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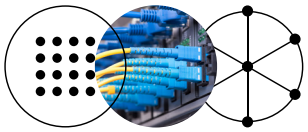

SIMPLIFY DWDM NETWORK DEPLOYMENT AND PROVISIONING WITH FLEXTUNE

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Telecommunications service providers have been using dense wavelength division multiplexing (DWDM) technology to increase the amount of traffic they can carry on their optical networks for a few decades.

The first DWDM systems, deployed in long-haul transport links, were based on discrete optical components. After many years of development and further integration, fixed-wavelength DWDM XFP and SFP+ optical transceivers began to be deployed in the field, originally for metro network applications, where they provided a great way to lower infrastructure CapEx by transmitting multiple data links over a single optical fiber. However, fixed-wavelength DWDM pluggable transceivers added operational complexity and OpEx by requiring users to maintain multiple wavelength-specific devices with unique part numbers in inventory.

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This operational inefficiency has been solved with the introduction of wavelength-tunable DWDM pluggable transceivers, which reduce the sourcing complexity and the sparing inventory required by enabling network operators to procure a single part number supporting the full C-band. Figure 1 shows wavelength-tunable DWDM SFP+ (T-SFP+) transceivers in both duplex and bidirectional configurations.

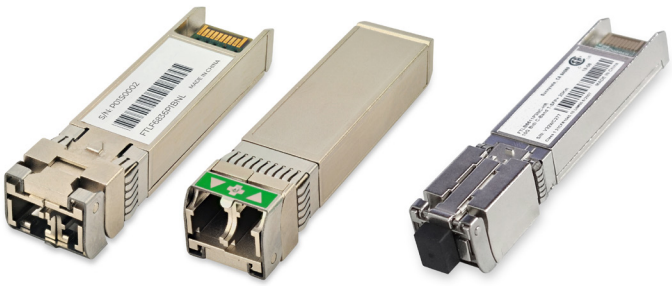

Figure 1: Duplex and bidirectional wavelength-tunable DWDM SFP+ transceivers.

However, the deployment and provisioning of a tunable DWDM pluggable transceiver still results in a time-consuming activity due to the following steps:

- A field technician must tune each transceiver to the correct wavelength on each system port by using portable tuning boxes or by coordinating with the network operation center (NOC).
- The technician must also optically connect each transceiver to the correct channel port on the optical mux/demux filter, which can be complicated due to poor fiber management or labeling errors. In some cases, the 40-port mux/demux is located a few kilometers away from the system, adding even more complexity to the fiber tracking process.

Because of this, the provisioning of a DWDM link with 40 or more wavelengths can take several hours and is prone to multiple operator errors.

Flextune™ provides the solution to simplify DWDM network deployment and provisioning

Flextune™ is Coherent's patented wavelength self-tuning function for optical pluggable transceivers that can significantly reduce provisioning time and operating expenses when deploying DWDM networks. Pluggable Self-Tuning Optics (STO) with Flextune™ automatically find the optical path to the module at the remote end of the link and tune themselves to the correct wavelengths. The self-tuning functionality is contained in the firmware of the transceiver, and no host-system intervention is required. This means that transceivers featuring Flextune™ are truly "plug-and-play."

Flextune™ typical use cases

Many telecom service providers are now requiring Self-Tuning Optics which can automatically set their transceiver wavelength as enabled by Flextune™. The Flextune™ self-tuning functionality is particularly useful in metro and access applications where a portion of the DWDM link is remote and not easily accessible. For example, a remote-PHY point-to-point DWDM link typically used by a cable company or MSO (Figure 2), or front-haul DWDM links in wireless networks (Figure 3).

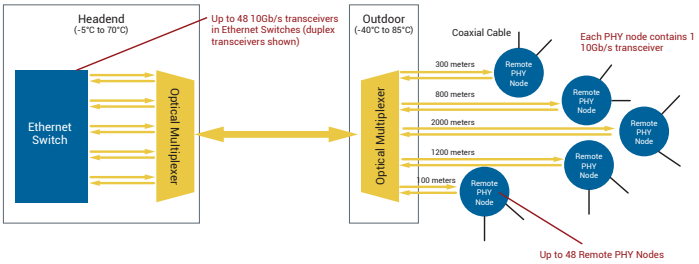

Figure 2: Remote-PHY point-to-point DWDM network.

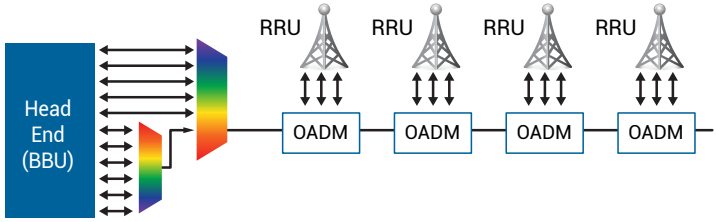

Figure 3: Mobile front-haul DWDM network.

Another use case is where a DWDM link is deployed between two pieces of equipment that do not have native support for wavelength-tunable DWDM pluggable transceivers, as in datacenter interconnects (DCIs) where T-SFP+ transceivers can be plugged directly into switches and routers without the use of transponder line cards.

Summary of Flextune™ operation

Flextune™ can leverage different Coherent patented technologies to implement the self-tuning functionality, depending on the application.

Duplex T-SFP+ Transceivers

In a remote-PHY point-to-point DWDM link between the head end and an outdoor hub (Figure 2), the DWDM portion of the link consists of multiple duplex T-SFP+ transceivers on each side, linked with up to 80 km of fiber.

This is what takes place when Flextune™-enabled duplex T-SFP+ modules are installed into their respective system ports:

1. Each transceiver automatically begins to scan all available wavelengths.
2. The transmitter signal gets blocked by the mux/demux filter if the wavelength is not correct for its mux port (Figure 4a).
3. The near-end transceiver continues to scan until the correct wavelength is reached. Once that happens, it will begin to communicate with the far-end transceiver (Figure 4b).
4. The far-end transceiver initiates a special scan and continues until the correct wavelength on its mux port is reached (Figure 4c).
5. Once the far-end transceiver reaches the correct wavelength, the handshake occurs and the transceivers at both sides of the link lock to their correct wavelengths (Figure 4d). The link is thus established and normal data transmission begins.

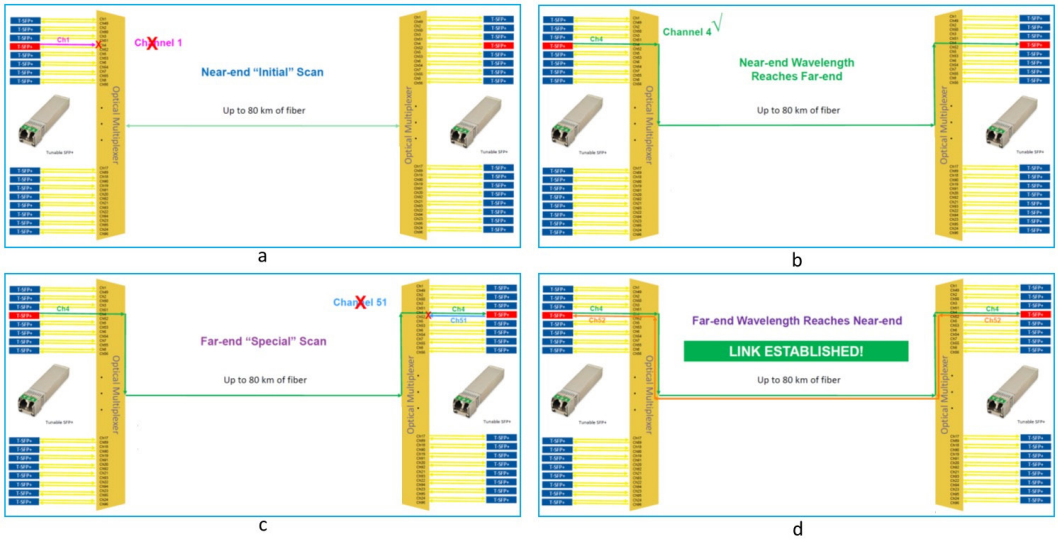

Figure 4(a-d): Flextune™ self-tuning process for duplex T-SFP+ transceivers.

The process described above occurs simultaneously in every transceiver installed on that link which has Flextune™ enabled.

Bidirectional T-SFP+ Transceivers

In this example, a mobile front-haul link between the base band unit (BBU) and the remote radio units (RRUs) consists of multiple bidirectional T-SFP+ modules utilizing Coherent's patented D2WDM™ (Dual DWDM) technology in the DWDM portion of the link.

The Flextune™ process in this scenario is slightly different from duplex T-SFP+, as only the near-end transceivers perform the scan:

1. Near-end transceivers begin to scan all available wavelengths.
2. The transmitter signal gets blocked by the mux/demux filter if the wavelength is not correct for its mux port (Figure 5a).
3. The near-end transceiver continues to scan until the correct wavelength is reached. Once that happens, it is able to communicate that information to the far-end transceiver (Figure 5b).
4. The far-end transceiver tunes to the correct wavelength and the handshake occurs. The link is thus established and normal data transmission begins (Figure 5c).

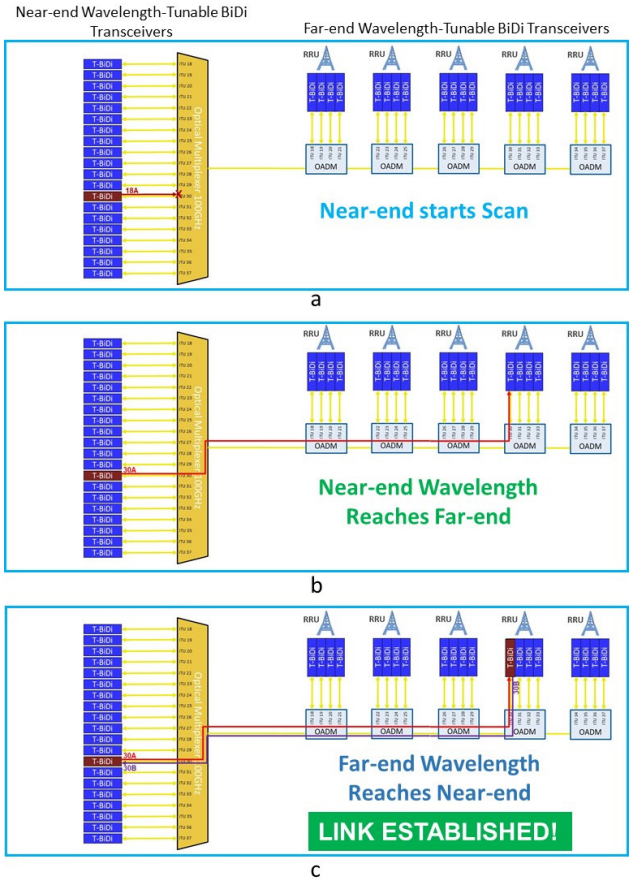

Figure 5(a-c): Flextune™ self-tuning process for bidirectional T-SFP+ transceivers.

Benefits of Flextune™

By using Flextune™, up to 96 wavelength-tunable transceivers will automatically configure their wavelength in less than 10 minutes without any intervention from field technicians or the host-network equipment.

Self-Tuning Optics featuring Flextune™ greatly reduce operational expenditures in several ways:

- It saves many hours in deployment time and cost, since the configuration of the wavelengths is automatic. Technicians do not need to manually set the wavelength or determine which fixed-wavelength transceivers to use, also eliminating the need to involve the NOC.
- It reduces complexity, as technicians can install the wavelength-tunable transceivers into any host port in the system and connect the jumper cables to any fiber port on the DWDM optical mux/demux.
- It also eliminates the need to track fibers manually from the optical mux/demux to the transceivers.

Conclusions

Flextune™ wavelength self-tuning enables considerable savings to network operators using DWDM applications such as remote PHY, mobile front-haul, and datacenter interconnects.

The operational savings are achieved thanks to Coherent's patented self-tuning functionality in its tunable DWDM pluggable transceivers, which allows significantly reduced deployment and provisioning time and minimizes the number of human errors caused by manual operation.

Pluggable tunable DWDM transceivers with Flextune™ functionality are in full production and available. Please contact your Coherent sales representative or send an email to photonics.sales@coherent.com.

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