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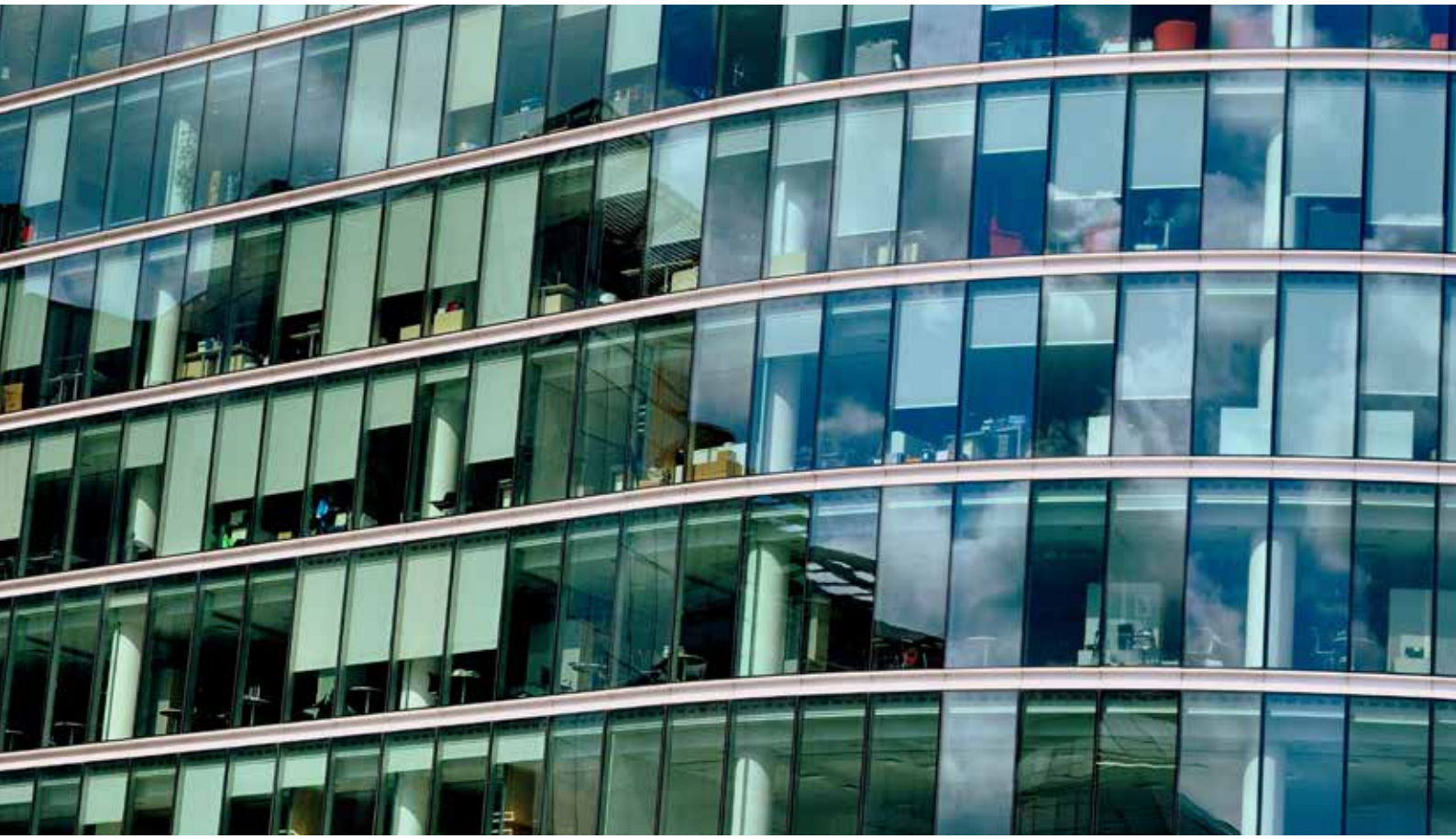

# A new view on wavelength services

Application note

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# Abstract

To stay ahead of the competition, service providers need to use SDN and NFV to turn their networks into agile services delivery platforms. These platforms will depend on high-bandwidth network interconnectivity provided by wavelength services, also known as Wave Services. But Wave Services present challenges for service providers because they require the use of complex optical transport networks and lack standard attributes.

This application note describes how the MEF LSO Layer 1 Connectivity Services (L1CS) project is working to advance Wave Services delivery. Initiated by Nokia, this project aims to abstract transport networking complexity to enable service providers to deliver standardized Wave Services and assure their performance.

# Introduction

Service providers are attempting to stay ahead of the competition by turning their networks into dynamic SDN- and NFV-based platforms that can deliver a wide variety of services, including new types of retail and wholesale services. They want these platforms to automate the network services lifecycle to support tasks ranging from end customer portal service activation and change to the automatic instantiation of virtualized compute, storage, and networking. Industry standardization in the areas of open network service data modeling, business process flows, interface profiles, and API definitions will play a critical role in supporting these platforms.

Today, the foundational network interconnectivity service is the transport service, also referred to as a wavelength service, or Wave Service. The Wave Service can be deployed on its own or used to underpin other services, such as Carrier Ethernet and IP VPN services. The significance of the Wave Service will grow as higher bandwidth and managed latency interconnectivity become more essential.

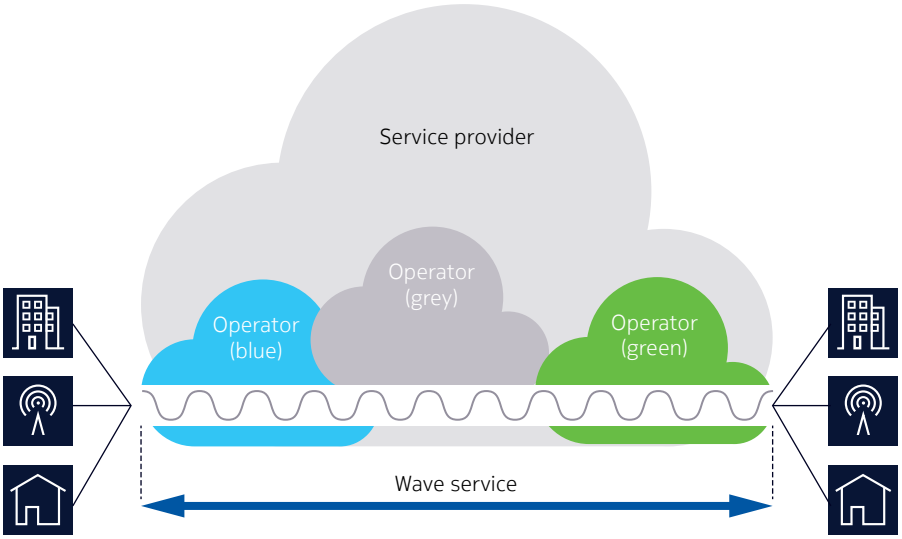
Wave Services are often realized through the deployment of OTN or DWDM networking equipment infrastructure. However, this underlying implementation complexity must be abstracted to support a more dynamic service delivery platform. This application note highlights the work being done by the Nokia-initiated MEF LSO Layer 1 Connectivity Services (L1CS) project to abstract transport networking complexity to facilitate the rapid delivery and assured performance of standardized Wave Services. These services are fundamental to supporting a more agile services delivery platform.

# A new framework for Wave Services

An underlying network of Wave Services is essential for interconnecting end users with services running on virtual compute and storage. Historically, Wave Services have been relatively slow to deploy and adapt to customer needs due to inflexible operational models and the complex physics involved in carrying data traffic over photonic DWDM wavelengths. The introduction of rate-adaptable super coherent wavelengths and CDC-F-based wavelength routing equipment has enabled optical networks to become much more efficient and agile. Optical networks are now ready to support a more dynamic SDN- and NFV-based services delivery platform.

The removal of barriers to on-demand Wave Services connectivity requires software based on standardization work relative to network resources and service data modeling, business process flows, interface profiles, and API definitions. This standardization work must address end-to-end logistics involved in supporting business interactions between the service provider and its partner network operators while also supporting end-to-end service assurance (Figure 1).

Figure 1: Wave Service deployment involving multiple network operators




The MEF L1CS project and its communications service provider (CSP) sponsors aim to create standard attributes that can be used to define Wave Services delivered over one service provider network or multiple interconnected networks. The result of the project will be an easily certified, standardized service framework. This framework will allow future projects to develop automated service ordering and configuration processes for Wave Services, including support for new managed low-latency Wave Services.

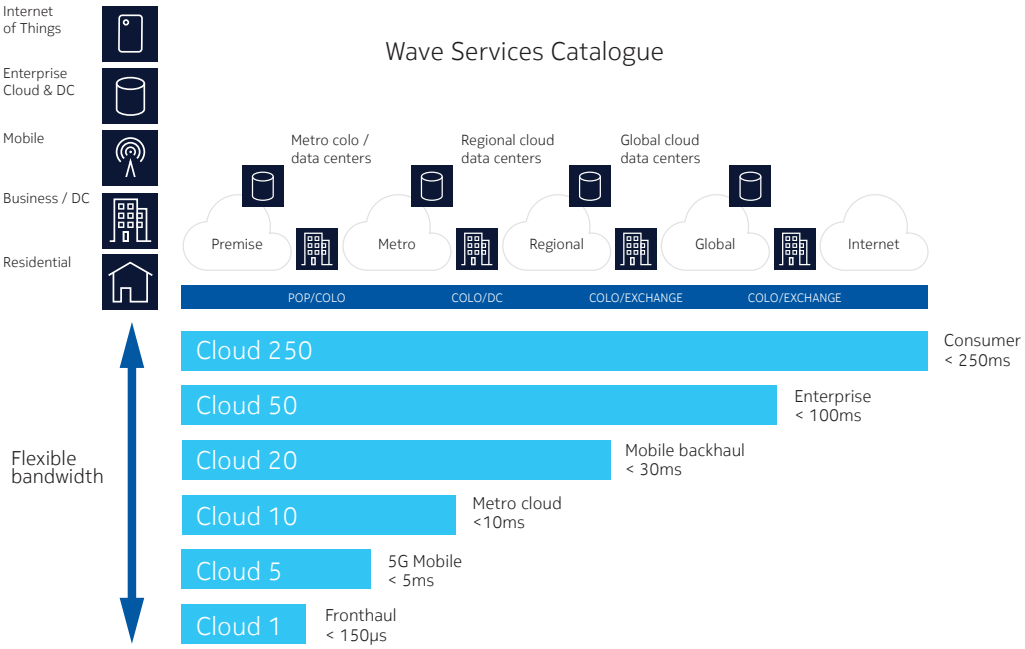
# Managing Wave Service latency

As demand for cloud services increases, service providers need more virtualized storage and compute to support them. To scale virtualized storage and compute to support new applications, they need higher bandwidth, managed latency, and connectivity to access and interconnect the virtualized resources.

In many cases, managing low-latency connectivity requires that underlying metro networks be designed with physical fiber-run topology and latency in mind. With a properly designed metro fiber topology and the right wavelength routing equipment, metro networks can support new low-latency services with service-level agreements (SLAs) as low as 150 microseconds with virtually no delay variation and high availability.

Figure 2 shows a Wave Services offer structured around a tiered-latency SLA and flexible bandwidth.

Figure 2: Potential network operator Wave Services catalogue



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# Wave Service applications

Wave Services can support a variety of applications, including:

- Enterprise data center interconnect (DCI) for site-to-site private clouds or site-to-colocation (COLO) hybrid clouds
- Internet content provider (ICP) regional and global web-scale DCI, as well as metro internet access bypass
- CSP in-territory regional and global interconnect, including out-of-territory interconnect
- Mobile CSP or mobile network operator (MNO) fronthaul, backhaul and Evolved Packet Core (EPC) interconnect
- Connecting data centers that support a wide range of Internet of Things (IoT) applications, including industry automation, transportation, surveillance, public safety, and healthcare centers

Wave Services can also provide the foundation for Carrier Ethernet or IP VPN services. Future lifecycle tools support will enable service providers to rapidly sell and activate Wave Services to support new, unforeseen services.

Carrier-neutral providers (CNPs) are expected to play a key role in network interconnection. CNPs may both consume and offer Wave Services between COLOs as they move to support mobile and cloud infrastructure and applications.

# MEF LSO automated Wave Service delivery

Although broadly available today, Wave Services have not been architected to support automated service delivery and deployment with networks based on SDN and NFV. Moreover, service providers use their own terminology to describe Wave Services, and there are no standardized service attribute definitions. All of this makes it difficult to:

- Compare service offerings
- Order services
- Instantiate service offerings
- Assure service offerings
- Certify service offerings
- Combine Wave Services with other services to create and automate the deployment of new, unforeseen services

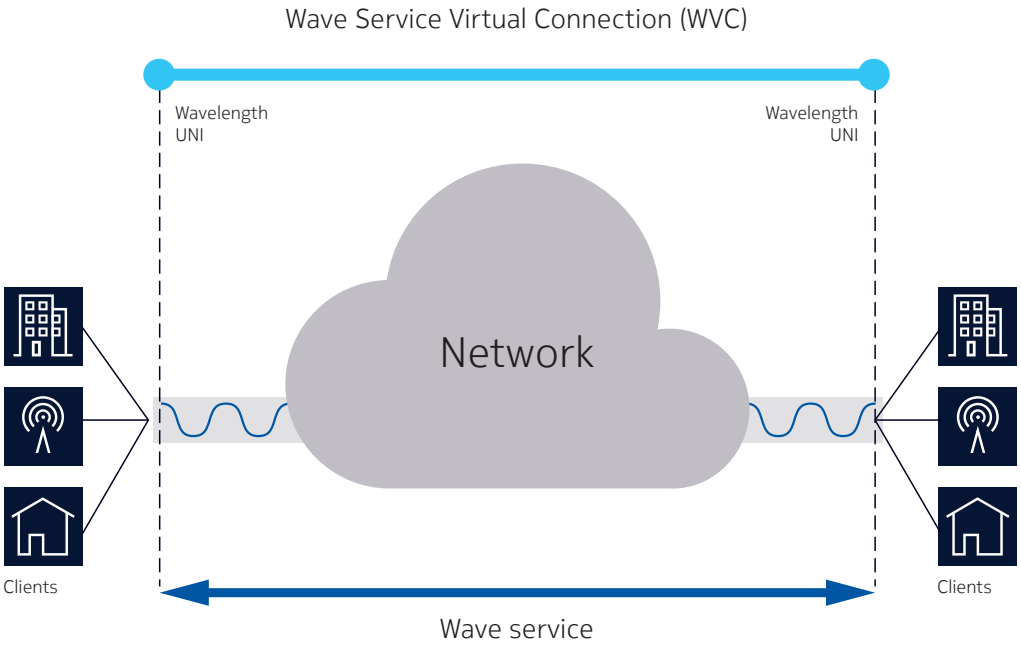
These tasks become more complicated when Wave Services span multiple service provider networks. Multi-provider deployments are currently achieved through cumbersome ad hoc agreements that take a long time to establish and are difficult to manage.

The MEF Lifecycle Service Orchestration (LSO) initiative aims to automate end-to-end service delivery to support a more agile, assured, and automatized service delivery platform. The MEF L1CS project seeks to use standardization to promote Wave Services interoperability and deployment worldwide. These efforts will enable all enterprises, CSPs, ICPs, and CNPs to orchestrate Wave Services for mobile, cloud, and industrial IoT applications.

## Wave Services preview

Wave Services use a model similar to that used for MEF-based Carrier Ethernet (MEF CE) services. As shown in Figure 3, this model uses a Wavelength Virtual Connection (WVC) to support Customer Edge (CE) point-to-point interconnect between a pair of Wavelength User–Network Interfaces (UNIs). Wave Services will scale from 1G to Nx100G and provide cost-effective cloud interconnect for private, public, and hybrid clouds. They will offer high-rate, high-performance service attributes such as low latency and high availability (e.g. 99.999% uptime) through optional equipment protection and diverse fiber routes.

Figure 3: Wave Service connectivity model




It is envisioned that a Wave Services SLA will support:

- Scalable bandwidth rates up to Nx100G for DCI
- Managed latency commitments for access, metro, and regional applications
- Ethernet and other protocols for the networking of compute and storage
- Flexible network protection options, including unprotected and dual-path access and end-to-end interconnect
- Monitoring and reporting relative to SLA attributes

Wave Services provide point-to-point connectivity and will include the following service types:

- W-Line, an end-to-end Wave Service that provides either a single- or dual-path service protection/availability option (comparable to the MEF CE E-Line service)
- W-Access, a Wave Service that provides either single- or dual-path access (comparable to the MEF CE E-Access service)
- W-Transit, a Wave Service that supports a network interconnect service (comparable to the MEF CE E-Transit service)

Table 1 shows the client interfaces that can be supported by the multi-protocol W-Line service.

Table 1: Foreseeable Wave Service client interfaces

| Type | Rates | Example applications |
|---|---|---|
| Fiber channel | FC100, FC200, FC400, FC800, FC1200 | SAN extension |
| Infiniband | IB SDR, IB DDR, IS QDR | HPC, grid computing |
| FICON | FICON, FICON Express, ISC3 | IBM mainframe interconnect |
| Ethernet | GigE, 10GigE, 40GigE, 100GigE | Enterprise, data centers |
| SONET/SDH | OC48/192/768; STM16/64/256 | Legacy interconnect |
| OTN | OYU1, OTU2, OTU3, OTU4 | Carrier's carrier |

To support assurance, Wave Services will likely be monitored using Maintenance Entity Group End Points (MEPs) and Maintenance Entity Group Intermediate Points (MIPs), which are analogous to Carrier Ethernet MEPs and MIPs:

- Wavelength MEP (W-MEP) is associated with service management at service end points.
- Wavelength MIP (W-MIP) is associated with intermediate management points.

Network OAM tools such as the following are also being considered:

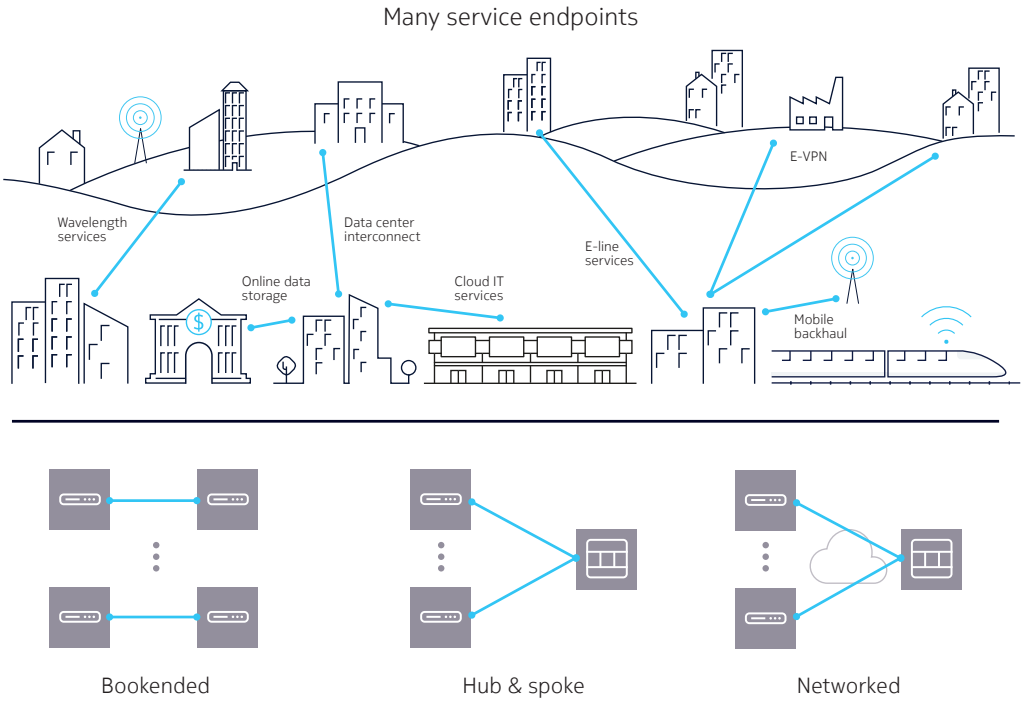
- Wave ping (W-Ping), a feature comparable to the Ethernet Connectivity Check Message (CCM) or IP Ping
- Wave network trace (W-Trace), a feature comparable to Ethernet Link Trace or IP Trace Route
- Wavelength network defragmentation (W-Defrag), a function for optimizing the wavelengths that support the Wave Service

# Wave Service network interface device

Service providers must be able to maintain end-customer SLAs based on end-to-end service parameters. This means separating their network domain from that of their end customer through a network demarcation device or network interface device (NID). This separation allows the service provider to test and monitor its network all the way to the customer's premises so that it can manage the network and ensure adherence to SLA performance requirements. To monitor and report on MEF-compliant Wave Services, service providers need new demarcation device capabilities that support SLA assurance, reporting, and rapid service activation and change in customer locations that have size and power constraints.

Rapid service activation is particularly important where Wave Services may need to support large numbers of customer endpoints. For example, enterprise branch/head office and mobile backhaul cell site/gateway deployments could include hundreds of "spoke" endpoints that converge to a few central "hub" endpoints. Deployment flexibility and adaptability are also important. Applications such as high-capacity enterprise internet access could initially involve relatively few endpoints (e.g. a connection between an enterprise site and a CNP site or interconnection exchange endpoint), but then grow as the Wave Service gains market traction. To efficiently support this service growth, a NID may have to evolve through bookended, hub-and-spoke, and networked service deployment topologies (Figure 4).

Figure 4: Wave Service NID deployments



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# Summary

Nokia understands that service standardization is essential for supporting a user-controlled, on-demand, SDN-orchestrated network services delivery platform. The Nokia-initiated MEF L1CS project will advance Wave Services delivery and allow these services to be quickly combined with other capabilities to support new offers.

The Nokia 1830 optical networking portfolio offers fully compliant support for MEF Carrier Ethernet services. It is ready to support MEF-compliant Wave Services once these services have been finalized by the MEF L1CS project. The Nokia 1830 portfolio includes products that address Wave Service and CE service demarcation at customer premises, Wave Service networking and reporting, and the metro network topology design required for new managed low-latency services.

For more information on our optical networking portfolio, visit https://networks.nokia.com/solutions/optical-networking.



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