Further considerations on objectives for PHYs running over point-to-point DWDM systems

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Supporters

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Introduction

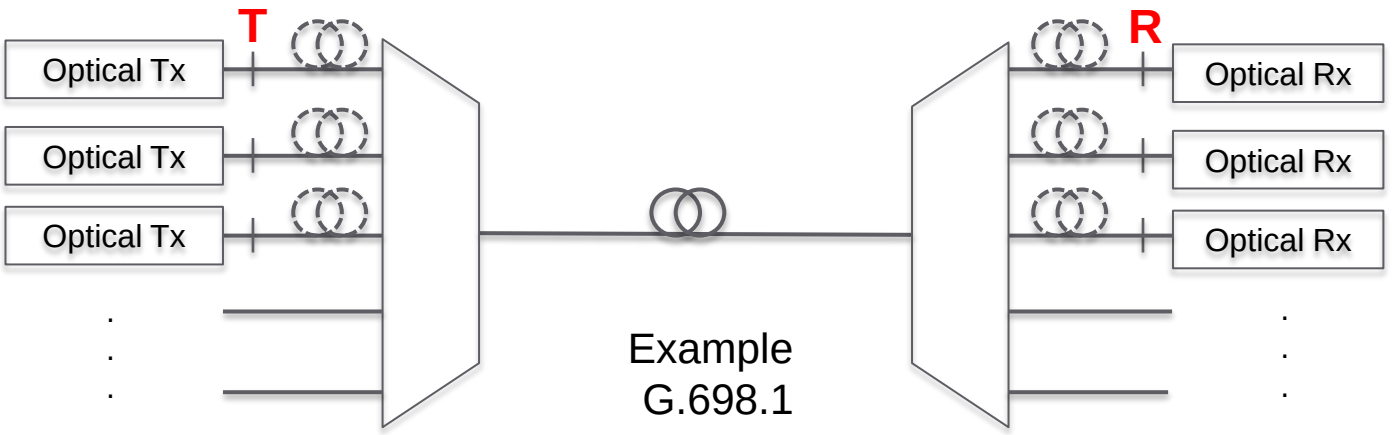
In this presentation reference is made to the following presentations provided to the b10k meeting in Geneva, January 2018:

- **http://www.ieee802.org/3/B10K/public/18_01/anslow_b10k_01_0118.pdf defining 6 different optical link types**
- **http://www.ieee802.org/3/B10K/public/18_01/stassar_b10k_01_0118.pdf proving further considerations on objectives for PHYs running over point-to-point DWDM systems using the 6 different optical link types as a starting point.**
- **http://www.ieee802.org/3/B10K/public/18_01/nicholl_b10k_01a_0118.pdf suggesting potential strawman language of a "DWDM PHY" objective**
- **In this presentation further considerations are provided.**

Recap on link type 3

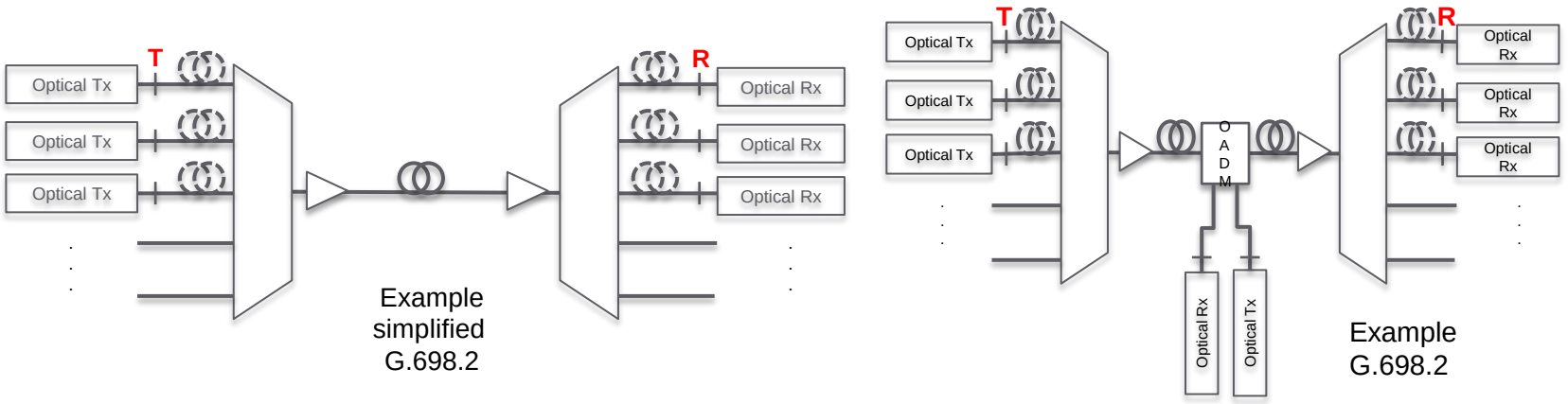
- **Is WDM link.**
- **Can be CWDM (20nm spaced) or DWDM (frequency spaced)**
- **CWDM examples: 40GBASE-LR4/ER4, 200GBASE-FR4**
- **DWDM examples: 100GBASE-LR4, 200GBASE-LR4, 400GBASE-FR8/LR8**

Recap link type 4



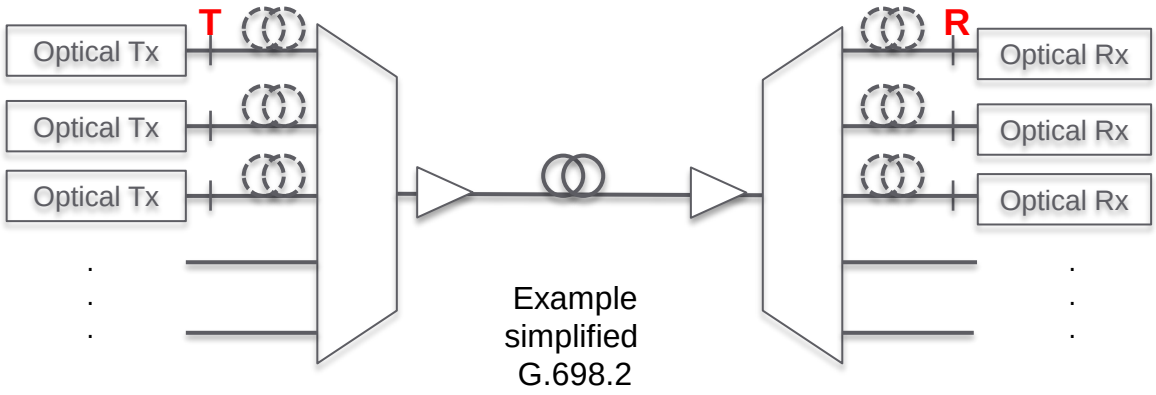
- **Is WDM network between multiple Tx and multiple Rx, each in point-to-point link via the network**
- **Black link between T and R is passive, no optical amplifiers.**
- **Can be CWDM (20nm spaced) or DWDM (frequency spaced, e.g. 800 GHz)**
- **CWDM examples in ITU-T G.695**
- **DWDM examples in ITU-T G.698.1**

Recap on link type 5 versus link type 6



- **The only difference between link types 5 and 6 is the presence of OADMs.**
- **From a specification methodology (black link) point of view there is NO difference between 5 and 6.**
- **Link type 5 requirements for OSNR @ R and “tunnel” width (max spectral excursion) may be less stringent than for type 6.**
- **In both cases the link performance may be heavily determined by non-linear effects inside the black link**

Back to Link type 5



- **The proposal in nicholl_b10k_01a_0118 is equivalent to adopt an objective for a PMD covering link type 5 in anslow_b10k_01_0118.**
- **Also the following is stated in nicholl_b10k_01a_0118**
  - ***"No need to define the details of the point-to-point DWDM system itself."***
- **This implies adoption of a black link specification methodology between T and R.**
- **More on black link later in this presentation**

ITU-T SG15 & IEEE 802 workshop 27 Jan 2018

Suggestion from the joint workshop between IEEE 802.3 and ITU-T SG15, held on 27 January 2018, in particular Session 1 "New High-Speed and Long Reach Optical Interfaces", as noted in https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20180127/Documents/Outcomes%20-%20Building%20Tomorrow%20Networks-Final.pdf:

IEEE 802.3 B10k SG should weigh the implications of moving away from a comprehensive "plug -and -play" specification to one where the detail of how to engineer the "black link" to meet the transfer specifications is not specified by the standard.

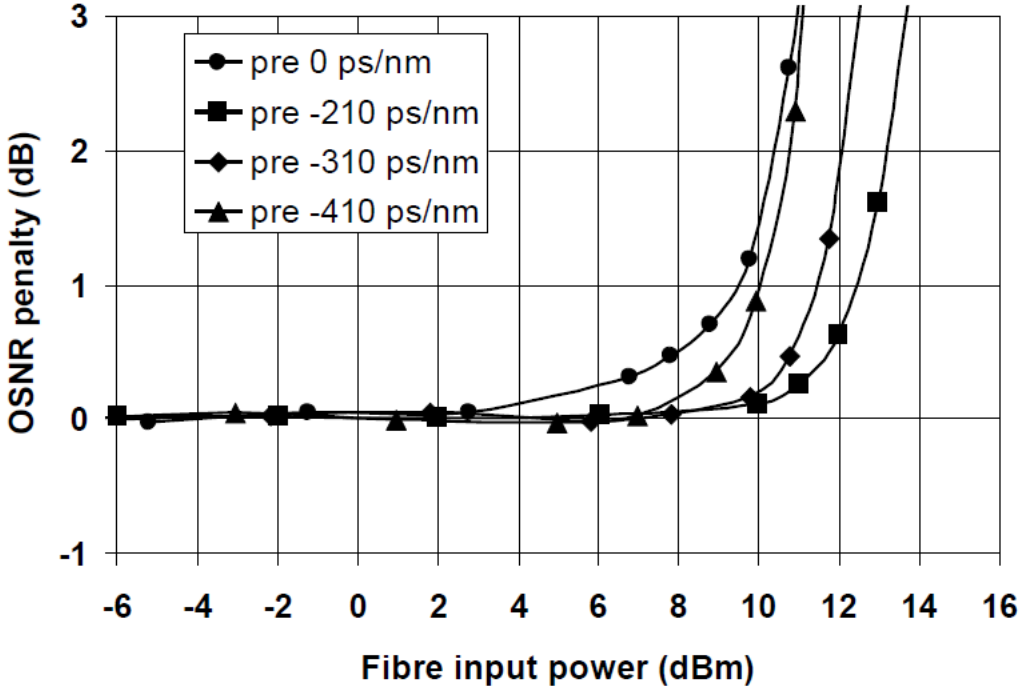
Impact of adopting black link methodology

- **The black link is intentionally “black”, no details are provided on constraints to operate a link or how to construct a link towards meeting overall performance objectives.**
- **Introduction of one or more optical amplifiers inside “black link” between T and R:**
  - **No longer loss limited system. OSNR at Rx input (R).**
  - **Introduction of non-linear impairments inside “black link”.**
- **Non-linear interaction between the parallel channels inside “black link” between T and R, depending heavily of the “nature” of the parallel channels.**
- **Hugely different link behaviour and “interaction”, e.g. in the case of 10G NRZ amplitude modulated signals in parallel to 100G coherent signals.**

Impact of adopting black link methodology

- One talks about a “black link provider” as the “entity” in control of the performance of the link
- Constructing a black DWDM link (even when it only contains a mux, one optical amplifier, one fiber section and a demux) is a complete engineering effort where one needs to take account of:
  - Manage amplifier gain tilt when loading the system from 1 or 2, to n channels, because the performance of the link changes versus number of loaded channels.
  - Avoiding transients (surges from amplifier due to changes in number of channels)
- Effectively managing the OA(s) in a black link requires a complete set engineering set of decisions.
- It’s impossible to cover all of this in a single specification.
- Therefore some speak of “a room full of PhD’s”.

Example of non-linear behaviour



Source: ITU-T supplement G.Sup39

Figure 9-21 – OSNR penalty versus fibre input power for one span of ITU-T G.652 fibre with different pre-compensation values; the NLT is the power value at 1 dB of OSNR penalty

If the black link is not engineered well, the OSNR penalty runs off a cliff.

Summary

- **The benefit of using black link specification methodology is that it allows the end user a lot of flexibility for a wide range of applications:**
  - **In terms of distance, number of channels, nature of signals carried across the DWDM link.**
- **In ITU-T a black link spec is created on the basis of terms of reference like “appropriate for 80 km distances, single span, no OADMs, not precluding 120 km and 1 or 2 OADMs”.**
- **Defining a DWDM (black) link spec for a very specific configuration, e.g. only 80 km single span no OADMs, would significantly narrow application space and thus broad market potential.**

Key question (workshop)

What are the implications of moving away from a comprehensive “plug -and -play” specification to one where the detail of how to engineer the “black link” to meet the transfer specifications is not specified by the standard?

Q & A?

Thanks