



HUBER+SUHNER Polatis – All Optical Switching

- FIBER LAYER SWITCHING – AT SCALE
- Highest Capacity All-Optical Switch
- Industry Leading Port Density
- Superior Optical Performance
- Carrier Class Reliability
- Proven SDN Interoperability



HUBER+SUHNER Polatis – All Optical Switching

- Company Overview
- What is Fiber Switching
- Polatis Technology
- Polatis Product Line
- Optical Switching Applications for the Telecom Market
- Summary

HUBER+SUHNER Polatis at a glance

Company

- Est. in 2000, acquired by H+S June 2016
- Offices in Cambridge (UK), Boston (USA) and Krakow (Poland)
- Over 4 billion port-hours accumulated on 2000+ systems in service
- Global customer base (200+) in diverse markets

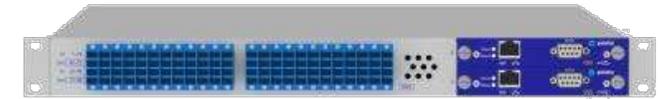
Technology

- Transparent physical layer **all-optical** matrix switch
- **Best** available **performance** (typ <1dB optical loss)
- **Highest-port count** (384x384) optical switch available
- **Broadest** optical switch **product range**, from 4x4 to 384x384 and everything in between

Polatis Field Deployed Port Hours

4,679,078,029

Carrier-Class Reliability



1U 48x48 All Optical Switch

SDN
ENABLED



Up to 384x384 in 4U

What is an All-Optical Switch?

A Circuit Switch - Not a Packet Switch (Router)

- Does not selectively route IP packets
- Switches all data on the fiber

OOO Switch - Not an OEO switch

- Does not convert Optical into Electrical (to switch it) and back into Optical (OEO)
- Optical input, Optical switch core, Optical output (OOO)
- Switches light from one fiber to another
- No timing jitter, no latency, no data corruption

What types of signals can an all-optical switch route?

Any wavelength that propagates through optical fiber

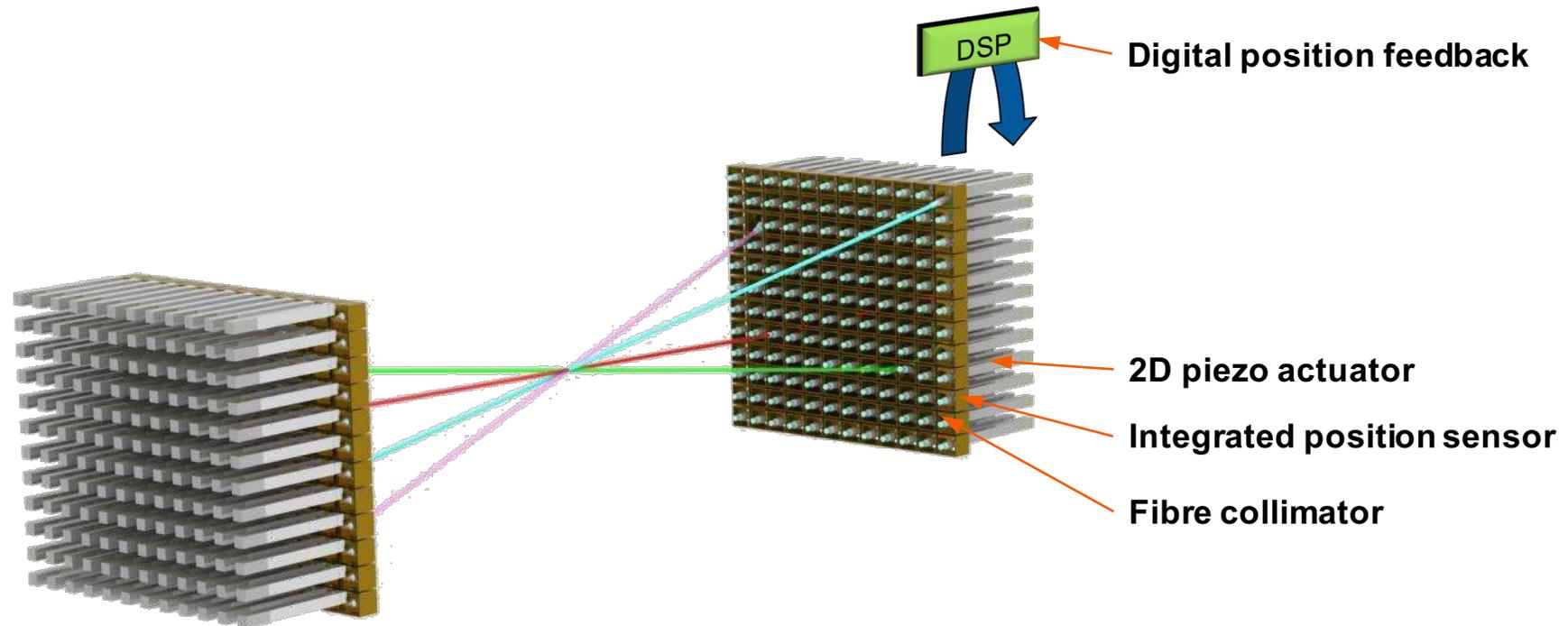
- Single mode: 1260-1675 nm wavelength
- Multimode: 850 and 1300 nm

Any signal that can be put into a fiber

- Digital data of any rate, and of any format
 - DC to 400 Gbps+
 - CPRI, Ethernet etc.
- Analog data of any rate, and of any format / protocol
 - RF over fiber
 - Video
 - Optical Sensor data (i.e. oil field sensors)

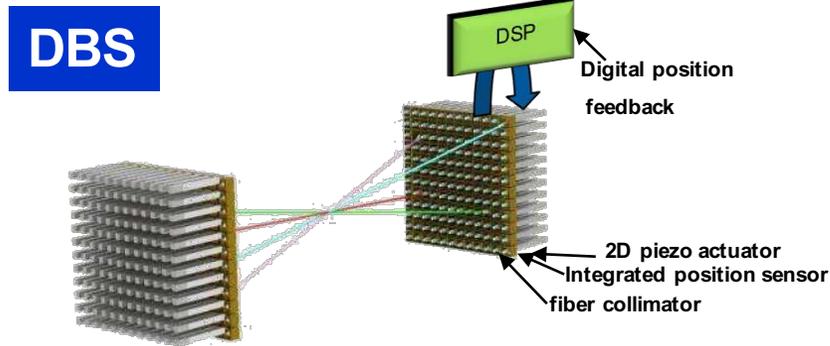
**Any signal you can put in fiber
can be switched**

DirectLight® Optical Switch Technology – The clever bit inside!



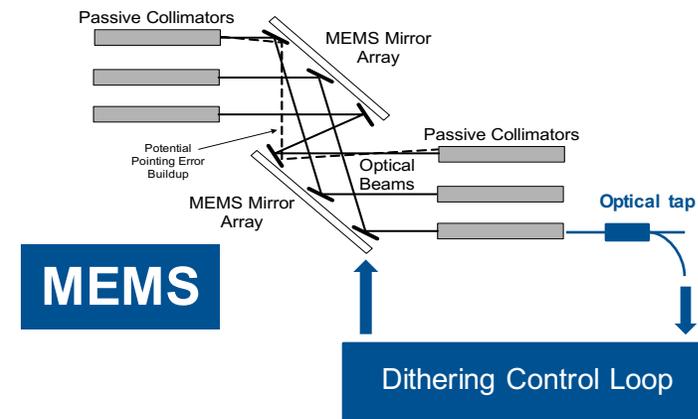
- DirectLight® **free-space** optical switch technology connects fibres with the best possible optical performance
- **Patented** 2D piezo beam-steering with integrated position control delivers dependable connectivity
- **Transparent**, proven, reliable technology maintains robust connections even on **dark fibre**

Piezo DBS Switch Technology



- Lower optical loss and back reflections
- True dark fiber switch, no light needed to make and hold connections
- Transparent all-band performance
- DBS: Position sensor alignment – no dither
- Commercially available in sizes up to 384x384 and beyond

3D MEMS Switch Technology



- Higher optical loss and back reflections
- Needs light on the fiber to maintain connections
- Switching range is limited by optical detector specs
- MEMS: Mirrors dithered for optical feedback adding noise to the transmitted signals
- Commercially available is sizes up to 320x320

Polatis Secure Optical Switch Product Line

OPM – optical power monitor APS – automatic protection switching VOA – variable optical attenuation	Matrix Size	Technology	Optional Functions	Key Features
	4x4 to 16x16	DirectLight™ Multimode		<ul style="list-style-type: none"> • World's only multimode fibre matrix switch • Supports OM1 and OM3/OM4 fibers • Available in NxN, MxN configurations
	4x4 to 192x192; 192-fiber	DirectLight™ Single mode	OPM APS VOA	<ul style="list-style-type: none"> • Low insertion loss / superior optical specs • Carrier class interfaces (SNMP, TL1, etc.) • Available in NxN and MxN configurations • Single sided N-fibre variants available • SDN enabled with OpenFlow and NETCONF
	4, 8 or 16 Rx/Tx line pairs Protection Services	DirectLight™ Single mode		<ul style="list-style-type: none"> • Compact 1+1 optical layer protection • Up to 16 services in 1RU, < 25 watts • Pre-configured, drop in APS system • Automatic LOS protection & restoration
	208x208 to 384x384	DirectLight™ Single mode	OPM APS VOA	<ul style="list-style-type: none"> • Superior optical specs • NxN and MxN configurations • SDN enabled carrier-class interfaces • Low power, resilient architecture

Polatis Switch Tray Configuration Options

True Transparency

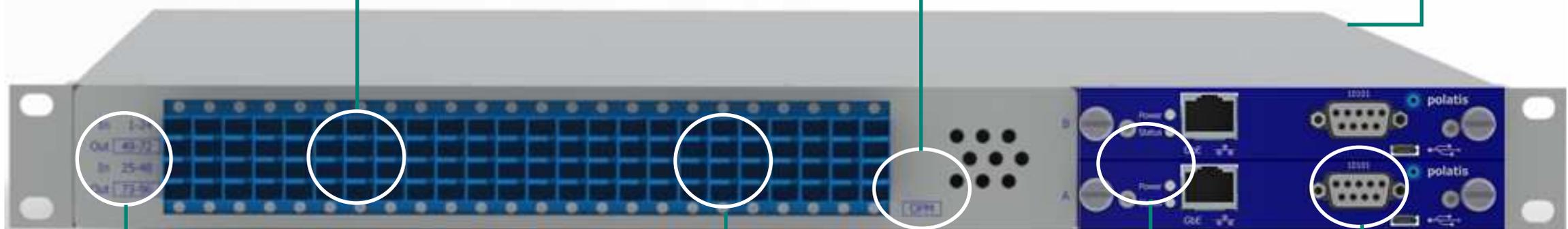
- 1270-1675nm
- Bidirectional, dark fiber
- DC to 100Gbs+
- DWDM, RF, coherent...

Power Monitoring Options

- Loss of signal alarms
- Automated protection switching

Power

- AC, 48 VDC
- Dual hot-swap power options



Switch Sizes

- Singlemode 4x4 to 384x384
- Standard matrix or customer configurable

Connectors

- LC, LC-HD, FC, SC, E2000, ST
- MTP-8, MTP-12 array connectors
- Front or rear connectors

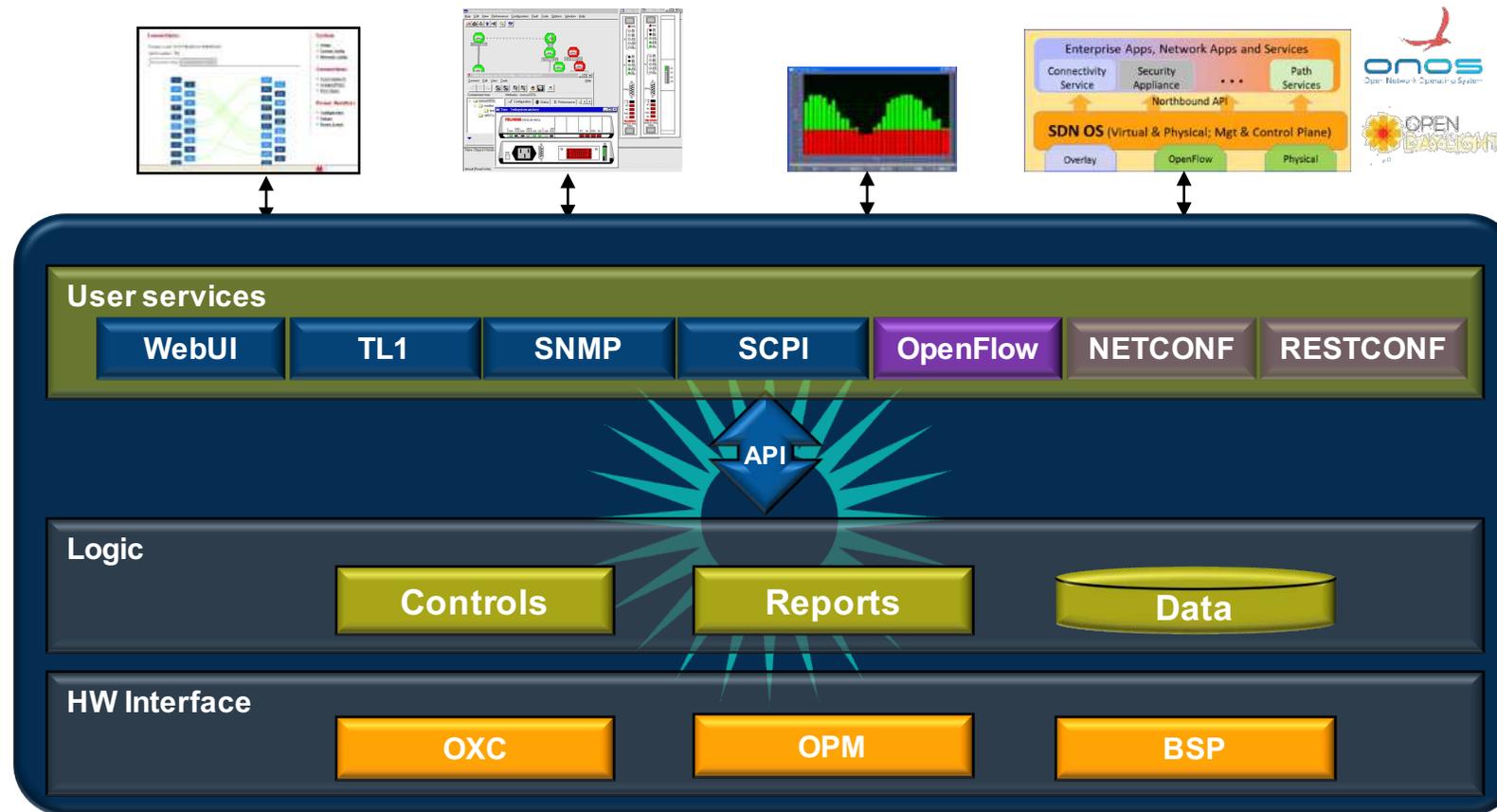
Control Protocols

- WebGUI, SNMP, TL1, SCPI
- Secure web server
- OpenFlow, NETCONF, RESTCONF

Physical Interface Options

- Ethernet, USB, serial
- Dual Hot Swap NIC

Polatis optical circuit switch user interfaces



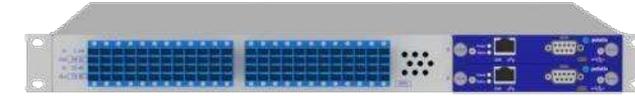
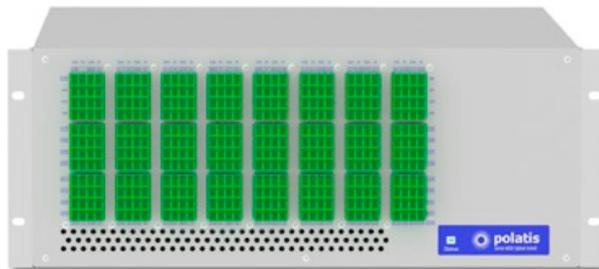
Modular architecture with multiple user interfaces for diverse applications

Embedded OpenFlow 1.4 agent enables integrated optical circuit and packet switch control plane

NETCONF & RESTCONF interfaces implement Polatis YANG models with Cisco Tail-f ConfD

Series 6000 Specifications

Performance Parameters	Polatis 6000n-Lite and 6000n Specifications
Matrix Switch Sizes (NxN) ¹	4x4 up to 192x192
Typical Insertion Loss ²	1.0dB
Maximum Insertion Loss ²	2.0dB
Maximum Insertion Loss with single OPM ²	2.5dB
Loss Repeatability ³	+/-0.1dB
Connection Stability ³	+/-0.1dB
Dark Fiber Switching	Yes
Bi-Direction Optics	Yes
Max Switching Time	25ms
Polarization Dependent Loss (PDL)	<0.1dB (C+L Bands) <0.3dB with optional OPM (C+L Band)
Crosstalk	<-50dB
Operating Wavelength Range	1260-1675nm 1260-1650nm with optional OPMS
Wavelength Dependent Loss (WDL)	<0.3 dB (C+L Band)
Return Loss (with APC connectors)	>50dB
Optional Optical Power Monitoring (OPM)	Wavelength range 1270-1330nm & 1510-1620nm Dynamic range -25dBm to +20dBm Accuracy +/-1.0dBm
Maximum Optical Input Power	+27dBm
Switch Lifetime	>10 ⁸ Cycles
Operating Temperature (Normal)	+10°C to +40°C <85% RH non-condensing
Storage Temperature (Normal)	-40°C to +70°C <40% RH non-condensing



Electrical and Mechanical	Polatis 6000n Specifications
Fiber Type	Single Mode
Single Fiber Connector Types	LC, LC-HD, SC or E-2000 Connectors Angled or straight connector types available
Array Connector Types	MTP-8 or MTP-12 Elite Array Connectors
Control Languages	OpenFlow, NETCONF, SNMP, TL1, SCPI & HTML
User Interfaces	RJ45 Dual Ethernet 10/100/1000 Base T RJ45 Dual Redundant Hot-Swap Ethernet 10/100/1000 Base T
Craft Interface	RS232 Serial, Ethernet 10/100/1000 Base T and USB
Power options	Single 100-240 VAC 50/60 Hz Single -48 VDC Hot Swappable Dual Redundant 100-240 VAC 50/60 Hz Hot Swappable Dual Redundant -48 VDC
Power Consumption	25-75W

Switch Chassis Size (HxWxD)	Polatis 6000n Lite 4x4 to 48x48 Size	Polatis 6000n 60x60 to 144x144 Size	Polatis 6000n 160x160 to 192x192 Size
MTP or LC-HD	1RU x 19" x 22"	3RU x 19" x 22"	4RU x 19" x 22"
LC	2RU x 19" x 22"	4RU x 19" x 22"	6RU x 19" x 22"
SC or E2000	3RU x 19" x 22"	6RU x 19" x 22"	8RU x 19" x 22"

The low-loss Series 6000-Ultra and the high-density Series 6000-Lite Network switches fit into a compact 1RU chassis height with high-density connectors. The larger Series 6000 network switch fits into a 3RU chassis height with up to 144x144 ports and a 4RU chassis height with up to 192x192 ports with high-density connectors.

All parameters are measured excluding connectors at 1550nm and 20°C with an unpolarized source after thermal equalization unless otherwise noted.

- Asymmetric MxN switches and single-sided NxCC customer-configurable switches with any-to-any port connectivity are also available
- Measured using the 3 patch-cord method as defined in ANSI/TIA/EIA-526-7-1998
- Stability and repeatability are measured at maximum transmission

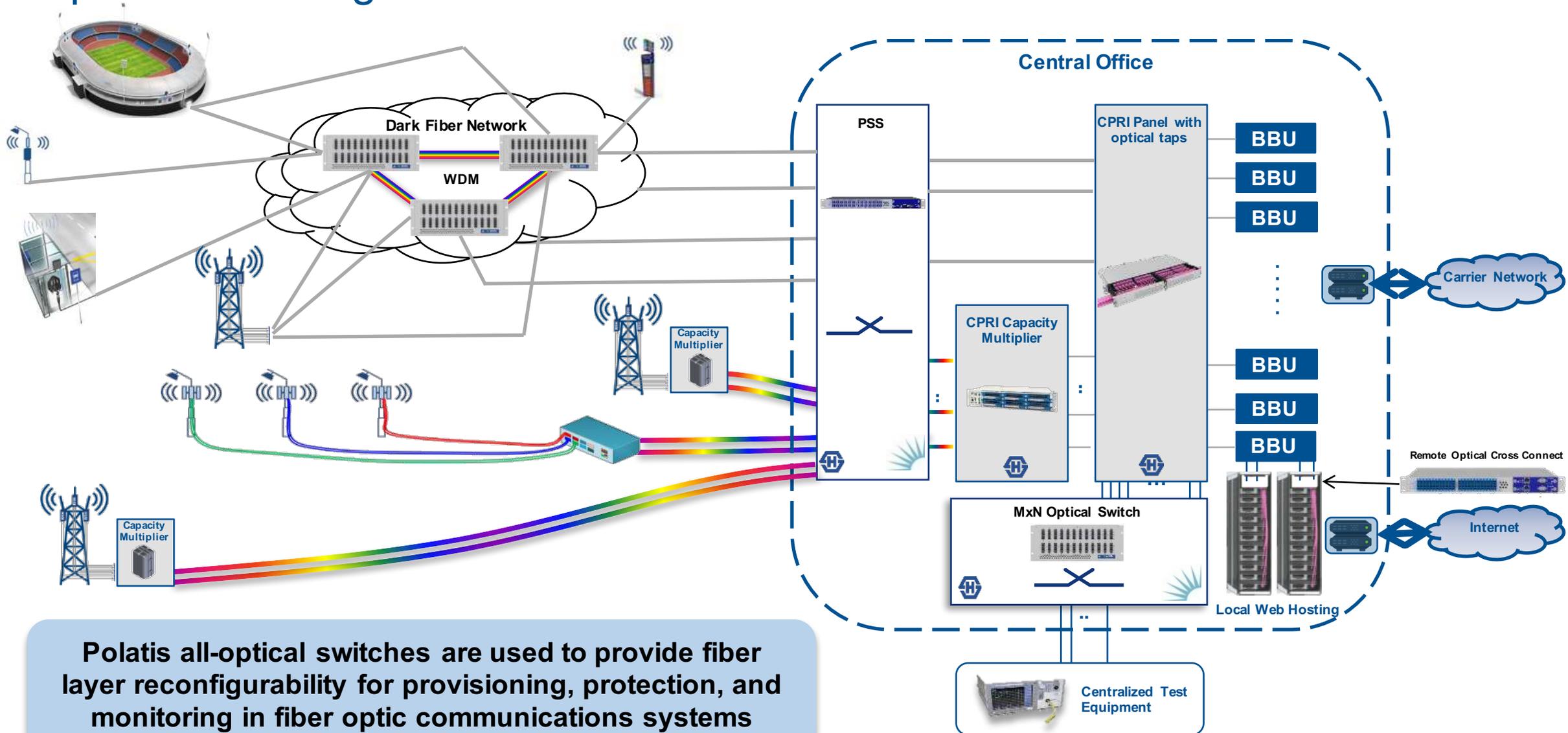
Optical Switching Markets and Applications

- Fixed & Mobile Telecom Networks
- Metro Networks
- Data Centers
- Intelligence Collection Systems
- Satellite Ground Stations / Communication Shelters
- Optical Test Automation / Network Simulation Labs
- Video Signal Routing

Anywhere there is a need to dynamically route optical signals

Provisioning, Protection, Monitoring, & Test

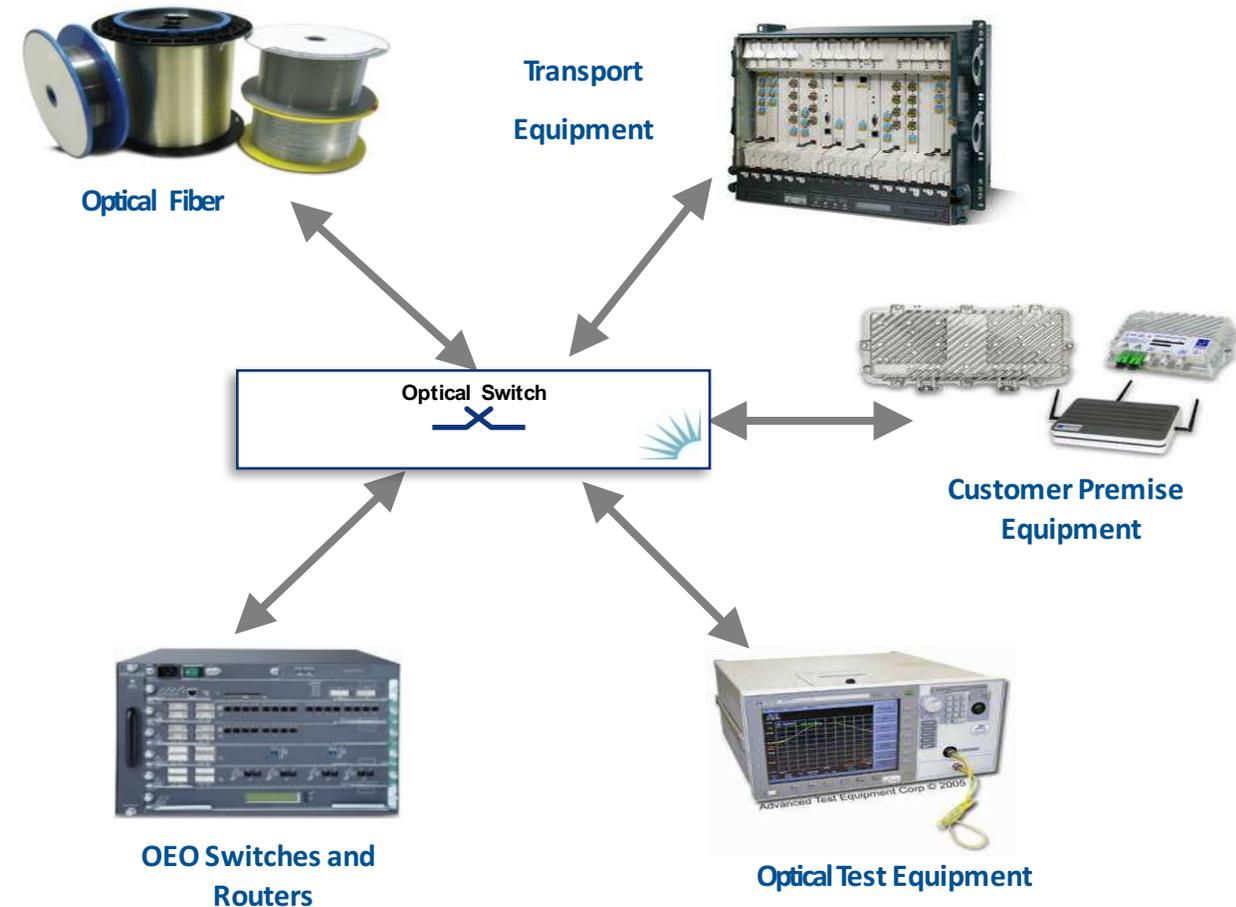
Optical Switching for Telecom & Mobile Networks



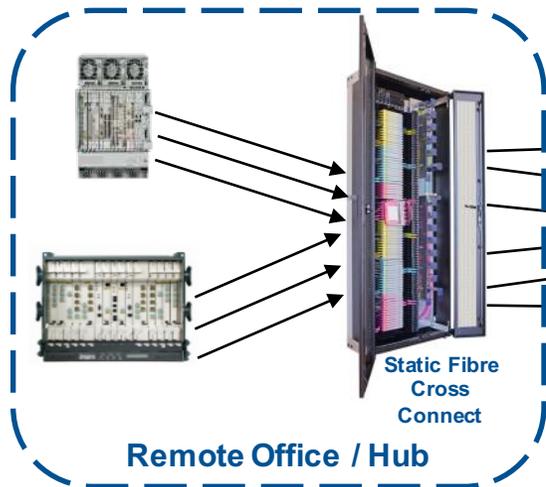
Polatis all-optical switches are used to provide fiber layer reconfigurability for provisioning, protection, and monitoring in fiber optic communications systems

Test Automation (Network Simulation Lab Application)

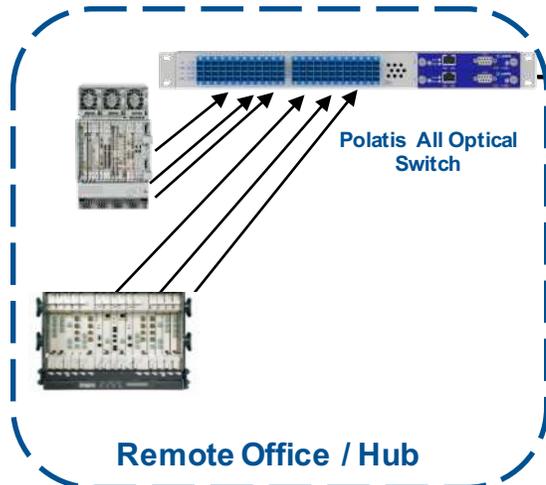
- Reconfigure your test lab in seconds
- Enables remote 24/7 lab operation
- Increases lab efficiency, equipment utilization and ROI
- Automates application development, QA and testing
- Allows rapid stress testing of new network equipment in multiple / repeatable configurations



Provisioning - Static vs. Automated



- **Static POP Cross connects require remote hands**
 - \$400+ per instance
 - Average install of 7 days (lost revenue)
 - 20 to 30% failure rate (missed install SLAs)



- **Automated Cross Connects**
 - Cable Telco and local services once
 - Dark Fiber Switch assures a connection
 - Cross Connects can be provisioned instantly
 - No Errors, time to revenue is immediate
 - Reuse of Cross connects Fibers
 - Bandwidth agnostic



Protection - Automatic Protection Switching (APS) for C-RAN

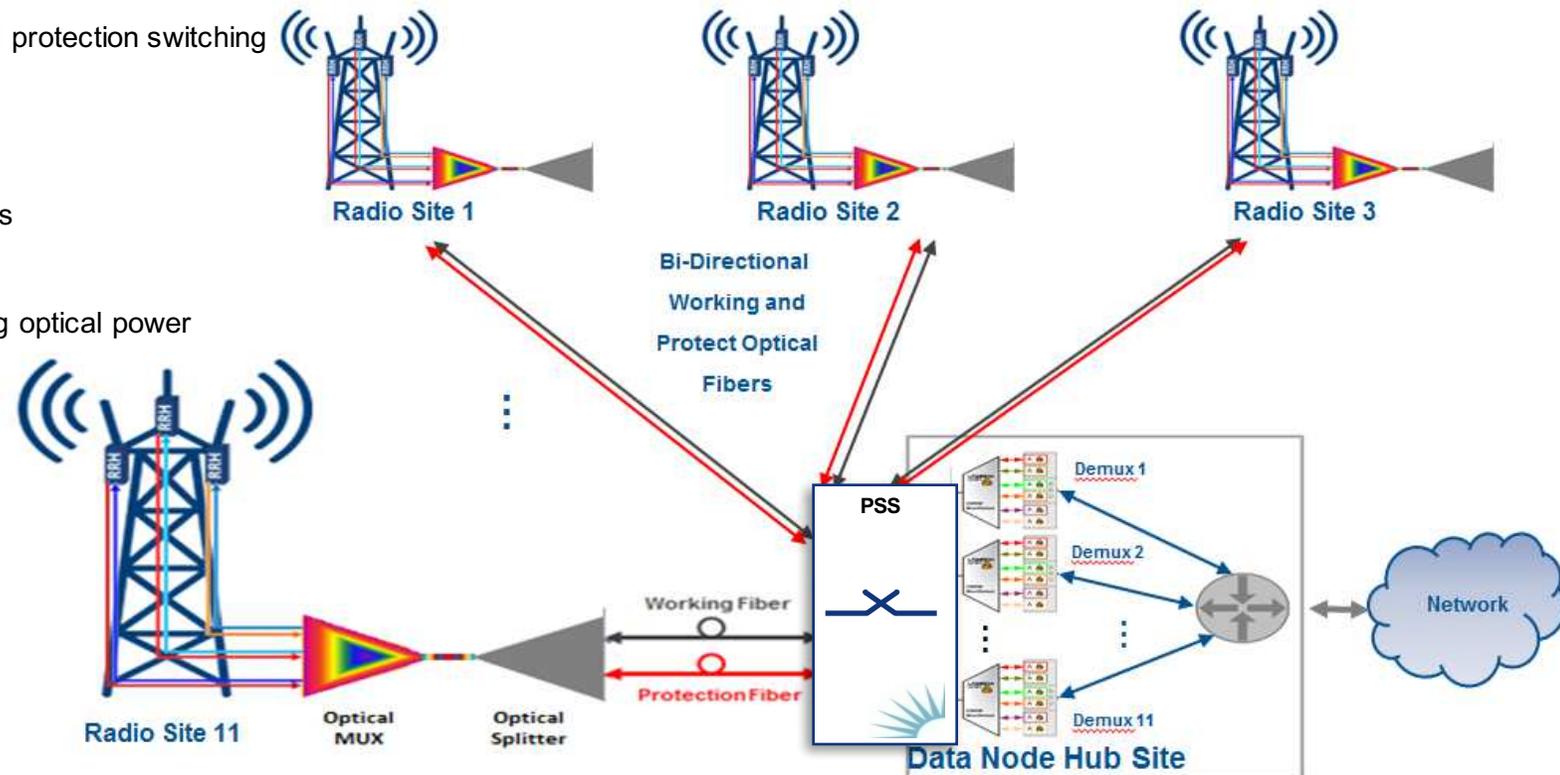
4G Mobile Network Application

- CPRI Fronthaul to increase density, improve coverage and lower cost
- Hub and Spoke Network with 11 Sites
- All fibers carry bi-directional DWDM traffic
- Optical muxes and splitters located in the radio sites
- Series 6000 Lite 24x12 Polatis Switch and optical demuxes located in Hub site
- Polatis switch is used for provisioning and 1+1 automated protection switching

Polatis Automated 1+1 Protection Switching

- Uses asymmetric 24x12 switches with APS software
- Can scale to virtually any size by stacking optical switches
- Fully automated protection switching in <30ms
- Optical switch detects failures at central hub by monitoring optical power

Series 6000n 1RU Protection Services Switch (PSS)

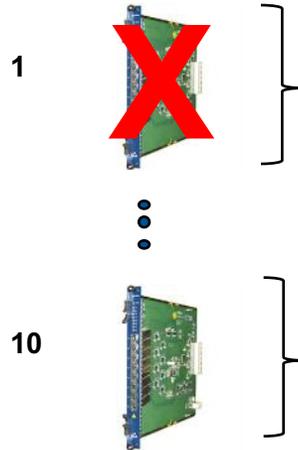


Telecom Protection Switching (FttX PON Application)

Active Optical Line Terminal (OLT)



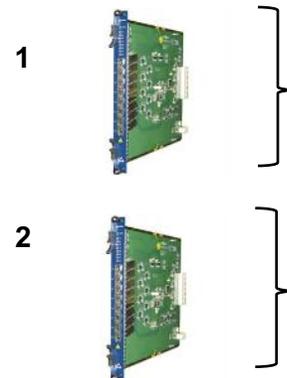
Active Line Cards



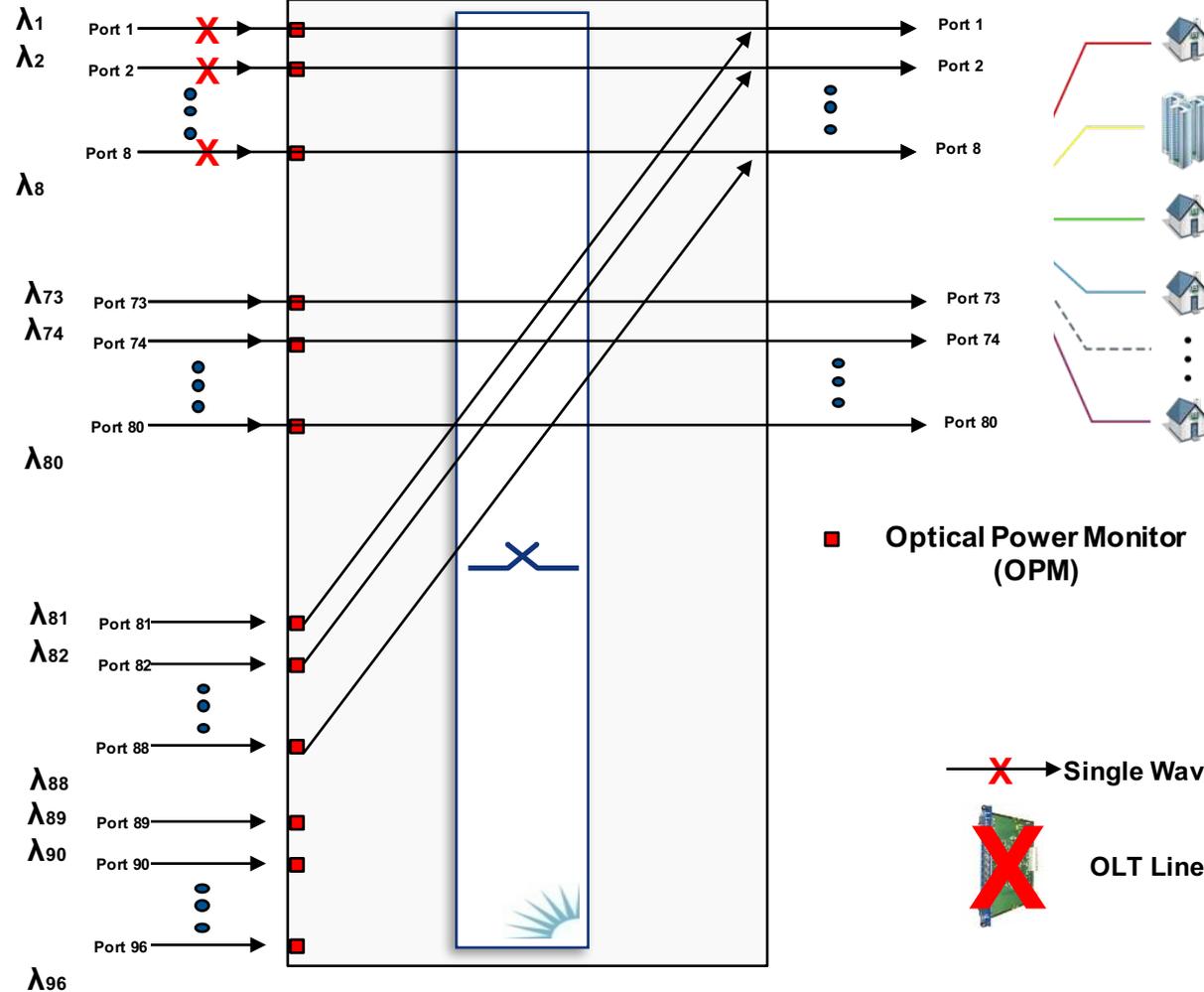
Stand-by Optical Line Terminal (OLT)



Stand-by Line Cards



96 x 80 Matrix with Input OPMs



Polatis Automated Protection Switching (APS)

Polatis APS functionality adapted from SDH/SONET requirements

- **SDH:** ITU-T G808.1 SERIES G: Transmission Systems
- **SONET:** GR-253-CORE Synchronous Optical Network Transport Systems
- Not all the SONET/SDH features are needed for all-optical switch APS
- Polatis APS adapted to trigger on optical power loss or degradation

Key Polatis APS Features

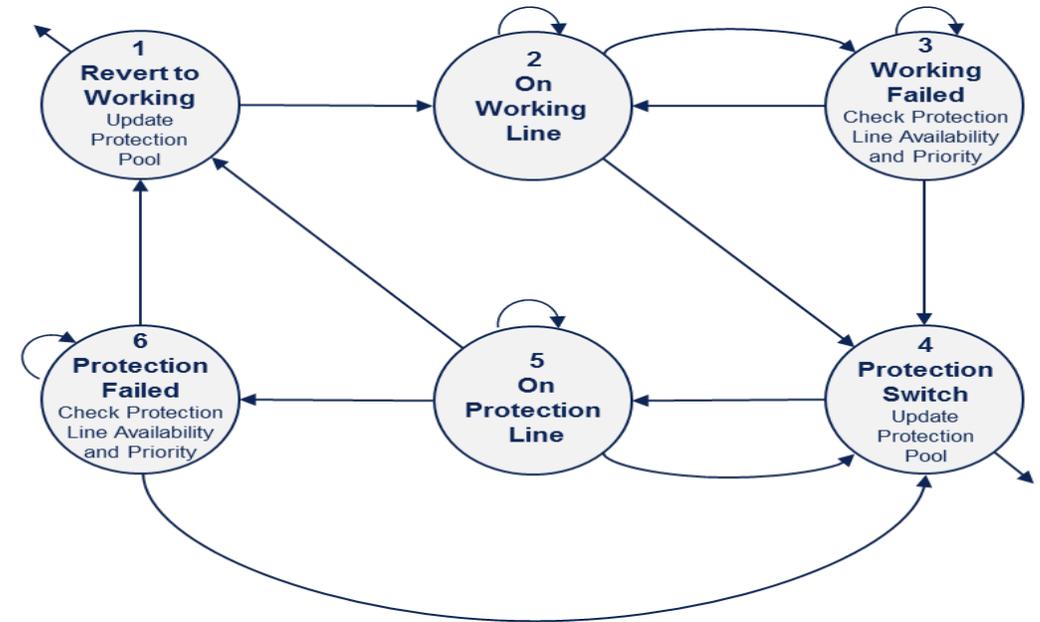
- Fully automatic or manual protection switching options
- Can be easily integrated into existing network control systems
- Similar set features to SONET/SDH APS
- User programmable automatic reversion option

Configurable for 1+1, 1:1, N:1, M:N protection switching

- Works for both single fiber unidirectional and bidirectional single fiber simplex systems

APS Can be deployed on any Polatis switch

- Polatis Protection Services Switch (PSS) is preconfigured with dedicated optical splitters and APS software to provide a drop-in automated 1+1 protection switching solution
- Regular symmetric NxN or MxN Polatis switches can be configured with APS software

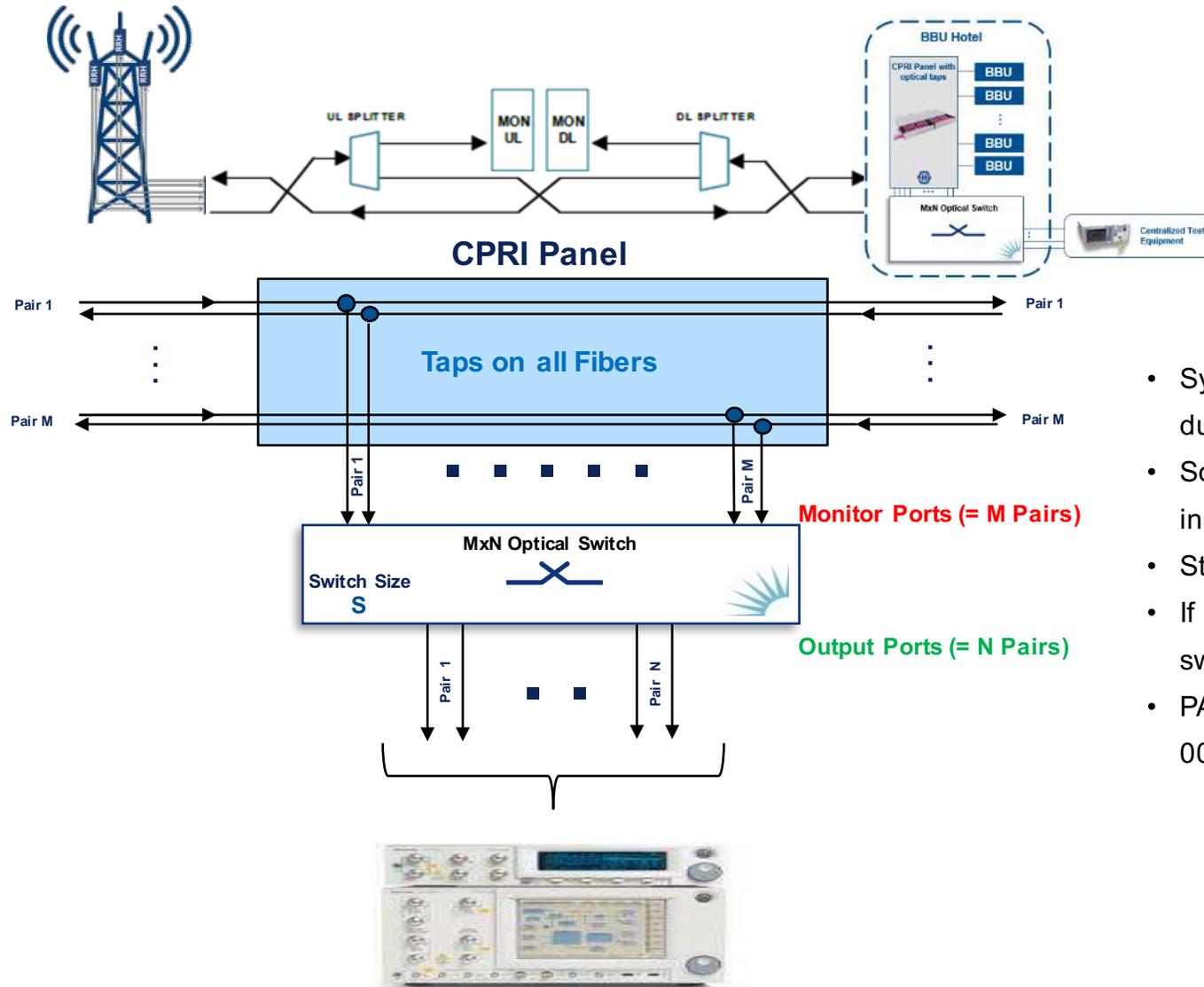


Polatis APS Operation



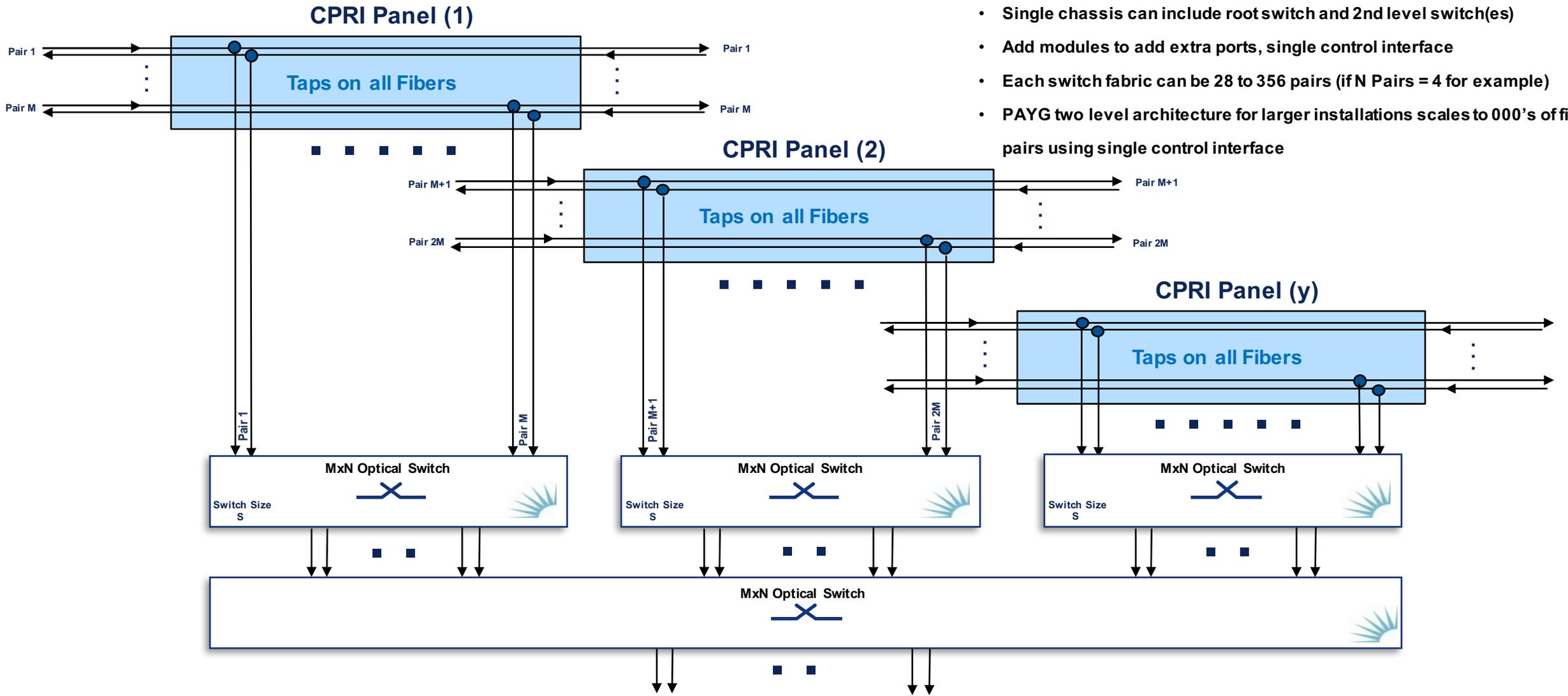
Series 6000 1RU Protection Services Switch (PSS)

Monitoring - C-RAN Application



- Symmetrical Switches used in 2 planes of MxN to connect duplex paths
- Solutions can be tailored across wide range of C-RAN installation sizes (**M pairs**)
- Standard switch sizes (**S**) of 32x32 to 360x360
- If **N Pairs** = 4 then **M Pairs** = 28 to 356 Pairs for single stage switch.
- PAYG two level architecture for larger installations scales to 000's of fibre pairs using single control interface

C-RAN Monitoring Scalability (two level architecture)



- Single chassis can include root switch and 2nd level switch(es)
- Add modules to add extra ports, single control interface
- Each switch fabric can be 28 to 356 pairs (if N Pairs = 4 for example)
- PAYG two level architecture for larger installations scales to 000's of fibre pairs using single control interface

C-RAN HUB, Customized H+S Solutions



- Polatis Optical Switches
- CPRI Converter
- LiSA ODR & Cable Management
- IANOS splice / tap modules & chassis
- MTP / LC Patch Cords

Thank You

HUBER+SUHNER Polatis