Considerations on objectives for Beyond 10km Ethernet Optical PHYs running over a point-to-point DWDM system

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IEEE 802.3 Beyond 10km Optical PHYs Study Group, Jan 2018 - Geneva

Background

There is interest within the industry in defining new Ethernet optical PHYs with the ability to run over a single-channel (wavelength) port on a point-to-point DWDM multichannel optical system.

- http://www.ieee802.org/3/B10K/public/17_09/villarruel_b10k_01b_0917.pdf

The intent of this presentation is to foster a better understanding of this application and associated terminology, with the ultimate goal of defining an objective for such a PHY.

Discussion is relevant to 100G, 200G or 400G objectives

Reference

This contribution draws heavily from the Peter Stassar and Pete Anslow presentation at the Nov 2017, B10K study group meeting in Orlando.

- http://www.ieee802.org/3/B10K/public/17_11/stassar_b10k_01a_1117.pdf

Note, this presentation focuses on “option 2” from the above presentation.

Overview

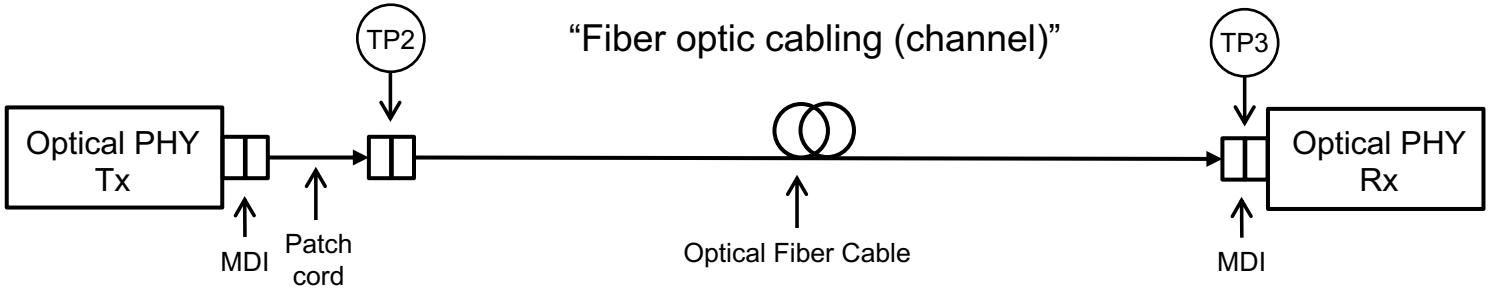
What we need to define:

An new Ethernet “DWDM PHY” that has optical interface specifications (i.e. at TP2 and TP3) enabling direct operation over single-channel (wavelength) ports of a point-to-point DWDM system (optical mux, optical amplifier, fiber, optical demux).

What do we NOT need to define:

The details of the point-to-point DWDM system itself.

Recap - Traditional Ethernet optical PHY link model



For clarity, only one direction of transmission is shown

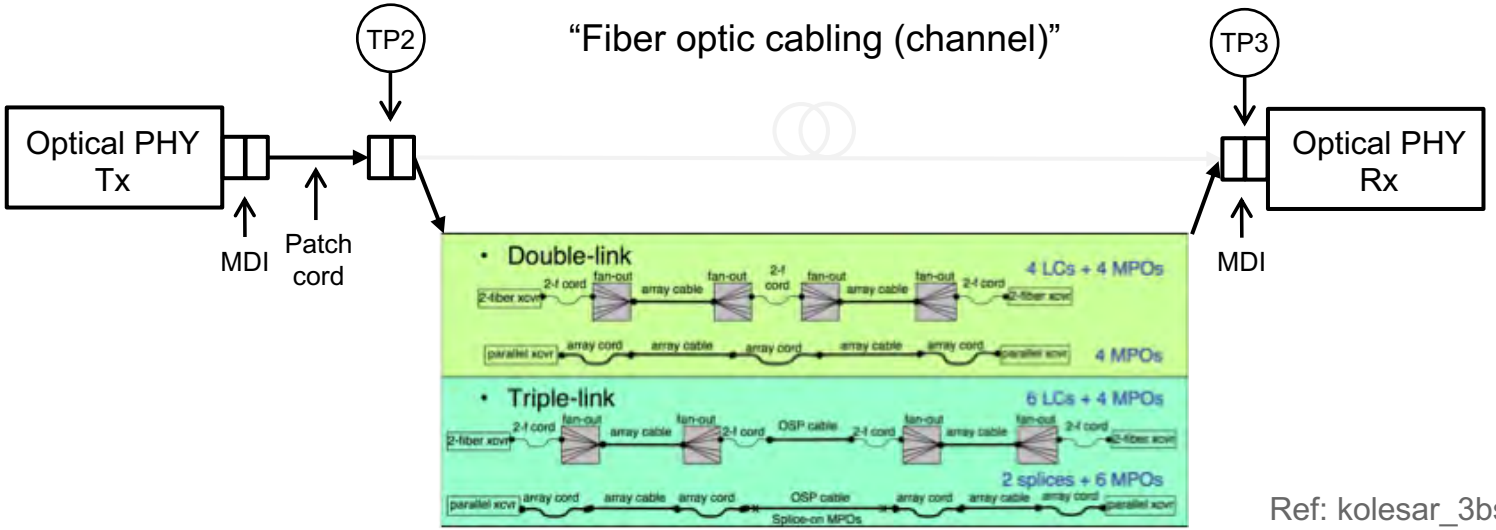
Ref: 802.3cd D2.2 Clause 139

In current IEEE 802.3 PHY's the optical link between transmitter and receiver, i.e. between TP2 and TP3, is in the form of a passive connection over a fiber optic cabling (channel).

The fiber optic cabling (channel) characteristics are defined in terms of a few key parameters, e.g. distance, loss, dispersion, DGD and return loss.

The detailed implementation of the fiber optic cabling (channel) is not defined by the standard (e.g. number and locations of splices, connectors, etc)

Recap - Traditional Ethernet optical PHY link model



Ref: kolesar_3bs_01_0514

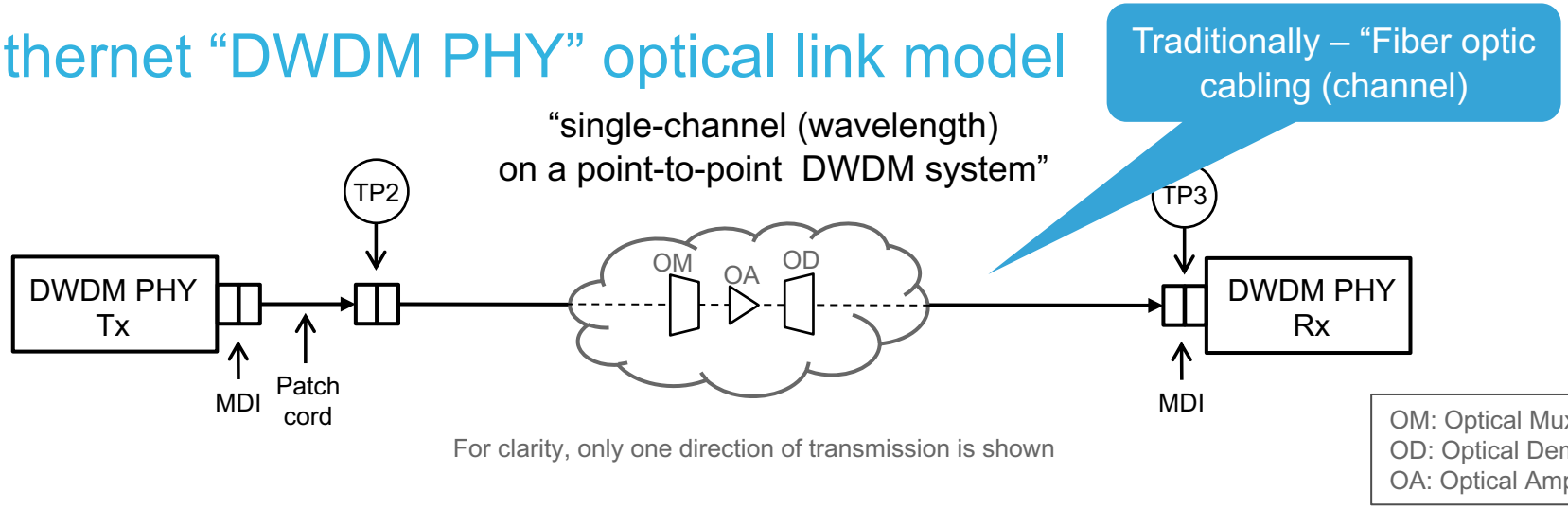
For clarity, only one direction of transmission is shown

The "reference" channels in kolesar_3bs_01_0514 were ***used*** to help define the optical interface parameters at TP2 and TP3.

The "reference" channels in kolesar_3bs_01_0514 are ***not*** part of the IEEE specification.

The "reference" channels in kolesar_3bs_01_0514 were not included in the objectives.

Ethernet “DWDM PHY” optical link model

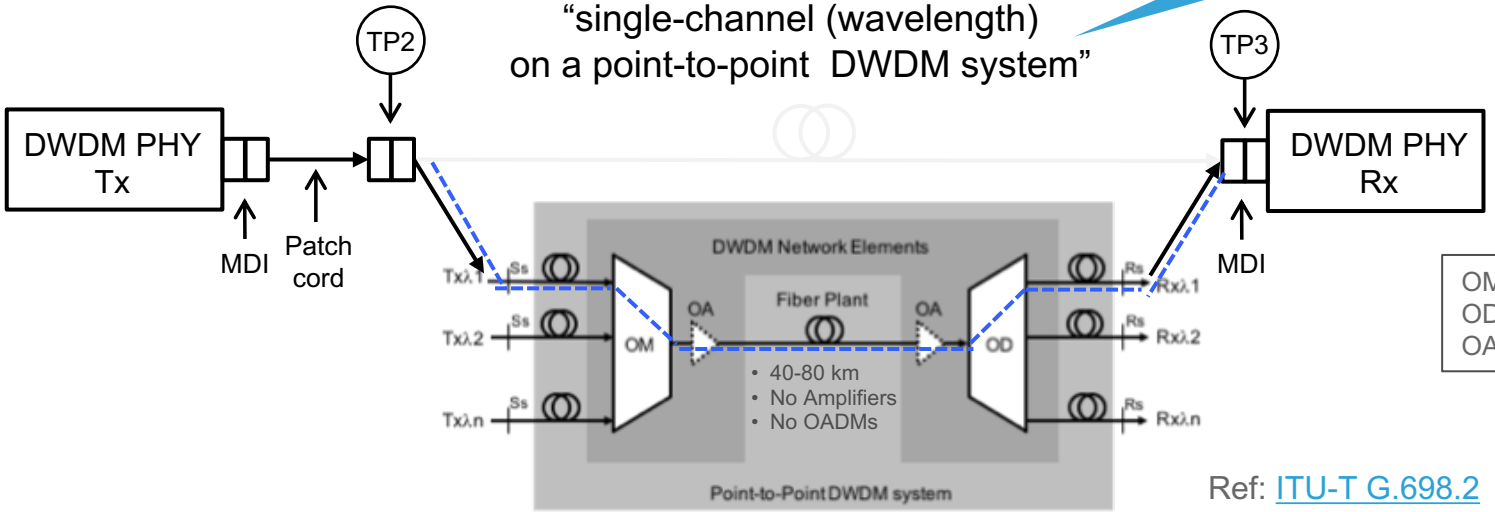


We need to define a “DWDM PHY” where the optical link between transmitter and receiver, i.e. between TP2 and TP3, is in the form of an optical channel connected over single-channel (wavelength) ports of a point-to-point DWDM system (optical mux, optical amplifier, fiber, optical demux).

At one level the link model is the same as a traditional Ethernet optical PHY. The difference is that the optical channel is more complex (see next slide).

Ethernet “DWDM PHY” optical link model

Traditionally – “Fiber optic cabling (channel)



Ref: ITU-T G.698.2

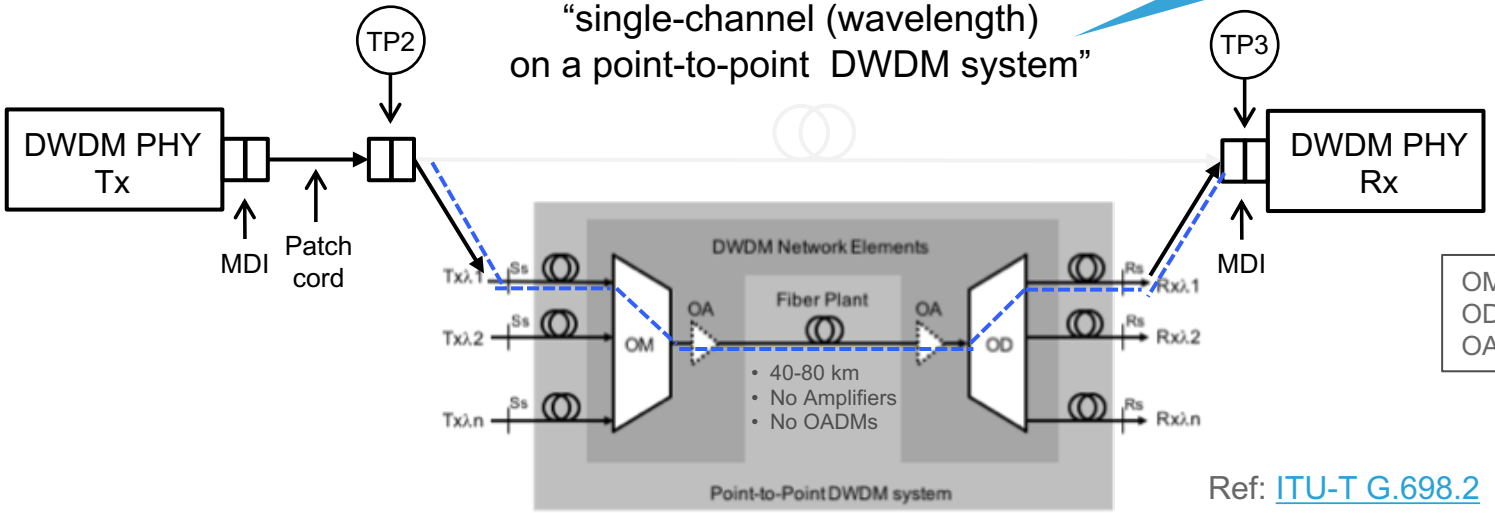
In this example the “DWDM PHY” runs over an optical channel comprising of λ1ports on the point-to-point DWDM system, using the ‘black link’ approach from ITU G.698.2

Note, λ2-λn ports of the same DWDM system could carry other Ethernet DWDM PHYs, or other (non-Ethernet) signals.

Ethernet “DWDM PHY” optical link model

Traditionally – “Fiber optic cabling (channel)

“single-channel (wavelength) on a point-to-point DWDM system”



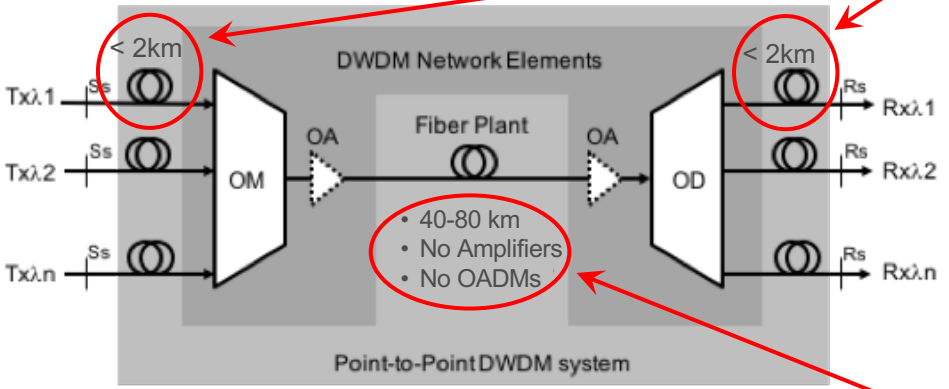
OM: Optical Mux
OD: Optical Demux
OA: Optical Amp

Ref: ITU-T G.698.2

As in the case of the traditional Ethernet optical PHY the optical reference channel (shown above) will be ***used*** to help define the optical interface parameters at TP2 and TP3.

Also like the case of the traditional Ethernet optical PHY, the optical reference channel (shown above) will ***not*** be a normative part of the IEEE specification

Important considerations for the optical channel



Ref: ITU-T G.698.2

This is important as limiting the distance (loss) between the DWDM PHY and the optical mux/demux of the DWDM system simplifies the optical channel.

This is important as it simplifies the challenges of defining the "DWDM PHY" compared to a more complex DWDM channel that could include concatenated in-line amplification or optical add-drop multiplexors enabling an any-to-any wavelength/fiber reconfiguration to happen.

This "limited" topology is anticipated to be the extent of Ethernet "DWDM PHY" specifications.

Writing Objectives

Given above discussion, a key goal is how to structure an objective in an IEEE project.

The full reference channel details do not need to be “captured” in the objective language

However, the Study group needs to look at, and agree upon some (many?) target reference channels in order to know the correct technical values to put into the objective language. This will be the subject of future contributions.

Objectives evolve to match the challenges. E.g. backplane objectives moved away from the relatively simple:

- (802.3ba) Provide Physical Layer specifications which support 40 Gb/s operation over
  at least at least 1m over a backplane

To the more complex:

- (802.3bj) Define a 4 lane PHY for operation over a printed circuit board backplane with a total channel insertion loss of <= 35 dB at 12.9 GHz

Potential strawman language of a “DWDM PHY”

Traditional Ethernet optical PHY objective language:

- “Define a single-lane 50 Gb/s PHYs for operation over SMF with lengths up to at least 2km”

Possible Ethernet “DWDM PHY” objective language:

1. Define a single-lane 100 Gb/s PHY for operation over single-channel (wavelength) ports on a point-to-point DWDM system over a distance of at least x km
2. Define a single-lane 100 Gb/s PHY for operation over single-channel (100 GHz wavelength spaced) ports on a point-to-point DWDM system over a distance of at least x km.

Thoughts on defining a baseline if objective adopted

Key work areas will be the specifications of TP2/TP3 with the new modulation techniques (new to IEEE).

Assumption is to highly leverage the existing good work in progress in ITU-T G698.2 revision on these parameters and more importantly the test and compliance methodologies.

Next Steps

- Establish clear terminology. Ethernet terms and ITU/Transport terms are not 100% interchangeable
- Review a number of reference channels that would satisfy the target applications
- Agree upon a wording structure for an objective for a “DWDM PHY”
- Pick the correct technical values for the objective that can then be used to build successful CSD responses against (Technical Feasibility, Economic feasibility, Broad Market Potential)

Thanks