

## Application Note

# Right-sizing your ROADM network



### Application Benefits

- Flexible platform for optimal small ROADM site deployment and expansion to large sites
- Efficient mix of active and passive blades for optimal economics
- Add L-band wavelengths, forward RAMAN amplification and OTDR fiber monitoring when needed, without downtime

### Functional Elements

#### 1FINITY™ L-Series

- ROADM blades
- Add/Drop blades
- Expansion blades
- Amplifier blades

#### Virtuora® Cloud

- Network Controller
- Planning & Design
- WDM Control
- Network Management

More, more, and still more to come: the forward march of video-on-demand, 5G, edge computing, fiber to the home and other technologies put an ever-increasing load on the optical transport network.

As bandwidth requirements continue to explode while revenues stay flat, the optical cost per bit needs to fall. But, equipment-based cost savings are becoming more incremental. Right-sizing your network in terms of functionality and capacity is crucial to avoiding over-engineering and keeping costs on budget. Yet at the same time, the ROADM platform must be modular and agile so that it can easily expand with market demand and evolve with upcoming technologies.

### Save where it counts most

Small ROADMs – up to 4 degrees, usually ring or spur sites in metro and regional networks – represent approximately 80% of sites deployed. A Fujitsu study of nearly 1,000 one- and two-degree sites over a seven year period found that less than 1% of these sites ultimately grew to be over 4 degrees. Hence, substantial savings can be realized by economizing on such sites in a network deployment or upgrade. The 1FINITY platform offers several choices to right-size small sites, with seamless options to extend functionality, grow up to 8 degrees, and increase port count as needed.

### Presenting the 1FINITY L-Series

The L-Series ROADM platform leverages disaggregated hardware components and reaggregates their functionality through software. The open architecture is built on modular blades, which delivers flexibility and scalability, providing a pay-as-you grow approach and an innovative technology design that can support colorless, directionless, contentionless, and gridless (CDC-G) ROADM

functionality. The platform includes four categories of blades:

- ROADM blades, which are the heart of the system and incorporate the WSS (wavelength selective switch);
- Add/Drop blades, which provide ports for local add/drop traffic;
- Expansion blades, which increase the number of degrees or port count;
- Amplifier blades, for signal amplification.

Refer to table 1 for a description of each 1FINITY L-Series blade.

### Building an Optimal ROADM Network

Spur, ring, and hub sites have different capacity and functionality requirements. Different site-specific blade combinations are recommended for an optimal deployment that maintains flexibility for future upgrades. Figure 1 presents a decision tree that steps you through that blade selection process.

#### Spur sites

Spur sites only require one degree, hence a single, colorless ROADM-on-a-blade (RoB) is a highly cost-effective solution. The L100 RoB provides 9 ports (see figure 1, configuration #1) while the L130 CDC RoB provides 32 ports (configuration #4). Scaling up the port count and the number of degrees is easily achieved by adding the appropriate add/drop or expansion blades.

#### Unmanned remote sites

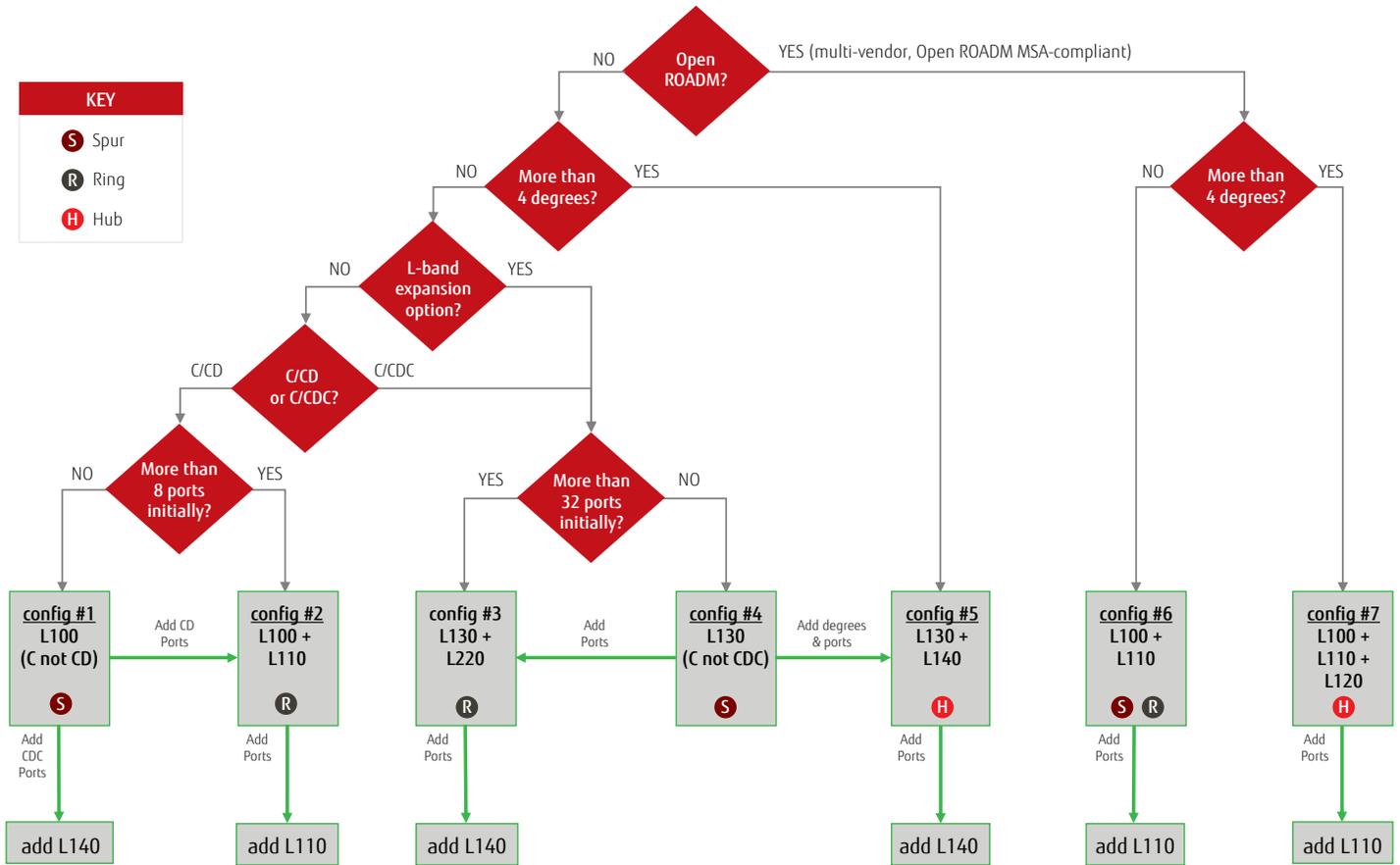
Unmanned cabinets have power and thermal limitations. Because the L220 is a purely passive blade that requires no power and does not generate any thermal load, it is ideally suited to accompany the L130 RoB for unmanned cabinets and other sites up to 4 degrees where heat dissipation is a concern (configuration #3).

# Flexible configurations with 1FINITY

Table 1: 1FINITY L-Series blade overview

		ROADM blades	Add/Drop blades	Expansion blades	Amplifier blades	
C/CD C-band		<b>L100</b> 9-port, CD WSS ROADM-on-a-blade	<b>L110</b> 4-degree, 32-port, CD Add/Drop	<b>L120</b> 8-degree, CD 12x9 WSS Expansion	<b>L200</b> In-line C-band Amplifier	<b>L160</b> Backward Raman C+L Amplifier
		<b>L130</b> 32-port, CDC WSS ROADM-on-a-blade	<b>L140</b> 8-degree, 24-port CDC Add/Drop & 8x24 WSS Expansion <i>(future release)</i>			
C/CDC C+L band				<b>L220</b> Passive 4-degree, 28-port CDC Add/Drop		<b>Forward Raman Amplifier</b> <i>(future release)</i>

Figure 1: 1FINITY L-Series blade selection and site expansion guide



# Functionality that matches your site requirements

## Ring sites

For multi-degree sites, each degree is served by a dedicated ROADM-on-a-blade. Add/drop blades are pooled across degrees and used for port expansion. A typical ring site, up to 4 degrees, would be well served by configuration #2 (L100 CD RoB + L110 CD Add/Drop), which supports up to 39 ports. A maximum of 96 ports in most configurations (and up to 144 for 2-degree sites) is possible by deploying additional L110 blades.

In a situation where the ring site needs (or is expected to need) many add/drops, the L130 CDC RoB is preferred because of options to add more ports and degrees. In addition, the L130's related Add/Drop blades are directionless and contentionless. Directionless sites have the flexibility of re-routing traffic in the opposite direction in the event of a fiber cut, enabling service providers to offer a higher quality service guarantee. With contentionless functionality: adding/dropping, and rerouting express (or bypass) wavelengths requires less spectrum planning and grooming. For less heavily loaded sites, this functionality is a nice-to-have, not necessarily a must-have. Foregoing this functionality means that more careful network engineering is needed. However, it leads to significant savings.

At busy ring sites with many add/drops, the L130 RoB + L220 CDC Add/Drop (configuration #3) is recommended. The add/drop port count is 28 and this increases to a maximum of 144 with additional L140 CDC Add/Drop blades.

## Hub sites

Hub sites tend to be busier, both in terms of traffic (express and local add/drop) and the number of degrees. For hub sites the L130 CDC RoB + L140 CDC Add/Drop (configuration #5) is recommended. Being contentionless, these blades offer greater flexibility in case of wavelength rerouting due to link or node failure. This configuration supports 8 degrees and 144 ports, and with additional L140 blades, a maximum of 600 ports is possible in a single node.

Network management can be facilitated via the optional 1FINITY C200 series Communications Integrator blades, which provide a single management interface for up to 22 L-Series blades in a hub node.

## Customized for Open ROADM networks

The Open ROADM Multi-Source Agreement (MSA) brought together multiple vendors and network operators to create a framework and standards for multi-vendor, interoperable ROADM networks. This promotes freedom of choice for products and vendors and allows service providers to build best-of-breed networks with assurance. The MSA includes:

- API specifications for management and control
- CD-ROADM specification for how the components interact
- Multi-wave specification for transponders, including mapping and error control

For network operators building MSA-compliant ROADM networks, the L100 CD RoB + L110 CD Add/Drop (configuration #6) is recommended for ring or spur sites and the L100 CD RoB + L110 CD Add/Drop + L120 CD Expansion (configuration #7) is recommended for hub sites.

Deploying an Open ROADM network requires timely communication and coordination with vendors, expert project management, interoperability testing, tracking bug fixes, and more. The Fujitsu Integration Services team can work as a trusted partner to help service providers fully realize the benefits of open, multi-vendor networks.

## Improving span reach with amplification

Purpose-built for use in ROADM networks with other 1FINITY L-series blades, the compact L200 In-line Amplifier supports bi-directional amplification, extending reach and cascaded configurations up to six spans.

The L160 Backward Raman Amplifier is designed for high optical signal-to-noise ratio (OSNR) performance and the challenges of long-reach optical network span. This compact blade supports C+L band amplification and is operationally integrated with the L100 and L130 RoBs as well as the L200 ILA.

## Ready for the future: A graceful evolution

ROADM systems have a long operational lifespan, so it is important to future-proof your investment. The L130 CDC RoB blade features built-in ports for adding functionality that can be activated as needed:

- L-band capacity expansion  
Usage of the L-band (from 1565 to 1625 nm) offers a way to double the capacity once the C-band is exhausted.
- Forward Raman amplification  
Forward Raman works in conjunction with backward Raman to extend the reach of an optical signal.
- External OTDR (optical time-domain reflectometer)  
A dedicated OTDR may be necessary for important circuits, or sites that are difficult to gain access to. Conversely, at many other sites, OTDR usage is infrequent. A ROADM with integrated OTDR across all ports may be an expensive convenience. Hence the option to plug in an external OTDR when needed can result in cost savings.

A maintenance window is not required to activate the new functionality. These blades permit in-service upgrades, with no downtime and no impact to customer SLAs.

These future-ready capabilities, together with its disaggregated modular design, make the 1FINITY L-Series platform a safe and economical choice.

# Innovative, open and automated

## Interoperability

The widely deployed FLASHWAVE® 9500 integrates ROADM, OTN, Ethernet, and TDM technologies onto a single platform. Full interoperability between the 1FINITY L-Series platform and the FLASHWAVE® 9500 is assured. Plus, the same network management software – the Virtuora Cloud – is used to manage both platforms.

## Cloud management

The Virtuora Cloud is a modular software suite for managing a virtualized, programmable network. Built on an open-source platform, the suite encompasses software-defined network (SDN) control, Network Functions Virtualization (NFV) orchestration and infrastructure management:

- Virtuora NC is the foundation for component applications and southbound interfaces. It controls network elements reliably and in real-time via a centralized control plane architecture that delivers unified operations and resource orchestration;
- Virtuora PD optimizes network planning, design, deployment, and testing functions. This includes a sandbox design environment, synchronization with the live network, capacity planning, and alien wavelength support
- Virtuora WDM Control automates services such as wavelength design and activation, path computation including routing and assignment, and transponder/muxponder management;
- Virtuora NM provides a unified fabric for optimal service delivery and network performance, including element, fault and performance management as well as network analytics.

## Summary

The 1FINITY L-Series platform offers multiple configurations and migration paths to right-size the spur, ring and hub sites in your ROADM network. Its modular, pay-as-you-grow architecture and its economical mix of active and passive blades allow for efficient optimal designs while remaining flexible for functionality enhancements and capacity expansion. With Fujitsu, you have the freedom to choose an interoperable ROADM solution that meets your needs today while future-proofing your investment as your network evolves.

## Acronyms

Acronym	Definition
C	Colorless
CD	Colorless Directionless
CDC	Colorless Directionless Contentionless
CDC-G	Colorless Directionless Contentionless Gridless
ILA	In-line Amplifier
OSNR	Optical Signal-to-Noise Ratio
ROADM	Reconfigurable Optical Add/Drop Multiplexer
RoB	ROADM-on-a-Blade
WDM	Wavelength Division Multiplexing
WSS	Wavelength Selective Switch

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