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AI OPEN LINE SYSTEM FOR OPTICAL

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3C-LINK OPTO CO,.LIMITED

OPEN LINE SYSTEMS

Reducing Vendor Lock-in and Speeding Innovation by

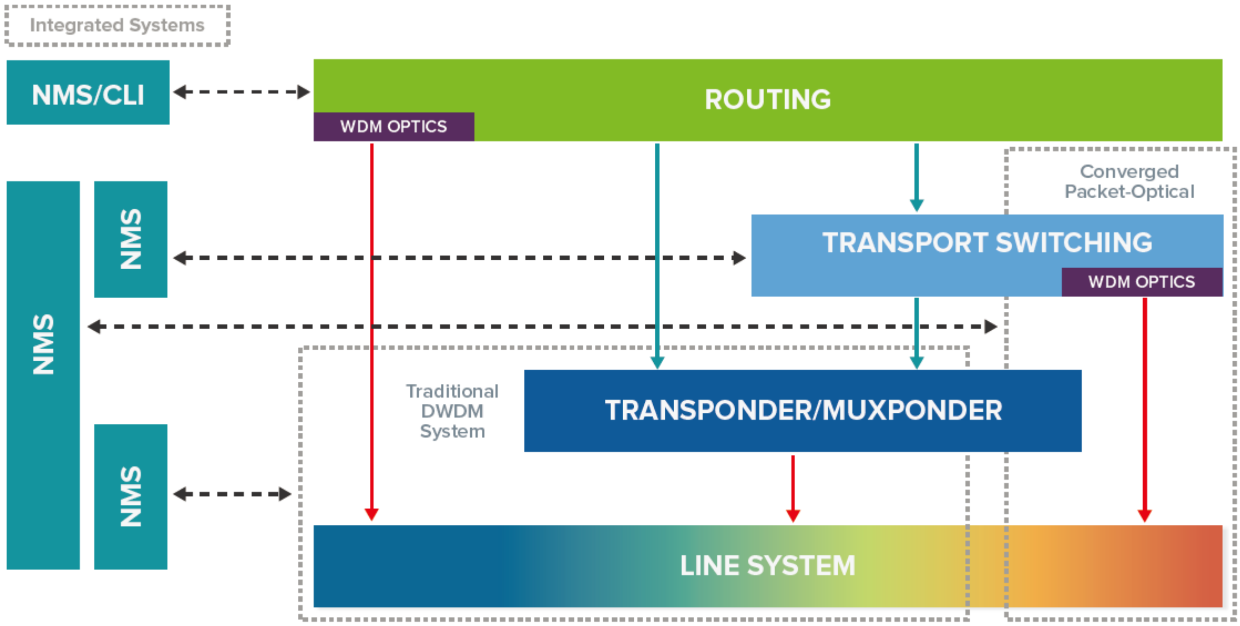
Disaggregating WDM Transport

> Taking a cue from the separation of hardware, operating systems, and applications software in IT, and more recently the separation of compute, storage, and networking in data centers, the trend toward disaggregation and openness is starting to impact the broader communications equipment market. This impact is already being felt with the shift to SDN, disaggregating the control plane from the forwarding plane, and the shift to NFV, disaggregating network hardware from software functions. In terms of WDM transport, disaggregation is coming in the form of open line systems.

WHAT IS AN OPEN LINE SYSTEM?

Traditional Integrated WDM Systems

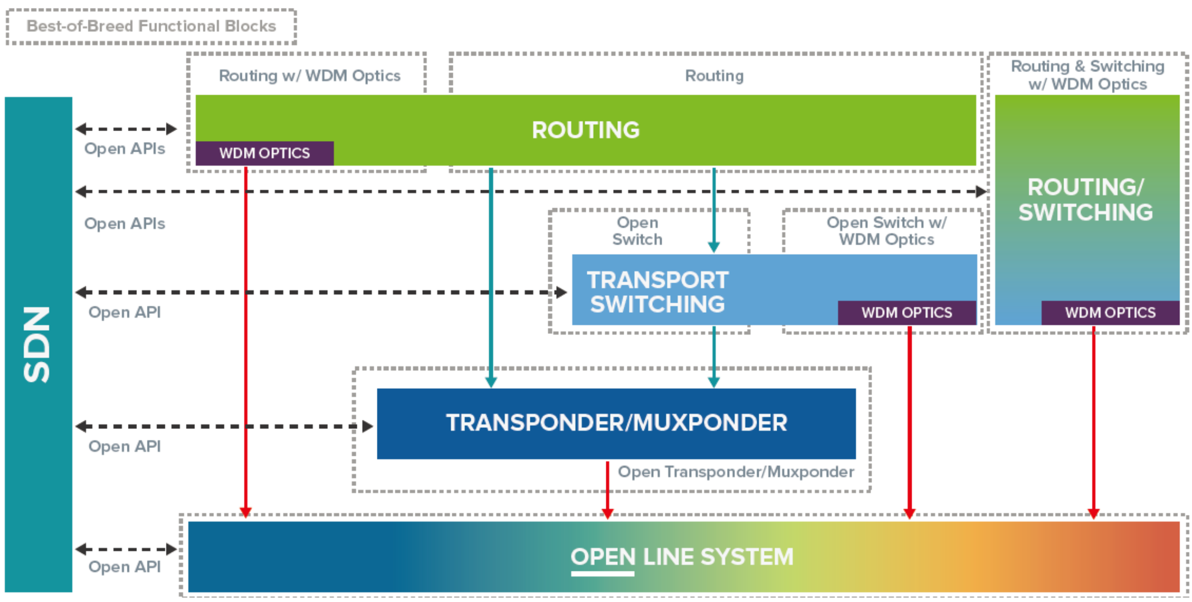
Traditional networks, as shown in Figure 1, typically consist of an integrated WDM system that includes transponders/muxponders and the WDM line system. The WDM line system can consist of filters for multiplexing and demultiplexing the WDM channels, Wavelength Selective Switches (WSSs) for ROADM, amplifiers, and other functions such as power monitoring, OSC, and OTDR. The integrated WDM system is provided by a single vendor and managed by a proprietary network management system (NMS). Routing and transport switching are provided by dedicated platforms each with its own NMS, though more recently converged packet optical platforms have integrated transport switching together with the transponder/muxponder function and the WDM line system.



<PIC 1> Traditional CWDM/DWDM System

Open Line Systems

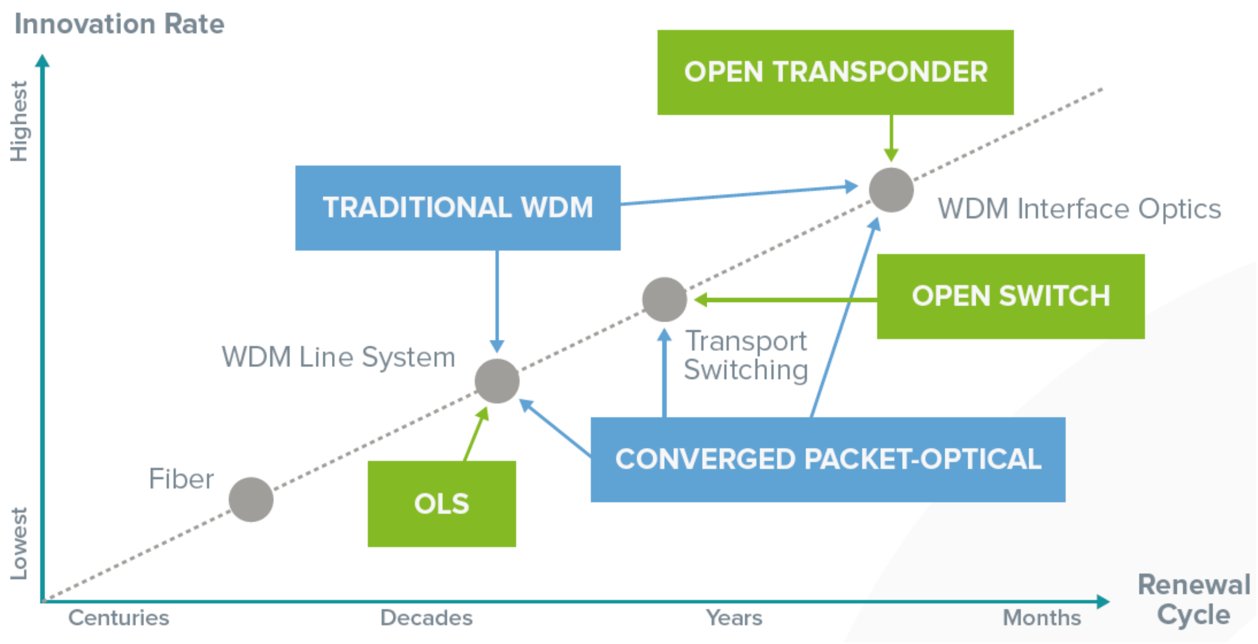
Disaggregation separates integrated systems into functional blocks, enabling the network operator to select best-in-class products for each functional block. In the context of WDM transport, this means disaggregating a traditional integrated WDM system into a separate open line system (OLS) and a separate transponder/muxponder platform. In terms of converged packet optical, this could mean two functional blocks, the OLS and transport switching with integrated WDM, or it could mean three functional blocks, OLS, transponder/muxponder, and switching. Additional possible functional block groupings, as shown in Pic2, include routing, routing with WDM interface optics, and switching/ routing with WDM interface optics.



<PIC 2> Open Line System

Disaggregation and Integration

Disaggregation and integration are not mutually exclusive. Within any of these functional blocks the goal is to reduce cost, footprint, and power consumption with tight integration, leveraging technologies such as photonic integration, including silicon photonics, and traditional silicon integration for the electronics. The grouping of functions within these functional blocks will depend on factors such as innovation, depreciation and renewal cycles, and capacity and scalability requirements.



<PIC 3> Open development direction

OPEN LINE SYSTEM BENEFITS

OLS benefits include reduced vendor lock-in resulting in competitive pricing and faster innovation, which in turn can drive lower CapEx and lower OpEx.

Reduced Vendor Lock-in

Reducing vendor lock-in is a key attraction of the OLS approach. Despite their many benefits, traditional integrated WDM solutions lock network operators into a single vendor’s solution for the lifespan of the network, which can be many years if not decades. Disaggregation and openness reduce vendor lock-in, reducing the barriers to introducing new vendors as and when needed, in accordance with the renewal cycle of each layer/functional block. New vendors with best-in-class technology for specific functional blocks can be introduced incrementally without the need for forklift upgrades, swapping out the entire optical network or building a parallel network. Reducing vendor lock-in has two primary benefits: competitive pricing and faster innovation.

Competitive Pricing

While the initial purchasing process for a traditional WDM network is typically highly competitive, once a vendor has been selected and the network has been deployed, the bargaining power of the network operator is severely diminished with the incumbent vendor in a much stronger position regarding future pricing negotiations. By reducing vendor lock-in and enabling other vendors to compete for incremental upgrades based on the renewal cycle of each functional block, competitive pricing pressures can be maintained throughout the lifecycle of the network. Furthermore, by lowering barriers to entry, innovative smaller vendors can also compete without having to be able to offer a complete solution including the NMS. An increased number of competitors will also have a positive impact on the ability of network operators to drive attractive pricing.

Faster Innovation

Innovation is the key driver for lower cost per bit, increased reach and capacity, and lower space and power in optical networking. With a traditional WDM solution, the network is constrained by the innovation capabilities of the single selected vendor and its suppliers. The OLS approach enables network operators to align the upgrade of each functional block to its renewal cycle while leveraging the innovation capabilities of the entire industry. As discussed previously, with reduced barriers to entry, new and smaller vendors will now be able to compete bringing new innovation capabilities to the market. Finally, with openness simplifying the integration of new technologies into the IT/OSS environment, new technologies can be adopted more quickly and with lower cost and less disruption.

Lower CapEx

The OLS approach can enable lower CapEx in a number of ways. The first is through competitive pricing throughout the network lifecycle as discussed previously. The second way is through innovation. Innovation is the primary driver of lower costs per bit in optical networking. Innovation is also the key driver for improved reach and capacity/spectral efficiency.

Extended reach reduces the cost of OEO regens and increased capacity/spectral efficiency extends the life of the network and reduces the cost of upgrading optical layer assets.

Lower OpEx

In addition to lower CapEx, the OLS approach can decrease operational costs. One of the benefits of faster innovation is reduced footprint and lower power consumption. In addition, openness, though not requiring disaggregation but often going hand-in-hand with it, can substantially reduce the cost of IT integration. Anecdotal reports suggest the potential cost reduction is up to 90%.

OPEN LINE SYSTEM USE CASES

Metro Point-to-point DCI

Point-to-point DCI over metro distances is an obvious starting point for OLS. Internet Content Providers (ICPs), with their focus on innovation and scaling bandwidth cost effectively, have been among the key proponents of the OLS approach. SDN adoption is also highest in data center environments. This use case requires compact products that meet data center requirements such as AC power, front-to-back airflow, and 600 mm depth. Given its point-to-point nature, a single vendor is likely to provide both ends of the OLS, while a different vendor, or vendors, can provide the traffic bearing functional blocks, also with data center form factors.

Metro Mesh

Unlike metro point-to-point DCI, this use case comprises rings and mesh topologies with a much larger number of nodes. As described previously, the added complexity of a metro mesh/ring topology with more than a few nodes is likely to require a transport SDN controller to provide a layer of abstraction with open APIs on the controller rather than the network element itself. Relative to long haul, with more limited reach requirements, interoperable FEC and ROADM degree interoperability become options in the metro, enabling multi-vendor scenarios both within functional blocks/layers as well as between functional blocks/layers.

Long Haul

Long haul differs from the metro use cases in terms of the optical performance required to support much longer distances. This requirement for performance cannot be met with lowest common denominator technology required for interoperability and requires vendor-specific innovations to achieve the maximum performance. In terms of WDM optical interface technology, these innovations include enhanced FEC, spectral shaping, impairment compensation, novel modulation, and increased baud rates.

WDM line system innovations that impact reach include the link control and amplification technology. For these reasons, long haul networks are likely to maintain a single vendor for the OLS layer, and while capable of supporting multiple vendors at the traffic bearing layers, equipment at both ends of each wavelength is likely to be from the same vendor. Like metro mesh, given the complexities of optimizing performance in a long haul network, a transport SDN controller is likely to be required for abstraction.

Submarine

The use of different vendors for the traffic bearing functional block, typically referred to as Submarine Line Termination Equipment (SLTE), and WDM line system, typically referred to as “wet plant,” is not new in submarine. However, what is new is that while in the past submarine networks were initially deployed with a single vendor and then evolved to multi-vendor systems with new vendors introduced for SLTE, new submarine systems are starting to be deployed with different vendors for the SLTE and wet plant from day one.

Wet plant and SLTE technology evolve at very different rates and the wet plant must be selected and deployed a long time before the SLTE. This approach lets the submarine cable operators select the best SLTE at the time it will be deployed rather than at the beginning of the wet plant deployment cycle.

OPEN LINE SYSTEMS VS. TRADITIONAL INTEGRATED APPROACHES

While the OLS approach offers many potential advantages, traditional integrated approaches including converged packet optical also have advantages.

	Open Line System Approach	Traditional Integrated Approaches
Pricing Competition	• Reduced vendor lock-in = competitive pricing throughout the network lifecycle • Lower barriers to entry = more competitors	• Intense pricing competition at the beginning of the network lifecycle
Innovation Speed	• Reduced vendor lock-in = industry-wide innovation • Better align upgrades to technology renewal cycles • Lower barriers = innovative new entrants	• Best approach for innovations that require tight coupling between line system and interface optics
Reach/Capacity	• Innovation is the primary driver for reach/ capacity • Ability to select best-in-class for each functional block	• More accurate planning • Possibility to tune performance across line system and interface optics
Operational Costs	• Innovation is the primary driver for space/power	• Simplified OSS integration in non-SDN environments • Guaranteed interoperability • Simplified troubleshooting/support • Fewer NEs to install, manage, maintain • Fewer shelves = reduced space/power
High Availability	• Fewer complex failure scenarios relative to more complex chassis-based solutions	• Guaranteed interoperability • Simplified troubleshooting

TABLE 1 – OLS Advantages vs. Advantages of Integrated Approaches Pricing Competition

Pricing Competition

The reduced vendor lock-in of the OLS approach enables competitive pricing throughout the network lifecycle while reduced barriers to entry may enable more competitors. This compares to traditional approaches, which benefit from intense price competition when the optical vendor is first selected but with more muted price competition thereafter.

Innovation Speed

The OLS approach enables network operators to leverage the innovation capabilities of the entire industry and fully benefit from the innovation rate of each functional block/layer through reduced vendor lock-in. Open APIs also simplify the task of integrating new technologies, though this can also apply to traditional approaches that provide open APIs. One area where traditional integrated approaches may have an innovation advantage is where there needs to be a tight coupling between innovations at different layers. An example of this is where an innovative new modulation scheme in the WDM interface optics requires enhanced per channel power monitoring or optical link control algorithms in the WDM line system.

Reach/Capacity

Innovation is the primary long-term driver of improved reach/capacity. Advantages of the OLS approach include faster innovation and the ability to select best-in-class products for each functional block independently. The advantages of traditional integrated approaches include more accurate end-toend planning with both the WDM interface optics and WDM line system coming from the same vendor. However, this planning advantage could be neutralized with a single vendor OLS solution or with planning that integrates real-time optical performance measurement as is the case with 3C-LINK Aware™ Technology (see the 3C-LINK white paper Evolving the Awareness of Optical Networks for details). An additional advantage for integrated approaches is the possibility to fine-tune system parameters such as the launch power across both the WDM line system and WDM interface optics to optimize the end-to-end performance.

Operational Costs

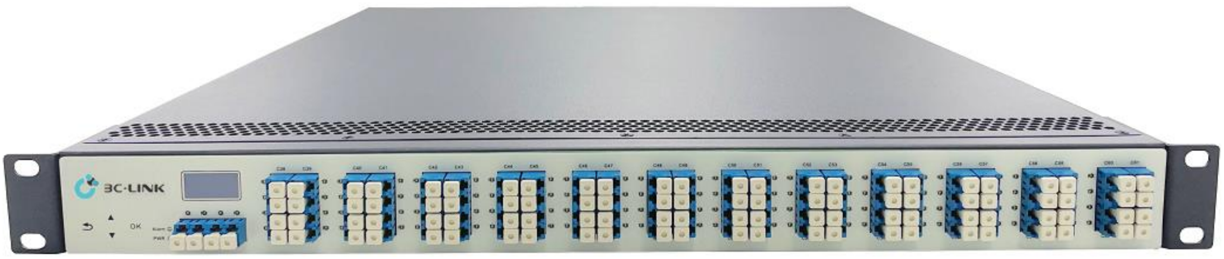
The faster innovation of the OLS approach is likely to give it an advantage in terms of space and power relative to integrated approaches. Integrated approaches on the other hand will have operational cost advantages in terms of guaranteed interoperability and simplified troubleshooting and support with a single vendor to hold accountable for any problems. Both the OLS approach and integrated systems with SDN support can reduce the cost of IT/OSS integration. However, in environments that have not yet adopted SDN, incorporating a single integrated platform will be easier and more cost-effective. Additional potential OpEx advantages for traditional integrated approaches include fewer NEs to install, manage, and maintain along with fewer shelves, which could potentially save space and power especially with converged packet optical platforms.

High Availability

One final topic to consider is network and service availability. Here integrated systems have advantages in terms of guaranteed interoperability and simplified troubleshooting/support as discussed previously. However, some proponents of the OLS approach make the argument that they have fewer complex failure modes relative to more complex chassis-based systems.

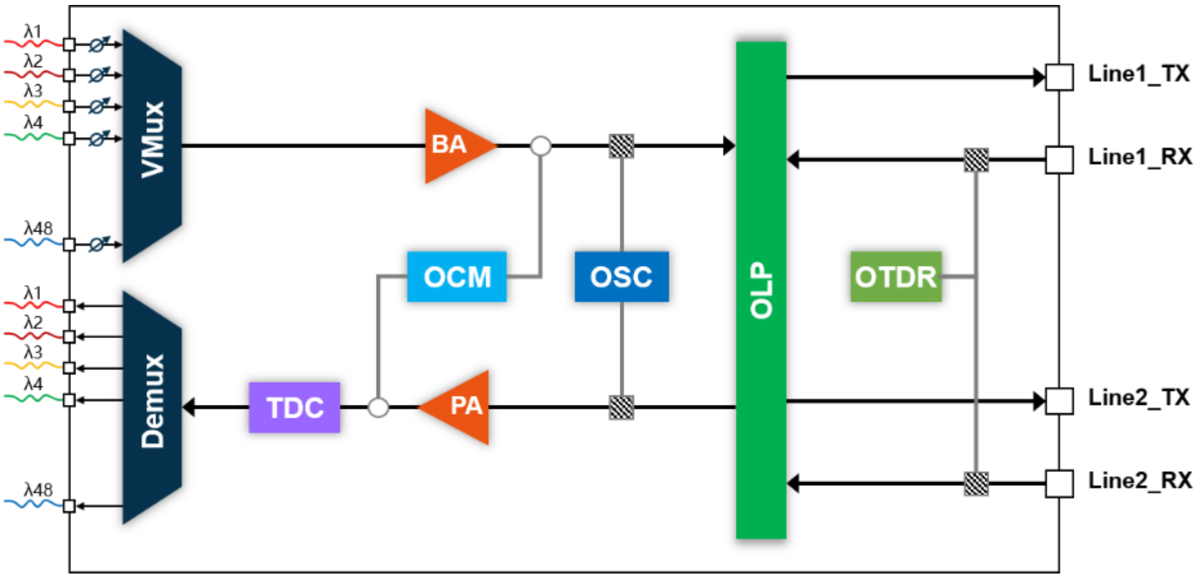
3C-LINK Open Line System: 3C-OTNS8600I-OLS

3C-OTNS8600I-OLS is an optical line system designed by 3C-LINK for open transport network architecture, aiming at treating the WDM line system at optical level as a whole and realizing decoupling from the electric layer, and it is a highly-integrated box product integrating the functions of VMux, Demux, OA, OTDR, OCM, OLP, OSC, and TDC into a whole; It can satisfy end-to-end management and rapid service sending, and combine with service protection, optical cable monitoring, channel performance monitoring and other functions to realize transparent service transmission and convenient operation and maintenance; it aims to build an ultra-wide and non-obstructive, flexible and efficient, intelligent and open DCI network for customers.



<PIC 4> 3C-ONTS8600I-OLS

Functional structure



<PIC 5> 3C-ONTS8600I-OLS Functional structure

Product features

☆ Standard 19" 1U box type, highly integrated with VMux, Demux, OA(BA/PA), OTDR, OCM, OLP, OSC, TDC functions.

☆ Suitable for C-band 48-wave (100GHz) DWDM system.

☆ Supports real-time high-precision monitoring of optical power for each group of DWDM channels and line-side optical power, and provides LED status indication on the device panel.

☆ Supports NRZ (1-32G), PAM4 (40G/100G), Coherent (QPSK/8QAM/16QAM) and other types of optical signal access.

☆ Supports pre-equalization of optical power for each channel at the transmitter.

☆ Supports transmitter booster amplification and receiver pre-amplification.

☆ Supports OSC in-band optical monitoring channel, fiber connection can manage the equipment at the other end.

☆ Supports ±1400ps dispersion compensation dynamic adjustment (optional configuration).

☆ Supports optical line 1+1 or optical multiplexing segment 1+1 protection, physical switching time <15ms (optional configuration).

☆ Supports fiber distance measurement and fault monitoring and location (optional configuration).

☆ Supports 100G PAM4 DWDM system auto-tuning and testing.

☆ Supports Web GUI, B/S and other management modes, and provide open SNMP interface.

☆ Supports front panel LCD screen visualization operation and maintenance.

☆ Supports dual power supply configuration, adopts Load Share mode 1+1 hot backup, supports AC, DC, high-voltage DC power supply options.

Product specifications

FUNCTION	DESCRIPTION	REMARK
EQUIPMENT SIZE	1U: 44 mm (H) x 440 mm (W) x 600 mm (D)	
INSTALLATION METHOD	19" Cabinet (800mm depth or more)	
CENTER FREQUENCY	191.40~196.10 THz (100GHz interval)	
NUMBER OF OPTICAL CHANNELS	48 channels	
SUPPORTED MODULATION CODE TYPE (DWDM OPTICAL SIGNALS)	NRZ(1~32G) PAM4(40G/100G) QPSK(100G/200G), 8QAM(200G/300G),16QAM (200G/400G)	
OPTICAL POWER MONITORING FUNCTION	Real-time monitoring of optical power for each group of DWDM channels, lineside optical power	
SERVICE PROTECTION FUNCTION	Optical line 1+1 protection (OLP) Optical multiplexing section 1+1 protection (OMSP) Physical switching time <15ms	optional configuration
FIBER CABLE MONITORING FUNCTION	Real-time monitoring of distance, loss and fault location in transmission fibers	optional configuration
DISPERSION COMPENSATION ADJUSTMENT	Support ±1400ps dispersion compensation dynamic adjustment	optional configuration

LINK POWER BUDGET	25G NRZ DWDM：28dB 100G PAM4 DWDM：23dB 100G QPSK DWDM：39dB 200G QPSK DWDM：37dB 200G 8QAM DWDM：34dB 200G 16QAM DWDM：32dB 400G 16QAM DWDM：30dB
AUTOTUNING FUNCTION	Support 100G PAM4 DWDM system auto-tuning test
MANAGEMENT PORTS	2*10/100/1000M Adaptive RJ45 network ports 1 micro-USB serial port
FRONT PANEL PORTS	2 Groups of line ports: 4*LC/UPC (Unprotected configuration only 1 group) 48 Groups of DWDM optical channel ports: 96* LC/UPC
INDICATOR LIGHT	Alarm and power status indicators 2 Groups of line port TX, RX indicators (Unprotected configuration only 1 group) 48 Groups DWDM optical channel port TX, RX indicators
POWER SUPPLY	Dual power supply 1+1 hot backup, hot-swappable
POWER SUPPLY METHOD	AC: 100 V AC to 130 V AC (50/60 Hz), 200 V AC to 240 V AC (50/60 Hz) Maximum voltage range: 90 V AC to 264 V AC (47 Hz to 63 Hz) High Voltage DC: 192 V HVDC to 288 V HVDC

	DC: -40 V DC to -72 V DC
MANAGEMENT STYLE	Support OSC in-band management channel Support Web GUI, SNMP, B/S and other management methods Provide open SNMP interface
OPERATION AND MAINTENANCE CHARACTERISTICS	Front panel LCD displays O&M information
HEAT DISSIPATION	2 hot-swappable fan units
POWER CONSUMPTION	<150W (Typical)
OPERATING TEMPERATURE RANGE	-5℃～55℃(Typical)
OPERATING HUMIDITY RANGE	5~85% non-condensing

Ordering information

Function	**Product Model**								
	3C-OLS100	3C-OLS101	3C-OLS111	3C-OLS200	3C-OLS201	3C-OLS211	3C-OLS300	3C-OLS301	3C-OLS311
48CH Mux/Demux	√	√	√	√	√	√	√	√	√
48CH real-time optical power monitoring	√	√	√	√	√	√	√	√	√

48CH transmitter power pre-equalization	√	√	√	√	√	√	√	√	√
Real-time line-side optical power monitoring	√	√	√	√	√	√	√	√	√
Transmit-side booster amplification and receive-side pre-amplification	√	√	√	√	√	√	√	√	√
OSC in-band network management channel	√	√	√	√	√	√	√	√	√
OLP 1+1 protection				√	√	√			
OMSP 1+1 protection							√	√	√
Dispersion compensation dynamic adjustment			√			√			√
Real-time monitoring of fiber optic cable		√	√		√	√		√	√

IP+ OLS Solutions

ABOUT 3C-LINK

3C-LINK is an fiber communication products leader in the provision of fiber Solutions, and is committed to becoming the most trusted partner of its customers in their quest for business innovation and digital transformation. We offer a full portfolio High speed networking, 5G, OTNS system, CWDM/DWDM System, FTTX Active and passive solutions. and provide a comprehensive one-stop FTTX services

3C-LINK develops innovative and purpose-built networking solutions for a fast-changing and cloud-enabled business world. The 3C-LINK portfolio of WDM-enabled, edge-to-core transport solutions enables network operators to reduce operational complexity, improve utilization of multi-layer network resources, and create new revenue-generating services optimized for the evolving demands of business and consumer applications, including video, hyperscale cloud, IoT, and mobile broadband.