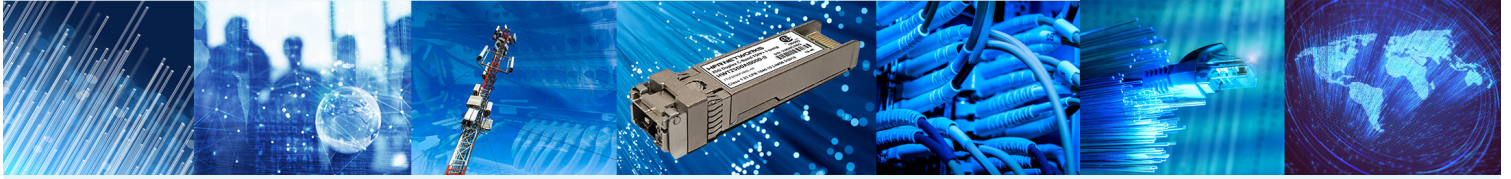


## Self-Tuning Optics Versus Fixed and Tunable Wavelength Optics



### Fixed Proprietary Wavelength Transceivers

Service providers are adding more Dense Wavelength Division Multiplexing (DWDM) capacity to networks to meet the growing demand for additional bandwidth. However, if fixed wavelength optical transceivers are utilized there are numerous issues, such as inventory management, logistics costs, and planning challenges.

Fixed wavelength optics require field technicians to stock many product variants and undergo a long drawn-out and labor intensive installation process. This challenge is even more complex when radio access network (RAN) vendors require proprietary optics that operate only with their solutions.

### Wavelength Tunable Transceiver Challenges

Wavelength tunable optical transceivers offer a more efficient solution compared to fixed wavelength transceivers, since service providers no longer have to anticipate in advance which wavelengths will be needed for a specific deployment.

Even with this advantage, wavelength tunable transceivers require an on-site technician to track fibers, and program each module with the correct wavelength – a slow and time-consuming process. These labor intensive efforts add to the turn-up time which delays the overall deployment.

### Smart Self-tunable Transceivers: Lower Costs, Maximize Ease of Operations & Speed Deployments

HFR Networks has innovated by adding Smart Tunable Optics into their flexiHaul solutions, including the 25G T-SFP28 duplex and 10G SFP+ bidirectional products.

The flexiHaul Smart Tunable Optics are intelligent, plug-and-play, wavelength self-tuning optical transceivers that eliminate the need for time-consuming or labor intensive tasks, such as wavelength planning, manual fiber tracking, and wavelength programming.

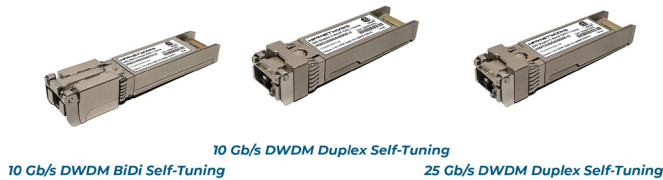
Without intervention by the host system or a field technician, each Smart Tunable transceiver on a DWDM optical link can automatically self-tune to the correct wavelength within ~5 minutes determined only by its physical connection to the passive mux/demux infrastructure.

Smart Tunable transceivers use integrated firmware to locate the correct optical wavelength of the filter ports connecting it, and self-tune to that specific wavelength at both ends. This reduces provisioning time from several hours to a few minutes and results in significant OPEX savings for service providers in DWDM metro and access applications, such as mobile fronthaul, remote PHY, and data center interconnections (DCI).

Transceiver Features	HFR NETWORKS Smart Tunable Optics	Tunable Wavelength	Fixed Wavelength
Wavelength Self-tunes Automatically	✓	✗	✗
"Plug & Play" Ease of Use	✓	✗	✗
Inventory: Only 1 SKU# Required	✓	✓	✗
Remote Loopback Capability	✓	✗	✗
Remote Monitoring Analytics	✓	✗	✗
Enables Host with WDM Capabilities	✓	✓	✗
Interoperability Across RAN Vendors	✓	✗	✗
Eliminates Wavelength Planning	✓	✗	✗
Eliminates Manual Fiber Tracking	✓	✗	✗
Eliminates Wavelength Provisioning	✓	✗	✗

HFR Networks' Smart Tunable Optics allow service providers to standardize RAN or access transport across a diverse ecosystem of suppliers which reduce costs while ensuring consistent performance across the network. With Smart Tunable Optics, service providers gain significant operational benefits with the ability to work over a wide range of optical channels using flexible self-tunable optics versus sourcing many different channels of fixed optics.

**flexiHaul Smart Tunable Optics: Intelligent, Plug-and Play, Wavelength Self-Tuning Transceivers**



### Optimized for xHaul Interoperability

HFR Networks is a long standing supporter of open standards, such as O-RAN. With years of experience in field-proven RAN interoperability, HFR Networks is committed to further advance and simplify the ability to interoperate across a large ecosystem of vendors. Within various deployments around the globe, HFR Networks has successfully integrated with all of the major RAN suppliers, such as Samsung, Ericsson, Nokia, ZTE and Huawei.

HFR Networks has done extensive work to integrate their flexiHaul Smart Tunable Optics into an xHaul environment, including providing the overall control software and logic to ensure interoperability across the complex RAN ecosystem. When Smart Tunable Optics are deployed with either the flexiHaul HSN8000 series or the flexiHaul packet-based M-Series solution (i.e. fronthaul gateway) the built-in diagnostics are enabled to ensure carrier-grade operations.

### Carrier-Grade Visibility and Operational Control

The Smart Optics are controlled and visible in HFR Networks' flexiHaul Element Management System (EMS) to ensure smooth efficient operations. The flexiHaul EMS provides the necessary tools for effortless set-up, traffic provisioning, integrated test measurement, and ongoing system monitoring. Offering full visibility and operational control into remotely deployed RAN transport and Ethernet access equipment, the EMS is pre-integrated with HFR Networks' solutions. As a highly scalable, carrier-class software solution, the EMS ensures service providers can quickly and economically add network capacity and new services, achieve higher performance to exceed their customers' service level agreements (SLAs), and gain full visibility to important portions of the access and/or xHaul networks for efficient ongoing operations.

### Smart Optics' Key Features:

With compelling benefits over both fixed wavelength and traditional tunable wavelength optics, HFR Networks' Smart Tunable Optics have many key features that differentiate them in the market.

- Automatically self-tunes to the correct wavelength without any input from a field technician or the host equipment.
- Simplifies installation and operations with true "plug & play" functionality.
  - Supports up to 96 self-tuning transceivers in a DWDM network.
  - Substantially reduces inventory with only a single SKU/part# needed to support the entire C-band.
- Proven interoperability with 3rd party RAN vendors.
  - Quickly add capacity to 4G networks in parallel with new 5G service deployments across a diverse ecosystem of RAN vendors.
  - Enables standardization across vendors to simplify operations.
  - Simplifies and reduces inventory by eliminating the need for proprietary vendor-specific optics.
- Provides remote optical loopback to allow for network segmentation.
- Integrates 25G T-SFP28 duplex & 10G bidirectional optics to support full 3G/4G/5G RAN requirements.
- Significantly simplifies the network deployment of DWDM transceivers, and also enables WDM tuning capabilities within the host equipment.
- Speeds deployments by eliminating manual programming and fiber tracking which saves hours of set-up and installation time.
- Robust EMS provides remote monitoring analytics, inventory, performance monitoring and built-in diagnostics for effortless carrier-grade operations.

### Smart Tunable Optics: Reduces Your TCO

Smart Tunable Optics deliver substantial savings in CAPEX and OPEX, shorten the overall deployment time to speed time to market, simplify operations, ensure interoperability across RAN vendors, and reduce the total cost of ownership (TCO).