



White Paper

Wavelength Services White Paper

Discussion of Wavelength Services and Mplify
February 2026

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1. Abstract

This white paper discusses the differences between Product Models for Wavelength Products. There are currently thought to be two distinct Wavelength Products, Wavelength - Capacity and Wavelength - Spectrum.

Wavelength - Capacity is defined within this White Paper as a Layer 1 service, terminated with OTN UNI or Ethernet LAN PHY UNI at a transponder or muxponder.

Wavelength - Spectrum is defined within this White Paper as a Layer 0 Optical Line System (OLS) service in the photonic domain where the client DWDM wavelength(s) are injected directly into the provider's OLS.

Both of these are commonly referred to as Wavelength Products within the industry but as discussed above have significantly different Product Attributes. This white paper will discuss each of these Products and highlight the differences between them.

2. Introduction

Mplify has defined the Service Attributes for a Wavelength - Capacity Service within MEF 63 and MEF 64. Work on Product Models within the CBC has defined Product Attributes for a Wavelength - Spectrum Product. There are significantly different attributes between these two Products. The purpose of this White Paper is to document the differences between Wavelength - Capacity and Wavelength - Spectrum Products and determine if both need to be specified within Mplify.

Wavelength - Capacity Products are currently supported by multiple Service Providers. The Wavelength - Capacity service transports Ethernet, Fibre Channel, or other protocols over an Optical Transport Network (OTN) infrastructure. While this is commonly referred to within the telecommunications industry as a Wavelength Product the entire wavelength may not be reserved for a single customer, and it may be shared by multiple products.

Wavelength - Spectrum Products are also currently supported by some Service Providers. These products reserve a portion of the DWDM spectrum for a single customer. The end customers can install any transport system that they want as long as it transmits and receives at the specified wavelength(s) within the allocated DWDM bandwidth.

3. Wavelength – Capacity Products

Wavelength – Capacity Product transports Ethernet, Fibre Channel, or other protocols over an Optical Transport Network (OTN) infrastructure. While this is commonly referred to within the telecommunications industry as a Wavelength Product the entire wavelength may not be reserved for a single customer, and it may be shared by multiple services.

MEF 63 defines the Subscriber Wavelength – Capacity Service Attributes for services provided to a Subscriber by the Service Provider using a Subscriber Layer 1 Virtual Connection (L1VC). MEF 64 defines Operator Layer Wavelength - Capacity Service Attributes for services provided to an L1 Service Provider or L1 Super Operator by an L1 Operator using an Operator L1VC. While these are Layer 1 products they are often referred to as Wavelength products.

3.1 Wavelength - Capacity Product UNI

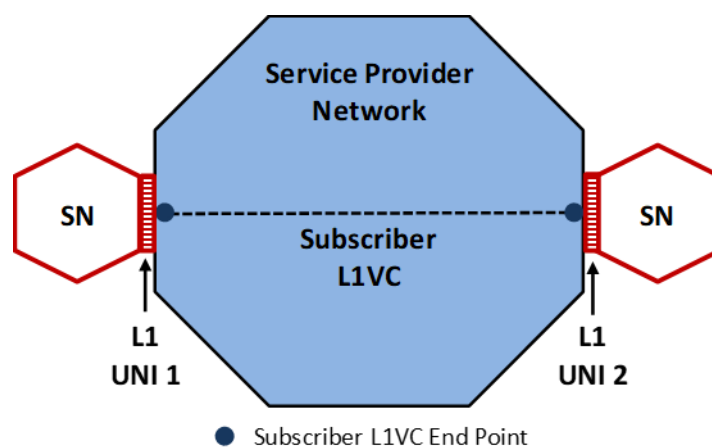
Mplify 63 defines Subscriber attributes for a Wavelength – Capacity service at Layer 1 including the User Network Interface (UNI). The UNI is the interface to the Subscriber. Mplify 63 defines a UNI at either end of the Layer 1 service. A Mplify 63 UNI supports Ethernet, Fibre Channel, SDH, or SONET technologies. UNIs at each end of the L1 service are the same technology and the same rate (speed). As an example, two 10Gbps Ethernet UNIs are able to be connected together via a Wavelength – Capacity service. A 10Gbps Ethernet UNI cannot be connected to a 100Gbps Ethernet UNI.

Mplify 63 specifies three Physical Layer Service attributes of a Wavelength – Capacity UNI: Client Protocol, Coding Function, and Optical Interface Function. These three attributes define how a Wavelength - Capacity UNI functions. Only the Optical Interface Function can be different at each end of a Layer 1 Virtual Connection.

Beyond the Wavelength – Capacity UNIs defined in Mplify 63, it is also possible that OTN is used as the handoff to the customer.

3.2 Wavelength – Capacity Product Virtual Connection

Mplify 63 defines the Layer 1 Virtual Connection (L1VC) that connects two Wavelength – Capacity UNIs together. The L1VC has a set of Service Attributes that include L1VC Service ID, Subscriber L1VC End Point List, and Subscriber L1VC Service Level Specification. These attributes are used to define the L1VC.

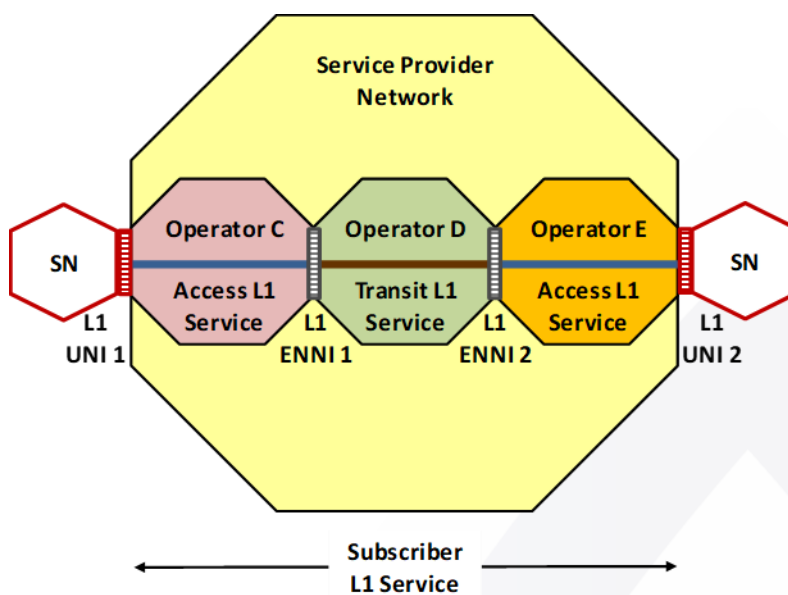


L1 Virtual Connection

Since a L1VC uses the same technology at each end, they are predominately used to transport data from point A to point Z using one of many transport technologies and interface rates. They are not used to aggregate lower speed traffic into higher speed “pipes” at the service level, although the end customer may perform aggregation before the data enters the Layer 1 Wavelength Product.

3.3 Wavelength - Capacity External Network Network Interface

Mplify 64 defines Wavelength - Capacity External Network Network Interfaces (L1 ENNI) that are used to connect L1 Service Providers, L1 Operators, and L1 Super Operators together. These ENNIs, in a similar fashion to L1 UNIs and L1VCs, must use the same technology at either side of the ENNI. As an example, the L1 ENNIs connect two operators together to provide an end to end Wavelength - Capacity service from L1 UNI to L1 UNI.



L1 ENNI Example

As can be seen in the above figure, multiple providers can be connected by different L1 ENNIs to extend a L1VC from L1 UNI to L1 UNI. Connections via different operators can reflect Access L1 Service or Transit L1 Service depending on whether the connection across the operator is from L1 UNI to L1 ENNI (Access Service) or L1 ENNI to L1 ENNI (Transit Service). Mplify 64 has a complete explanation of L1 Operator services.

4. Wavelength - Spectrum Products

While not defined as an Mplify service, many providers sell Wavelength - Spectrum Products. These are also currently supported by some Service Providers who also sell Wavelength - Capacity Products. These products reserve a portion of the DWDM spectrum for a single customer. The end customers can install any transport system that they want as long as it transmits and receives at the specified wavelength(s) within the allocated DWDM bandwidth.

The key difference between Wavelength - Capacity and Wavelength - Spectrum Products is that Wavelength - Spectrum Products are not technology specific, rather they provide a “pipe” that can be used by any compatible optical technology. As an example, a Wavelength - Spectrum Product can transport Ethernet at 100 Gbps. If the Customer Provided Equipment is changed to 400 Gbps Ethernet, the same Wavelength - Spectrum product can be used subject to optical impairment constraints. Wavelength services are most commonly implemented across a single operator's optical domain, though it is possible to have a wavelength service span multiple operator's optical domains and happens on occasion, though it does require additional coordination between the subscriber and operators.

The following sections describe the Product Attributes that are expected to be agreed upon when describing a Wavelength - Spectrum Product by the Subscriber. This is not a comprehensive list as there is no Mplify standard that defines Service Attributes for Wavelength - Spectrum services at this time.

4.1 Wavelength - Spectrum Product Delivery Attributes

Product Delivery attributes provide information such as the locations of the Wavelength - Spectrum Product, when and where it will be delivered to the Subscriber, Contract Term, and Requested Installation Date. These attributes are agreed upon by the Buyer and Seller. There are often significant timeframes involved with the delivery of Wavelength - Spectrum Products. This means that the Requested Installation Date might be months in the future to allow the Seller time to extend fiber facilities to the Subscriber locations.

4.2 Wavelength - Spectrum Product Interface Attributes

The Product Interface Attributes define the technical behavior of the Wavelength - Spectrum Product. These include attributes such as Connector Type, Spectrum Band (C or L), Central Wavelength, Spectral Bandwidth, and Launch Power. Each of these impacts the operation of the Wavelength - Spectrum Product.

These Product Interface Attributes are agreed to by the Buyer and Seller. Ordering of Wavelength - Spectrum Products may be a manual process or may be supported by automation. Often manual processes are used because the number of Wavelength - Spectrum Products that are sold is small compared to other technologies. With the addition of a Product Model, POQ and Quote functions could be automated even if Product Ordering is manually performed.

5. Comparison of Wavelength – Capacity (L1) and Wavelength – Spectrum (L0) Products

This section provides a high level discussion of the key use cases for and differences between Wavelength – Capacity and Wavelength - Spectrum Products. As can be seen in the previous sections, there are significant differences between the two types of Wavelength Products. These differences impact not just the Product Attributes but also can impact commercial agreements dealing with the Products.

Key differences between the two types of Wavelength Products are, of course, the layer that they operate within. When requesting a quote or ordering Wavelength - Capacity Products the interface technology, such as Ethernet, Fibre Channel, etc. and the operating rate, must be specified. When requesting a quote or ordering Wavelength - Spectrum Products the interface technology does not need to be specified. Only the wavelength and other optical attributes that are used are key to the operation of the Product. Underlying technologies which utilize the Product are not needed to complete the Product Order.

When quoting or ordering either Wavelength Product, information such as delivery addresses, contract term, and contacts are required. The Seller returns the expected delivery date for each type of Wavelength Product.

The following Table shows a comparison of these two Products.

Attribute Name	Wavelength – Capacity	Wavelength - Spectrum
OSI Layer	Layer 1	Layer 0
UNI Technology	Ethernet, Fibre Channel, SDH, SONET	Optical Spectrum
Shared or Dedicated	Shared	Dedicated
Typical Upgrade Model	Change Service	Change CPE only
Typical Use Cases	Managed Transport	Customer Provided DWDM/OTN

Table 1 – Comparison of Wavelength – Capacity and Wavelength – Spectrum

Note that some upgrade paths for Wavelength – Spectrum may require that the spectrum bandwidth assigned to the Product may need to be wider to support the modified requirement.

5.1 Benefits of Wavelength - Capacity Products

The major benefits of Wavelength - Capacity Products over Wavelength - Spectrum Products are their cost, their availability, ability to use multiple providers, and their support of defined technologies and speeds.

The cost of Wavelength - Capacity Product may be lower than Wavelength - Spectrum Products since Service Providers because the provider can multiplex multiple Wavelength - Capacity Products over the same underlying photonic resources (e.g., via OTN), thus sharing wavelengths or fibers among several customers. Higher rate services (100G and higher) often utilize Wavelength - Spectrum vs. OTN services, while lower rate Wavelength - Capacity (100G and below) are transported over OTN products due to lower cost of multiplexing vs. the higher cost of spectrum.

Because dedicated fiber or wavelengths are not required, the availability of Layer 1 Wavelength Products is normally more widespread than Layer 0 Wavelength Products. Service Providers that offer wavelength services typically will offer them at colocation sites or data centers, while OTN services can be offered with demarcation equipment at colocation sites, as well as directly at customer premise in many cases.

Since industry standard interfaces are used for Layer 1 Wavelength Products, compatibility between providers is fairly common and the technologies supported and speeds of those technologies are often the same.

5.2 Benefits of Wavelength - Spectrum Products

The major benefits of Wavelength - Spectrum Products over Wavelength - Capacity Products are the flexibility of payload, the longer amortization period, and ease of upgrading. Wavelength - Spectrum is typically chosen when the customer wants full control of the optical/transport layer (e.g., running their own DWDM/OTN equipment, specific vendor features, or proprietary schemes) and is prepared to accept a higher cost for that degree of control and independence from the provider's transport roadmap

While the overall cost of Wavelength - Spectrum Products may be higher, fiber has a different amortization schedule than other types of equipment and may result in lower costs for the end user since the cost is amortized over a longer period.

Wavelength - Spectrum Products are more flexible when it comes to supporting different payloads. Depending on how they are constructed, the end customer may be able to simply change out their equipment which terminates the Wavelength and replace it with other compatible equipment that operates at a different speed.

6. Wavelength Products Use Cases

This section describes use cases for Wavelength – Capacity and Wavelength – Spectrum use cases. These are not meant to be all encompassing but are shown as examples of the possible use cases.

6.1 Wavelength – Capacity Use Cases

There are several Wavelength – Capacity use cases that are discussed in this section. These are each briefly described in the following sections.

6.1.1 Wireless Backhaul or Fronthaul

This use case provides high bandwidth connectivity between wireless locations. Usually, customer facing interfaces are Ethernet. Bandwidth can range from 10Gbps to 100Gbps and beyond.

6.1.2 Fixed Latency

This use case provides a determinate path with consistent latency for applications that are either latency sensitive (require low latency) or are impacted by jitter (require consistent latency). By using a dedicated path for the Wavelength – Capacity Product, the latency is consistent and jitter is lower than might be provided via a product with variable paths such as most switched Ethernet Products.

6.1.3 Critical Infrastructure

Some customers have mission critical applications with requirements that cannot be met with switched infrastructure. Instead, they require highly available, highly deterministic paths. Applications that fall into this category might be things such as connections between data centers or connections to manufacturing centers.

6.1.4 L2CP and Payload Transparency

Customer applications sometimes require L2CP protocols to function without modification or being discarded. In other cases, payload transparency is required to ensure that end to end payload is not modified by the L2 network between the end points. These applications can use Wavelength – Capacity Products to meet these requirements.

6.1.5 Layer 1 Encryption

Encryption of customer data is becoming more prevalent, sometimes mandated by law and other times mandated by good business practices. Layer 1 encryption often hides things like VLAN ID from intermediate sites, where they only appear to make switching or routing decisions at the end points. The requirements for Layer 1 Encryption, including Post Quantum Encryption, often require dedicated facilities that do not need to inspect headers or payload at intermediate sites.

6.2 Wavelength – Spectrum Use Cases

There are several Wavelength – Spectrum use cases that are discussed in this section. These are each briefly described in the following sections.

6.2.1 Wholesale Interconnect

Wholesale providers sell products used to interconnect two locations using Wavelength – Spectrum products. These products provide the high bandwidth required for the interconnection. An example of where Wavelength – Spectrum products might be used is to connect two colocation spaces together.

6.2.2 Campus Interconnect

Interconnections between locations in a campus environment often require significant amounts of bandwidth. To provide this bandwidth, Wavelength – Spectrum products are often used. These bandwidth requirements are easily met by Wavelength – Spectrum products.

6.2.3 Data Center Interconnect

Bandwidth and capacity requirements for Data Center interconnection are significant. To provide this bandwidth and capacity, Wavelength – Spectrum products are often the most economical solution. They provide not only the bandwidth and capacity required, they also can be the most cost effective method for interconnection of Data Centers.

6.2.4 Submarine Fiber Systems

Submarine Fiber systems carry traffic between countries and continents. Often, Submarine Fiber system owners will lease these cable systems to provide Wavelength – Spectrum products. Parties with large demand for bandwidth between countries and continents can use these Submarine Fiber systems to meet their demand cost effectively.



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