EFFECT PHOTONICS

NarroWave

Unique Network Automation Technology

www.effectphotonics.com

Technical Paper

Introduction

The ongoing rapid appearance of 5G networks around the world is creating an increasing demand for more bandwidth required for handling the increasing amount of data. The pressure for operators to provide 5G related services does not make installation of new fibre connections feasible so existing fibre networks need to be utilized more efficiently. This is possible by using DWDM transceivers with functionality designed to simplify deployment, monitoring and SLA assurance.

The constantly increasing demand for more bandwidth in Edge and access networks can be met either by adding more fibre connections or by deploying more 10G or upcoming 25G DWDM wavelength transceivers sharing the existing fibre infrastructure. The latter option is better because it offers cheaper and faster deployment. The exceptional inventory management which tunable transceivers offer is offset by the demand for individual configuration which requires high-level accuracy and field technician training.

EFFECT Photonics' Tunable SFP+ modules are especially suited to be used in the deployment of Edge and 5G networks when increased data throughput, ease of deployment and versatile remote monitoring and control is required. These modules are available with the NarroWave toolkit, which consists of two main functions: Autotune and Diagnostics. These are explained in more detail in the following sections.

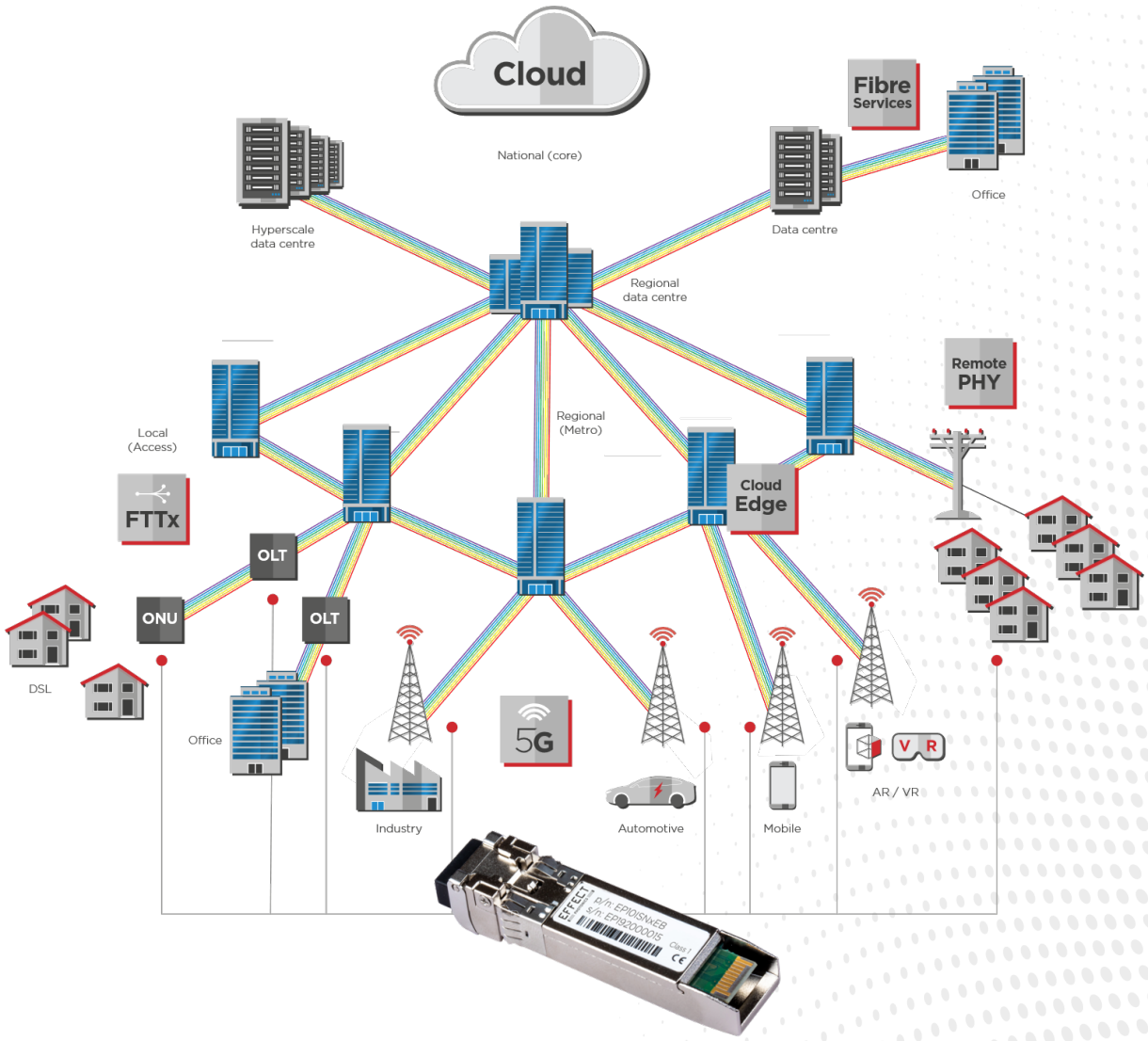

Figure 1: *EFFECT Photonics' Tunable SFP+ modules address the demand for increased data throughput at the Edge and in 5G networks.*

Faster and more economical deployment

EFFECT Photonics' tunable transceivers with NarroWave functionality provide a full set of installation tools, including automatic wavelength tuning, proactive remote monitoring and versatile SLA assurance tools. Together these unique features offer seamless system integration, efficient circuits provisioning and rapid deployment. The benefits of NarroWave are listed in Figure 2 below.

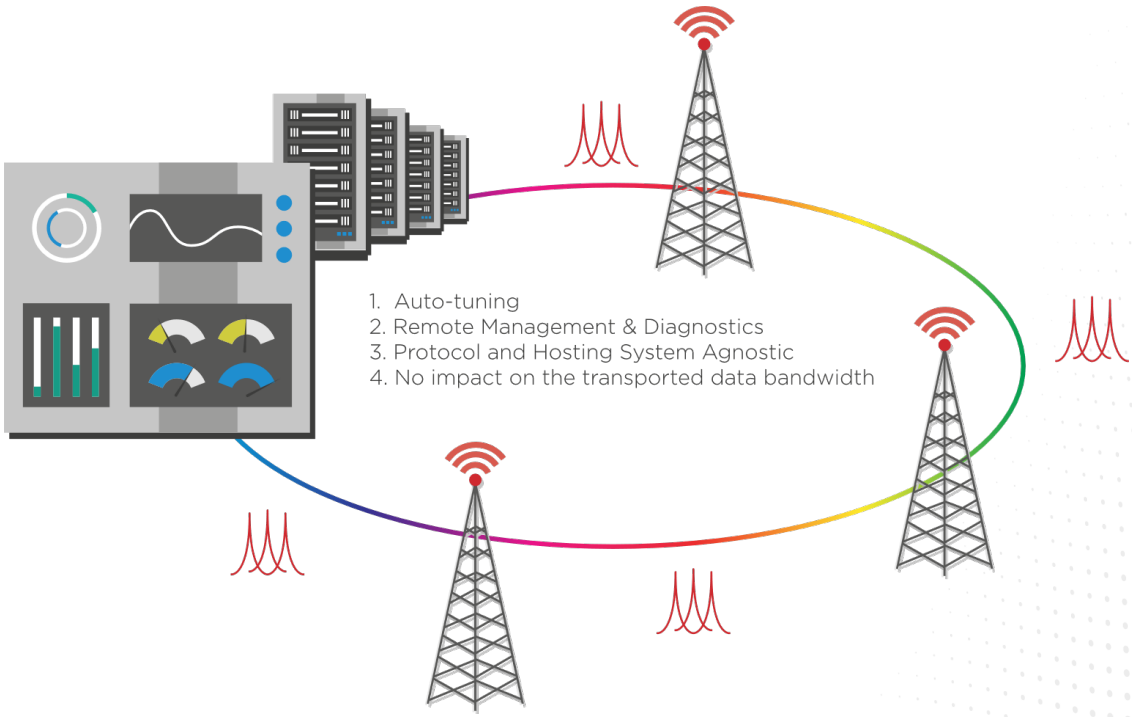

Figure 2: *EFFECT Photonics' NarroWave general benefits*

NarroWave Autotune

The NarroWave Autotune process is applied to a pair of Tunable SFP+ with built-in NarroWave functionality. As is common in hub and spoke access architecture, one SFP+ is located at the aggregation or Head-End (HE) location, while the second SFP+ is hosted at a remote or Tail-End (TE) location. This common configuration is illustrated in Figure 3 below.

Figure 3: *Typical hub and spoke in access architecture.*

An EFFECT Photonics Tunable SFP+ may be provisioned by the hosting system through its local management (I2C) bus, remotely by the peer hosting system through its Tunable SFP+, or by itself through an independent channel/wavelength match discovery process.
NarroWave Autotune offers multiple autotune modes that vary in the level of remote or Tail-End (TE) SFP+ provisioning independence, from the Head-End (HE) system and its SFP+. The three available modes are:

1. Paired Tuning
2. Blind Tuning
3. Autonomous Tuning

The last two of the NarroWave Autotune modes eliminate the need to carefully connect the remote Tunable SFP+ to a specific port on the optical multiplexing element. The technician can connect it to any available port and the NarroWave Autotune will discover and auto-provision the matching channel/wavelength.

The next figure illustrates the main differences between these three modes.

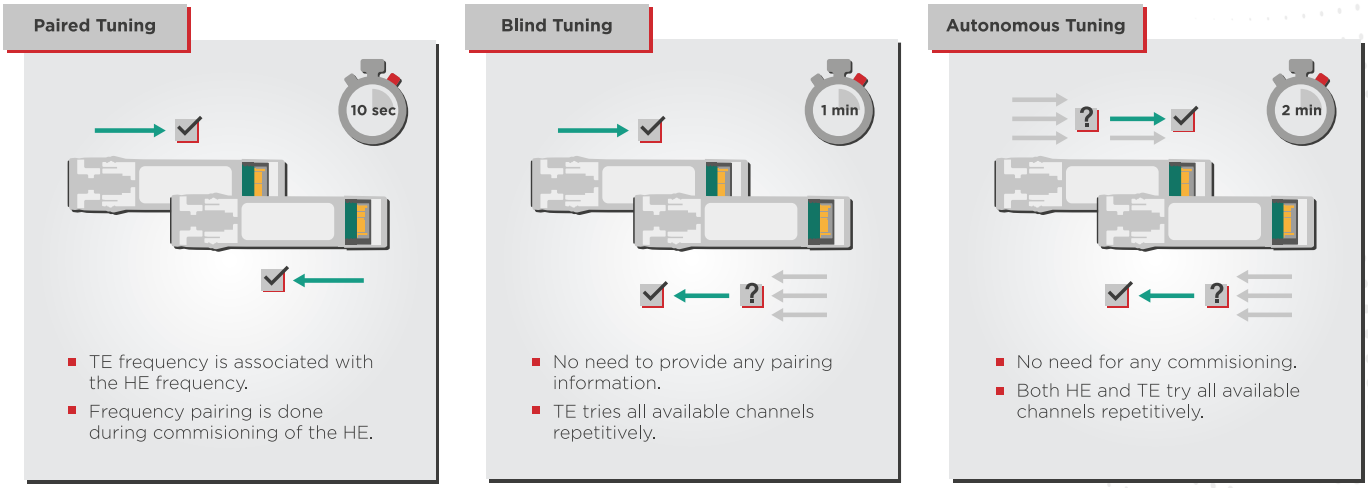

Figure 4: *The main differences between the three NarroWave Autotune modes.*

1. Paired Tuning mode

The NarroWave Autotune process is applied to a pair of Tunable SFP+ with built-in NarroWave functionality. As is common in hub and spoke access architecture, one SFP+ is located at the aggregation or Head-End (HE) location, while the second SFP+ is hosted at a remote or Tail-End (TE) location. This common configuration is illustrated in Figure 3 below.

- The Head-End (HE) provisions its own Tunable SFP+ locally over its local SFP+ I2C bus.
- The Head-End (HE) provisions the Tail-End (TE) SFP+. It issues a channel/wavelength programming command to the remote TE SFP+, through the local HE SFP+ over the NarroWave bus

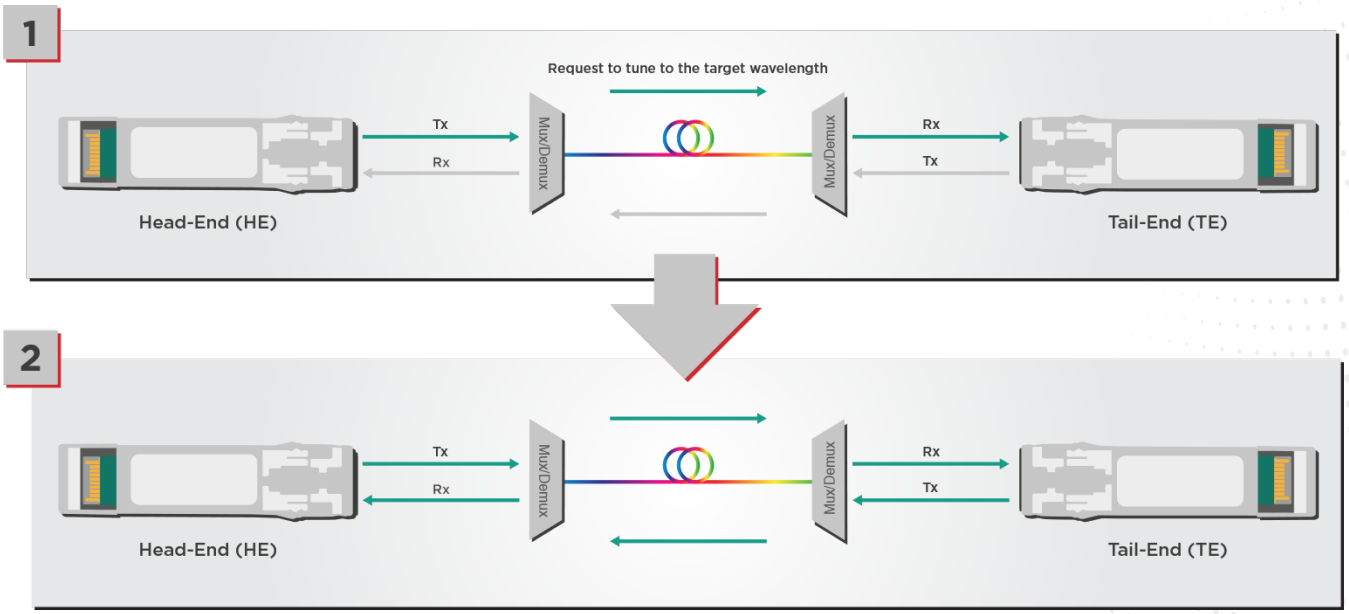

Figure 5: *NarroWave Paired Tuning*

Once the TE channel/wavelength is provisioned, its value may be remembered over a loss of link or over a remote/Tail-End system re-boot. Paired Tuning mode requires a Head-End (HE) system that fully integrates the EFFECT Photonics' Tunable SFP+ software support.

2. Blind Tuning mode

In the NarroWave Blind Tuning mode, the Head-End (HE) system controls only its own HE SFP+ provisioning. The Tail-End (TE) SFP+ self-provisions by discovering the link paired channel/wavelength, through successive trials of all the available channels. In this mode link provisioning occurs in the following steps (see also Figure 6 below):

- The Head-End (HE) provisions its own Tunable SFP+ locally over its local SFP+ I2C.
- The HE requests TE to perform Blind Tuning process.
- Then, Tail-End (TE) SFP+ scrolls through the available channels/wavelengths until a match is found.
- Once the TE channel/wavelength is provisioned, its value may be remembered as the starting channel in a new Blind Tuning process, caused by loss of link or by the remote Tail-End system re-boot.

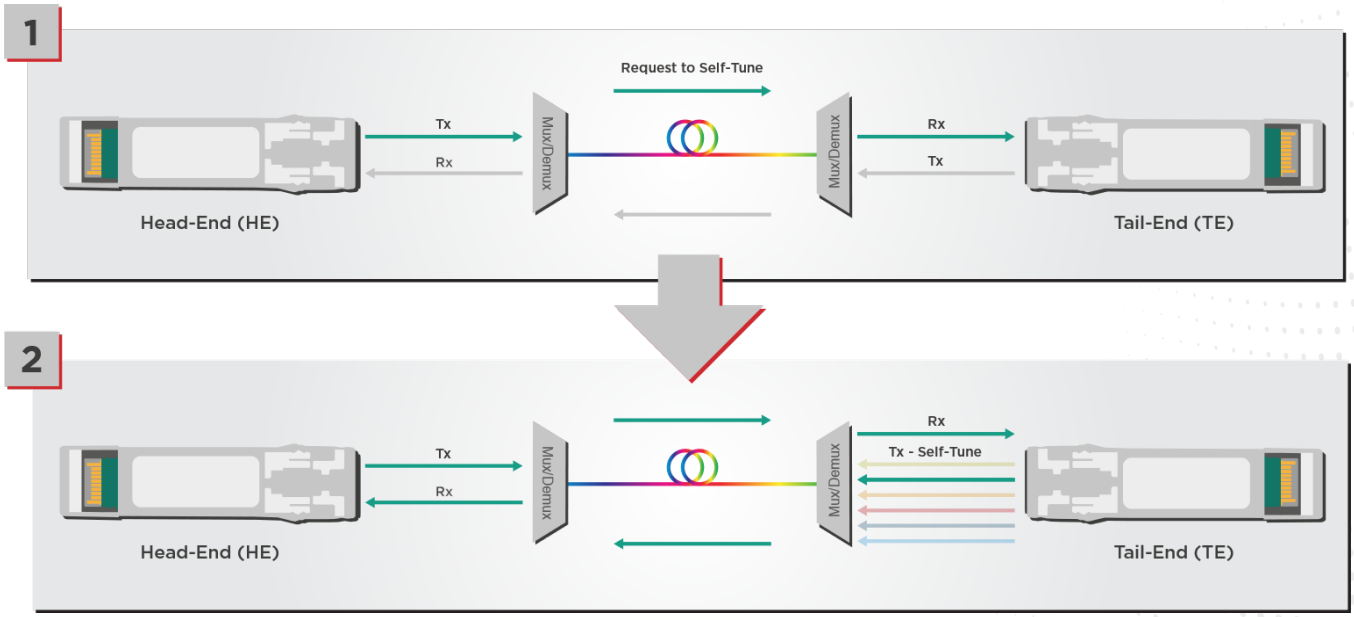

Figure 6: *NarroWave Blind Tuning*

Blind Tuning mode does not require any integration of EFFECT Photonics' Tunable SFP+ software in Tail-End (TE) systems. As such, this mode allows a combination of Head-End (HE) system that integrates tunable SFP+ MSA or EFFECT Photonics' Tunable SFP+ software support, and a Tail-End (TE) system that is agnostic to any tunable SFP+. As a result, less capable Tail-End (TE) systems with no support for tunable SFP+ can now use the EFFECT Photonics' Tunable SFP+. Such systems may be Radio Heads (RRH), R-PHYs, FTTH OLTs, etc., all tunable SFP+ agnostic.

3. Autonomous Tuning mode

In the NarroWave Autonomous Tuning mode, both the Head-End (HE) SFP+ and the Tail-End (TE) SFP+ are self-provisioning. Both sides independently discover the link paired channels/wavelengths, by successively trying all the available channels. Link provisioning occurs in the following independent steps (see also Figure 7 below):

- The Head-End (HE) SFP+ scrolls through the available channels/wavelengths until a match is found.
- The Tail-End (TE) SFP+ scrolls through the available channels/wavelengths until a match is found.
- Once the HE and/or TE channel/wavelength is provisioned, its value may be remembered as the starting channel in a fresh Autonomous Tuning, caused by loss of link or by any system (HE or TE) re-boot.

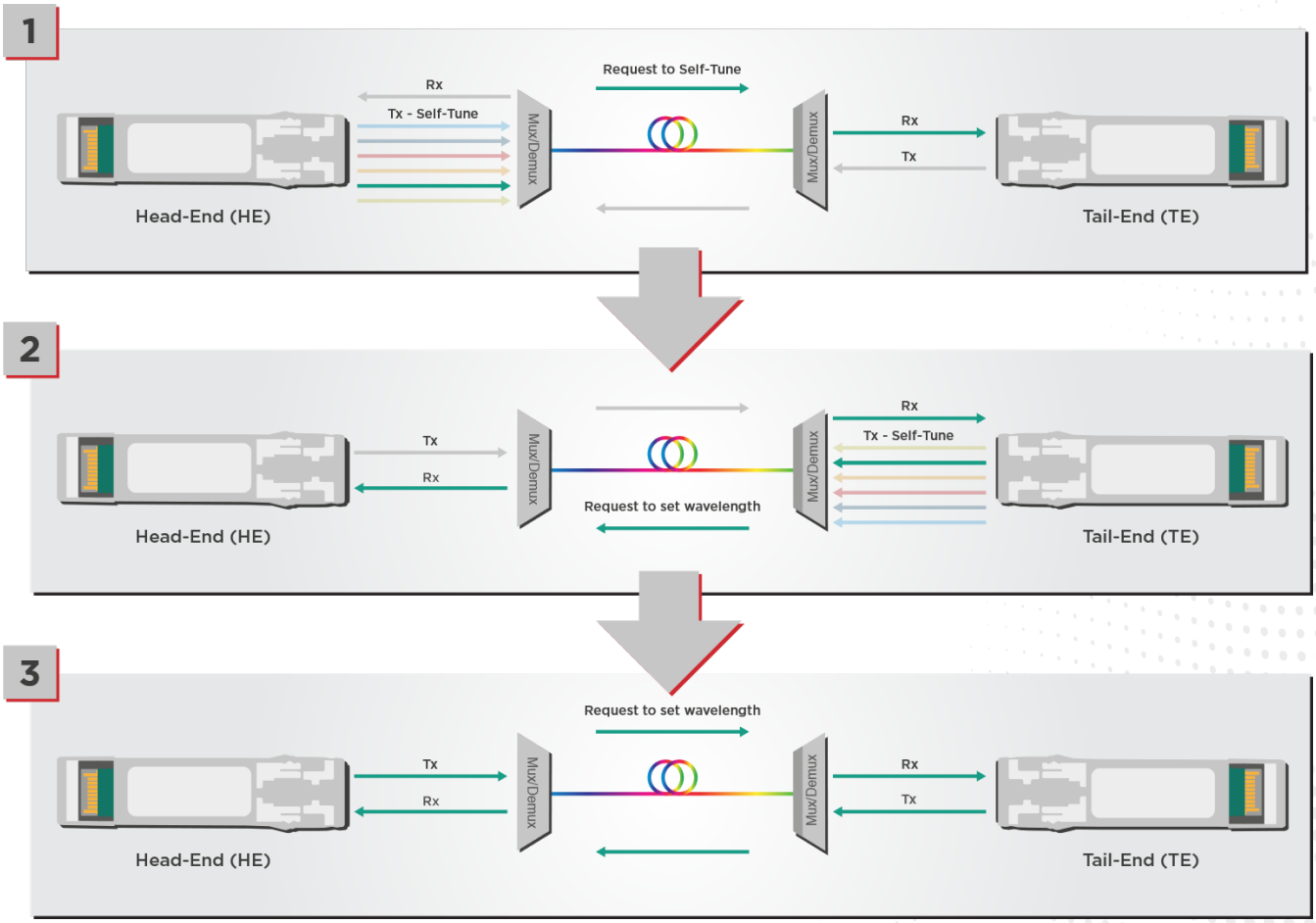

Figure 7: *NarroWave Autonomous Tuning*

Autonomous Tuning mode does not require any Tail-End (TE) system EFFECT Photonics tunable SFP+ software integration. This mode allows Head-End (HE) and Tail-End (TE) systems that are agnostic to any tunable SFP+ support. As a result, less capable Tail-End (TE) systems, with no support for any tunable SFP+ can use the EFFECT Photonics' Tunable SFP+. Such systems may be Radio Heads (RRH), R-PHYs, FTTH OLTs, etc., all tunable SFP+ agnostic.

NarroWave Autotune benefits

EFFECT Photonics' Tunable SFP+ with NarroWave autotune reduces CapEx and OpEx associated with DWDM circuits installation and provisioning. Some of the benefits NarroWave autotune offers are:

- Tunable SFP+ reduces inventory for field deployment and spares (CapEx).
- NarroWave autotune allows usage in end-systems that are tunable SFP+ agnostic.
- NarroWave autotune reduces human involvement and the time spent by field technicians.
- With NarroWave Autotune there is no need to trace and debug the SFP+ connectivity to the optical multiplexing elements: connect to any available port and the NarroWave Autotune will find the matching channels/wavelengths.
- Overall DWDM circuits installation and provisioning complexity is dramatically reduced, resulting in exceptional OpEx cost reductions.
- Implementation is based on the G.metro preliminary standard.

In all autotune modes, Head-End (HE) systems with full EFFECT Photonics's Tunable SFP+ software support also offer network operators the advanced optical layer management, monitoring, and SLA tools unique to these DWDM transceivers.

NarroWave Remote Management and Monitoring

NarroWave Autotune enables seamless system integration and automated provisioning of a DWDM circuit. Once the circuit is provisioned and active, the Service Provider NOC (Network Operations Centre) will monitor its health to assure proper functionality and to proactively detect any deterioration that may lead to the circuit's failure.

NarroWave remote management protocol running on the Head-End (HE) Tunable SFP+ periodically reads the Digital Diagnostic Monitoring (DDM) A0 and A2 pages of the peer Tail-End (TE) Tunable SFP+ and stores their content in dedicated pages of the Head-End (HE) Tunable SFP+ memory range. The remote DDM information includes industry standard MSA (Multi-Source Agreement) SFF-8472 database fields:

- Inventory management reflected in SFP+ Serial Number, Vendor information.
- SFP+ type and capabilities
- Provisioned channel number/wavelength
- Temperature
- Tx power, RX power and other Real Time Diagnostics.
- Alarms and Thresholds

Head-End (HE) systems with full EFFECT Photonics' Tunable SFP+ software support offer network operators the capacity to monitor the optical health of the full circuit. Monitoring is possible for both the local and remote networking systems, independent of the management capabilities and the tunable SFP+ level integration at the Tail-End (TE) network edge unit. These capabilities are typically used in applications like Wireless Fronthaul (see Figure 7 below), Distributed Access Architecture R-PHY, Carrier and Optical Ethernet Fibre Services, or simply in P2P DWDM access circuits.

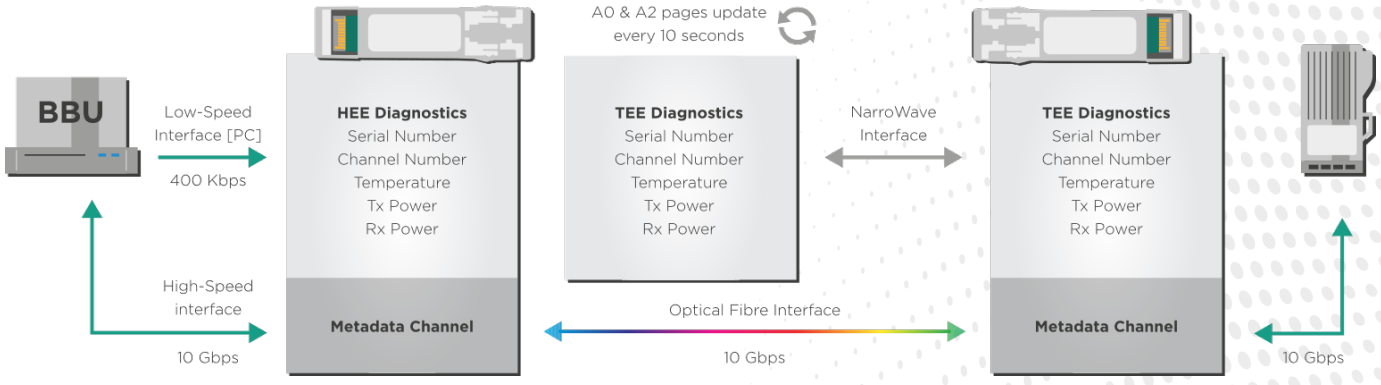

Figure 7: Example of Wireless Fronthaul application with NarroWave diagnostics.

NarroWave future SLA assurance tools

The NarroWave capabilities built into EFFECT Photonics' Tunable SFP+ will allow for the addition of new, powerful, and sophisticated circuit installation and debugging tools, such as remote loopback enable and module-driven link testing.

Summary

The application of DWDM transceivers is the preferred method for providing enough bandwidth required by 5G networks. DWDM transceivers help defeat the need for additional physical fibre connections by making it possible to increase data throughput from the existing fibre infrastructure. By selecting DWDM transceivers such as EFFECT Photonics' Tunable SFP+ NarroWave Autotune transceivers operators can elegantly defeat the problems related to tedious individual configuration procedures and minimize field technician training needs. They provide autotuning, remote centralized management and monitoring as well as other useful functions, which speed up installation, provisioning and testing.

Revision history

R 01 Initial Release

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