Terminology around DWDM systems and relation with ITU-T SG15 Recommendations

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Introduction

Over the past weeks the terms “DWDM system”, “DWDM link” and “black link” have come up several times during various discussions in P802.3ct about comments and associated resolutions to D3.0.

Some have been trying to retrieve definitions from information in Recommendation ITU-T G.698.2.

In this presentation the author provides his perspective on this terminology from his experience in ITU-T SG15 and development of G.698.2 in particular.

Finally a view is provided on the impact of these terms on the actual PMD specification in D3.0 and D3.1.

What do we have so far in D3.1

1.4.160a black link: A multi-channel link specified using a methodology where the input, output, and transfer characteristics of the uni-directional transmission path between TP2 to TP3 for a given DWDM channel are specified, without specifying how the transmission path is implemented. (See, for example, IEEE Std 802.3, Clause 154, Figure 154–3)

1.4.237a DWDM channel: The transmission path between a DWDM PHY transmitting to another DWDM PHY.

1.4.237b DWDM link: One DWDM PHY transmitting to one other DWDM PHY through the transmission path between them.

1.4.237c DWDM PHY: An Ethernet PHY that is capable of running over one DWDM channel in each direction of transmission.

1.4.237d DWDM system: An aggregate of DWDM links optically multiplexed and demultiplexed onto and off either a single optical fiber or a single optical fiber per direction.

What exactly is a DWDM system?

A specific definition of “DWDM system” does not exist in ITU-T SG15 Recommendations.

- It is a term generally used, but always in a certain context.
- Without that context trying to create a specific definition will be meaningless.

There are 2 elements in this term “system” and “DWDM”.

What’s a system?

Even IEEE 802.3 standards do not seem to contain a definition for “system”.

It’s the author’s view that “system” is a generic term.

So what is a system?

An obvious place to look for some explanation is Wikipedia

https://en.wikipedia.org/wiki/System:

A system is a group of interacting or interrelated entities that form a unified whole. A system, surrounded and influenced by its environment, is described by its boundaries, structure and purpose and expressed in its functioning.

And furthermore:

A subsystem is a set of elements, which is a system itself, and a component of a larger system.

These are generic and also appropriate for our usage in IEEE 802.3.

So what is a DWDM system?

The term “system” is generic.

“DWDM” being “dense wavelength division multiplexing” as included in D3.1’s list of abbreviations.

From that point of view “DWDM systems” is generic as well.

Is the current definition then not too specific?

An aggregate of DWDM links optically multiplexed and demultiplexed onto and off either a single optical fiber or a single optical fiber per direction.

Why even need it?

Perhaps we should seriously consider to delete it.

Black link related terminology in G.698.2

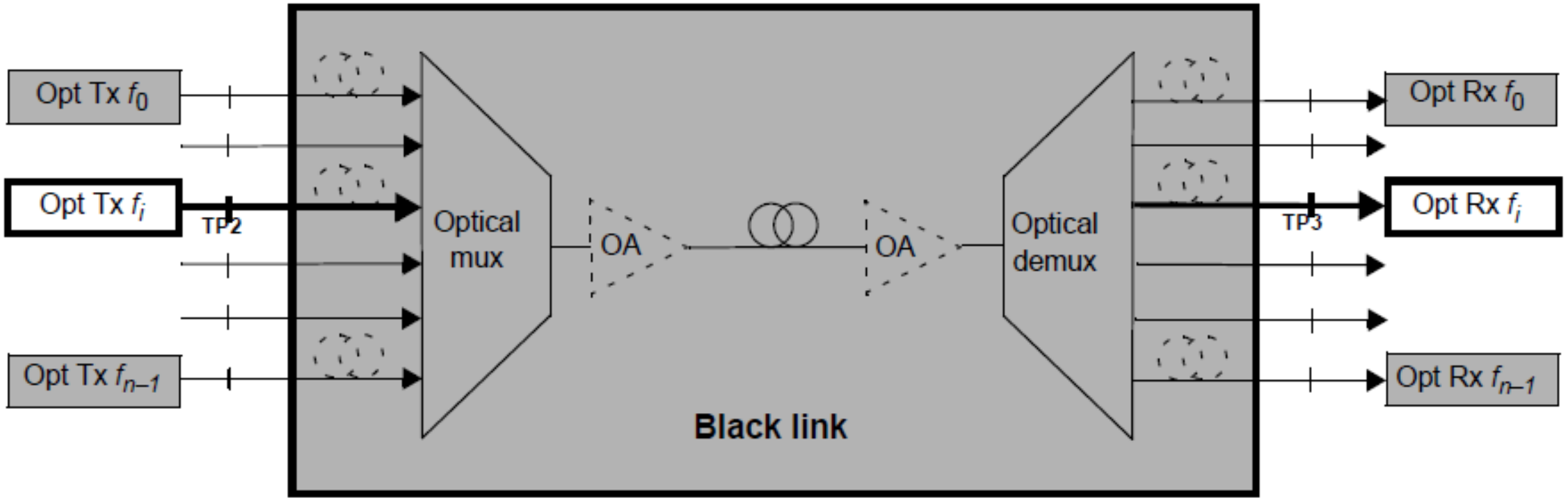
In several discussions in the TF reference has been made to figures in Recommendation ITU-T G.698.2, in particular Figure 5-1, Figure II-1 and, Figure II-2.

Unfortunately due to some IEEE rules/restrictions it has not been possible to include a copy of these figures in this presentation (despite specific permission by ITU-T legal).

Instead some specific references to those figures have been included in this presentation to encourage participants to IEEE 802.3 to access and download publicly available Recommendation ITU-T G.698.2 from the ITU-T website:

https://www.itu.int/rec/T-REC-G.698.2-201811-I

Figure 154–3—Black link example configuration for specifying n DWDM channels



Fully consistent with Figure 5-1 in G.698.2. The transmitter frequency is used instead of transmitter wavelength, no OADM is shown, and “black link” is referred to instead of “DWDM link”.

Purpose of Figure 5-1 from G.698.2

This figure was included in G.698.2 to show/define the location of the reference points for the linear "black link" approach for the single-channel connections between transmitters (Tx) and receivers (Rx), equivalent to TP2 and TP3 in IEEE 802.3.

The further description of Figure 5-1 includes statements equivalent to subclause 154.6 in D3.1, saying that the DWDM network elements include an optical multiplexer (OM) and an optical demultiplexer (OD) and that also one or more optical add-drop multiplexers (OADMs) may be included. And furthermore that the arrangement of elements within the black link shown is not intended to place constraints on the construction of the black link, but simply to define the location of the single channel interfaces.

Figure 5-1 is not intended to create definitions only to clarify.

Purpose of Figures II-1 and II-2 from Appendix II to G.698.2

Appendix II of Recommendation ITU-T G.698.2 is an informative appendix. Again, not intended to provide definitions.

The contents are intended to clarify one of the purposes of G.698.2, to enable elimination of transponders via the creation of single channel DWDM interface specifications.

Figure II-1 shows previous usage of proprietary DWDM line systems connected to external equipment (e.g. routers) via so-called “non-coloured” optics. Here the term “system” is used generically.

Figure II-2 shows the embedding of G.698.2 compliant transmitters & receivers in equipment external to a single vendor black link creating a multivendor DWDM line system with transponders removed. This is consistent with the purpose of subclause 154.6.

“black link” in earlier ITU-T recommendations

- Recommendation ITU-T G.698.2 is not the first ITU-T recommendation where “black link” terminology is used.

- The first recommendation is G.695, “*Optical interfaces for coarse wavelength division multiplexing applications*”, first version approved 02/2004, latest version approved 07/2018: https://www.itu.int/rec/T-REC-G.695-201807-I

- In G.695, terms like “black link approach”, “black link applications” and “black link” are used throughout the standard.

- The second recommendation is G.698.1, “*Multichannel DWDM applications with single-channel optical interfaces*”, first version approved 06/2005, latest version approved 11/2009: https://www.itu.int/rec/T-REC-G.698.1-200911-I

Intents of introducing “black link” in ITU-T recommendations

- Specifying details of the link between the single channel reference points S_s/R_s (TP2/TP3 in 802.3) were regarded complicated, with endless variations and probably not achievable.

- Therefore the “thing” between the single channel reference points was made “black”, called a “black link” and the associated methodology / approach to enable the creation of a suitable optical interface specification was called “black link approach / methodology”.

- It is essential to understand that this was done for the case where inside the “thing” there are parts were multiple channels are simultaneously present on a single fiber. If this were not the case, then the whole approach would not have been necessary, i.e. for the conventional case of transmission of one channel via a single fiber.

Correlation of link related terms

1.4.160a black link: A multi-channel link specified using a methodology where the input, output, and transfer characteristics of the uni-directional transmission path between TP2 to TP3 for a given DWDM channel are specified, without specifying how the transmission path is implemented. (See, for example, IEEE Std 802.3, Clause 154, Figure 154–3)

1.4.237a DWDM channel: The transmission path between a DWDM PHY transmitting to another DWDM PHY.

1.4.237b DWDM link: One DWDM PHY transmitting to one other DWDM PHY through the transmission path between them.

The definitions for “black link” and “DWDM link” are consistent with each other, except that “DWDM link” applies to both “black” links and “non-black” links and thus is more generic than “black link”.

“DWDM channel” is not equivalent to “DWDM link” because it refers to the transmission path, read “canal”.

Correlation of link related terms, continued

- Some people seem to be of the view that we shouldn’t use the term simultaneously for the approach/methodology and the link itself.
- However many seem to be of the view that consistency and alignment with G.698.2 should be maintained.

- The term “black link” occurs 52x in G.698.2
- The term “DWDM link” occurs 10x in G.698.2 (of which 5x in a Figure)
- “DWDM link” should be seen as a term consistent with “black link”, to express the same thing, but a wording alternative in G.698.2, being less precise than “black link”.
- The Scope (as important in ITU-T as CSD/PAR in IEEE 802.3) of G.698.2 clearly uses both the “black link” approach as well as the term “black link” from a link perspective.
- In G.698.2 “black link” clearly applies to the “whole thing”, being a “grey box” with a number of single channel inputs & outputs.

Author’s view on “DWDM system” terminology

The current definition for “DWDM system” is unnecessarily specific and potentially excluding some use cases.

The author will submit a comment to D3.1 to delete the current definition.

Author's view on "black link" terminology

The current definition for "black link" in D3.1:

black link: A multi-channel link specified using a methodology where the input, output, and transfer characteristics of the uni-directional transmission path between TP2 to TP3 for a given DWDM channel are specified, without specifying how the transmission path is implemented. (See, for example, IEEE Std 802.3, Clause 154, Figure 154–3).

Is appropriate, very much aligned & consistent with G.698.2, and should be maintained.

The only viable alternative term for describing the link itself could be "DWDM black link".

Changing it to anything else will make the term "black link approach" or "black link methodology" meaningless.

Author’s view on impact of terminology, continued

- The term “black link” (or alternatively “DWDM black link”) has no impact on the actual PMD specification in Clause 154.
- The PMD specification in D3.1 is technically complete and not related to the terminology discussion.
- There are 30 instances of “black link” in Clause 154, of which 3 instances in connection to approach/methodology.
- It is the author’s view that Clause 154 is not broken from a specification perspective.
- We shouldn’t try to fix what is not broken.

Author’s view on impact of terminology, continued

- With respect to the ongoing crosstalk discussion in P802.3cw the only relevant term is “DWDM channel”, referring to the transmission path between a DWDM PHY transmitting to another DWDM PHY, which can be read as “canal” through the black link.

- Characterization of that “canal” is very relevant for the crosstalk modelling.

Thanks!