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White Paper

Performance Assured: Transceiver Considerations for Remote PHY Deployments.

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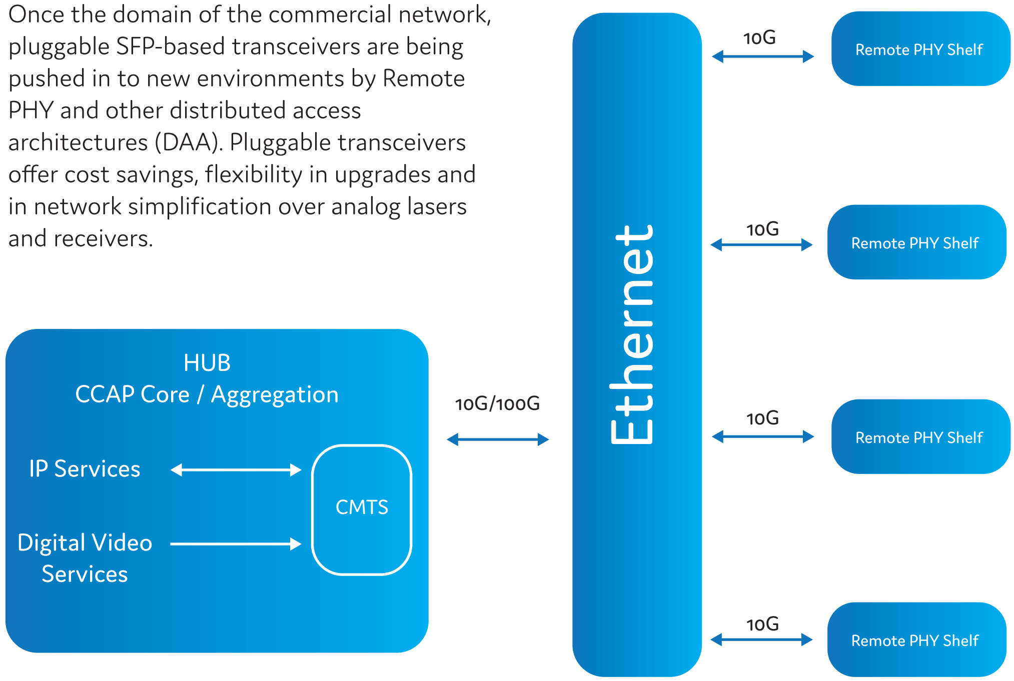
Once the domain of the commercial network, pluggable SFP-based transceivers are being pushed in to new environments by Remote PHY and other distributed access architectures (DAA). Pluggable transceivers offer cost savings, flexibility in upgrades and in network simplification over analog lasers and receivers.



Remote PHY nodes exist in the outside cable plant, away from robust environmental control systems found in headend or hub sites. Understanding the effect of operating temperature, wavelength drift, and wavelength stabilization is critical to ensure network performance is assured over time.

Operating Temperature

Transceiver operating temperatures fall into three envelopes.

- Commercial Temperature (C-Temp), 0°C to +70°C. C-Temp transceivers are commonly used in head end or hub sites.
- Industrial Temperature (I-Temp) -40C to +85C. I-Temp transceivers are commonly used in applications outside of controlled environments.
- Extended Temperature – Extended temperature is not a singular, recognized standard. Extended Temperature generally describes operating temperatures outside of C-Temp, but failing to meet I-Temp requirements.

Operating temperature can effect the performance of pluggable transceivers in the outside plant portion of the Remote PHY network. Repeated hot and cold temperature cycles of over time can weaken components to a state where network services can be impacted by increased power consumption or unstable laser performance.

Standard 10G transceivers used in the data center/head end/hub sites rely upon environmental controls to maintain operation within the C-Temp envelope. The same transceivers installed in the outside plant put the performance of Remote PHY networks at risk.

At high temperatures, standard transceivers power consumption is likely to increase outside the alarm thresholds programmed into the transceiver. Should the transceiver's components (printed circuit boards, laser drivers, etc.) not be rated for temperatures greater than +70°C, the risk for component failure over the life of the unit also becomes much more likely.

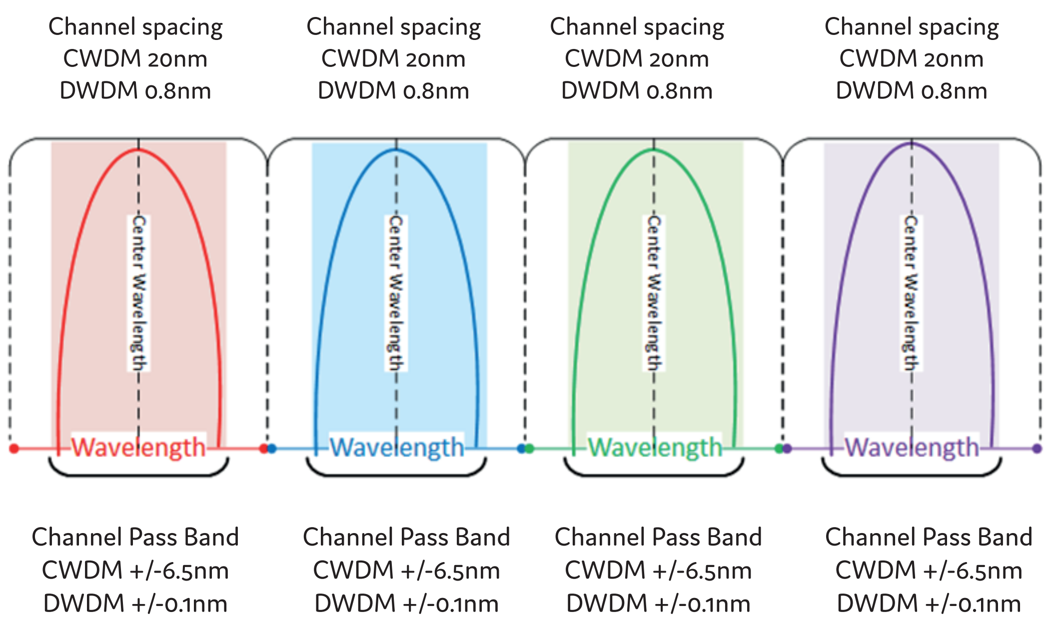
Wavelength Drift

Pluggable optical transceivers also offer Remote PHY designs a cost-effective method to leverage existing WDM technology to maximize existing fiber infrastructure. WDM technologies (both CWDM and DWDM) require additional consideration for deployment in the outside plant. Repeated high and low temperature cycles can cause the optical wavelength to 'drift' off center.

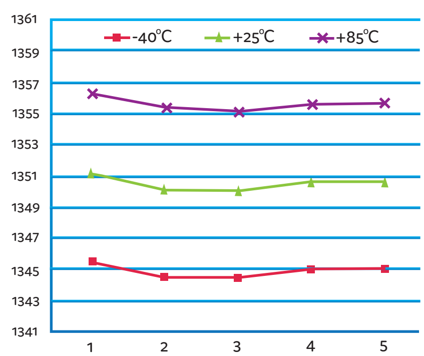
Wavelength drift impacts all types of optics, WDM and standard gray optics alike. Fiber optic wavelengths fluctuate around their center wavelength over time. Like their 'standard gray' optics cousins (1310nm, 1550nm), WDM transceivers have wideband receivers, even capable of receiving light transmitted at different wavelengths, even different than its own. When directly connecting two like transceivers, fluctuations in wavelength away from the transmitter center wavelength really don't matter to the service of the circuit, as the transceiver can receive light from across the spectrum.

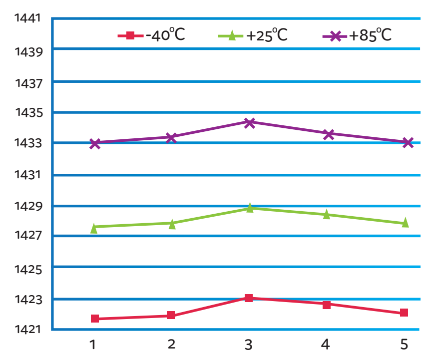
Where WDM transceivers and gray optics differ are in the use of passive WDM devices to multiplex multiple circuits onto a single fiber or fiber pair. WDM passive devices have a channel 'passband' that essentially acts like lane markers or dividers in a swimming pool.

The passband ensures that each wavelength stays in their own lane as it is transmitted across the fiber optic circuit. Like a swimming pool lane divider, there is a certain amount of room for WDM wavelengths to vary within the lane. Furthermore, like a swimming competition, should a wavelength attempt to pass light outside of its assigned lane or passband, the passive device will penalize or even disqualify and drop the transmission



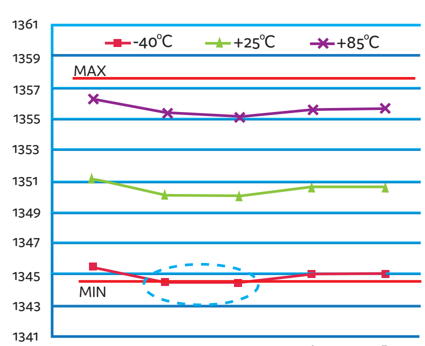
To demonstrate how time and temperature can impact a WDM optical transceiver, let's look at a simple accelerated aging study of two CWDM transceivers transmitting at 1351nm and 1431nm. The study cycled temperatures five times between -40C and +85C, measuring the transmitting wavelength at low, mid, and high temperatures.

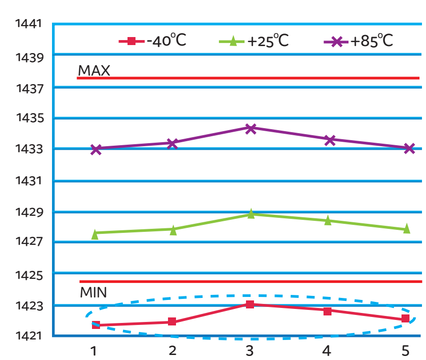




The WDM transceiver with the 1351nm center wavelength drifted between just short of 1357nm at high temperature down to 1345nm at low temperature in this study. Whereas, the 1431nm transceiver experiences a much wider drift, down to 1421nm at low temperature.

The passband of a typical passive CWDM device is +/-6.5nm from the center wavelength. This means that a 1431nm CWDM optic cannot transmit outside the 13nm range of 1424.5nm to 1437.5nm to ensure service is maintained on the circuit. In this study, service on the 1431nm WDM would have likely have be interrupted at the coldest points of the temperature cycles.





This study demonstrates the real world impact of time and temperature on network performance.

Wavelength Stabilization

Transceivers in the outside plant offer new considerations over those deployed in traditional head end or hub sites. Transceivers rated for industrial operating temperatures (-40C to +85C) are the right choice to ensure Remote PHY network performance over temperature and time.

The transceiver marketplace offers two approaches to maintaining operating temperatures. First is the 'should be good enough' approach. In this approach, transceivers are screened in the factory for characteristics that indicate performance temperatures. The screening may include reading optical test results or perhaps placing the transceiver in an environment chamber.

Screening is a point in time analysis that may or may not be backed up by a statistical analysis citing the transceiver's performance over time. The result is that perhaps one out of every 3 to 5 transceivers produced will meet specifications that should be good enough over temperature, over time in the network. The key point for network operators to consider is that the transceiver may perform at temperature at 'birth', but it does not consider the effect of temperature cycles over time on the transceiver.

The second approach is transceivers that incorporate wavelength stabilization technology to ensure WDM wavelengths remain in their 'swim lanes' over time and temperature.

Thermo-electric cooling (TEC) is the ideal choice for Remote PHY deployments using 10G WDM pluggable transceivers. TEC is a robust, proven technology that stabilizes WDM wavelengths by cooling the laser at high temperatures and warming it at cold temperatures. TEC seamlessly integrates with transceiver digital diagnostic monitoring (DDM) or digital optical monitoring (DOM), allowing full monitoring of transceiver temperature and power.

Summary

Remote PHY requires introducing SFP-based transceivers to the outside plant. In specifying transceivers for Remote PHY, consideration of transceiver operating temperatures, wavelength drift, and stabilization is critical. Selecting transceivers rated for the Industrial Temperature range and with integrated wavelength stability are concrete steps to assure network performance over temperature, over time.

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