Optical Services over Middle-Mile Networks

Many carriers and last-mile providers may be interested in purchasing out-of-the-box “lit” services from a middle-mile network, like a Virtual Private Network (VPN) or connectivity to cloud providers or the global Internet. If they wish to configure a custom service, they might choose to lease a pair of fiber-optic strands via a dark fiber IRU (a long-term lease) and light the fiber themselves, but there are other options on the Optical Layer between dark fiber and lit services: Optical Services.

Optical Services means purchasing one or more “slices” of the total spectrum of light carried by a fiber pair: a defined amount of bandwidth on either side of a central wavelength. The capacities that a carrier or last-mile provider can obtain through such services typically run into the hundreds of gigabits per second, making Optical Services equivalent to a dedicated high-performance fiber path.

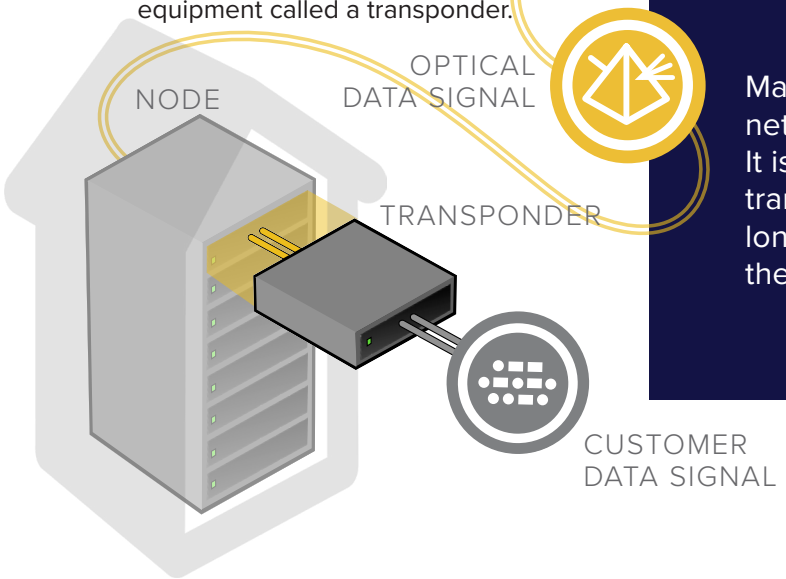
What’s more, recent innovations in technology can enable smaller carriers and last-mile providers to take advantage of such services in a cost-effective manner.

How Optical Services Work

1 **CUSTOMER DATA HANDOFF**
At the Optical Layer, data signals from the last-mile provider are not modified in any way but turned directly into light pulses of a specific color (wavelength). This “transparent” data signal translation is done by a piece of equipment called a transponder.

2 **TRANSIT ALONG FIBER BACKBONE**
These light pulses are then sent down the fiber and then turned back into customer data signals when they reach the node at the other end.

3 **DATA ARRIVES AT DESTINATION**
Depending on the transponder and the width of the spectrum band, one “slice” of spectrum can support different data throughputs.



Managed Optical Services are where a middle-mile network operator owns and manages transponders. It is also possible for customers to provide their own transponders to the middle-mile network operator, as long as those transponders have been validated by the network operator.

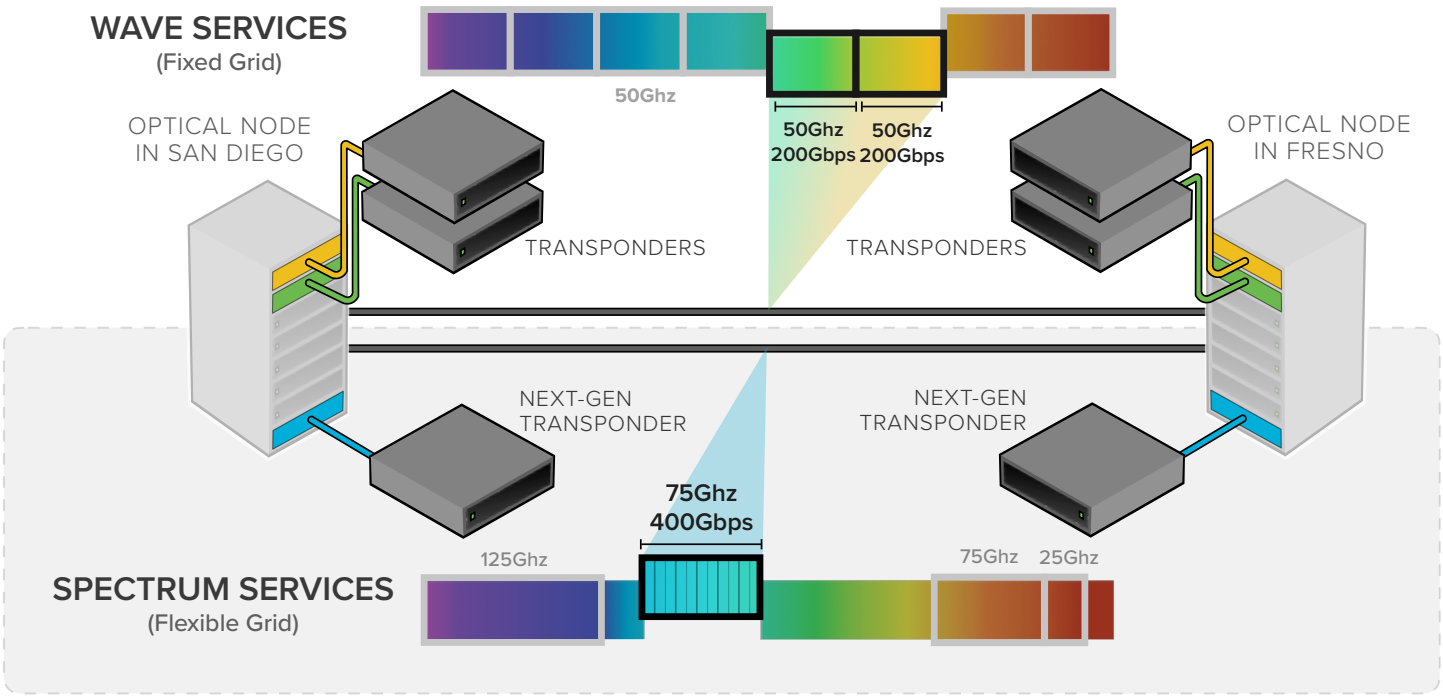
Rapid Expansion and Upgrades for Last-Mile Networks

Many carriers or last-mile providers may wish to expand their services to new locations or add capacity and resilience to their existing network via a second network path, but find this cost-prohibitive due to a lack of existing fiber infrastructure in the regions of interest. Even if a new fiber build is possible, it may simply take too long. Using Optical Services, a customer can quickly expand to a new location hundreds of miles away and appear as a single very high-capacity network, or add capacity and resilience to their existing network via a new high-performance network path.

Wave and Spectrum Services: Fixed or Flexible Grid

An Optical Services customer also enjoys a great deal of freedom in terms of the services they can provision within their purchased "slice" of spectrum, and depending on the capacity they need, their own resources, and what they wish to provide to their own customers, they can choose between two types of Optical Services: Wave and Spectrum.

For most middle-mile networks, the full 4800 GHz spectrum that a typical pair of fiber-optic strands can carry is evenly divided into a fixed grid of uniform 50 GHz-wide "slices", and fixed-grid ***wave services*** are sold by the "slice". Depending on the transponder that is used to turn data signals into light pulses, each 50 GHz "slice" can carry up to 200 Gbps of data traffic. To do this, each "slice" requires a transponder on each end of the fiber pair.



Future-facing middle-mile networks feature the ability to provide a customer's desired capacity on a pair of fiber strands with ***spectrum services***: combining multiple much smaller "slices" (currently 6.25 or 12.5 GHz wide) into one composite "slice" of flexible size. This composite "slice" is treated as a single signal by one pair of Next-Generation Internet (NGI) transponders, which can enable considerably higher data throughputs thanks to recent innovations.

The comparison below illustrates how spectrum services can use less spectrum than wave services to provide greater capacity while also using less equipment, rack space, power, and maintenance.

Wave (Fixed Grid) Services

To provision 400 Gbps of capacity using wave services, at least four transponders are required, a pair for each of the two 50 GHz "slices" of spectrum that must be purchased.

Additionally, all four transponders require power, rack space, and ongoing maintenance costs.

Spectrum (Flexible Grid) Services

To provision 400 Gbps using spectrum services, only one pair of NGI transponders are needed for 75 GHz worth of spectrum, composed of multiple much smaller "slices". Therefore, half as much equipment is required, and thus half the rack space, power, and maintenance costs.

Additionally, since NGI transponders are capable of much greater capacity than the typical 200 Gbps of most transponders, customers can reach near-Terabit data rates depending on the size of the purchased "slice" of spectrum and which NGI transponder is used.