



802.3df

Optics PMD Overview

Primer for Optics Track

IEEE P802.3df
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Focus of the optics track – near term

Organization of Project Work

Logic	Electrical	Optical
<ul style="list-style-type: none">• Amendments to MAC, RS, and MAC PHY interfaces• RS and MII• Extender Sublayers?• PCS functions• PMA functions• Provide support to enable mapping over OTN	<ul style="list-style-type: none">• Extender Sublayer?• C2C AUIs• C2M AUIs• Copper PMDs• Channel characteristics for electrical interfaces and PMDs	<ul style="list-style-type: none">• Optical PMDs• MDIs?• Media Characteristics
FEC Architecture and Budget		
<ul style="list-style-type: none">• Overall Architecture	<ul style="list-style-type: none">• FEC related to electrical interfaces and PMDs	<ul style="list-style-type: none">• FEC related to Optical PMDs
<ul style="list-style-type: none">• Management related to Logic functions (Clauses 30, 45, etc.)	<ul style="list-style-type: none">• Management related to electrical interfaces and PMDs (Clauses 30, 45, etc.)	<ul style="list-style-type: none">• Management related to Optical PMDs (Clauses 30, 45, etc.)

Further insight to be provided by Track Leadership @ 18 Jan 2022 Meeting

802.3df Adopted Objectives

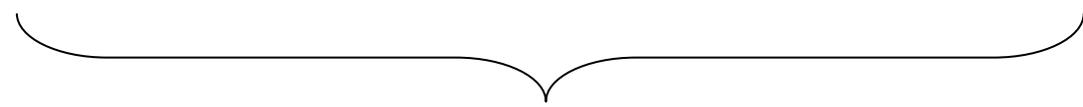
Ethernet Rate	Assumed Signaling Rate	AUI	BP	Cu Cable	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
200 Gb/s	200 Gb/s	Over 1 lane		Over 1 pair			Over 1 Pair	Over 1 Pair		
400 Gb/s	200 Gb/s	Over 2 lanes		Over 2 pairs			Over 2 Pair			
800 Gb/s	100 Gb/s	Over 8 lanes	Over 8 lanes	Over 8 pairs						
	200 Gb/s	Over 4 lanes		Over 4 pairs			Over 4 pairs	1) Over 4 pairs 2) Over 4 λ 's		
	TBD								Over single SMF in each direction	Over single SMF in each direction
1.6 Tb/s	100 Gb/s	Over 16 lanes								
	200 Gb/s	Over 8 lanes		Over 8 pairs			Over 8 pairs	Over 8 pairs		

Leverage existing or work-in-progress 100 Gb/s per lane (e.g. 3cu, 3ck, 3db) to higher lane counts

Develop 200 Gb/s per lane electrical signaling for 1/2/4/8 lane variants of AUIs and electrical PMDs

Develop 200 Gb/s per optical fiber for 1/2/4/8 fiber based optical PMDs and 4 lambda WDM optical PMD

Potential for either direct detect and / or coherent signaling technology



13 Optical PMD Objectives

Goal for this presentation

- Review and highlight potential topics for the .3df Optics Track to explore
 - Most likely this isn't an exhaustive review/summary
 - Early contributions will likely identify further work areas
- Solicit and encourage contributions
 - We are a contribution-led group

Items for today

- 1) Topics related to other 802.3df Tracks
- 2) 100 Gb/s based PMDs
- 3) 200 Gb/s based PMDs
- 4) Longer reach SMF PMDs
- 5) Discussion on Objectives



Topics related to other 802.3df Tracks

Optical inputs related to other Tracks

- Initial need for all aspects of 802.3df is to define an architecture and FEC
 - See `gustlin_3df_01_210118`

- **Big questions:**
 - What FEC gain is required by the PMDs/AUIs at 200Gb/s/lane?
 - What error models are dominant (Gaussian vs. non-Gaussian)
 - These questions will likely take a long time to answer
 - Wrapped up in the modulation chosen per interface type
 - Equalization used, etc.
- **What FEC architecture do we need/want?**
 - End to end vs. segmented vs. concatenated structures (or other)
 - Is it PMD dependent?
 - Almost certainly for some PMDs (40km for instance)
 - Where to optimize power vs. flexibility vs. gain

All of these questions need contributions from an optical perspective

- Specification impacts
- Implementation impacts

- Electrical Track
 - what is optimal modulation for copper cable or AUIs? Impact to optics?

100 Gb/s based PMDs

100 Gb/s based PMDs - questions

Ethernet Rate	Assumed Signaling Rate	AUI	BP	Cu Cable	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
800 Gb/s	100 Gb/s	Over 8 lanes	Over 8 lanes	Over 8 pairs						

- In theory, this is low-hanging fruit
- Existing specifications or drafts in place
 - 802.3 for 100 Gb/s SMF specs
 - 400GBASE-DR4, 100GBASE-DR, 100GBASE-FR1
 - 802.3db drafts in progress for 100 Gb/s MMF
 - 100GBASE-VR1, 100GBASE-SR1, etc...
- Questions (contributions needed)
 - Do we leverage existing work?
 - Review objectives (see later in this presentation)
 - New MDI for 8x SMF PMDs

200 Gb/s based PMDs

200 Gb/s based PMDs

- These will be new-to-industry PMDs
- All typical aspects of an optical link budget will need to be explored
 - 1) High speed component aspects
 - Component bandwidths
 - Equalization requirements
 - Launch powers, Rx sensitivities
 - Reference receiver definition
 - Transmitter quality metrics (eg TDECQ)
 - etc
 - 2) System/Arch aspects
 - FEC requirements (& error statistics)
 - Modulation (different FEC strategies, Elec vs Optics)
 - Power
 - Latency
 - 3) Channel
 - Dispersion effects – does 200G change anything?

- 4) Market needs
 - Module backwards compatibility with slower speeds (impacts modulation and wavelength choices)?
- 5) New PMDs – 2km parallel
- 6) New MDIs (8x, new dense connectors)

Ethernet Rate	Assumed Signaling Rate	SMF 500m	SMF 2km
200 Gb/s	200 Gb/s	Over 1 Pair	Over 1 Pair
400 Gb/s	200 Gb/s	Over 2 Pair	
800 Gb/s	100 Gb/s		
	200 Gb/s	Over 4 pairs	1) Over 4 pairs 2) Over 4 λ 's
	TBD		
1.6 Tb/s	100 Gb/s		
	200 Gb/s	Over 8 pairs	Over 8 pairs

Longer Reach PMDs

Longer Reach PMDs

- Signaling rate and number of lanes is “TBD” for these PMDs as a group
- 40 km – coherent modulation likely but direct detect presented in SG
- 10 km – direct detect or coherent could be considered
- Questions/Contributions
 - Coherent vs direct detect suitability for 10km / 40 km
 - Possibility to leveragability of existing specs to help
 - Economics of options
 - Feasibility of options with target implementations
 - FEC requirements
 - Amplified/engineered links?
 - Market needs:
 - Multi-reach compatibility? Multi-rate (aka backwards) compatibility?
 - Coherent – Transmitter quality metric (.3cw hopefully will resolve)

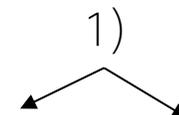
Ethernet Rate	Assumed Signaling Rate	SMF 10km	SMF 40km
200 Gb/s	200 Gb/s		
400 Gb/s	200 Gb/s		
800 Gb/s	100 Gb/s		
	200 Gb/s		
1.6 Tb/s	TBD	Over single SMF in each direction	Over single SMF in each direction
	100 Gb/s		
	200 Gb/s		



Discussion on objectives

Observations on objectives

Ethernet Rate	Assumed Signaling Rate	AUI	BP	Cu Cable	MMF 50m	MMF 100m	SMF 500m	SMF 2km
200 Gb/s	200 Gb/s	Over 1 lane		Over 1 pair			Over 1 Pair	Over 1 Pair
400 Gb/s	200 Gb/s	Over 2 lanes		Over 2 pairs			Over 2 Pairs	
800 Gb/s	100 Gb/s	Over 8 lanes	Over 8 lanes	Over 8 pairs				
	200 Gb/s	Over 4 lanes		Over 4 pairs			Over 4 pairs	1) Over 4 pairs 2) Over 4 λ's
	TBD							
1.6 Tb/s	100 Gb/s	Over 16 lanes						
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- 1) Parallel SMF PMDs: We have both 500m and 2km reaches. Are both necessary?
- 2) 8x100G @ 2km exists, but 4x100G @ 2km objective doesn't. This is often known as 400G-DR4+ in industry. Is there interest to codify it into this project?
- 3) Parallel 400 GbE (2x200G) SMF 500m PMD objective exists, but unclear on SMF adoption of 2x infrastructure by industry or any previous 802.3 project. Keep/remove objective? Add 400 GbE (2x200G) 2km objective? Add 200 GbE (2x100G) objective?

Summary

- 802.3df has 13 optics objectives
 - Do we prioritize?
- Goal is to work towards establishing a baseline specification for each first
 - Necessary technology investigations (i.e. contributions) needed in many cases
 - Inputs into other tracks and knowledge from other tracks will be important
- Reminder of presentation request deadline of 1/21 for February meetings

Thank You!