology achieved 100Gb/s operation.
- Second generation doubled speeds and improved component density.
- The third generation of coherent technology operates at speeds ranging from 100Gb/s up to 600Gb/s speeds per wavelength while also improving power consumption, performance and spectral efficiency of slower speeds.

	1st Generation	2nd Generation	3rd Generation
Year / release	R11.1 - 2012	R1.1 - 2016	R3.1 - 2019
Capacity per wavelength	100G	100G/ 150G/ 200G	100G to 600G
Baud rate	32GBaud	32 to 45GBaud	32 to 69GBaud
Modulation Format			
ADVA Product	WCC-PCTN-10G+100G 	QuadFlex OpenFab+ 	TeraFlex 

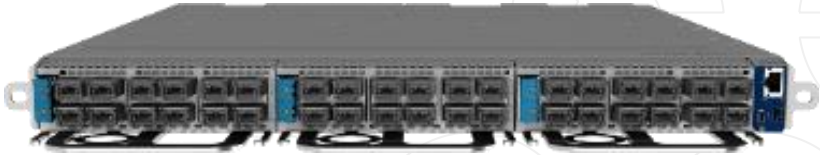
High-speed services multiplexing

FSP 3000 QuadFlex™

- 400G line card
- 4 x 100G client ports multiplexed onto two 200Gbit/s wavelengths
- Smooth upgrade from 10GbE to 100GbE via MicroMux™
- Configurable modulation schemes for highest bandwidth efficiency
- ConnectGuard™ encryption option

TeraFlex™

- 1U chassis delivering 3,6Tbit/s duplex capacity
- 600Gbit/s sled for 10GbE to 400GbE services
- Highest speed, bandwidth and flexibility
- ConnectGuard™ encryption option



FSP 3000 low-speed services multiplexing

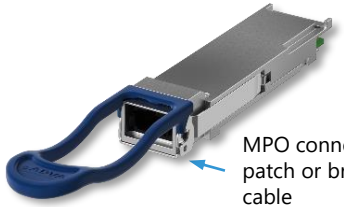
SW-defined coherent optics

FSP 3000 OpenFabric+™

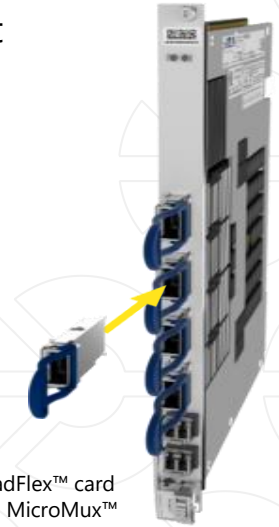
- 200Gbit/s line card
- Multi-service transport
- Flexible network port at 100Gbit/s and 200Gbit/s with different modulation schemes
- ConnectGuard™ encryption option

FSP 3000 MicroMux™

- Convert 100GbE QSFP28 client port into 10 x 10GbE ports
- Zero incremental footprint



MPO connector for patch or break-out cable



QuadFlex™ card with MicroMux™

FSP 3000 grooming at a glance

The optimum solution for each application

	OpenFabric™	OpenFabric+™	QuadFlex™	TeraFlex™	MicroMux™
					
Low-speed service multiplexing		✓			✓
High-speed service multiplexing			✓	✓	
Low-speed service switching	✓				

What do the options look like?

100G wavelengths:

- Transponder, 100G QSFP28 client plugs
- Muxponder, 10G/OTN/SONET/FC SFP+ client plugs

200G wavelengths:

- 1x200G Flexponder, 10-100G, Ethernet /OTN /SDH /FC
- 2 x QSFP28 & 3 x QSFP10 client plugs

2x200G Muxponder:

- 10GbE/40GbE available with MicroMux

600G wavelengths:

- 100G/400G QSFP28/QSFP-DD client plugs
- 10GbE/40GbE available with MicroMux

100G per 1RU

400G per 1RU

800G per 1RU

3.6T per 1RU

Flexible 400G coherent module
QuadFlex - Enhancements

MP-2B4CT

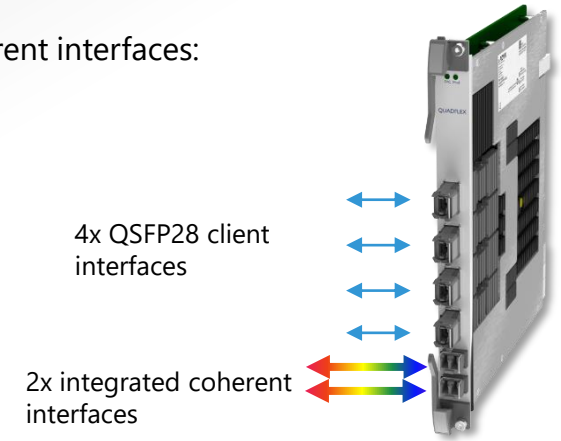
Single slot trp/mxp with two integrated, flexible and tunable coherent interfaces:

- QPSK, 8QAM and 16QAM coherent transmission at 100G/150G/200G
- Flexgrid tunability to any Optical Line System
- High performance SD-FEC (15/25%)

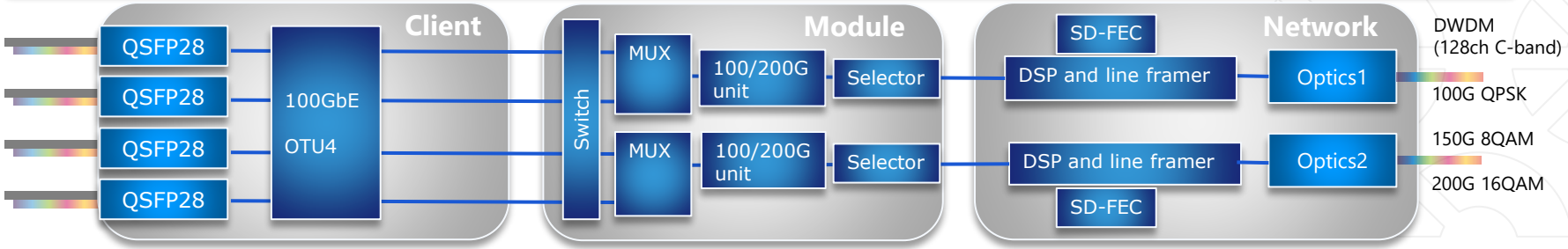
Up to 25.6Tb/s C-band fiber capacity

4x QSFP28 client pluggables:

- 100GbE/OTU4: SR4, LR4, CWDM4, AOC, DAC
- 100GbE: PSM4, MicroMux*
- 10GbE/40GbE: MicroMux*



*R1.3



SR4, LR4, CWDM4, PSM4, AOC, DAC, MicroMux*

MicroMux
QSFP28 Integrated Multiplexer

QSFP28/10x10G

ADVA unique solution: 10x10 into QSFP28 client port

QSFP28 with integrated **Multi-Link-Gearbox** (MLG) for 10GbE aggregation to 100GE CAUI-4 ports (QSFP28)

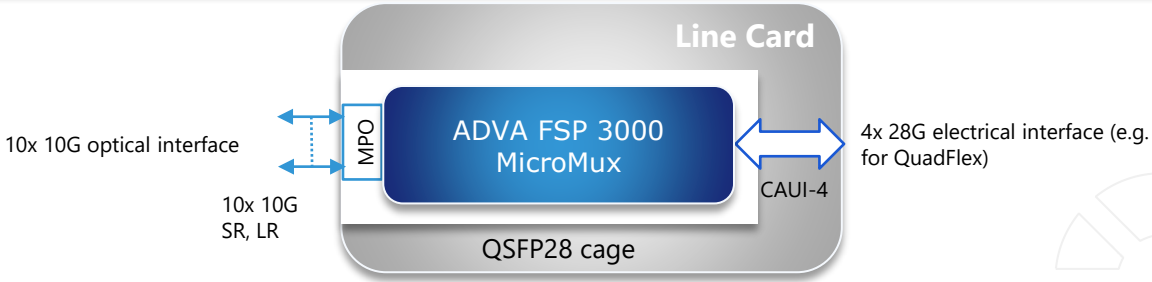
Fits existing QSFP28 cages with no modification

MPO connectors for 10GbE and 100GbE clients:

- **QSFP28/10x10G/1310S/SM/MPO**: 10GbE LR
- **QSFP28/10x10G/850I/MM/MPO**: 10GbE SR, 100GbE SR10

Break-out cables for single-mode and multi-mode clients

100% usage of total system capacity

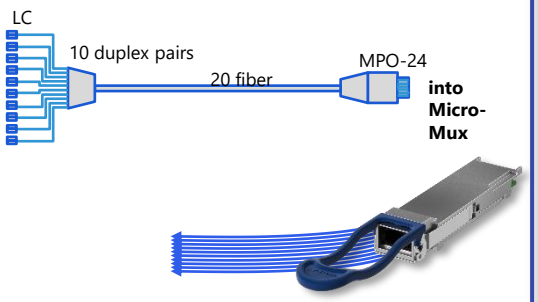


MicroMux

QSFP28/10x10G – Supported Services

ADVA unique solution: 10x10 into QSFP28 client port

10GbE



Services

10x LR (single mode), 10km

10x SR (multi mode), 100m

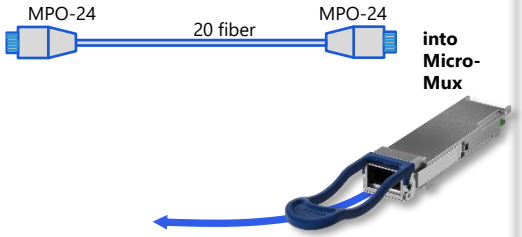
Monitoring

Byte and frame counter

Utilization

LoS

100GbE



Services

1x SR10 (multi mode), 100m

Monitoring

Byte and frame counter

Utilization

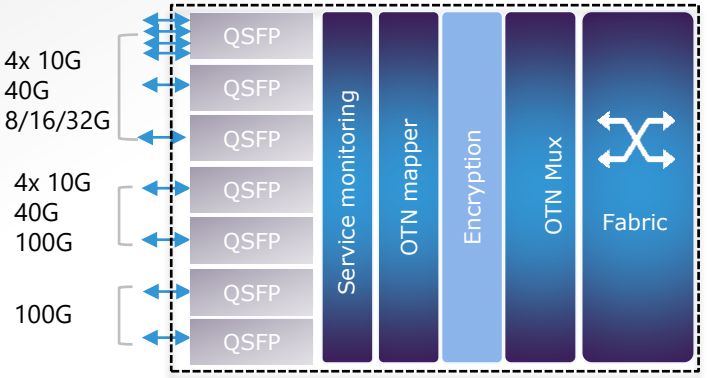
LoS

OpenFabric400

Universal Card for all Datacenter Services (10GE, 40GE, 8/16/32G FC)

A Universal 400G OTN Fabric

- Multi functional
  - Service aggregation, grooming and switching
  - Encryption option
- Multi service
  - Ethernet, OTN, SDH, FC
  - 10/25/40/100G
  - Integration of legacy networks
  - 8/16/32G FC
- Compact
  - Single slot, <110W
  - 7x QSFP (40G or 100G) with 4x 10G fan out
- Open
  - Optical connect to transport cards



OpenFabric400 – MA-2C5LT

Flexible Subtending Aggregation - Enhancements

MA-2C5LT

Aggregation module for Ethernet, OTN, SDH and FC services

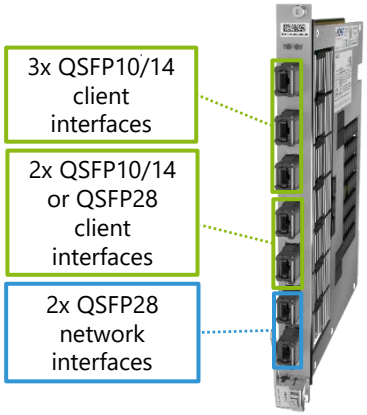
- 20x 10G (8G FC/10GbE/STM64/OC192/OTU2/OTU2e)
- 12x 16G FC (ODUflex)
- 6x 25GbE, 32G FC (ODUflex)
- 4/5 x 40GbE (ODU3, proprietary)
- 2x 100GbE

Muxponder and Cross-Connect functions

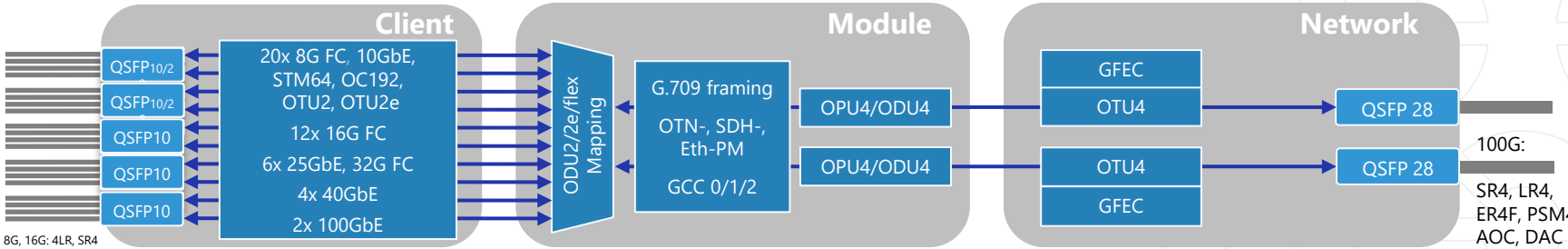
- ODUflex, **ODU0**, **ODU1**, ODU2, ODU2e

Handover to MP-2B4CT Quadflex for transport

Client Channel Card Protection*, (ODU2) Path protection*



*Rel. 19.1

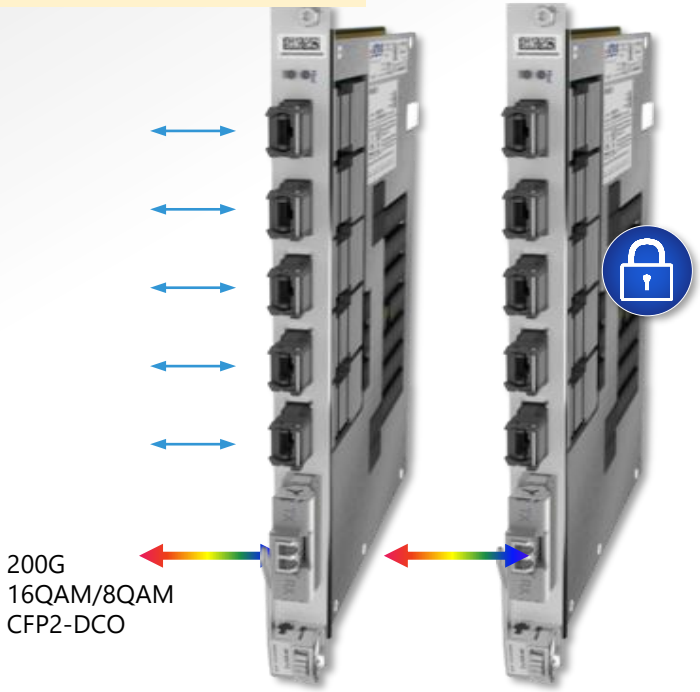


8G, 16G: 4LR, SR4
10G: DAC, AOC, 4LR, SR4
25G, 32G: DAC, AOC, SR4, PSM4
40G: DAC, AOC, SR4, LR4
100G: DAC; AOC, SR4, LR4, ER4F, PSM4, CWDM4

Optional: OpenFabric+/CryptoMux+

Universal Card for all Datacenter Services (10GE, 40GE, 8/16/32G FC)

- 200G colored network interface (CFP2)
  - Tunable DWDM interface
  - Coherent CFP2-DCO for distances >800km
- Service Flexibility
  - 10/25/40/100GE
  - OTU2/2e, OTU4
  - 8/16/32G FC
- Two variants
  - OpenFabric+ (CFP2):
    - Carrier infrastructure market
  - CryptoMux+ (CFP2):
    - AES256 Encryption (FIPS140-2)
    - SAN and Enterprise market



OpenFabric400 – MA-2C5LT

Supported Pluggable Interfaces

MA-2C5LT

Client Service	Client QSFP10/14/28	Network QSFP28
8G FC	QSFP10/11G/4LR/SM/MPO QSFP10/43G/SR4/MM/MPO QSFP14/56G/SR4/MM/MPO QSFP14/16GFC/4LR/SM/MPO	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/DAC/0xxx (0.37, 1m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO QSFP28/112G/LR4/SM/LC QSFP28/112G/ER4F/SM/LC
16G FC	QSFP14/56G/SR4/MM/MPO QSFP14/16GFC/4LR/SM/MPO	
STM-64, OC-192 OTU2 OTU2e	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP10/11G/4LR/SM/MPO QSFP10/43G/SR4/MM/MPO	
32G FC	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO	

OpenFabric400 – MA-2C5LT

Supported Pluggable Interfaces - continued

MA-2C5LT

Client Service	Client QSFP10/14/28	Network QSFP28
10GbE	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP10/11G/4LR/SM/MPO QSFP10/43G/SR4/MM/MPO QSFP14/56G/SR4/MM/MPO QSFP14/16GFC/4LR/SM/MPO	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/DAC/0xxx (0.37, 1m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO QSFP28/112G/LR4/SM/LC QSFP28/112G/ER4F/SM/LC
25GbE	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/103G/SR4/SM/MPO QSFP28/103G/PSM4/SM/MPO QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO	

OpenFabric400 – MA-2C5LT

Supported Pluggable Interfaces - continued

MA-2C5LT

Client Service	Client QSFP10/14/28	Network QSFP28
40GbE	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx QSFP10/43G/SR4/MM/MPO QSFP10/43G/LR4/SM/LC QSFP14/56G/SR4/MM/MPO	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/DAC/0xxx (0.37, 1m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO QSFP28/112G/LR4/SM/LC QSFP28/112G/ER4F/SM/LC
100GbE	QSFP28/112G/DAC/CR/0xxx (1, 3m) QSFP28/112G/AOC/0xxx (1, 3, 5m) QSFP28/103G/SR4/MM/MPO QSFP28/103G/PSM4/SM/MPO QSFP28/103G/LR4/SM/LC QSFP28/103G/CWDM4/SM/LC QSFP28/112G/SR4/MM/MPO QSFP28/112G/PSM4/SM/MPO QSFP28/112G/LR4/SM/LC QSFP28/112G/ER4F/SM/LC	

OpenFab400+ and CryproMux+

Variants with 200G CFP2-DCO DWDM Network Interface

MA-B5LT / MA-B2C3LT-A

200G colored network interface (CFP2)

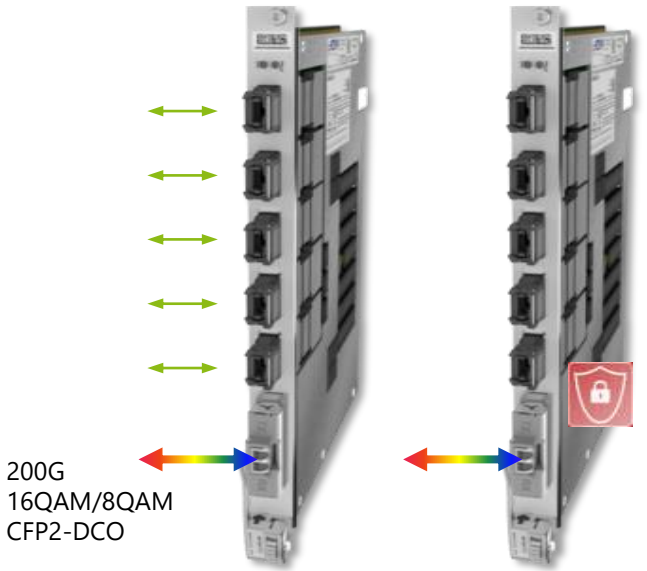
- Tunable DWDM interface
- Coherent CFP2-DCO for distances >800km

Service Flexibility

- 10/25/40/100GE
- OTU2/2e, OTU4
- 8/16/32G FC

Two variants

- OpenFabric+ (MA-B5LT):
  - Carrier infrastructure market
- CryptoMux+ (MA-B2C3LT-A):
  - AES256 Encryption (FIPS140-2)
  - SAN and Enterprise market



Coherent DWDM CFP2

100/200G Coherent CFP2-DCO

"G" variant with tunable Tx filter to support passive add/drop

Configurable data rate

Network OTU/ODU monitoring

Low power implementation

Supported by the following modules:

- OpenFab400+ (MA-B5LT)
- CryptoMux+ (MA-B2C3LT-A)

New

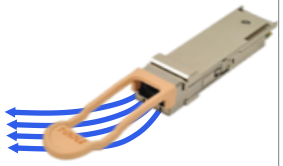
CFP2/224G/#DCTC/SM/LC
CFP2/224G/#DCTCG/SM/LC

	100G QPSK	200G 8QAM	200G 16QAM
Baud Rate, Gbaud, 15% OH	31	42	31
Receiver Sensitivity, dBm	-30	-24	-22
Min. OSNR, dB/0.1nm	11.3	18	20
Min. Dispersion Tolerance, ps/nm	40,000	20,000	20,000
Min. PMD Tolerance; <ps>	30	15	15
Min, Channel Spacing, GHz	37.5	50	37.5
Max. Power Consumption, W	16.5	20	19

Optical Components /QSFP28

QSFP28

100G client optics option (available at ADVA)

Intra-shelf	Intra-node	Short reach	Intermediate reach	Medium reach	Long reach
					
Direct attached cable, two transceivers with copper connection solution, 1/3m reach	Integrated multimode cable transceiver solution, 3/5/10m reach	Multimode 850nm, 4 fibers per direction MPO12 100m reach	Singlemode 1310nm 4 fibers per direction MPO12 500m reach	Singlemode 4 lambdas per fiber 2x LC 2km reach	Singlemode 4 lambdas per fiber 2x LC 10km reach
DAC	AOC	SR4	PSM-IR4	CWDM4	LR4

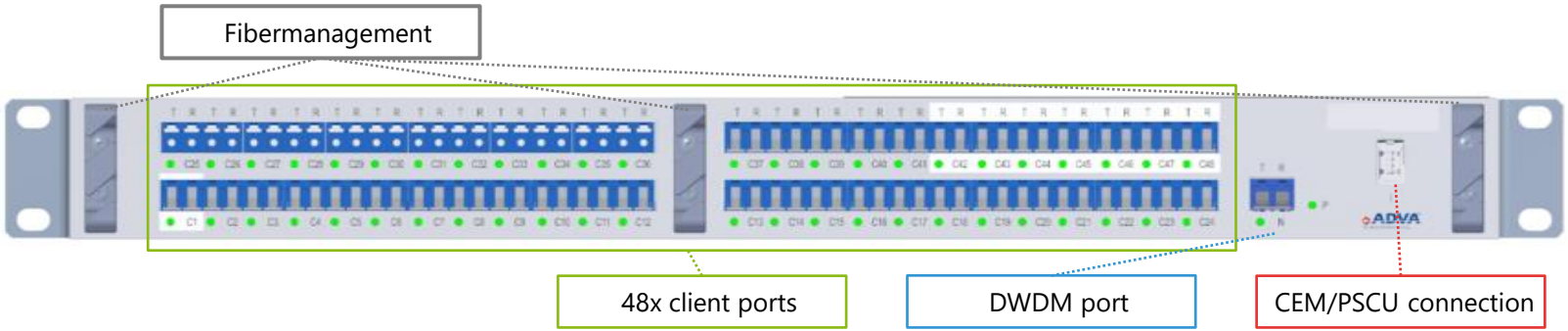
The color of the pull-tab latch determines the type of QSFP pluggable transceiver

Optical Components /Filters

Compact 48CSM Mux/Dmx

wide passband for high baud rate signals

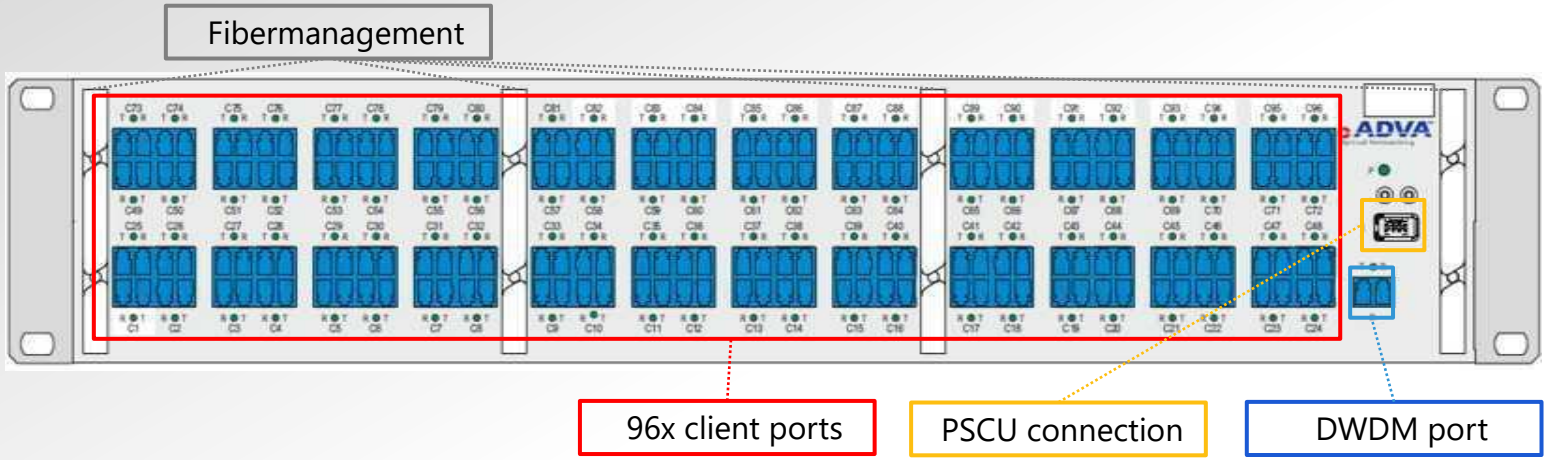
48CSM/1HU-#19600-#19130



- Compact 1HU Mux/Dmx shelf for 48ch C-band (100 GHz grid, wide passband to support >>100G signals)
- Terminal-, fixed OADM and ROADM applications
- Fully managed via CEM (9HU shelf) or limited using PSCU (7HU shelf) connection
- With CEM/9HU: Individual port LED's for guided installation and operational state mirroring of connected channel module N-port

Compact 96CSM Mux/Dmx

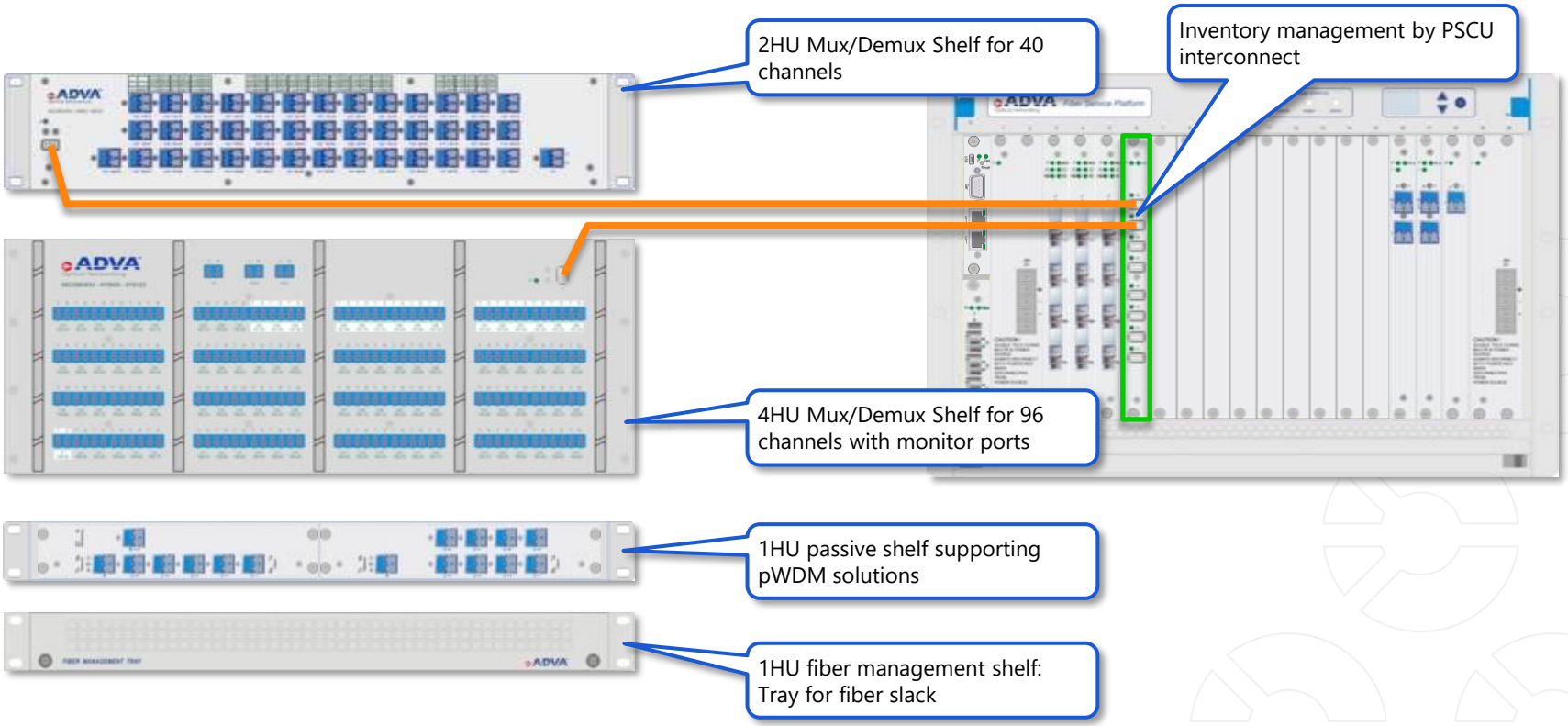
96CSM/2HU-#19600-#19125°



- Compact 2HU Mux/Dmx shelf for 96ch C-band (50 GHz grid)
- Fully managed via PSCU connection
- Individual port LED's for guided installation and operational state indication of connected channel module N-port*

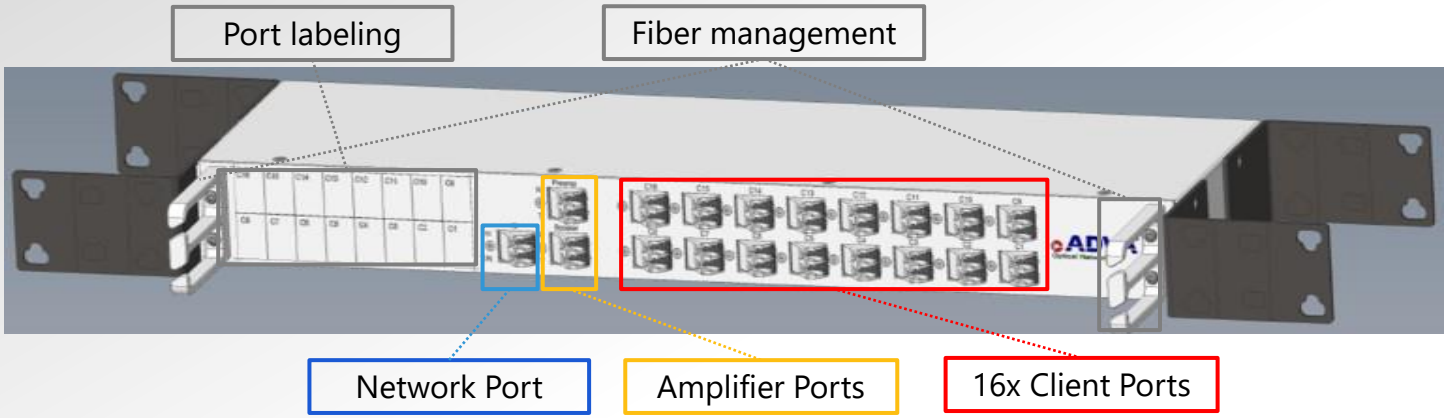
°Rel.16.3.2
*Rel.18.1

System Architecture
Passive Shelves



Single Fiber Working DWDM Mux/Dmx

16CSM/P-1HU-#19600-#19200-SF(A/B)



- Compact 1HU Mux/Dmx shelf for 16 SFW channels
- Optional amplifier ports (pre-amp and booster)
- Fully passive, operational temperature range -5°C to +65°C
- Industrial temp range -25°C to +70°C with loss penalty
- W x D x H (w/o brackets) 440mm x 125mm x 45mm

Amplifiers

FSP 3000 innovative technology

MicroAmp™

- Consolidation of common line terminal functions (OSC, EDFA, OTC&OTDR port) in just one module
- Variants with and without add/drop function, and with and without booster

MicroROADM™

- Central wavelength blocker for 2-degree ROADM functionality without expensive WSS
- Colorless
- Flexgrid

9ROADM-RS

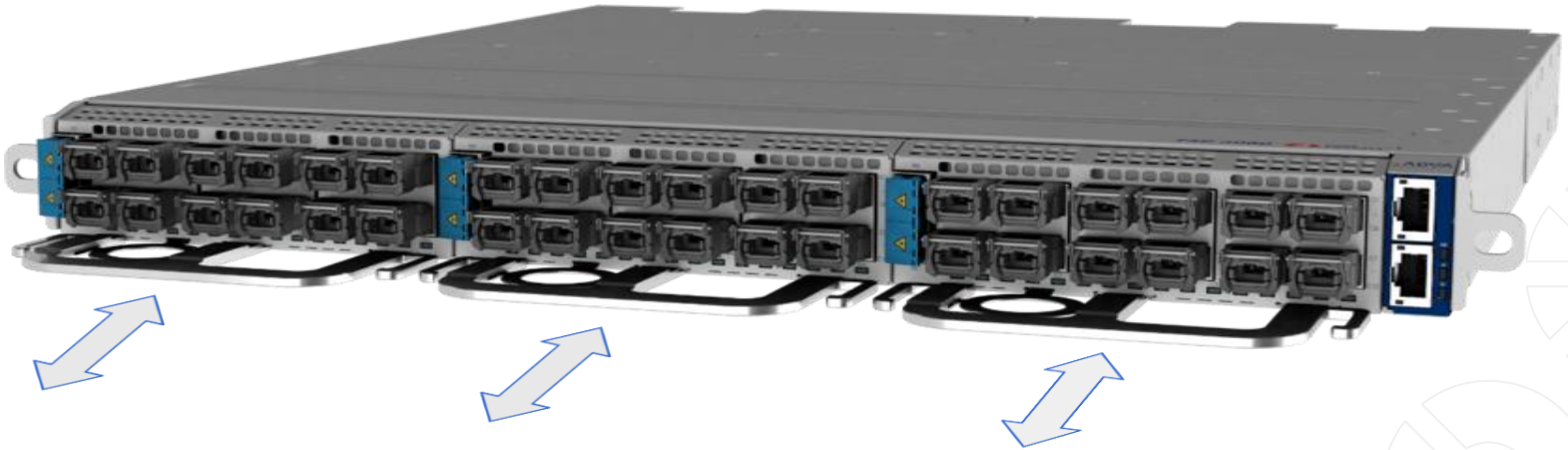
- Compact 9-degree module with route-and-select architecture for up to 9-degree ROADM nodes
- Colorless, directionless
- Flexgrid

Innovation that meets all metro requirements

TeraFlex = 36 x 100GE / 9 x 400GE

TeraFlex

1RU platform supporting 3.6Tb/s



3x hot swappable traffic units

550mm depth supporting 600mm+ racks

Data Center footprint for high speed terminals

DCI at ultimate density

TeraFlex sled: T-MP-2D12CT

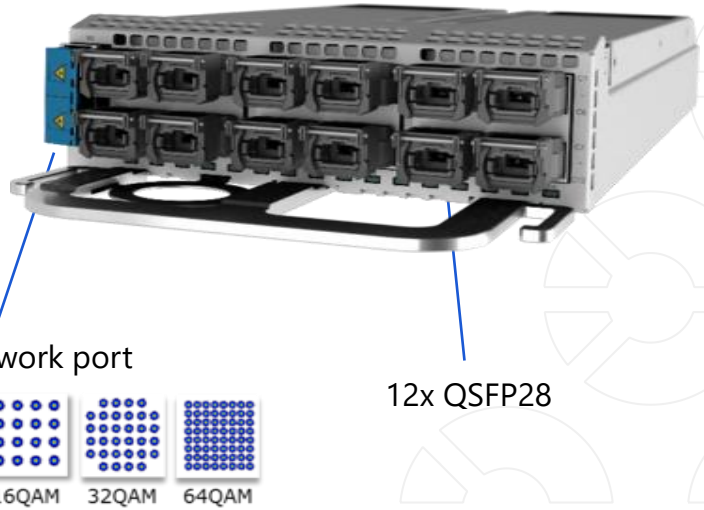
Network data rate flexible from 100G to 600G

Record density at 69GBd/64QAM

- 3.6Tb/s per 1RU, 38.4Tb/s per fiber pair (P2P)

Market leading power efficiency

- TEER* 0.15 W/Gb/s
- Full shelf 910W @ 110V per 1RU



Eco Design

* Ecology Guideline for the ICT Industry V.8, 2018, ICT Ecology Guideline Council Japan. Available online: www.tca.or.jp/information/pdf/ecoguideline/guideline_eng_8.pdf

Flexible transport up to 3.6Tb/s per 1RU

DCI at ultimate density (2)

TeraFlex sled: T-MP-2D12CT

Network data rate flexible from 100G to 600G

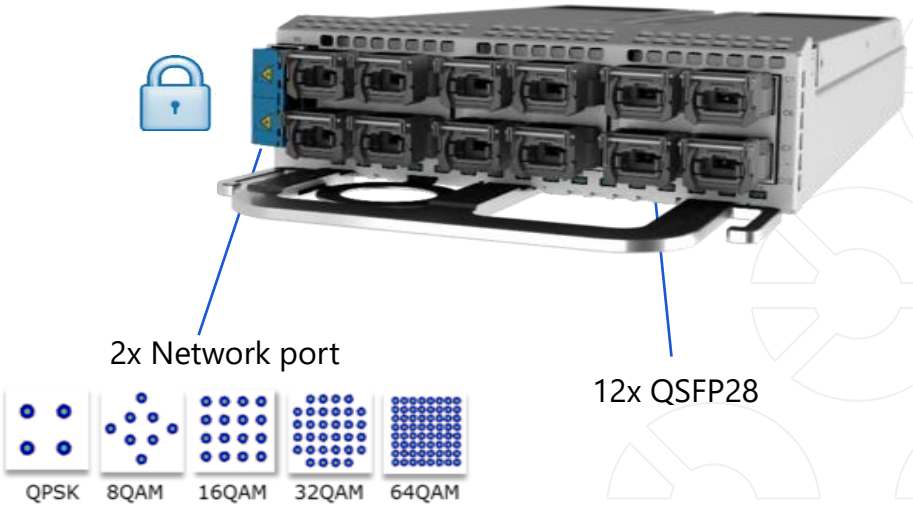
Record density at 69GBd/64QAM

- 3.6Tb/s per 1RU, 38.4Tb/s per fiber pair (P2P)

AES256 encryption

Market leading power efficiency

- TEER* 0.15 W/Gb/s
- Full shelf 910W @ 110V per 1RU



Eco Design

* Ecology Guideline for the ICT Industry V.8, 2018, ICT Ecology Guideline Council Japan. Available online: www.tca.or.jp/information/pdf/ecoguideline/guideline_eng_8.pdf

Flexible transport up to 3.6Tb/s per 1RU

TeraFlex application range

versatile application from long haul to metro

Long Haul: maximum distance

Regional: maximum capacity per link

Metro: maximum spectral efficiency

Optimizing flexible reach vs capacity

Service speed growth

from 100GE to 400GE

12x100G sled: T-MP-2D12CT

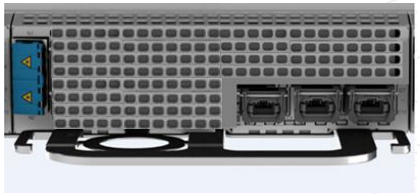
12x QSFP28 per sled (28G NRZ host lanes)

- 12x 100GE – LR4, CWDM4, ER4, SR4, AOC, DAC, 'alien'
- 120x 10GE / 30x 40GE via QSFP28 MicroMux and fan out
- FlexE support

3x400G sled: T-MP-2D3DT*

3x QSFP-DD (56G PAM4 lanes)

- 3x 400GE – FR4, DR4, SR8, LR8, CWDM8
- 12x 100GE – fan out to 100GE LR/FR/DR (single lambda)
- FlexE support



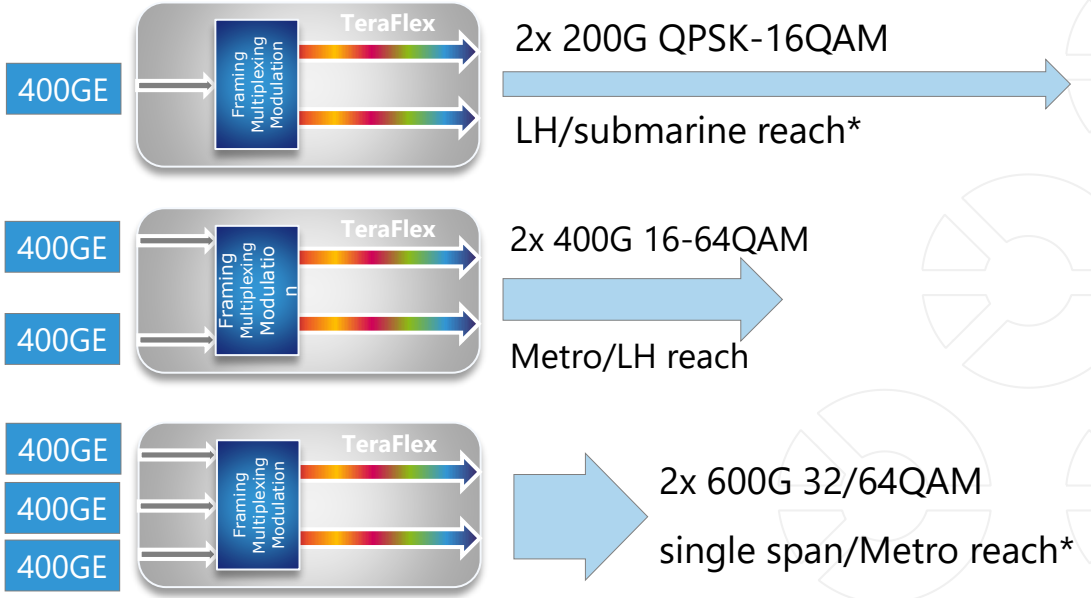
*Rel.19.2

Data Center migration to 400GE services

TeraFlex™

400GE client pluggables

- 3x 400GE
- **QSFP56-DD** PAM4 technology
- 12x 100GE via **QSFP-DD**/DR4 fan out to QSFP28/DR

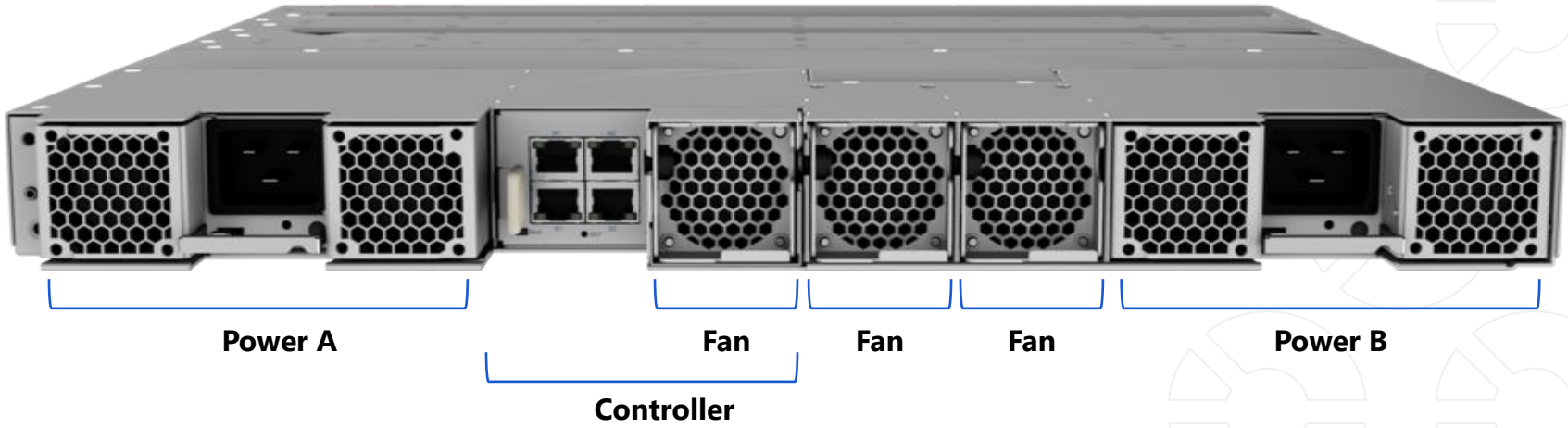


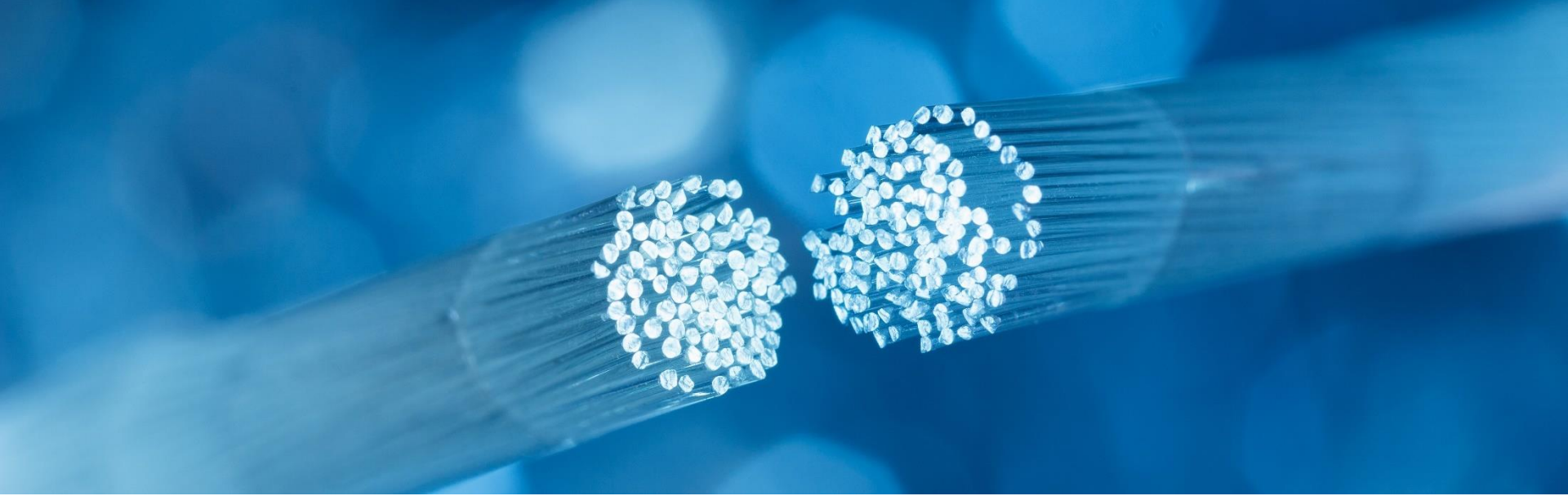
both interfaces via same fiber ; max. 750ns (equ. 150m fiber) path difference

Migration to 400GE from Metro to Long Haul

Rear side functions

- 1+1 hot swappable power supplies (AC 105-230V, DC +/-48V): T-PSM-AC(-DC) w/ individual fans
- System fans: T-FTM
- Rear side field replaceable controller: T-ECM
  - Non-service affecting replacement
  - Easy access to non-volatile memory

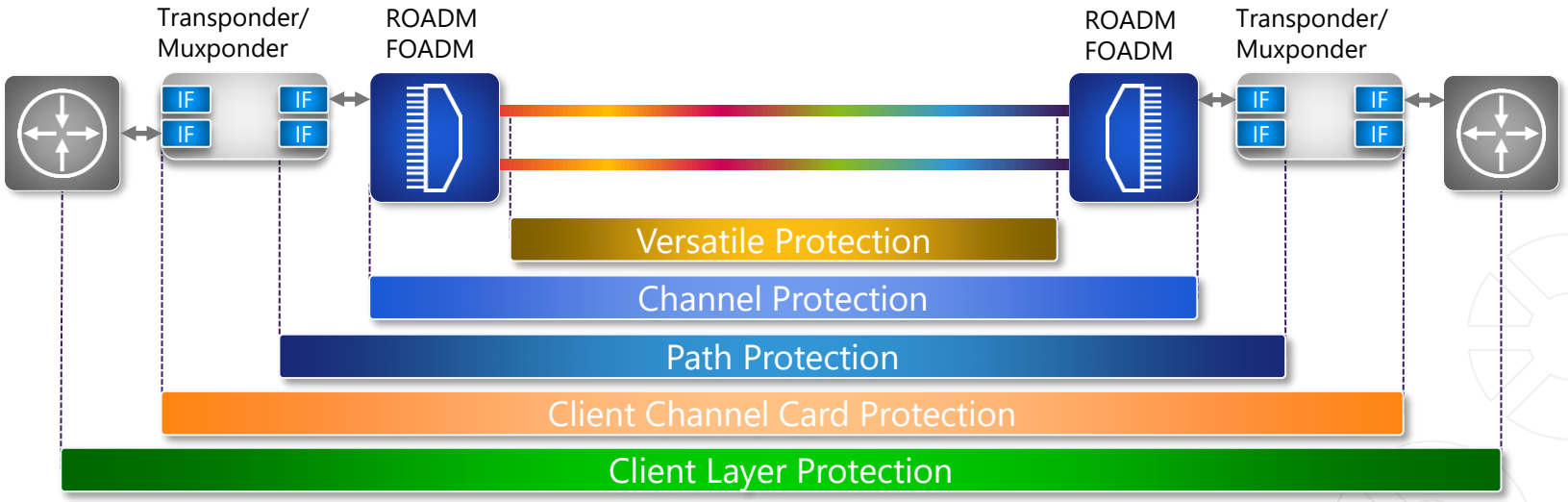




Protection

Network Resiliency for Data Centers

Protection Options

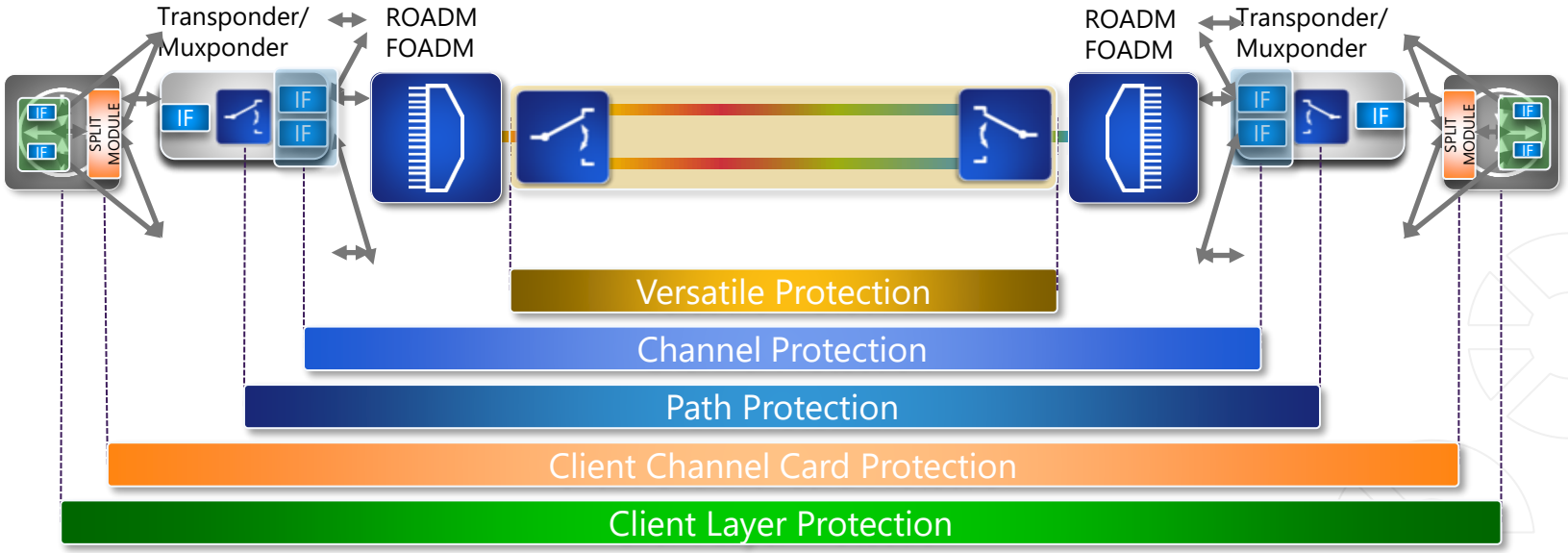


Prevents single points of failure

Wide variety of options to protect different parts of the network

Allows match of required availability to necessary CapEx

Protection Options



Prevent single points of failure

Wide variety of options to protect different parts of the network

Allows match of required availability to necessary CapEx

Versatile Protection

Versatile Protection

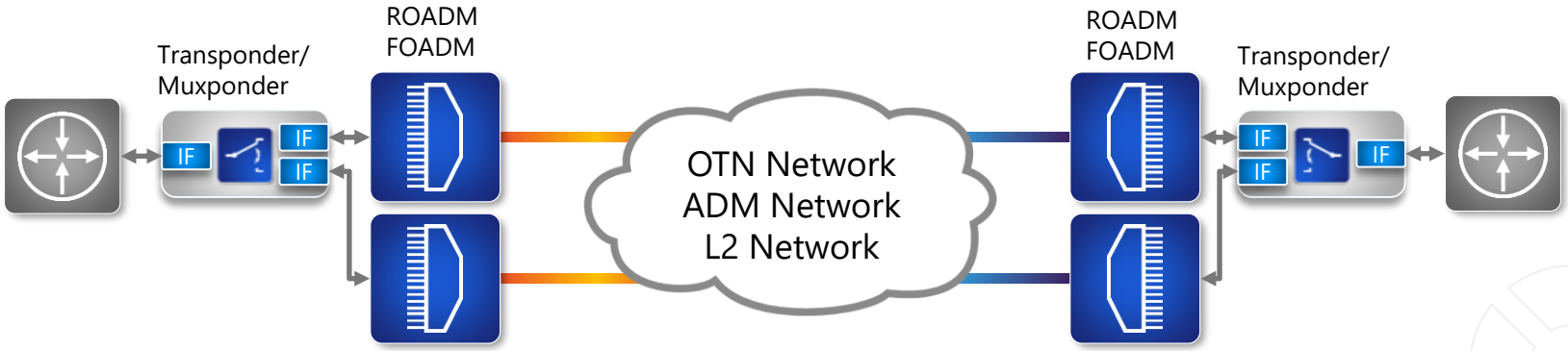
- Protection of a fiber link, wavelength group or single wavelength
- Versatile Switch Module (VSM)
  - Triggered by LoS of supervisory channel (OSCM)
  - Protection path available for low priority traffic
- Remote switch module with optical line monitoring (RSM-OLM)
  - Pilot channel provides detection of fiber cuts, intrusion and degradation
  - Switching time <15ms
  - Specific module RSM-SF for single fiber working support available

Channel Protection

Channel Protection

- Switching on a traffic card with two network interfaces
- High equipment/service availability by protection of the whole network side
- Switching trigger by LOS, LCK or signal degrade (e.g. SE, FEC, B1/B2, TCM ...)

Path Protection



Path Protection

- Protection by two different network paths (<50ms) where remote equipment selects between working and protection signal
- Switching on:
  - ODU0/ODU1 layer (10TCC-PCN-2G7U+10G)
  - Time Slot / ADM protection (4TCA-PCN)
  - Ethernet / EVC (10PCA-PCN-1G3+10G, 2PCA-PCN-10G)
- SNC/N according to G.873.1/G.798

Client Channel Card Protection

Client Channel Card Protection

- Client connected to two channel cards via passive splitter module (1PM,2PM)
- Switching by channel cards: always only one client transmitter of a protection group is active
- Highest optical layer availability
- Switching trigger by LOS, LCK or signal degrade (e.g. SE, FEC, B1/B2, TCM ...)

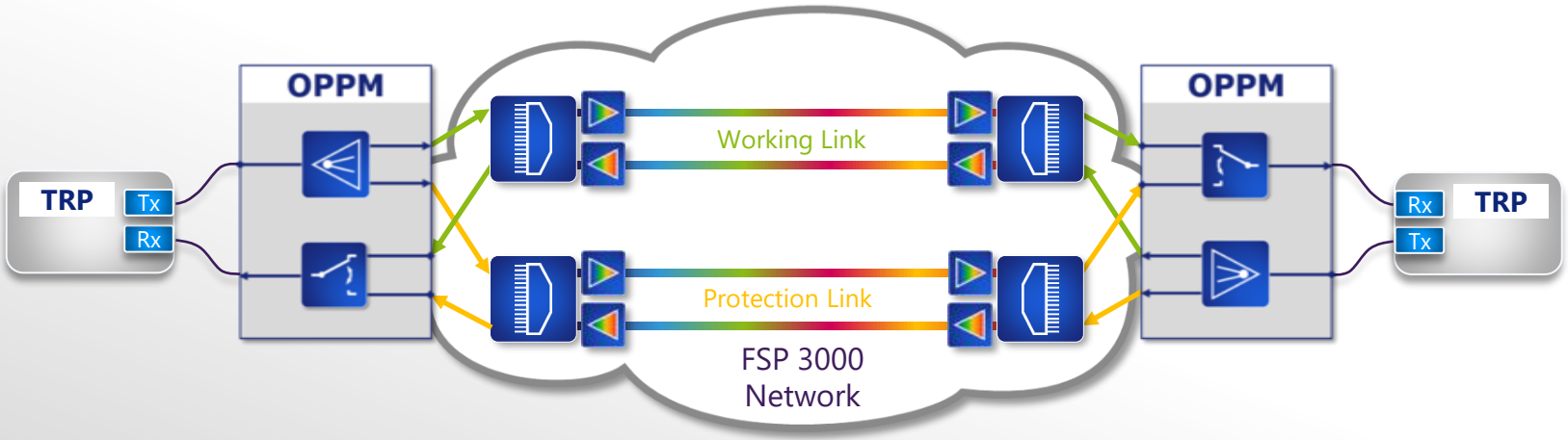
Client Layer Protection

Client Layer Protection

- Switchover by client equipment
- Client and transport equipment is protected
- Highest service availability
- High CAPEX by redundant transport equipment

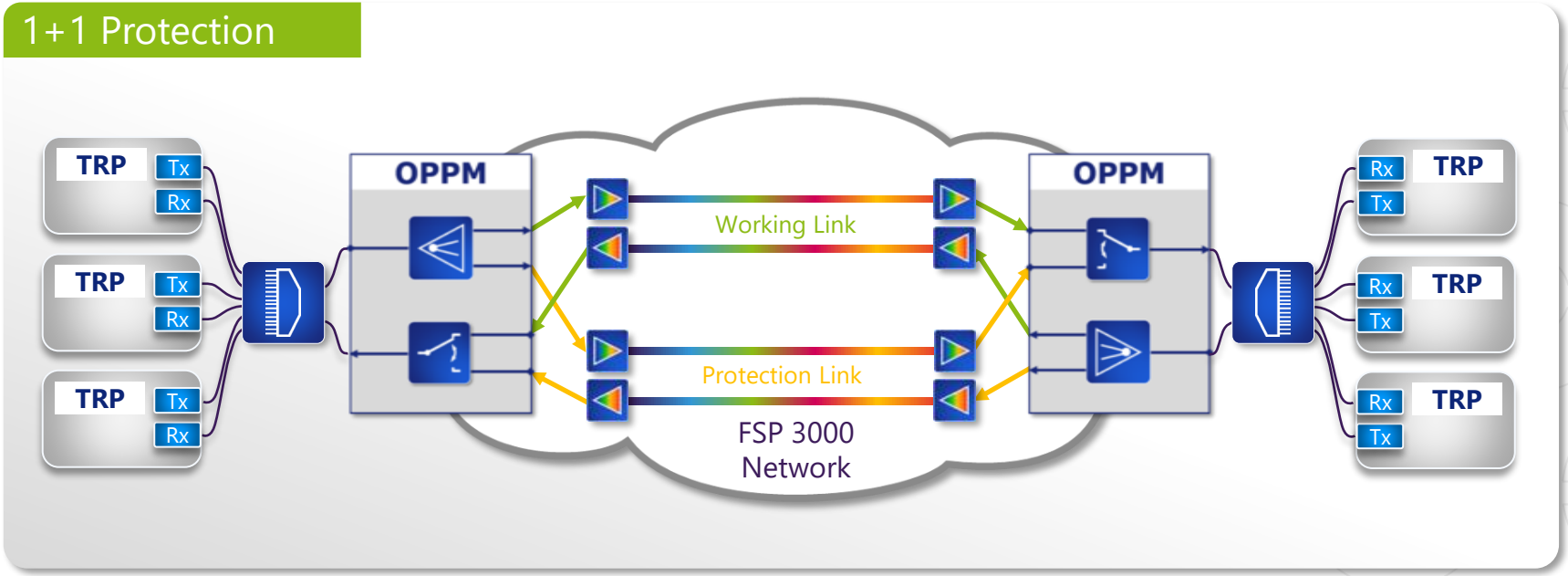
OPPM Single Channel Line Protection

1+1 Protection



1+1 Transponder Network Port Protection

OPPM Multi Channel Line Protection

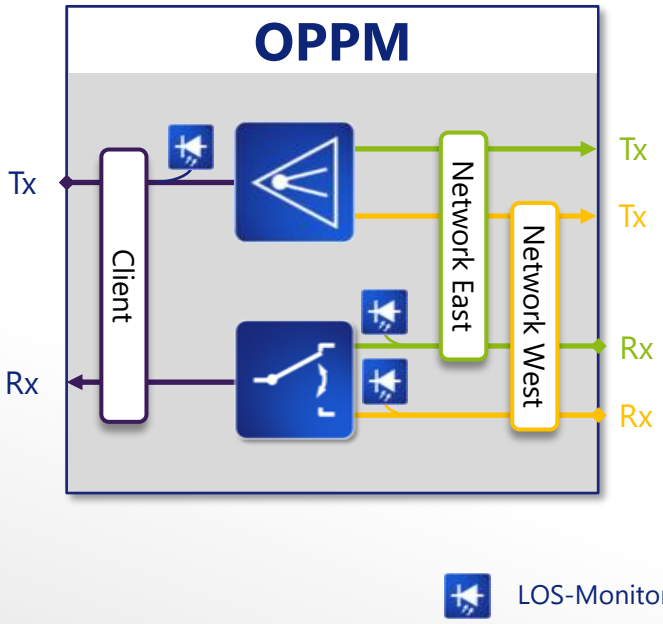


1+1 Fiber Link Protection

OPPM - Local Trigger (LOS)

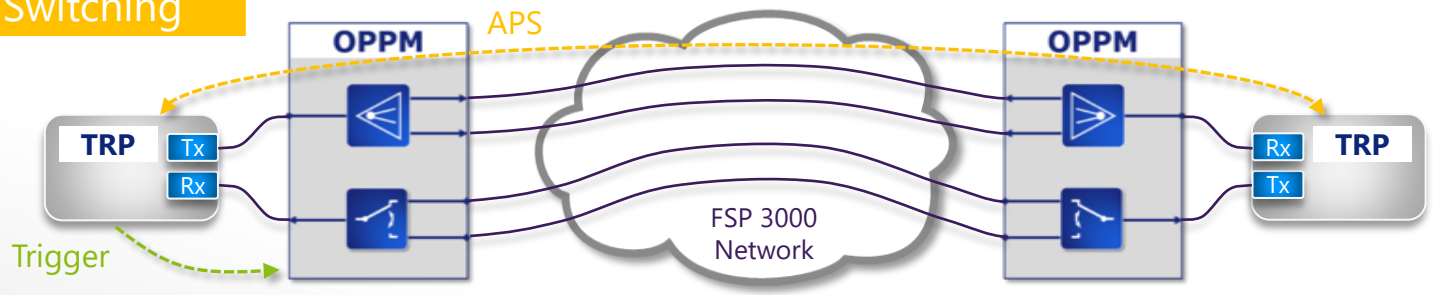
Functional Overview

- The OPPM is triggered by a loss of signal (LOS) detection
- Switching threshold < -43 dBm (fixed value)
- Independent of transponder types
- Not suitable for amplified systems due to ASE background



OPPM - Remote Trigger (EPTE)

OPPM Switching



- Protection switching carried out by OPPM
  - Trigger is based on SF (signal fail) detected by transponder
  - EPTE (External Protection Trigger Entity) supported by 100G and selected 10G cards
  - Customer can select a group of cards as trigger – switch occurs if all cards detect a defect (max of 4 cards)
  - Single Fiber configurations are supported
- Single and dual-ended bidirectional operation
  - For bi-directional operation, APS protocol support is required (e.g. ODU APS)
  - SCU-II necessary
- Cards providing EPTE can be placed in different shelves

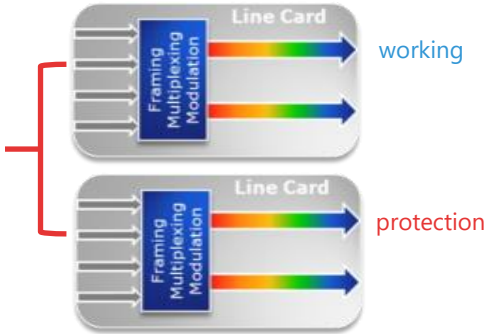
Protection Options

Path Protection

- Diverse network paths
- Provisioning of a 1+1 bridge and selector for 100G and 200G line rates
- Protection on ODUx level
  - QuadFlex: ODU4
  - OpenFabric: ODU0/1/2/3/4
- <50ms

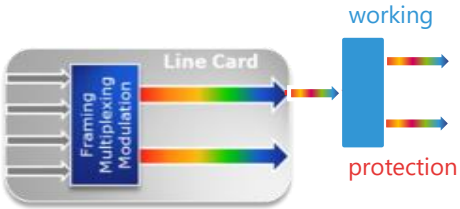
CCCP Protection

- Client signal splitting by Y-cable or PM module
  - Alternative by client side OPPM
- Independent of line rate setting
- LR4 client optics – requires power budget >3dB
- <50ms



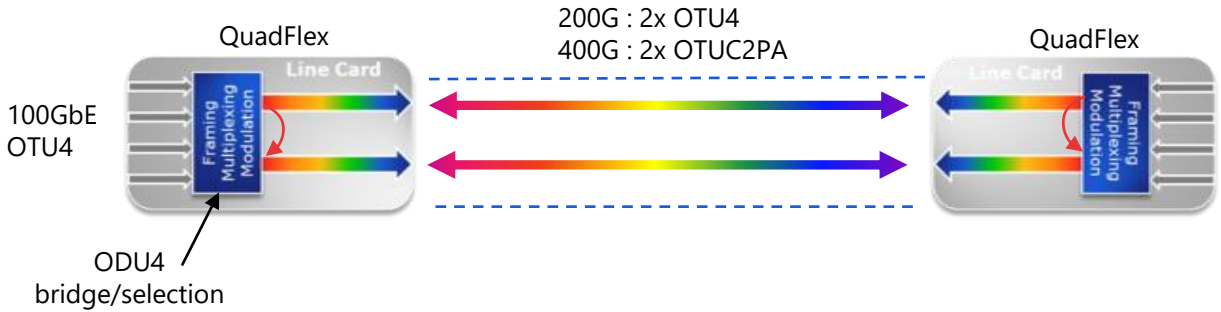
Line Protection

- External optical line protection module for switching of colored or DWDM on alternative paths.
- Trigger options
  - Local on line protection module
  - Other triggers depending on line protection module type
- <50ms



QuadFlex Path Protection

On-card switching



100G

- Triggers : 2 x OTU4
- PHY : LOS
- OCh : Loss of modem alignment
- OTU : LOF, LOM, TIM
- ODU : AIS, OCI, LCK, TIM

200G

- Triggers : 2 x OTUC2PA
- PHY : LOS
- OCh : Loss of modem alignment
- OTUC2PA : LOF, LOM
- LO ODUk : LOFLOM, AIS, OCI, LCK, TIM

Settings

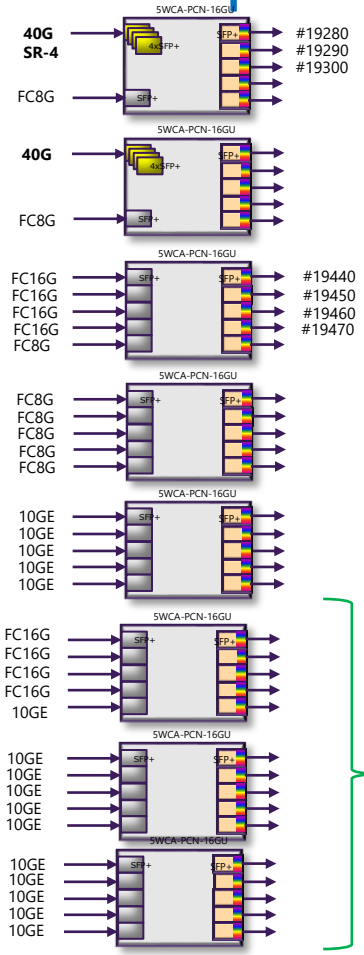
- Hold off Timer : 0-10s (100ms steps)
- WTR Timer: 5-12min (1min steps), default 7min
- Switch Commands : Clear, Manual, Freeze

Topology of HA-Datacenter

Agenda

1. Introduction ADVA
2. Datacenter Interconnectivity (DCI) and DWDM
3. Overview of ADVA's DWDM Hardware
4. Examples and Solutions
5. Security

Example



N_001

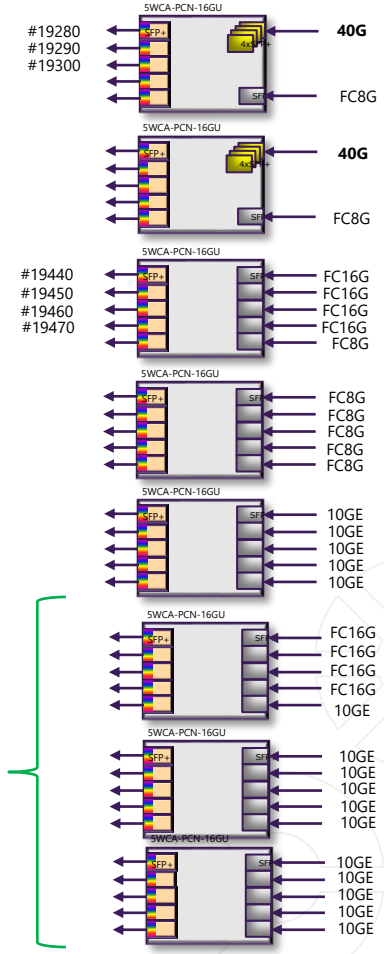
Services System#1:

- **2 x 40G, 850nm, MPO**
- **8 x FC8G, 850nm, LC**
- **5 x 10GE, 850nm, LC**
- **4 x FC16G, 850nm, LC**

plus:

- **4 x FC16G, 850nm, LC**
- **11 x 10GE, 850nm, LC**

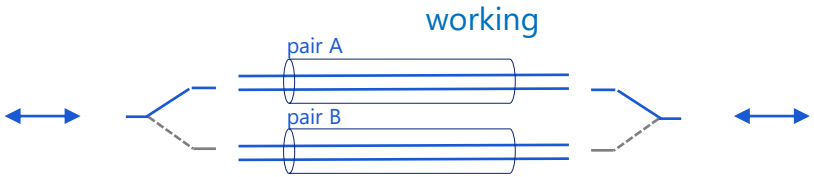
N_001_2



Proposal#1 Double Fibre

DWDM#1

DWDM#2



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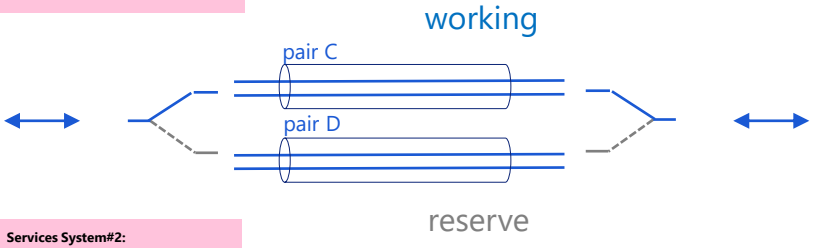


Services System#2:

- **2 x 40G, 850nm, MPO**
- **8 x FC8G, 850nm, LC**
- **5 x 10GE, 850nm, LC**
- **4 x FC16G, 850nm, LC**

plus:

- **4 x FC16G, 850nm, LC**
- **11 x 10GE, 850nm, LC**

Proposal#2 Single Fibre

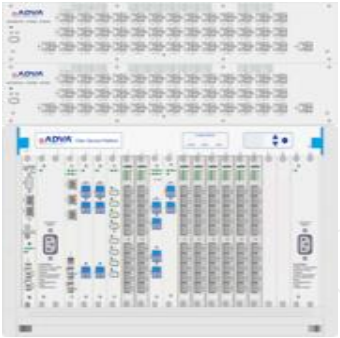
DWDM#1

Services System#1:

- **2 x 40G, 850nm, MPO**
- **8 x FC8G, 850nm, LC**
- **5 x 10GE, 850nm, LC**
- **4 x FC16G, 850nm, LC**

plus:

- **4 x FC16G, 850nm, LC**
- **11 x 10GE, 850nm, LC**



Services System#2:

- **2 x 40G, 850nm, MPO**
- **8 x FC8G, 850nm, LC**
- **5 x 10GE, 850nm, LC**
- **4 x FC16G, 850nm, LC**

plus:

- **4 x FC16G, 850nm, LC**
- **11 x 10GE, 850nm, LC**

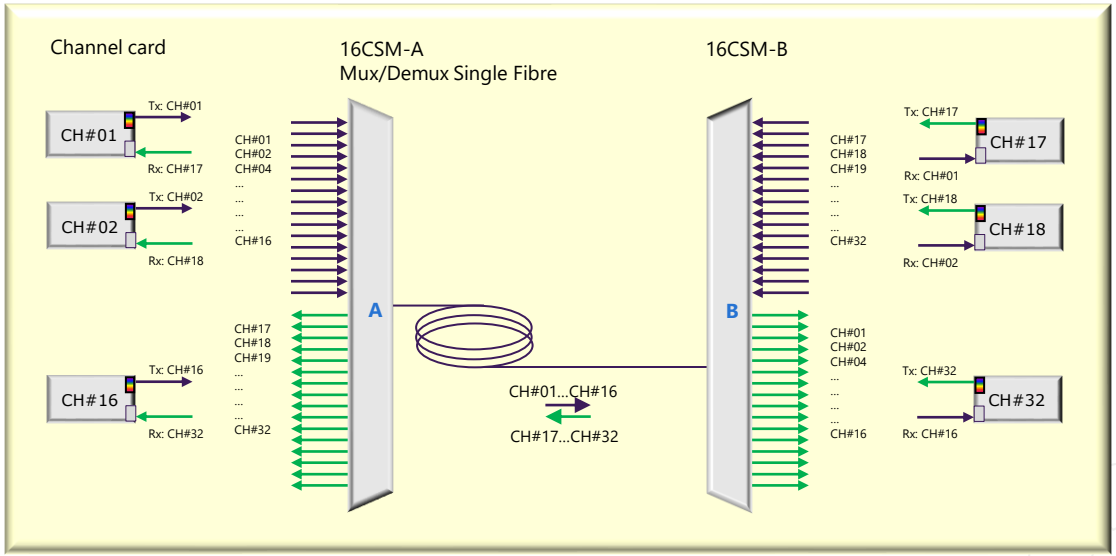
DWDM#2

Understanding of ADVA's Single Fibre Working

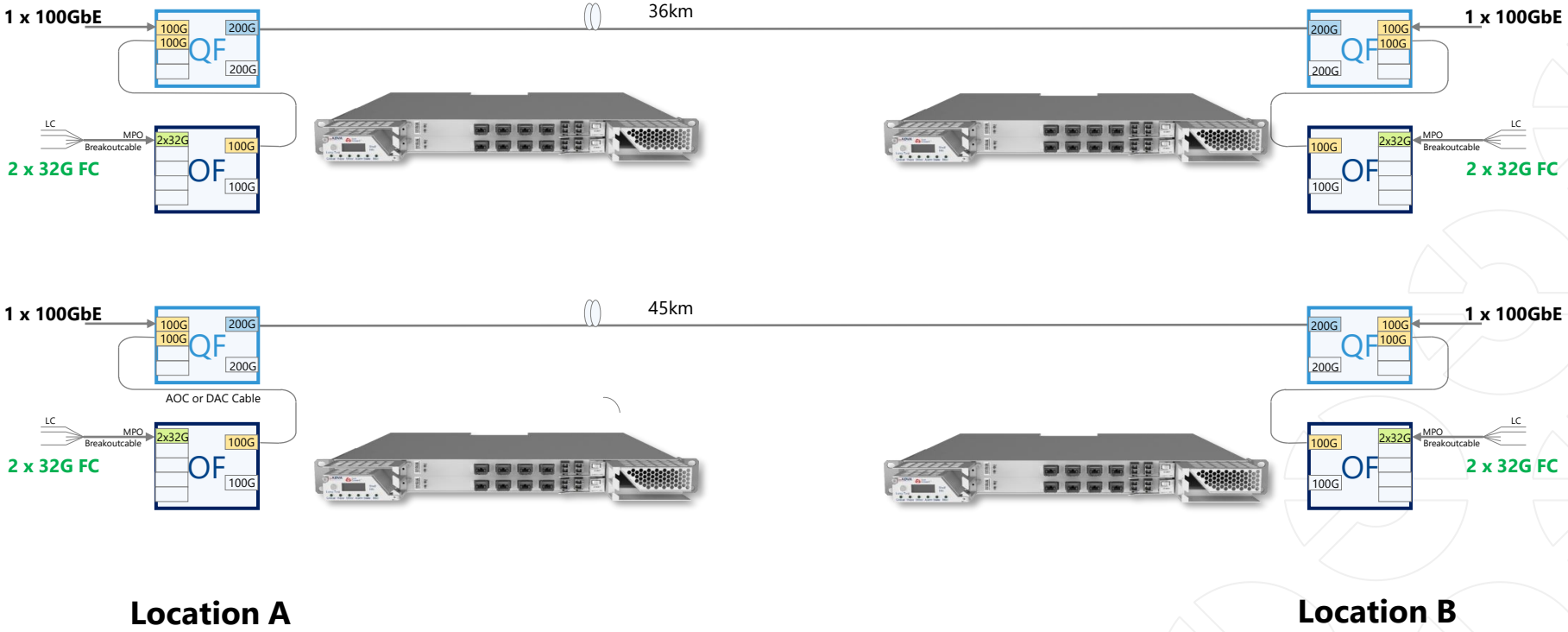
Really, you need only one optical fibre!

ADVA offers up to 16 services (cards) per single fibre

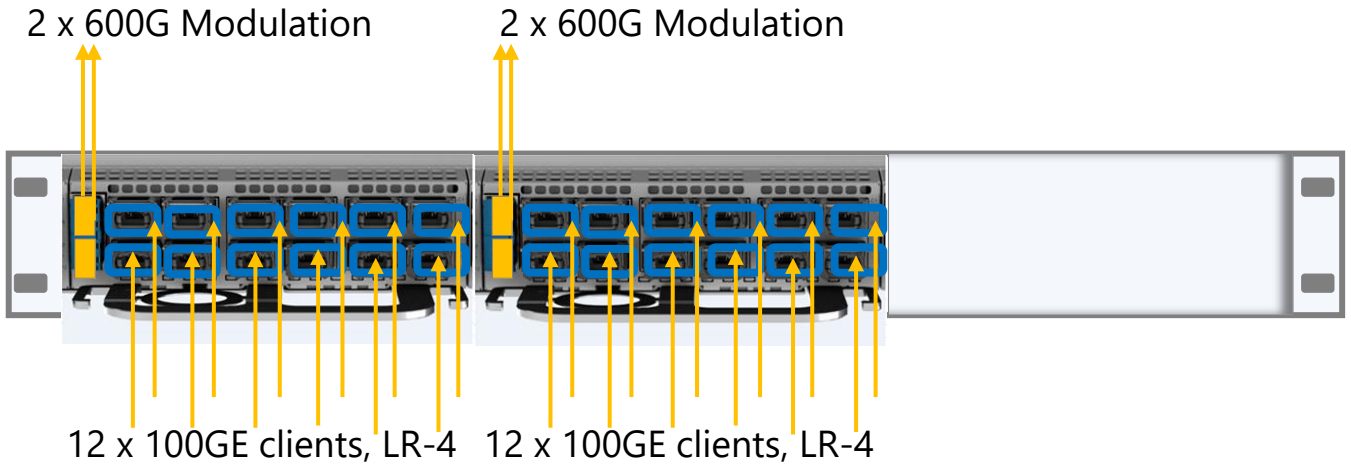
Example



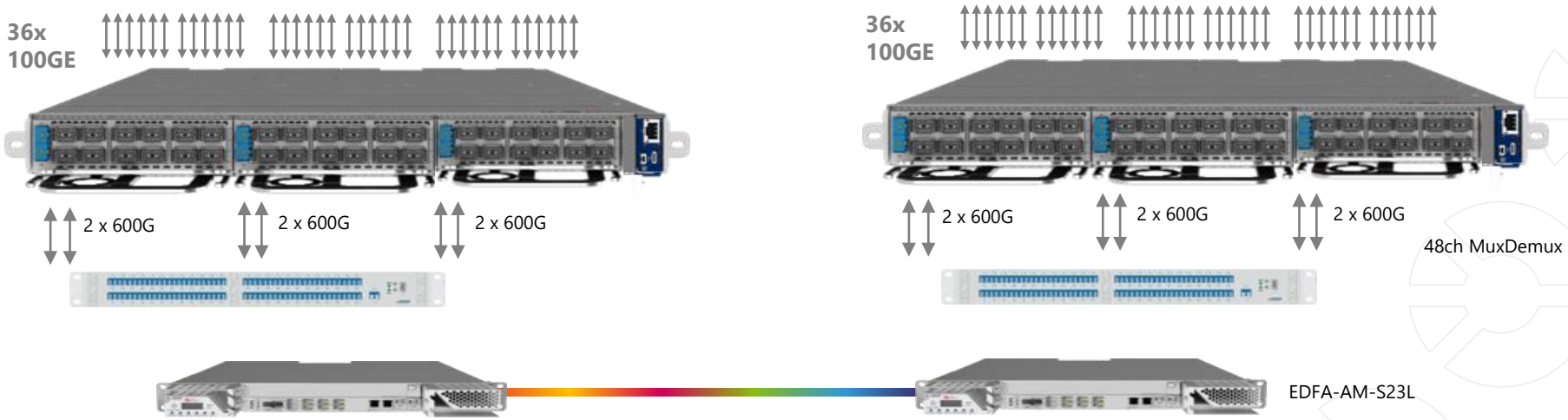
Example: Mix 100GE + 32/16G FC



Example: TeraFlex 24 x 100GE



Example: TeraFlex Deployment (max.)



Initial data:

36 x 100GE via 18km point-to-point plus new EDFA-AM-23L

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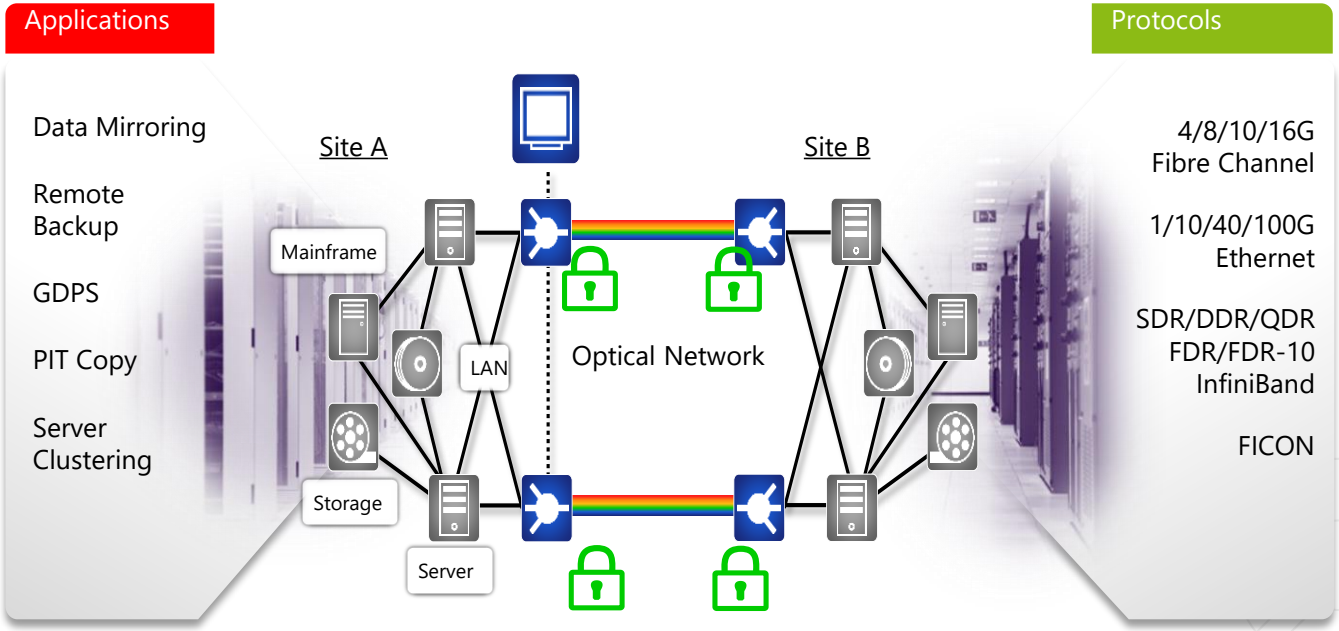
Secure Data Center Interconnect (DCI)



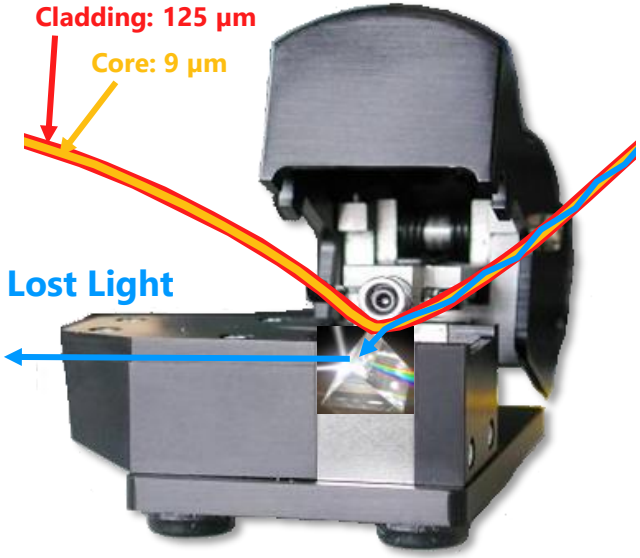
Data center environment & security

…and what about the fiber connection?

There are multiple ways to access fiber

Fiber optic networks

Optical tapping method



NETWORKWORLD
THE CONNECTED ENTERPRISE

"For both public and private networks, optical taps and analytic devices are required and inexpensive maintenance equipment in common use worldwide today. **Various types of optical taps [...] are also used for corporate espionage...**"

„Clearly, **physical protection** of optical transmission media and junction boxes **is essential**; in addition, **data encryption plays a role in protecting sensitive data.**" [5]

[5] Security Strategies Alert, M.E. Kabay, already in March 2003

Three Options:

1 Encryption

AES-256
Authentication
Diffie-Hellman Key Exchange
Man-in-the-middle Protection

2 Physical Layer Monitoring

Power Tracking
Intrusion Detection
Optical Time-Domain Reflectometer (OTDR)
Advanced Link Monitoring (ALM)

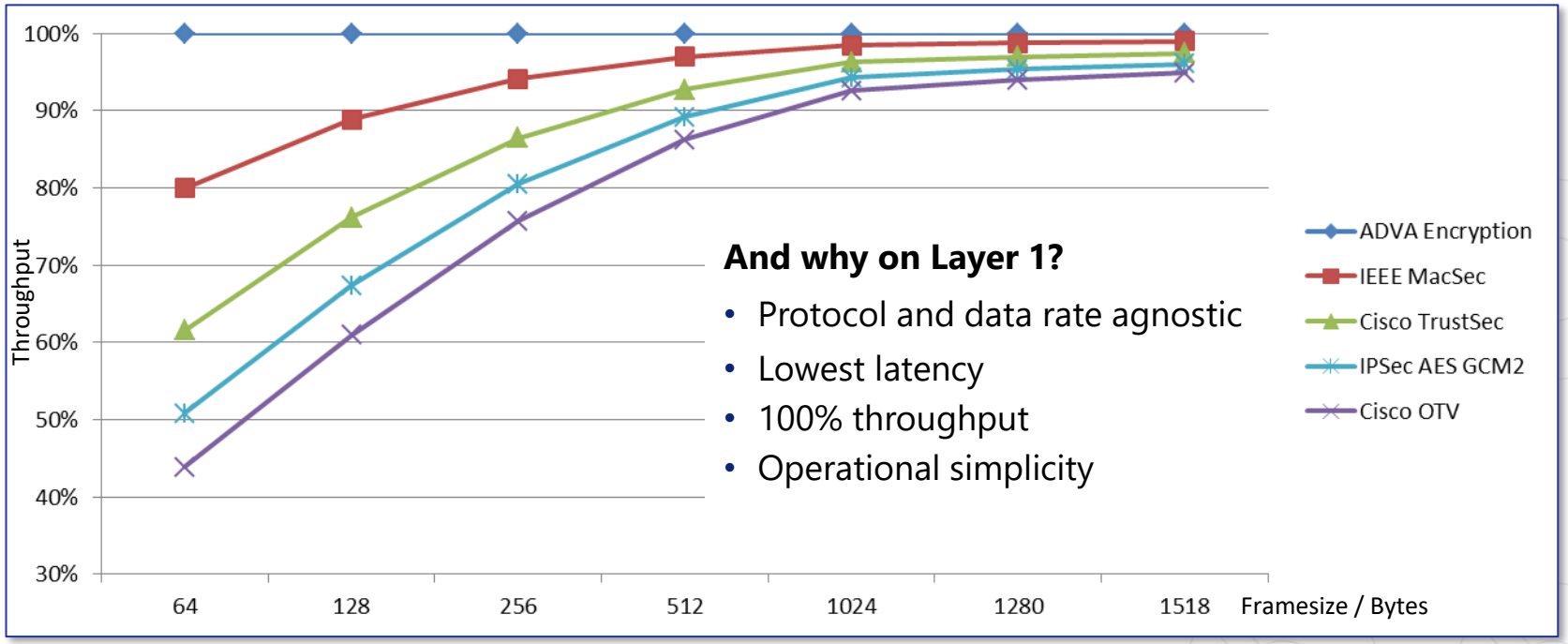
3 Security-Hardened Software

RADIUS
Secure Shell
SNMPv3

Data Encryption

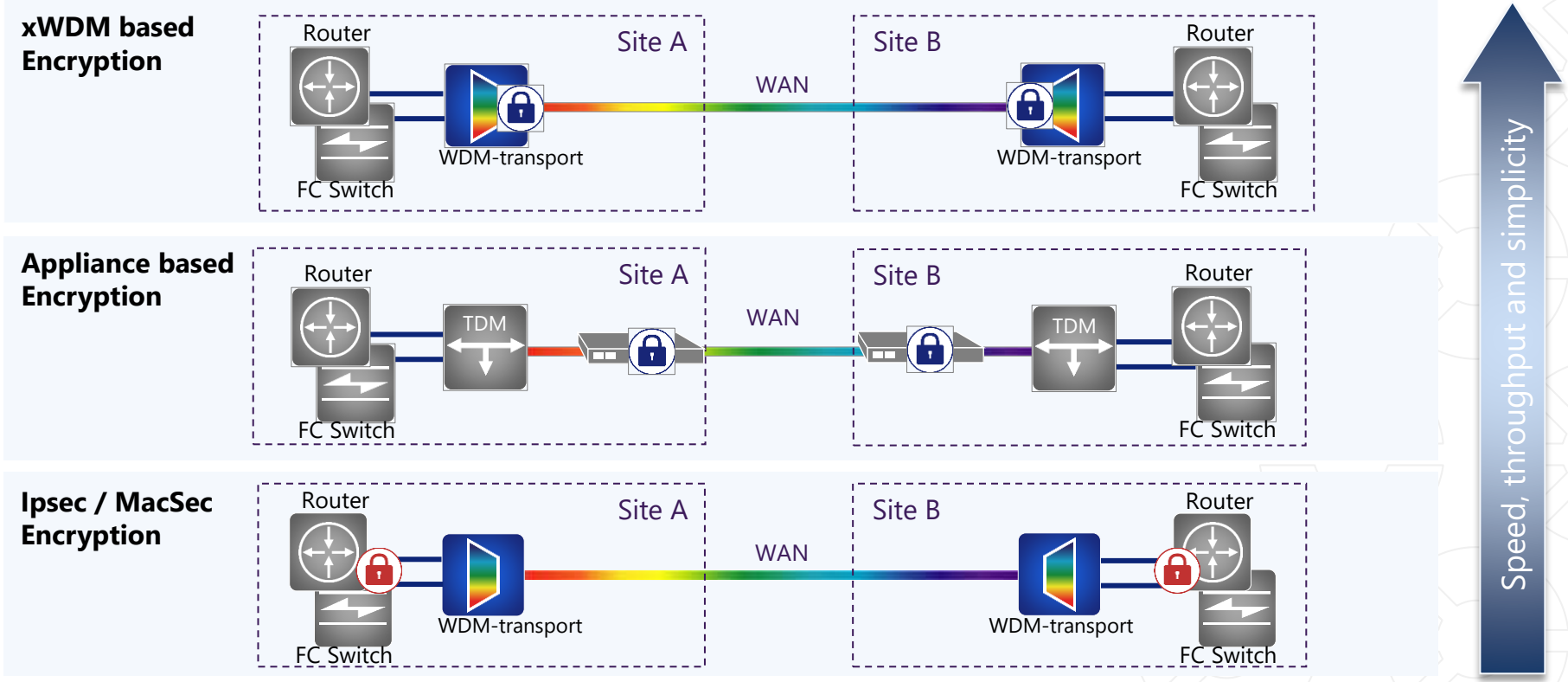
Encryption performance

Comparison of maximum throughput



Optical transmission security

Classic datacenter dark fiber solution

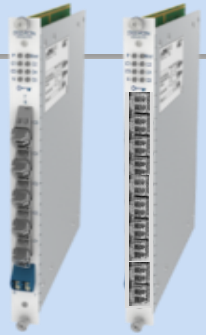


Layer1 encryption solution suite

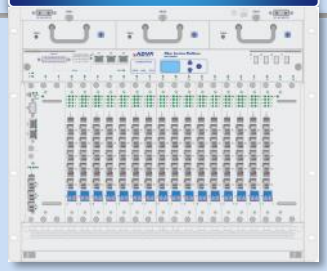
100GbE
40GbE
FC 32G
25GbE
FC 16G
10GbE / RoCE
OTU-2
STM-64/OC-192
FC 10G
FC 8G
IB 5G
FC 4G
STM-16/OC-48
FC 2G
FC 1G
GbE

AES 100G Encryption

AES 200G Encryption



AES 10G Encryption



100G
25-40G
5G – 15G
1G – 5G

ADVA™

CryptoMux – MA-2C2C3LT-A

Flexible Subtending Aggregation with Encryption

MA-2C2C3LT-A

Aggregation module for Ethernet, OTN, SDH and FC services

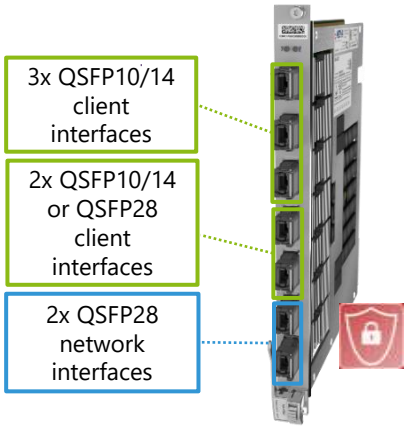
- 20x 10G (10GbE/STM64/OC192/OTU2/OTU2e)
- 6x 25GbE (ODUflex), 4/5x 40GbE (ODU3, proprietary)
- 2x 100GbE
- 20x 8G FC, 12x 16G FC, 6x 32G FC (ODUflex)

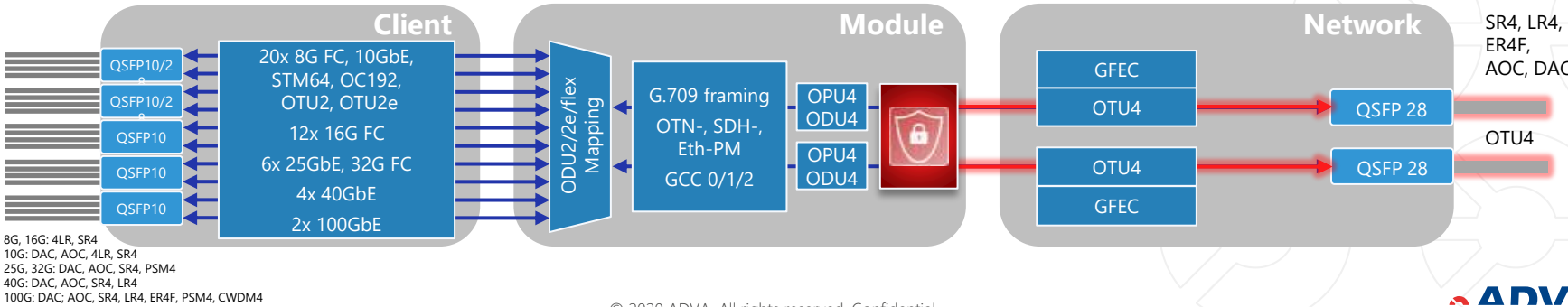
Path protection, Client Channel Card Protection

PCS & MAC monitoring for 10GbE, 40GbE, 100GbE

10GbE, 25GbE, 40GbE SyncE (G.8261) and PTP (1588v2) transparency

Encryption engine: Key management, AES256 session key, authentication





8G, 16G: 4LR, SR4
10G: DAC, AOC, 4LR, SR4
25G, 32G: DAC, AOC, SR4, PSM4
40G: DAC, AOC, SR4, LR4
100G: DAC; AOC, SR4, LR4, ER4F, PSM4, CWDM4

Physical Layer Protection & Monitoring

Physical Layer Monitoring

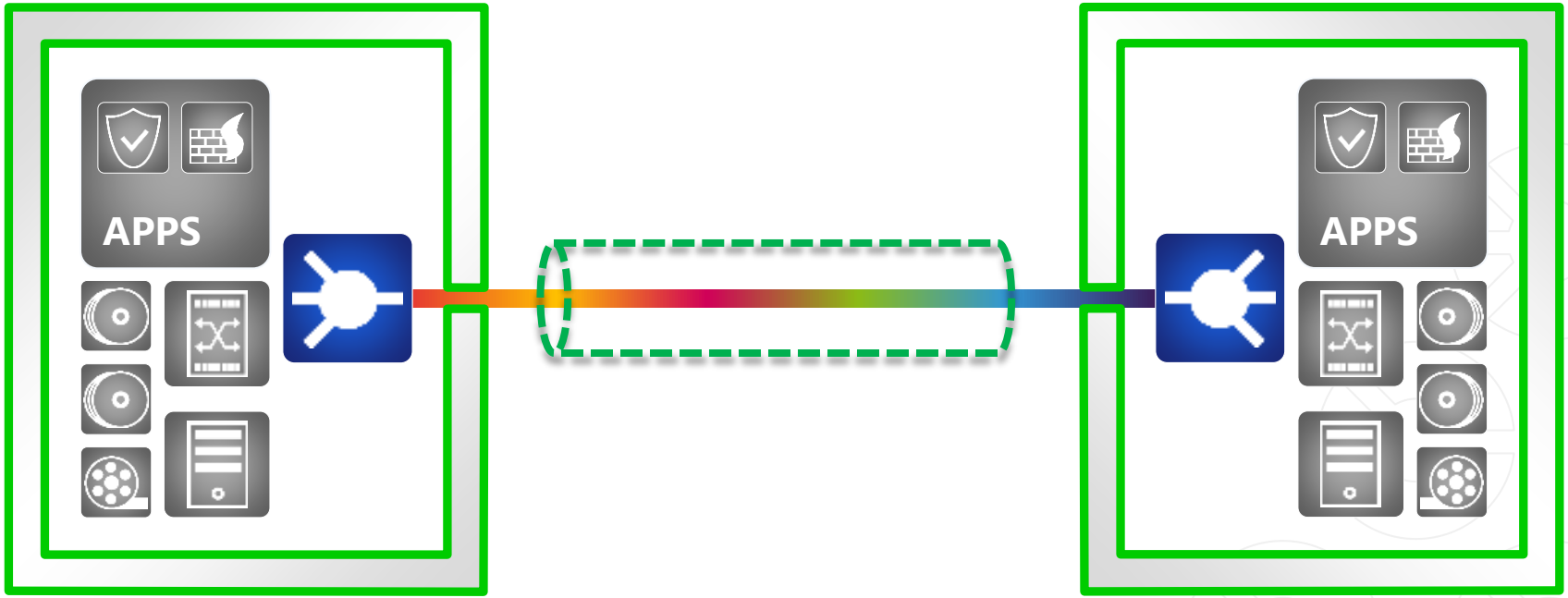
Fiber Cut:
Detection through software-adjustable switching thresholds

Fiber Degredation:
Alarm generation through adjustable fiber attenuation thresholds

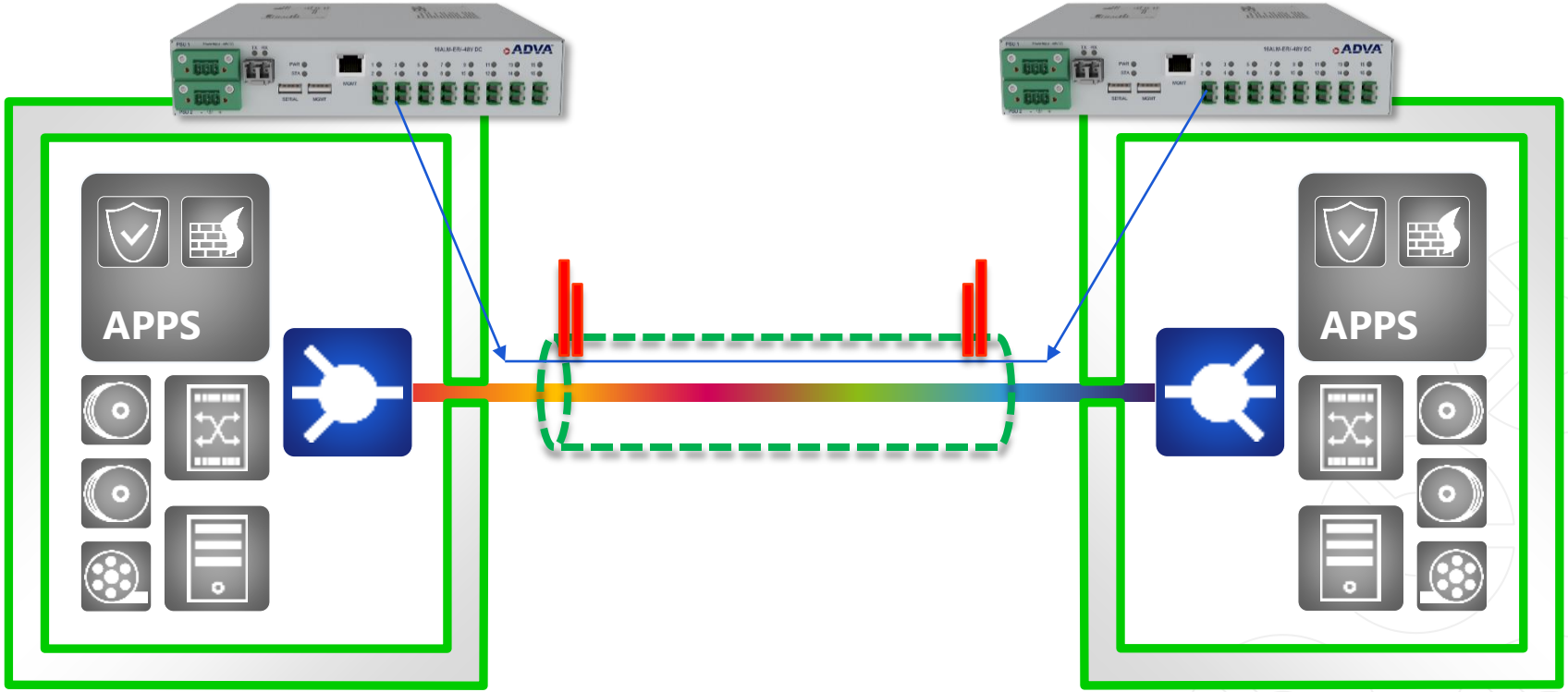
Long Term Effects:
Long term fiber performance information monitoring
Intrusion detection through correlation of typical power signatures

Fault Location Detection:
In-service OTDR measurement or Access Link Monitoring (ALM) to locate fiber problems and possible fiber taps

Physical Layer Protection & Monitoring of Optical Fibre



Today: „Optical Protection Shield…“



ALM Monitoring Suite

*) ALM64 is currently in development and available Q2 2018

Fastest fault detection time

Fiber integrity measurement takes 2 to 5 seconds only

Best detection accuracy

With demarcation reflection differentiation between cut and attenuation can be made

Compact Footprint

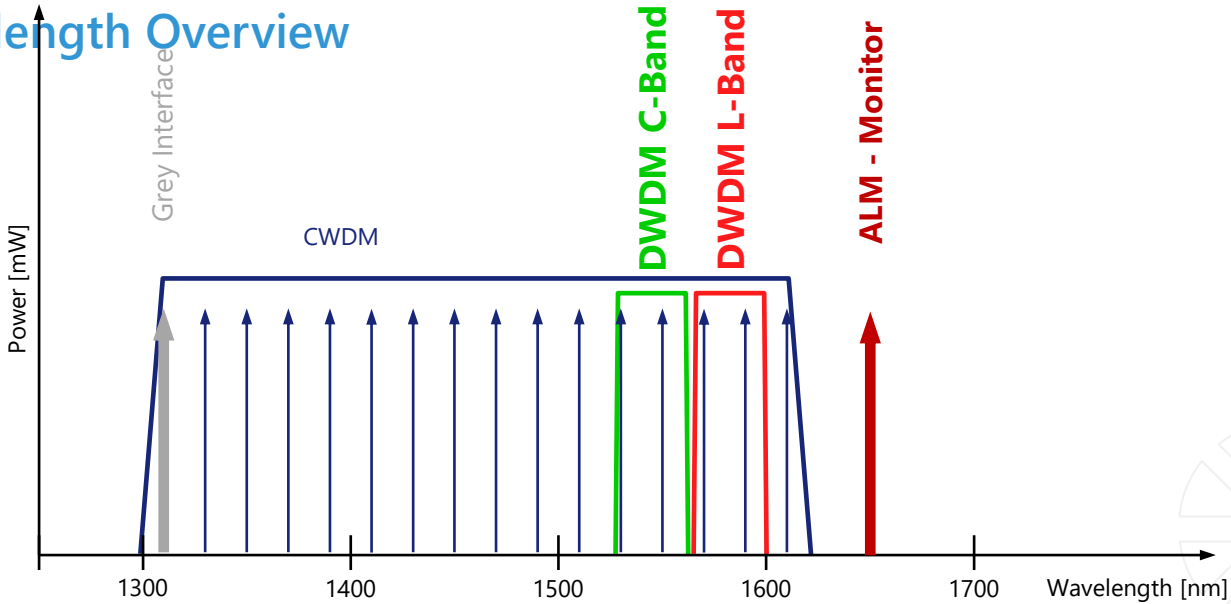
With 64 ports in 1RU the ALM is the densest solution with lowest power consumption.

Full-fledged north-bound interface

The ALM offers an extensive NBI and is integrated in many GIS and ADVA NM

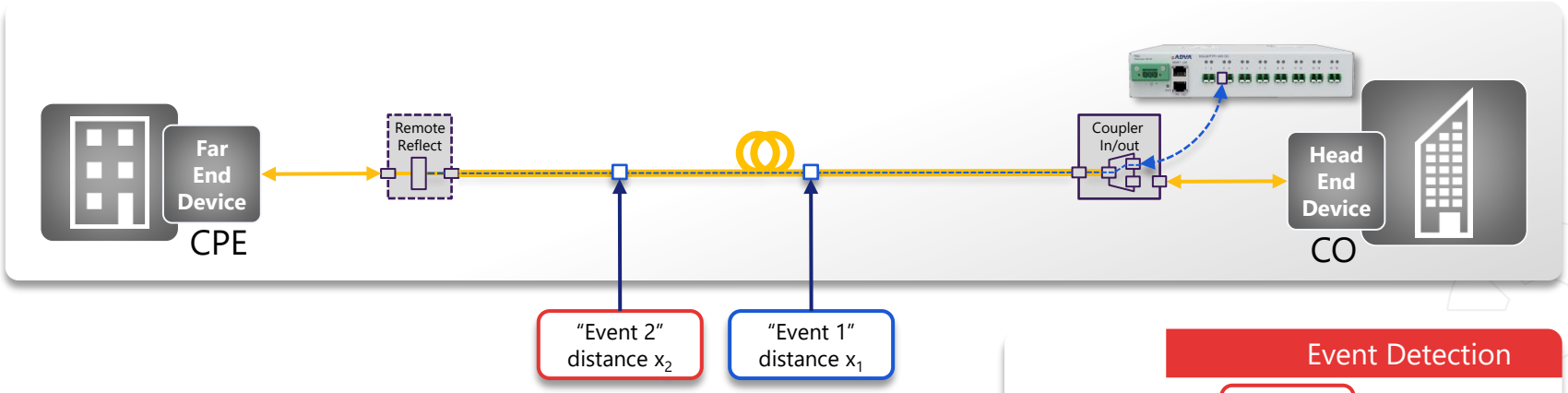
How does it work?

ALM Wavelength Overview

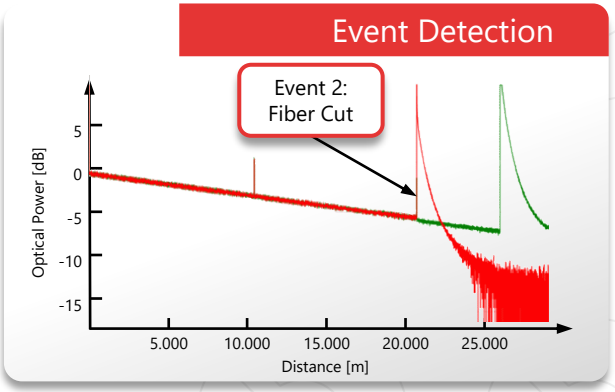


Permanent ALM Monitoring does not interfere with any other transport wavelengths

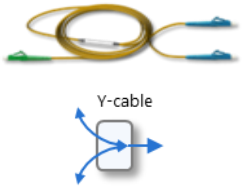
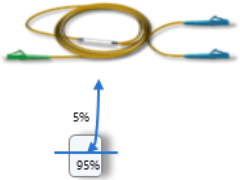
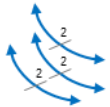
ALM Optical Measurement
Event Detection and Alarm Generation



- Automatic Alarm Generation in case of events
  - Reference Measurement is used for comparison
  - List of reflective optical events with associated latency / distance per fiber link is created



Tool-Box & Components, Hardware

16ALM DC, (16ALM AC) 	**Coupler 1x, Y-cable** 	**Reflector** 	**Sensor, WALL** 
64ALM DC, (64ALM AC) 	**Coupler 16x** 	**Splitter 5/95%** 	**Sensor, CORNER** 
LC/APC duplex 	**Coupler 32x** 	**Coupler 8x** 	

Tool-Box & Components, Software

Firmware for ALM device per unit and free of charge 	**GEO Manager Server** 1 x Server license for complete Network (ADVA don't deliver server HW)	**NMS Ensemble Director** 1 x Server license for complete Network (ADVA don't deliver server HW)
	Geo Manager, Licenses (1x per 16ALM) Geo Manager Connection License per shelf of ALM16	**Connection License for one shelf 16ALM** 1 x per shelf 16ALM
	Geo Manager, Licenses (1x per 64ALM) Geo Manager Connection License per shelf of ALM64	**Connection License for one shelf 64ALM** 1 x per shelf 64ALM

Here's how GIS Mapping works

GIS integration status

- CableScout (available)
- OSPInsight (available)
- ConnectMaster (available)
- Cocon (available)
- NetGeo (available)
- ArcGIS/Smallworld (evaluation stage)

Scalable ADVA GIS
(under development)

- Conversion tools
- Online Interface for Engineers

GIS: Geographical Information System

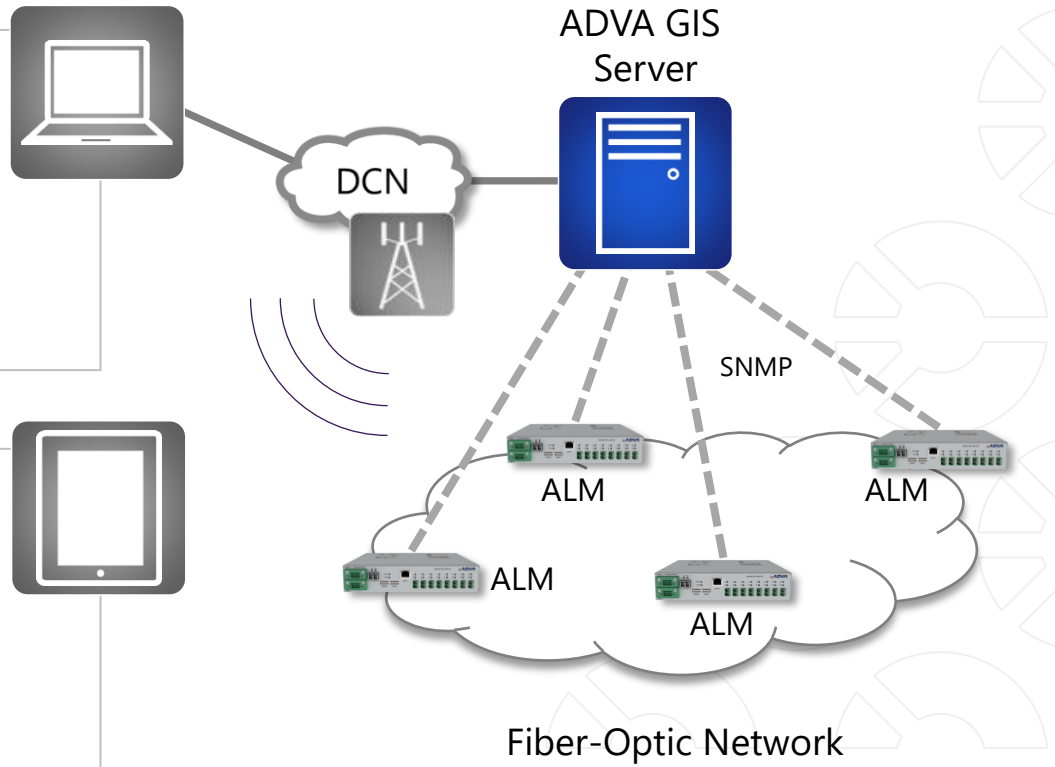
GIS Structure

Administrator

- AutoCAD Map 3D based environment
- ADVAgis Plugin installed for editing
- Wide range of import/export functions
- Available “as-a-service” as well

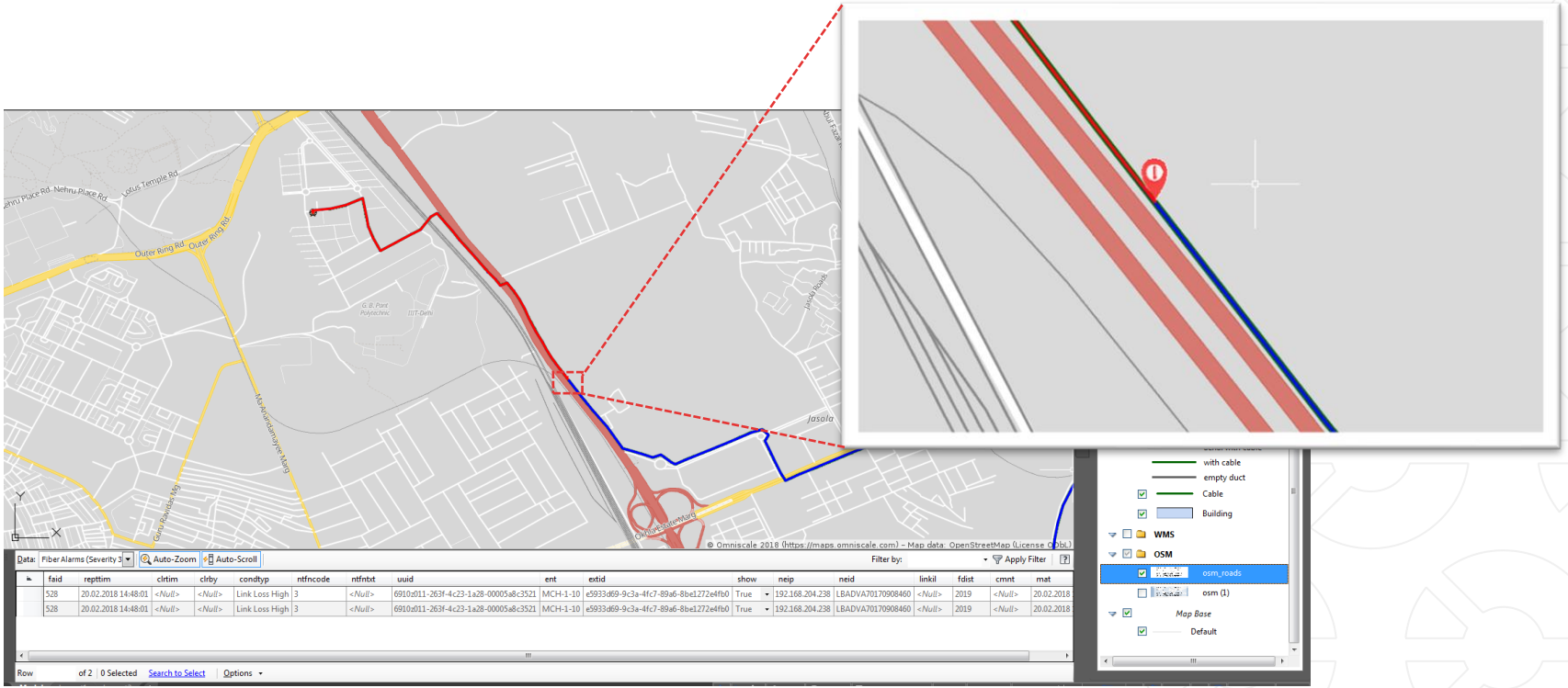
Service Engineer

- Web-browser GUI
- Runs on PCs, tablets and phones
- Access to all service-relevant functions
- No special installation required



Geo Manager Fault detection

With ALM configured and fiber fault detected



Fault analysis screenshot

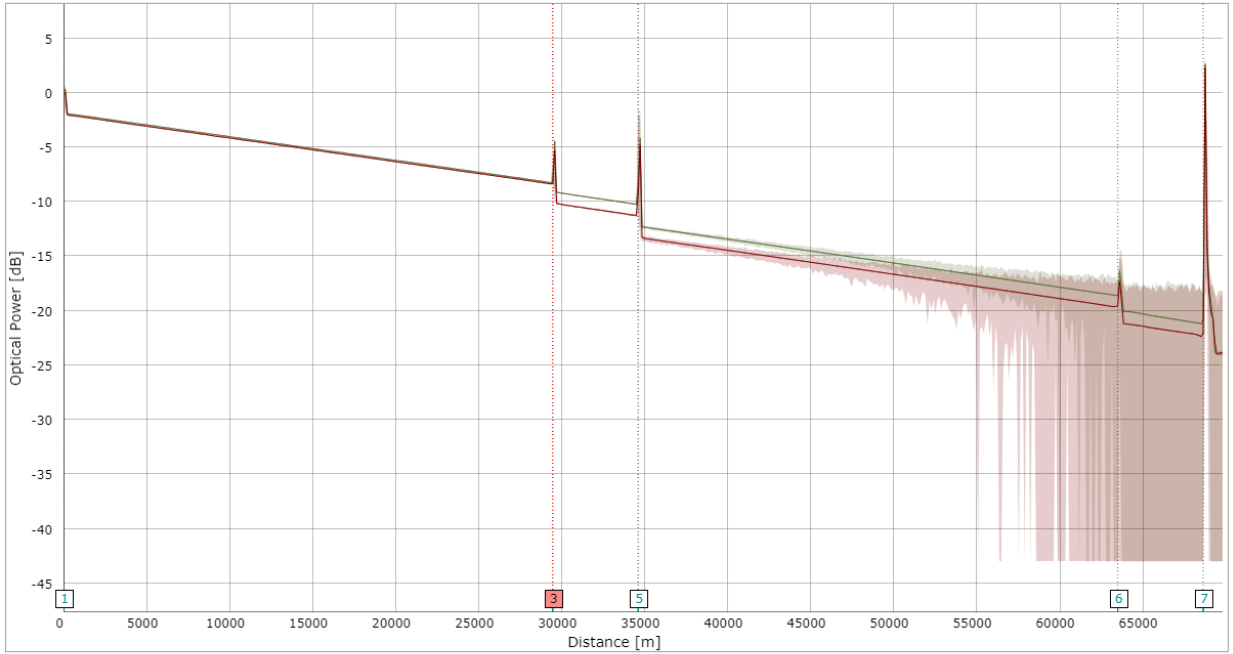
Fault Analysis Port 1

Fault Analysis Results

Loss Slow Deviation High CLEAR	Deviation: 1.1 dB - Threshold: 2.0 dB
Loss Medium Deviation High CLEAR	Deviation: 0.0 dB - Threshold: 1.5 dB
Link Loss High CLEAR	Value: 20.2 dB - Threshold: 22.5 dB
Loss Fast Deviation High CLEAR	Deviation: 0.0 dB - Threshold: 1.0 dB
Timestamp:	2018-07-18 15:13:44
Link Loss [dB]:	20.2
Mean Fast/Medium/Slow [dB]:	20.2/20.2/19.2
Fault Position [m]:	29496

Fingerprint Results

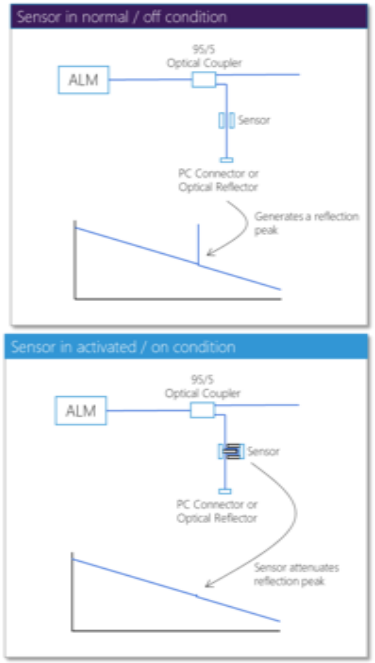
Link Loss [dB]:	19.2
External Offset [m]:	0
Max Laser Power [dBm]:	10.00
Line End Position [m]:	68673
Link Latency [µs]:	336.5
Refractive Index:	1.4689
Coupler Loss [dB]:	0.7
Timestamp:	2018-07-17 13:14:06



Show Trace: 100ns 1000ns Export

ID	Fingerprint Position [m]	Fingerprint Reflectance [dB]	Fingerprint Attenuation [dB]	Fault Analysis Position [m]	Fault Analysis Reflectance [dB]	Fault Analysis Attenuation [dB]	Remark
1	0	-54.9	1.1	0	-56.7	1.2	ISANDO coupler
2	29472	-48.1	0.8	29472	-49.5	1.8	Fiber splice
3	29480	-61.2	n.c	29480	-62.3	n.c	Fiber splice
4	34599	-35.8	2.0	34599	-34.0	2.0	BRYANSTON OSFMA pass through
5	---	---	---	34614	-66.3	n.c	

Passive Environmental Supervision

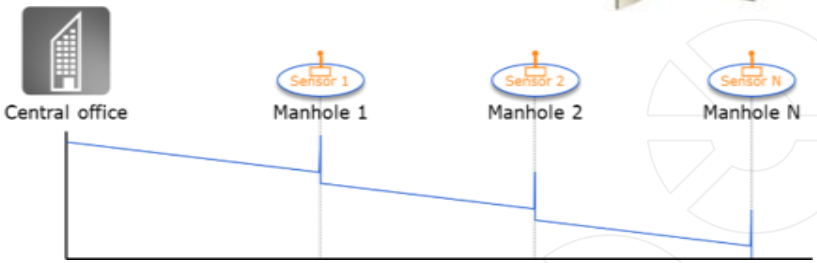


With the ALM one can passively monitor a complete fiber infrastructure

- Intrusion sensors (OEM)
- Water detectors (OEM)

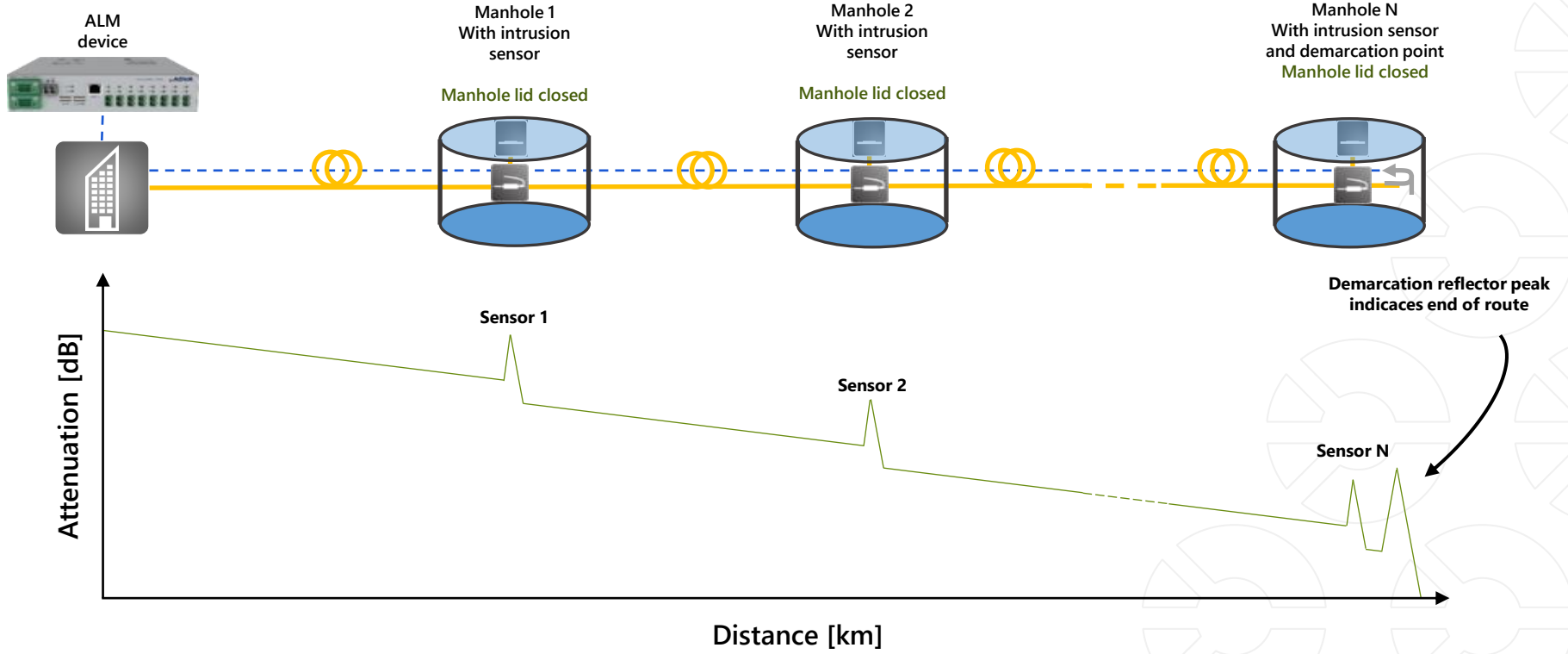
Intrusion sensor P/N: 1043709864-01

Water sensor P/N: coming soon



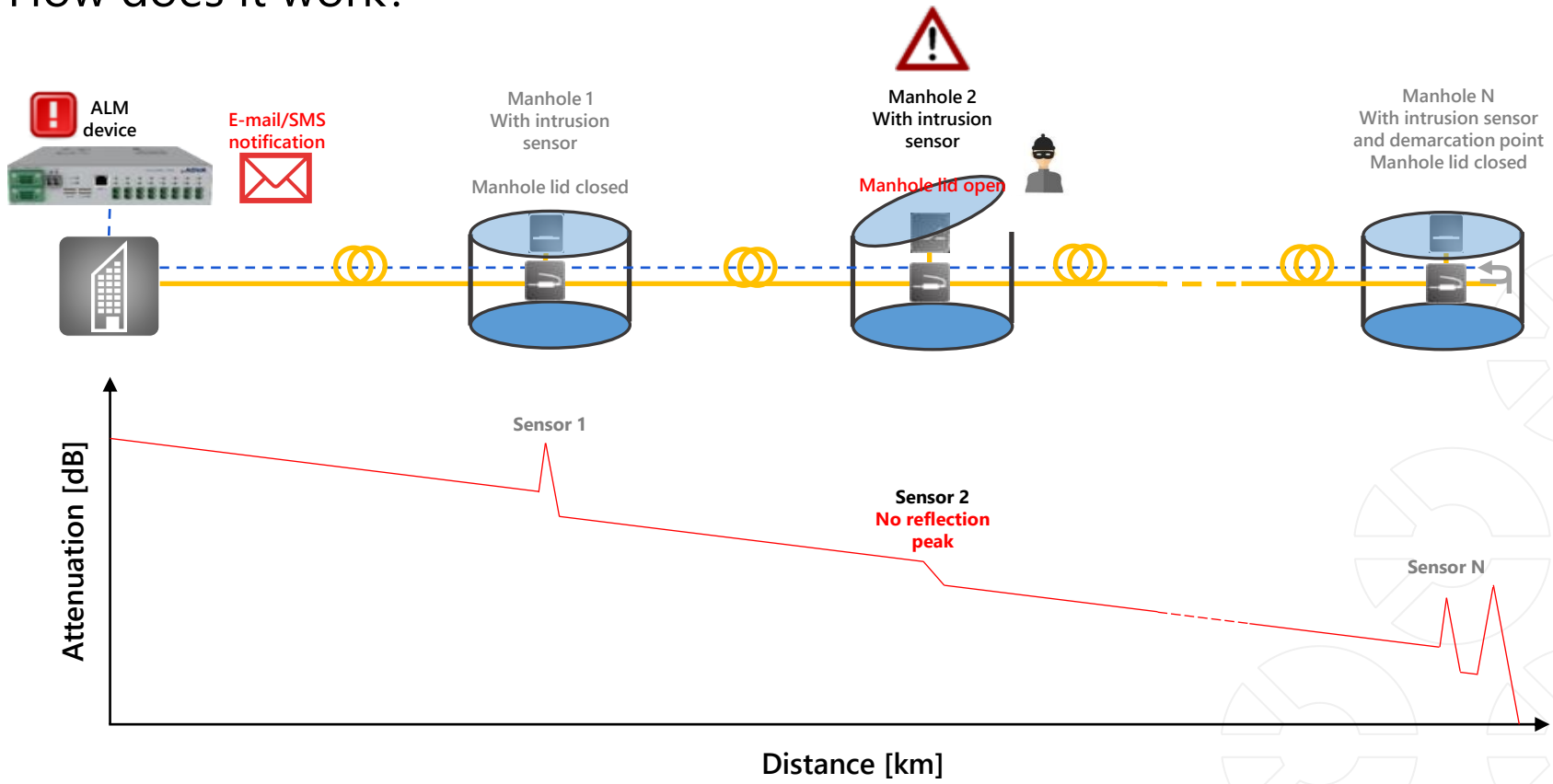
Intrusion sensor concept

How does it work?



Intrusion sensor concept

How does it work?



Thank you

Спасибо

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