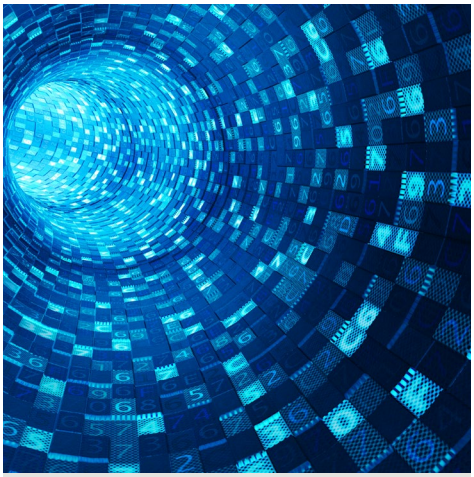
FUJITSU

Application Note

Simplifying Alien Wavelength Deployment



Application Benefits

- Increase vendor diversity and second-sourcing options
- Deploy 400G services over existing fixed grid networks
- Reclaim fiber bandwidth and equipment ports to extend life of existing assets
- Improve spectral efficiency
- Simplify and streamline alien wavelength planning and design

Functional Elements

- 1FINITY™ Transport Series
- 1FINITY™ S100 Switch
- Virtuora® AX OLS Designer
- Virtuora® Network Control Solution

The demand for alien wavelengths has been steadily growing, due to two trends in optical transport networking:

- Strong market demand for 100G+ high speed services. Many networks were engineered for 10G services over a fixed grid, so incrementally adding high speed services can present a technical challenge. Meanwhile, upgrading the entire network to support high speed services is a strategic decision with major impacts on costs, time, and customer SLAs.
- Advances in open optical networks. For an alien wavelength the transponder pair is from a different vendor than that of the open line system (OLS), and hence some degree of interoperability and multi-vendor management is needed. While there are many benefits to an open network, one key challenge has been the closed, proprietary nature of most vendors' OLS that makes alien wavelength planning difficult.

Lowering costs with alien wavelengths

Circuits that span multiple carrier networks end-to-end are an opportunity for cost reduction using alien wavelengths. Transponders are typically used at the boundary between two networks as the demarcation point. This keeps the wavelength native for each network but incurs transponder costs. By handing off the optical circuit as an alien wavelength instead of a layer 2 interface, transponders are no longer required. Eliminating these transponders frees up rack space, lowers CAPEX, and reduces latency as electrical-optical-electrical conversion is also eliminated.

New services with alien wavelengths

If the incumbent vendor does not offer the transponder that a customer requires at the needed time and/or price, consider introducing a new transponder vendor. A pair of transponders bookends the optical circuit and transits through the OLS network as an alien wavelength. For example, with the Fujitsu 1FINITY™ T700 transponder it is possible to add 400 GbE services to a 10G-optimized network. This extends the operational lifespan of the OLS and avoids network upgrades.

Benefits of multi-vendor networks

An open network that leverages alien wavelengths has several benefits:

- A larger selection of products (and prices) from multiple vendors;
- A more diverse and reliable supply chain. Second-sourcing builds resilience in the supply chain, and helps avoid potentially costly delays;
- A second vendor gives the service provider greater leverage when negotiating with the incumbent vendor. In fact, introducing a second vendor reduces the total cost of ownership by 15%-25% over five years, in most cases[1].

Various degrees of interoperability already exist today. Adding a second OLS vendor requires substantial integration effort, while adding a pair of transponders does not. The benefits of openness can be achieved incrementally, when and where it makes sense.

Automated, open line system planning and design

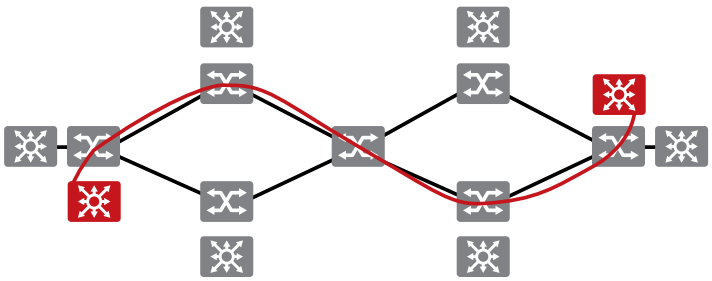


Figure 1: Alien wavelength deployment with 1FINITY T310 muxponder at Marcatel Com

Challenges to alien wavelength deployment

A key challenge has been the unavailability of detailed OLS technical characteristics from vendors, such as FEC (forward error correction) and OSNR (optical signal noise ratio) tolerance. Without access to such proprietary information, Operations technicians must manually compile field measurements from in-service network equipment to harvest this information. This reliance on labor-intensive, manual data collection carries a risk of stranded capacity and slower innovation, and results in inefficient, error-prone network planning and design. Conventional planning tools have not yet been available to adequately handle alien wavelengths without vendors releasing this information.

Another challenge is that multi-vendor networks have their unique set of operational issues. Strong technical support and cooperation from all vendors will be critical to the success of the alien wavelength deployment.

Fujitsu is committed to advancing the deployment of alien wavelengths, and introduces the Virtuora® AX OLS Designer, a new multi-vendor planning tool that greatly streamlines and automates the design and wavelength routing process without the need for proprietary information from the OLS vendor.

Alien wavelength planning & design

OLS Designer overcomes the challenge of obtaining detailed OLS technical parameters from vendors through the use of AI and machine learning algorithms[2]. By gathering and analyzing empirical performance data from the network, it accurately plans and predicts optical performance of alien wavelengths. It is truly vendor-agnostic, accurate for all vendors because it utilizes data from the live network, and does not require vendor specific parameters. The tool models optical nodes and elements, and works as follows:

- Collect network data such as the BER from any vendors' transponders, ROADMs and/or management systems;
- Train the optical model by applying machine learning algorithms on the network data;
- Predict transponder performance using the optical model, and recommend the best modulation format;
- Refine the optical model with new network data once the alien wavelength is deployed

Figure 2 below shows the OLS Designer being used to plan an alien wavelength deployment. The signal quality is predicted as a function of reach and nodes traversed, depending on whether DP- QPSK (red), DP-8QAM (grey), or DP-16QAM (blue) modulation is used. When applied to all wavelengths, overall network capacity is optimized by utilizing the maximum recommended modulation rates. In one network, a 28% increase in optical fiber capacity was achieved.

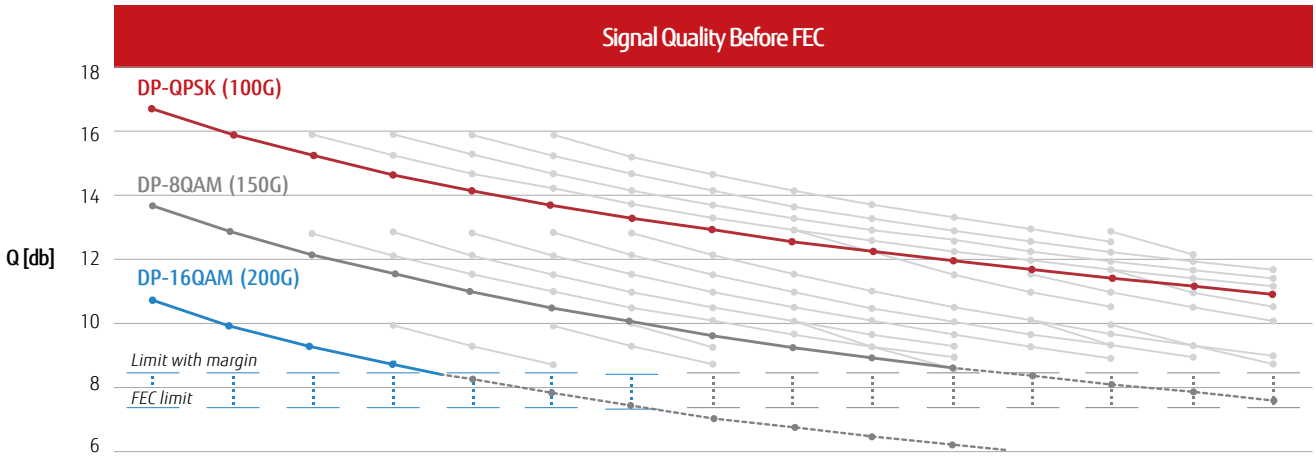


Figure 2: Predicted alien wavelength signal quality depending on modulation using OLS Designer

Comprehensive portfolio for open transport

Network management for alien wavelengths

What should be the strategy for integrating network management systems from two different vendors? Fujitsu proposes an incremental approach that scales with the number of alien wavelengths in the network:

Small Deployment – 1 to 9 alien wavelengths

Quick and economical is best when the scale is small. A standalone transponder element manager for configuration and monitoring can be introduced alongside the existing NMS, without any integration. Transponder alarms can be integrated as SNMP traps.

Medium Deployment – 10 to 100 alien wavelengths

The Virtuora Network Controller (NC) is recommended in place of the element manager. This comprehensive and modular platform, implemented via SDN/NFV, provides the capabilities and feature set needed for medium-sized (and larger) networks. Integration between Virtuora NC and the existing NMS is not required.

Large Deployment – 100+ alien wavelengths

At this large scale, an orchestration engine (e.g., Virtuora Service Activator) is recommended. Such a unified NMS sits above the existing NMS and Virtuora NC and provides holistic management of a large multi-vendor network. Standard management protocols and interfaces such as REST, NETCONF, and gRPC help to reduce the complexity of the integration effort.

Integration and technical support are essential

Finding the root cause of a fault can be tricky, especially in multi-vendor situations. The resolution may involve a simple configuration setting, a workaround, or a new software release. Cooperation between vendors and a partner with experience in building multi-vendor networks and resolving issues are key to the ultimate success of a deployment.

Fujitsu is a contributing member to the Open ROADM MSA, ODTN, ONOS, and TIP – industry associations and projects that advance open optical networking. Interoperability between Fujitsu and most other major vendors' products has been tested, trialed, or deployed in different scenarios, so many integration and support issues have already been encountered and resolved. Fujitsu staff have developed the requisite expertise, processes and test procedures for problem identification and resolution.

Alien wavelengths with 1FINITY transponders

The 1FINITY Transport, or T-series, of transponders and muxponders (see Table 1) is designed for current and upcoming data center interconnect, wireless, and optical transport applications. With high port density, open optics, and a disaggregated architecture, these blades deliver cost-effective performance.

One example is the 1FINITY T700, which can provide 400G service over a traditional, fixed 50 GHz grid optical network. This is achieved by splitting the client signal over 2 × 200G wavelengths, which fits in a 50 GHz slot. At the other end of the circuit, the two wavelengths are inverse multiplexed (i.e. re-combined) back to a single client signal. An additional benefit is that the 200G wavelengths can span longer distances compared to a single 400G wavelength because it uses a lower order modulation.

Another example is the 1FINITY T310 that has 20 × 10 GbE client ports, which are multiplexed onto 1 × 200G or 2 × 100G wavelengths. This reclaims 10G wavelengths and frees up fiber spectrum for new services.

Alternativley, an alien wavelength can also be deployed by connecting the OLS to a narrowband DWDM optic in the 1FINITY S100 layer 2 switch, eliminating the need for a stand-alone transponder.

FEATURE	T100	T300	T310	T600	T700
Maximum Capacity	800G	1T	200G	2.4T	1.6T
Client Optics	8 × QSFP28	10 × QSFP28	20 × SFP+	24 × QSFP28	16 × QSFP28 4 × QSFP56-DD
Client Signal Type	100GbE	100GbE/OTU4	10GbE/OTU2/ OC192	100GbE	100GbE/OTU4/400GbE
Line Optics	4 × CFP2-ACO	5 × CFP2-ACO	2 × CFP2-ACO	4 × discrete DCO	4 × discrete DCO
Modulation	QPSK/16QAM	QPSK/16QAM	QPSK/16QAM	16QAM/32QAM/ 64QAM	QPSK/6b4D-2A8PSK/ 16QAM/ 32QAM
Line Rates	100G/200G	100G/200G	100G/200G	200G/300G/400G/ 500G/600G	200G/300G/400G
Optical Grid	Fixed	Fixed	Fixed	Flex	Flex
Power Options	AC/DC	DC	DC	AC/DC	DC
NEBS compliant	No	Yes	Yes	No	Yes

Table 1: Fujitsu 1FINITY™ T-series transponders and muxponders

Existing DWDM network with simplified upgrade to higher capacity

Summary

Alien wavelengths offer a range of benefits – increasing vendor diversity and second-sourcing options, the introduction of 400G services over fixed grid networks, improved spectral efficiency, reclaim fiber bandwidth and equipment ports to extend life of existing assets – but have yet to see widespread deployment in the industry due to the lack of adequate tools.

The OLS Designer from Fujitsu simplifies and streamlines alien wavelength planning and design, greatly automating what used to be a highly manual and labor-intensive process. It is completely vendor-agnostic because it does not require any proprietary information about the OLS. Instead, its accuracy is based on actual performance data from the live network.

The Fujitsu 1FINITY T-Series of transponder and muxponder blades is well-suited to alien wavelength deployments. With a variety of high-density client-side interfaces, and line-side speeds from 100G to 600G, it supports a full range of transport applications. Together with potential network management integration and extensive experience in multi-vendor networks, Fujitsu delivers a comprehensive alien wavelength solution that helps service providers maximize the utility and lifespan of their OLS systems.

References

[1] "Debunking the Myth of the Single-Vendor Network", Gartner RAS Core Research Note G00208758, November 2010.

[2] M. Bouda et al., "Demonstration of Continuous Improvement in Open Optical Network Design by QoT Prediction Using Machine Learning", Optical Fiber Communication Conference and Exhibition, January 2019, DOI: 10.1364/OFC.2019.M3Z.2.

Fujitsu Network Communications, Inc.

2801 Telecom Parkway, Richardson, TX 75082
Tel: 888.362.7763

us.fujitsu.com/telecom

1.0/03.21