Observation on the Rate of Beyond 400GbE

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Background

- From [dambrosia_nea_01_1119](), this contribution try to share some observation and insight to help consensus on Beyond 400GbE at IEEE 802.3

  - Thoughts on needing new speed?

  - Timing – start / completion?

  - 800 GbE versus 1.6 TbE versus both? (Good question for a study group!!!!)

  - Target application spaces and PHYs?

  - Technology – 100 Gb/s versus 200 Gb/s signaling?
    - 100 Gb/s signaling
      - In development now
      - Impact on speed choice? 16x100G interface? Optical Mux loses impact reach?
    - 200 Gb/s signaling
      - Optics –
        - PAM4?
        - Coherent up to 400 Gb/s already being standardized / developed – building block?
      - Electrical – significant paradigm shift?
   - Technical / economic feasibility?

The Rate Debate: When and What?

□ Even based on the output of BWAII only , 800GbE and/or 1.6TbE should be discussed RIGHT NOW in IEEE 802.3 as this community's responsibility to answer this interested question to industry
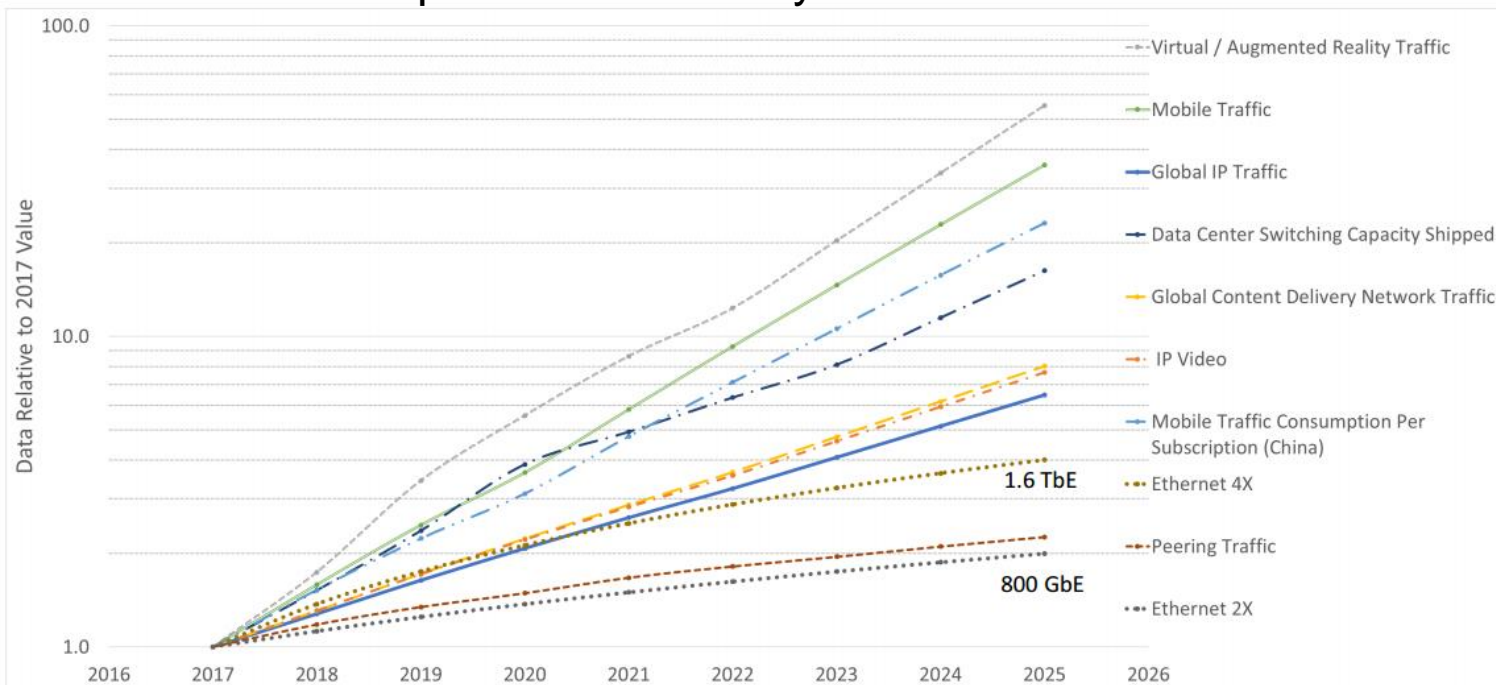
Further Information to Support the Bandwidth Forecast: Artificial Intelligence

❑ AI from wikipedia: In computer science, artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans

❑ AI from WIPO(World Intellectual Property Organization): WIPO Technology Trends 2019: Artificial Intelligence

   https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf

❑ The AI capability relying on computing and high performance server will further impact Ethernet network based infrastructure
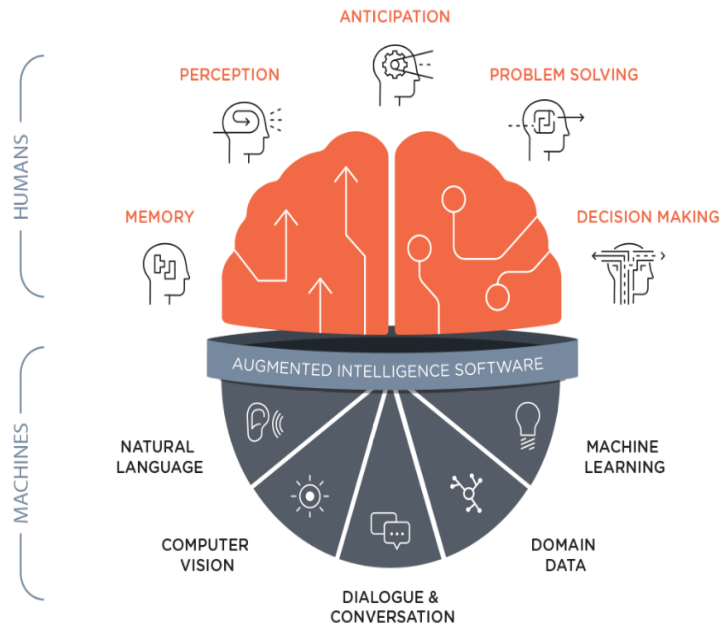
AI Computing Platform Example: 100GbE Now

□ The Atlas 900 AI cluster consists of thousands of Ascend 910 AI processors. It integrates HCCS, PCIe 4.0, and 100G RoCE high-speed interfaces through the cluster communication library and job scheduling platform

□ With the emerging high performance AI silicon processor, higher bandwidth on NIC(Network Interface Card) and network is expected

https://e.huawei.com/en/products/cloud-computing-dc/atlas/atlas-900-ai

Refer to 2019 Ethernet roadmap from Ethernet Alliance

- Backplane
- Twinax Cable
- MMF: Diversity reach with SR#
- SMF: PSM4 for 500m
- SMF: 2/6km
- SMF: fixed wavelength 10/40/80km
- SMF: 80km DWDM

EMERGING INTERFACES AND NOMENCLATURE

	Electrical Interface	Backplane	Twinax Cable	Twisted Pair (1 Pair)	Twisted Pair (4 Pair)	MMF	500m PSM4	2km SMF	10km SMF	20km SMF	40km SMF	80km SMF
10BASE–		T1S		T1S/T1L								
100BASE–				T1								
1000BASE–				T1	T							
2.5GBASE–		KX		T1	T							
5GBASE–		KR		T1	T							
10GBASE–				T1	T				BIDI Access	BIDI Access	BIDI Access	
25GBASE–	25GAUI	KR	CR/CR-S		T	SR			LR/ EPON/ BIDI Access	EPON/ BIDI Access	ER/ BIDI Access	
40GBASE–	XLAUI	KR4	CR4		T	SR4/eSR4	PSM4	FR	LR4			
50GBASE–	LAUI-2/50GAUI-2								EPON/ BIDI Access	EPON/ BIDI Access	BIDI Access	
50GAUI-1		KR	CR			SR		FR	LR		ER	
100GBASE–	CAUI-10 / CAUI-4/100GAUI-4 / 100GAUI-2 / 100GAUI-1	KR4 / KR2 / KR1	CR10 / CR4 / CR2 / CR1			SR10 / SR4 / SR2	PSM4 / DR	10X10 / CWDM4/ CLR4 / 100G-FR	LR4/ 4WDM-10 / 100G-LR	4WDM-20	ER4/ 4WDM-40	ZR
200GBASE–	200GAUI-4 / 200GAUI-2	KR4 / KR2	CR4 / CR2			SR4	DR4	FR4	LR4		ER4	
400GBASE–	400GAUI-16 / 400GAUI-8 / 400GAUI-4	KR4	CR4			SR16 / SR8/SR4.2	DR4	FR8 / 400G-FR4	LR8 / 400G-LR4		ER8	ZR

Gray Text = IEEE Standard   Red Text = In Standardization   Green Text = In Study Group
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces

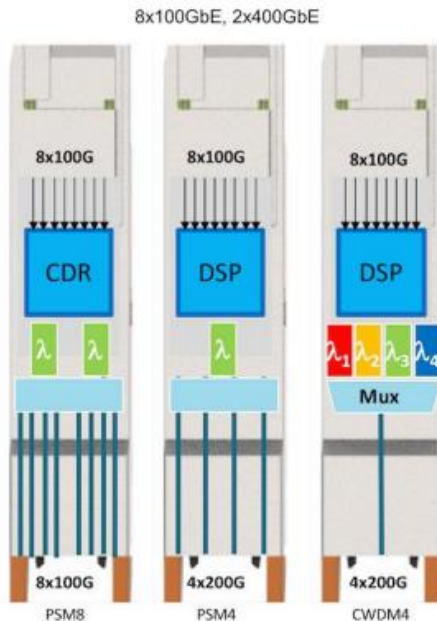Refer to 2019 Ethernet roadmap from Ethernet Alliance

Technology: More Clarification Needed to Support Feasibility

- 800G MSA VS 800GbE?

  - New FEC and logic layer definition comparing KP4 FEC with 6.3dB NCG?

- Reach for 8X100G PSM8? 100m, 500m, or 2km?

- Gap or overlap between 8X100G and 4X200G with PSM#?

- Reach for 4X200G CWDM4? 2km, or extend to 6km, 10km?

800G MSA

Source: http://www.gazettabyte.com/home/2019/9/18/companies-gear-up-to-make-800-gig-modules-a-reality.html

8x100GbE, 2x400GbE

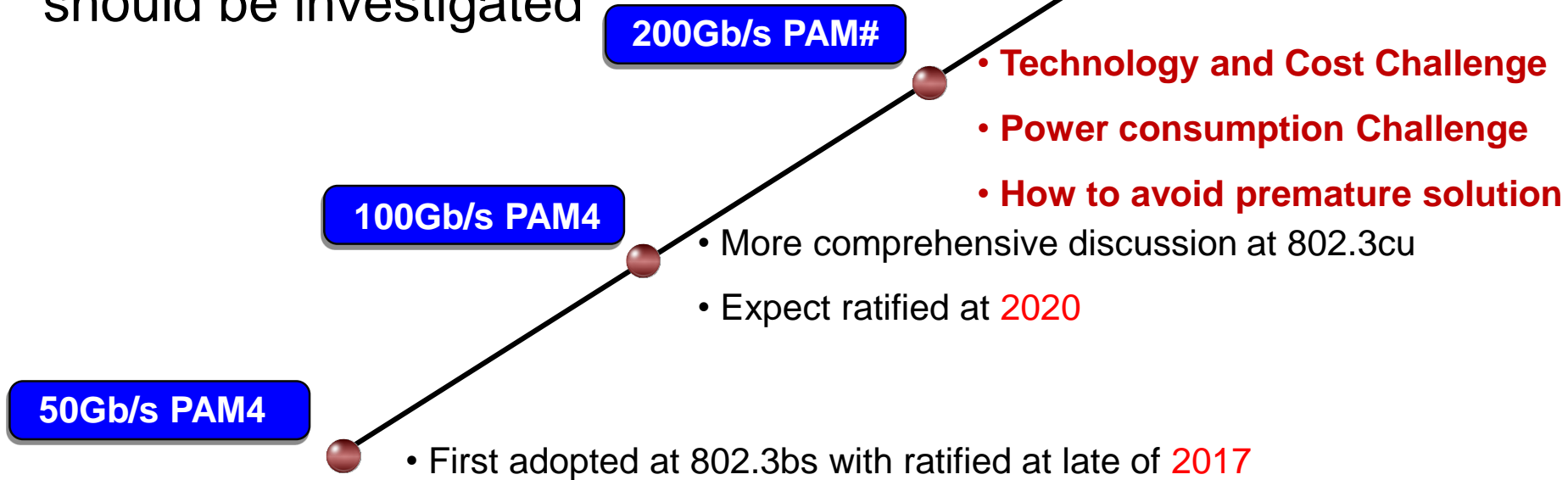| 8x100G | 8x100G | 8x100G |
CDR	DSP	DSP
λ λ	λ	λ₁ λ₂ λ₃ λ₄
		Mux
8x100G	4x200G	4x200G
PSM8	PSM4	CWDM4

"The MSA members believe that for 25.6Tbps and 51.2Tbps switching silicon, 800–gigabit interconnects are required to deliver the required footprint and density," says Maxim Kuschnerov, a spokesperson for the 800G Pluggable MSA.

Refer to: lyubomirsky_nea_01a_111

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Technology: Intensity Modulation/Direct Detection (IM/DD)

□ The potential time line of Beyond 400GbE standard is depend on PAM technology in short reach, either optical and Electrical should be investigated

200Gb/s PAM#

- **Technology and Cost Challenge**
- **Power consumption Challenge**
- **How to avoid premature solution**

100Gb/s PAM4

- More comprehensive discussion at 802.3cu
- Expect ratified at 2020

50Gb/s PAM4

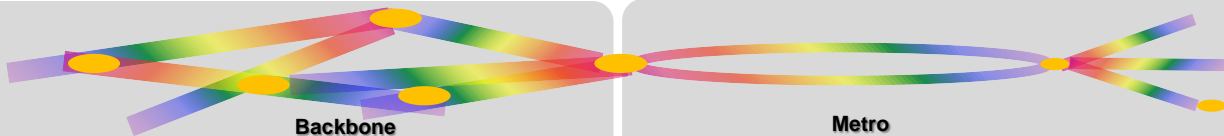- First adopted at 802.3bs with ratified at late of 2017
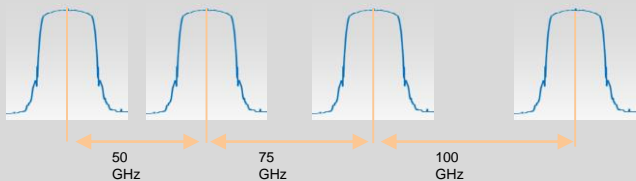
Technology: Coherent Evolution as Leverage from 802.3ct/cw?

- >200Gb/s Signaling should be investigated to stimulus innovation to achieve low cost and broad market potential

BPSK

QPSK

802.3ct
100GbE

16QAM

802.3cw
400GbE

64QAM?

Reach
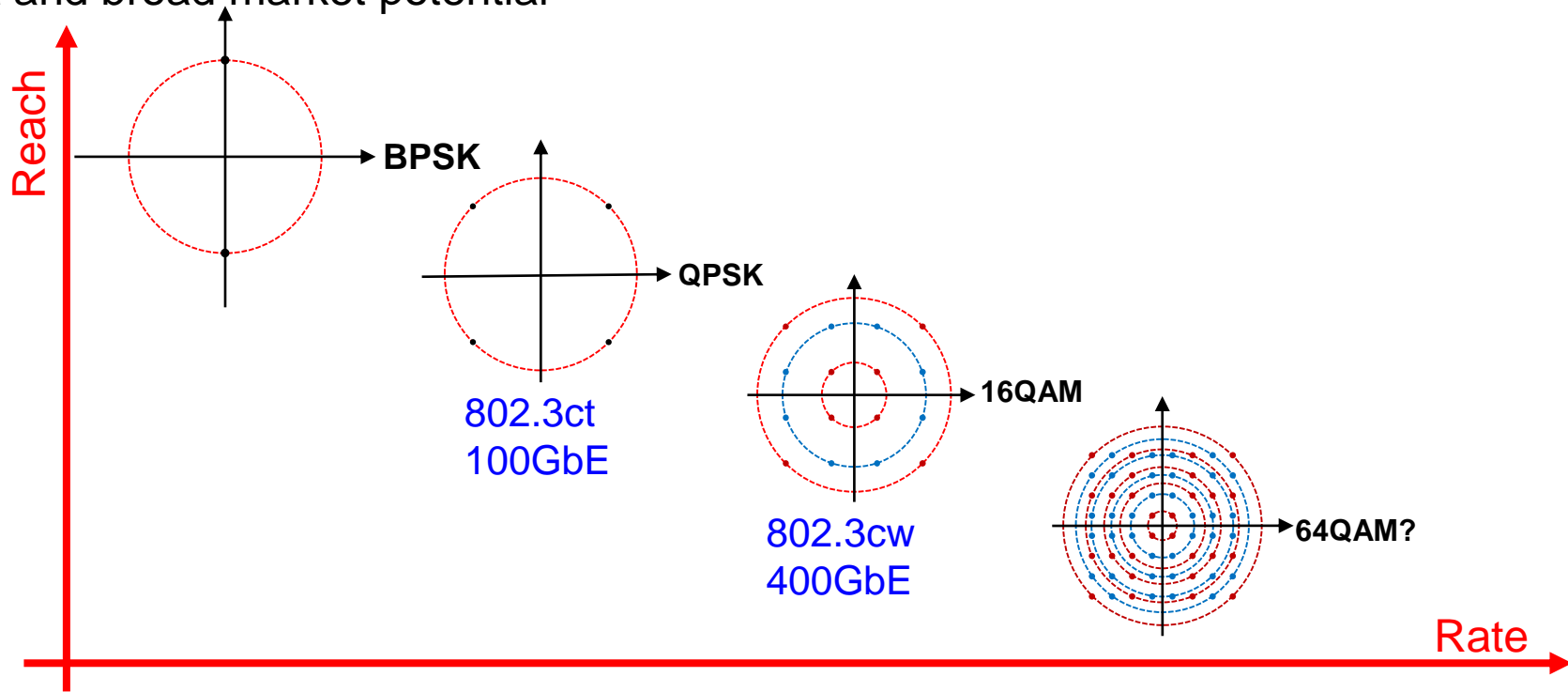
Rate

Technology: Innovation Research for Coherent Optical Modules

Backbone

Metro

DCI

① FlexGrid, applicable to different networks

50 GHz 75 GHz 100 GHz

② FlexRate with multiple code types

800G 64QAM

400G/200G 16QAM

200G/100G QPSK

③ High-speed interconnection

ODSP DIE

Organic Substrate

DRV MZM
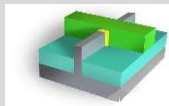
PCB
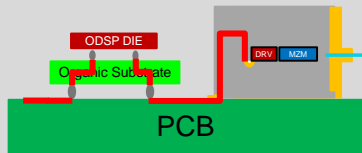
Extremal performance

④ Core technologies that support low power consumption of optical modules
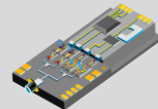
Algorithm Optimization

Innovative dispersion compensation and link error correction algorithms

Process Improvement

16 nm → 7 nm FinFET

Vertical Integration

In-depth joint design of components

Lower power consumption

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Thank you