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Observation on the Rate of Beyond 400GbE

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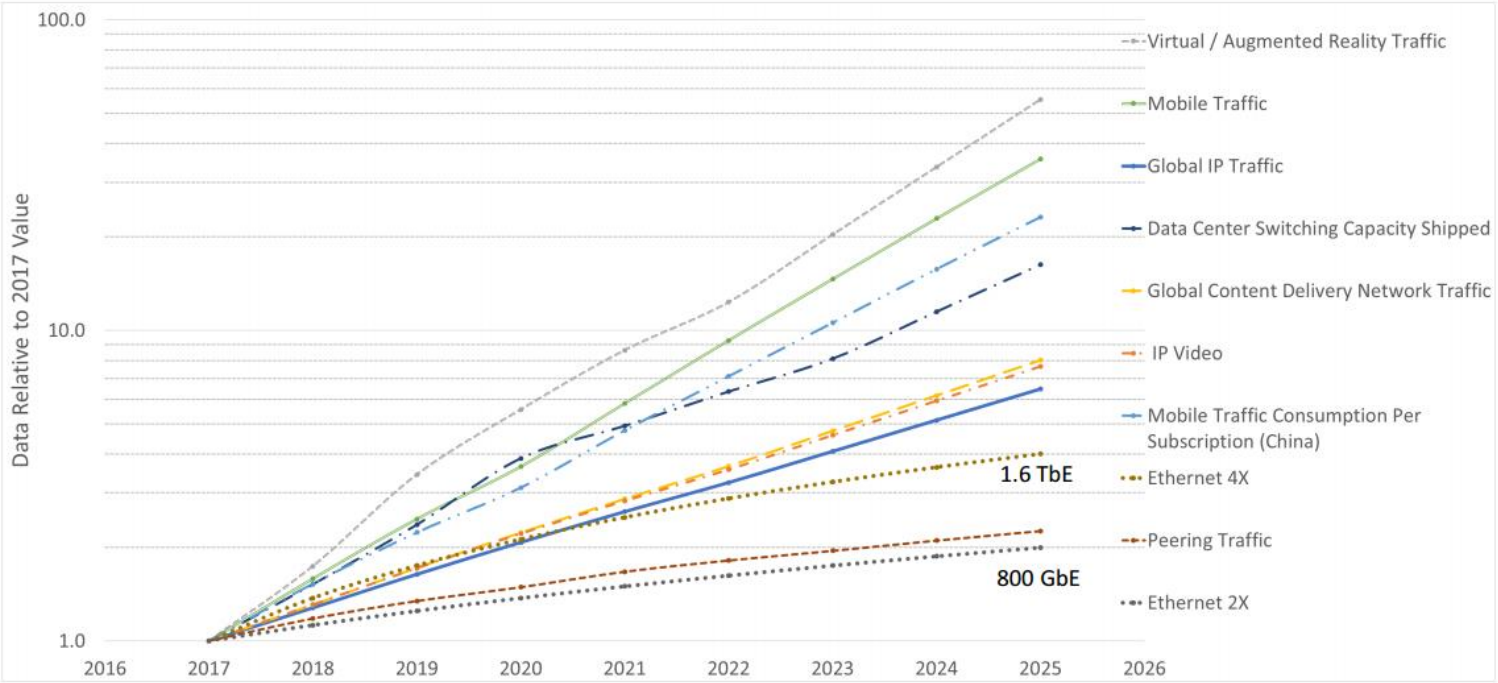
Background

- 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



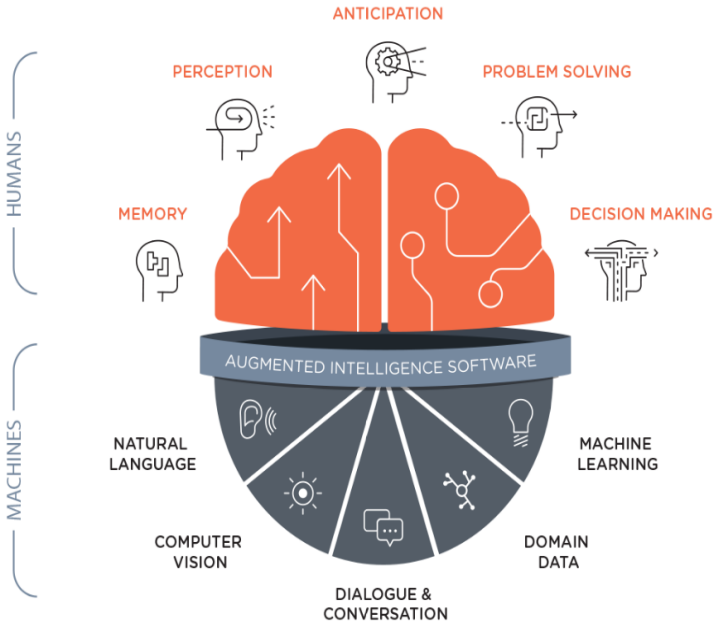
Further Information to Support the Bandwidth Forecast: Artificial Intelligence

- 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



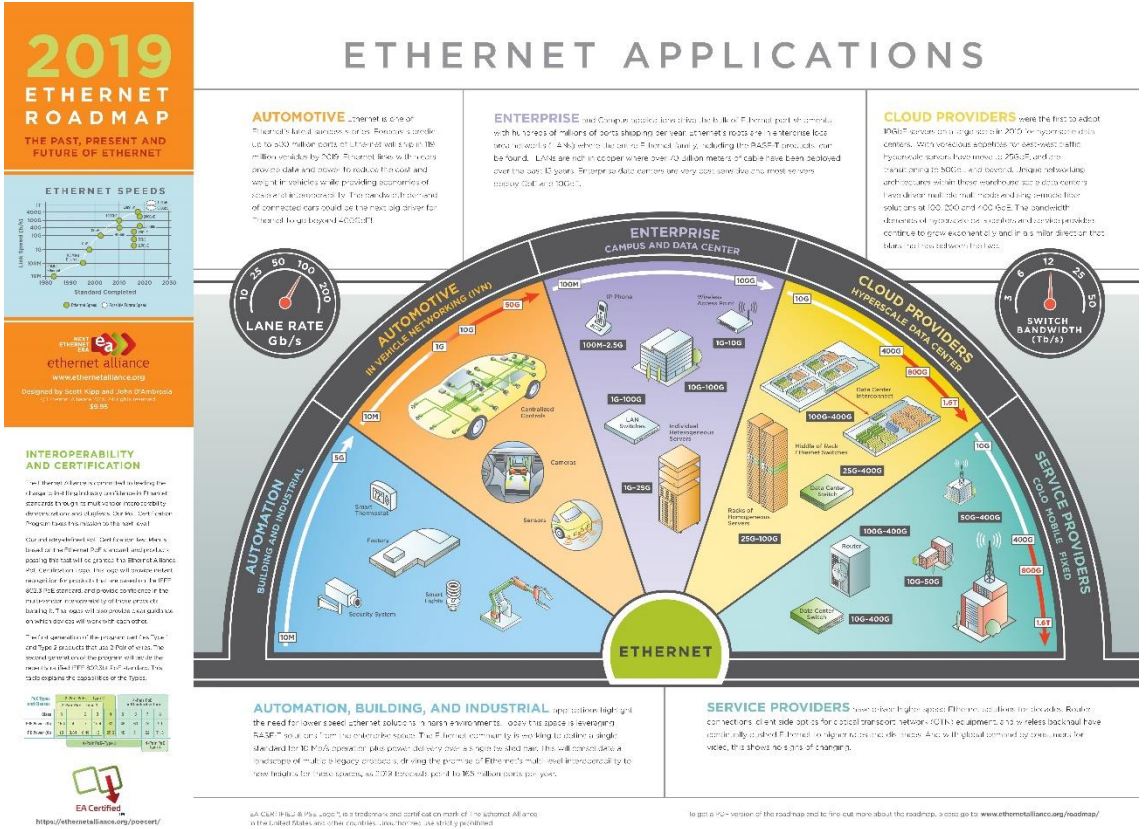
AI Computing Platform Example: 100GbE Now

- 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

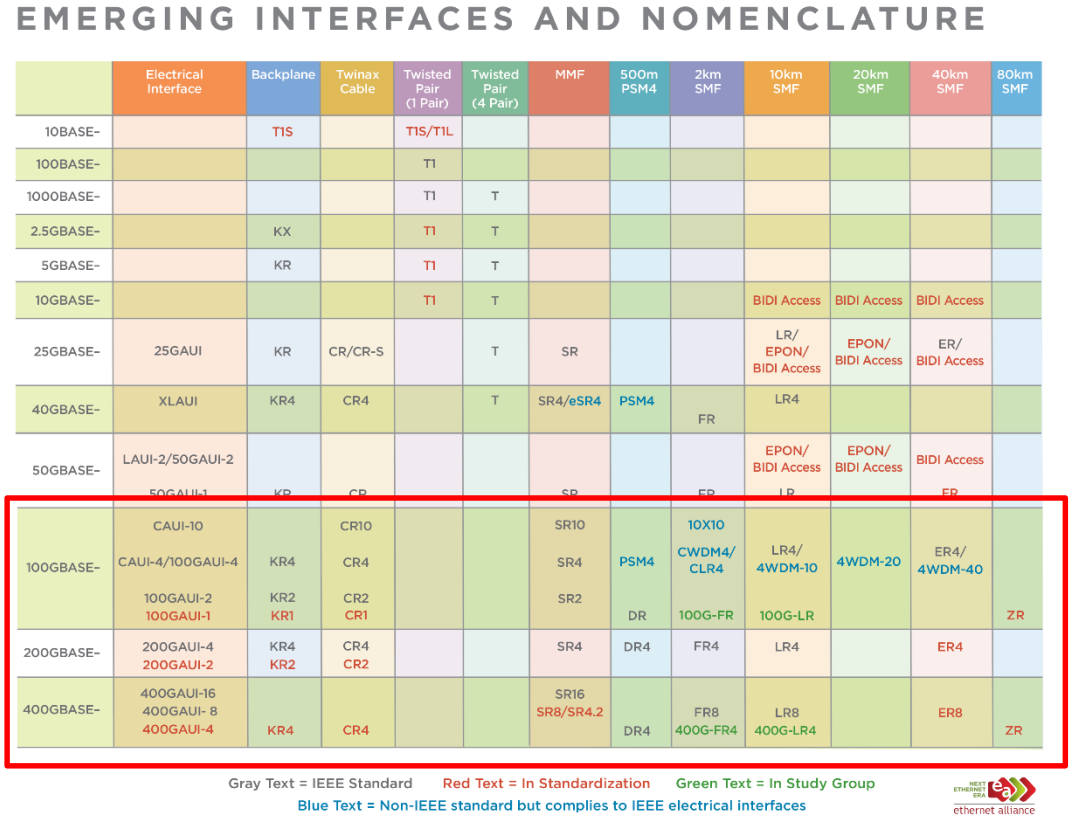
Beyond 400GE Application: Cloud and Service Providers



Refer to 2019 Ethernet roadmap from Ethernet Alliance

Beyond 400GE PHYs: Refer to 100/200/400GbE Standards?

- 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 50GAUI-1	KR	CR			SR		FR	EPON/ BIDI Access LR	EPON/ BIDI Access	BIDI Access FR	
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

ethernet alliance

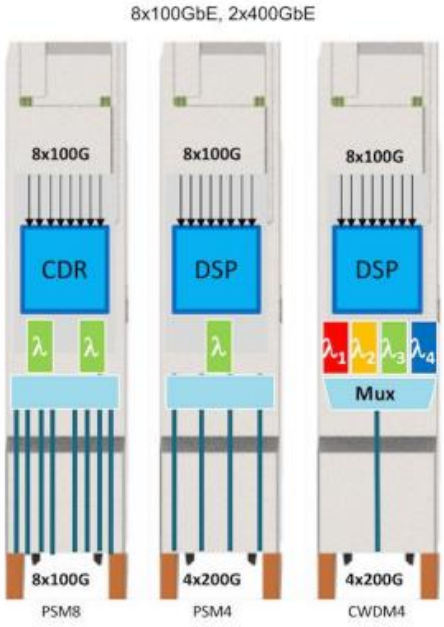
Refer to 2019 Ethernet roadmap from Ethernet Alliance

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



"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]

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

50Gb/s PAM4

- First adopted at 802.3bs with ratified at late of 2017

100Gb/s PAM4

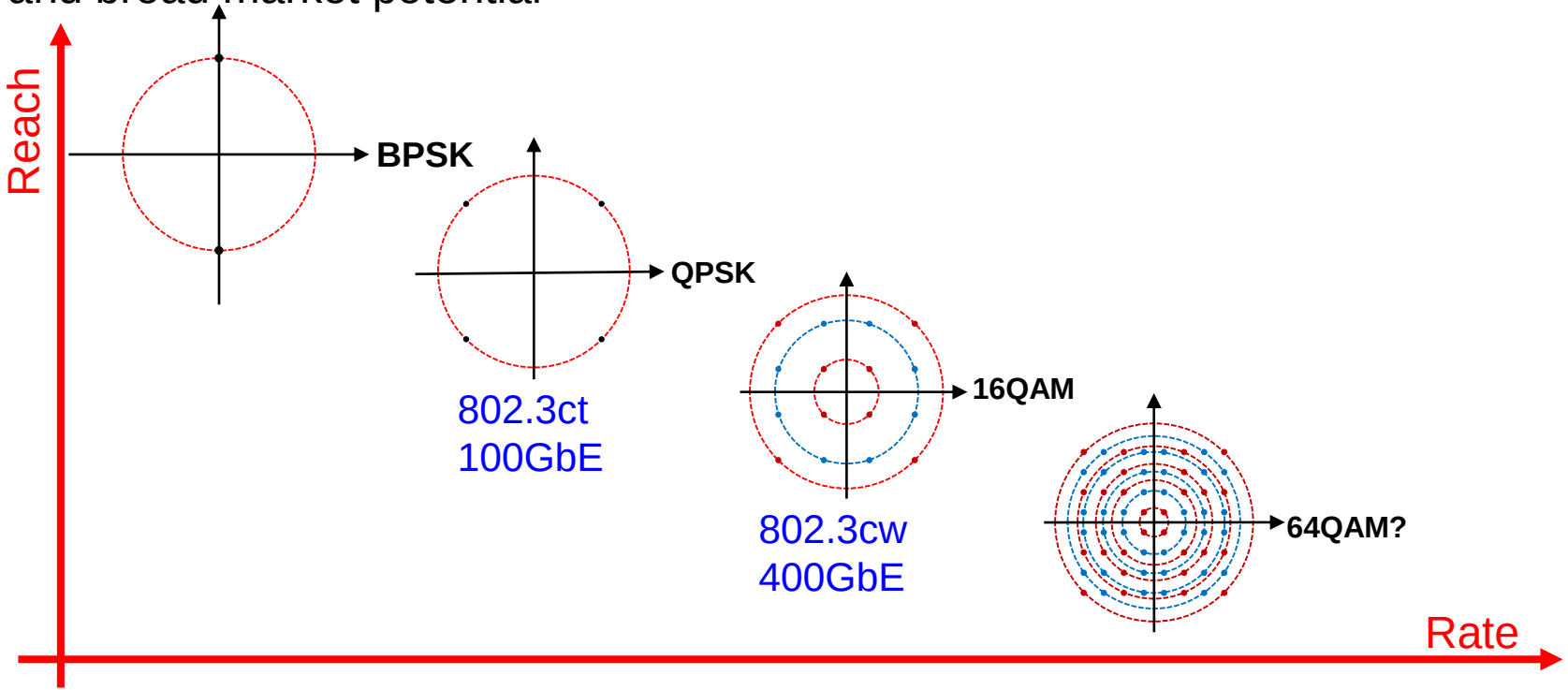
- More comprehensive discussion at 802.3cu
- Expect ratified at 2020

200Gb/s PAM#

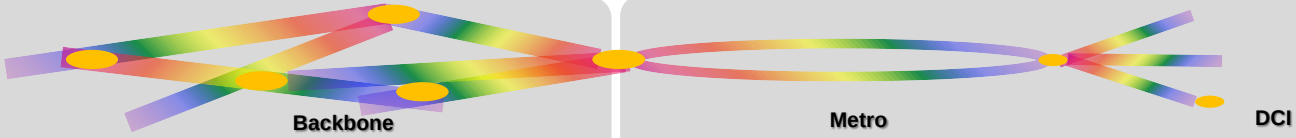
- **Technology and Cost Challenge**
- **Power consumption Challenge**
- **How to avoid premature solution**

Technology: Coherent Evolution as Leverage from 802.3ct/cw?

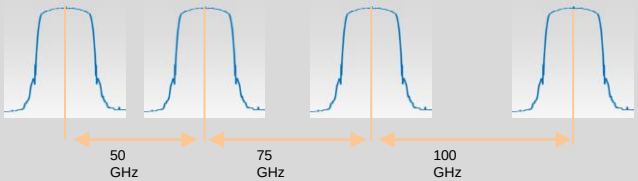
- >200Gb/s Signaling should be investigated to stimulus innovation to achieve low cost and broad market potential



Technology: Innovation Research for Coherent Optical Modules

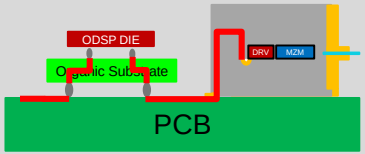


① FlexGrid, applicable to different networks



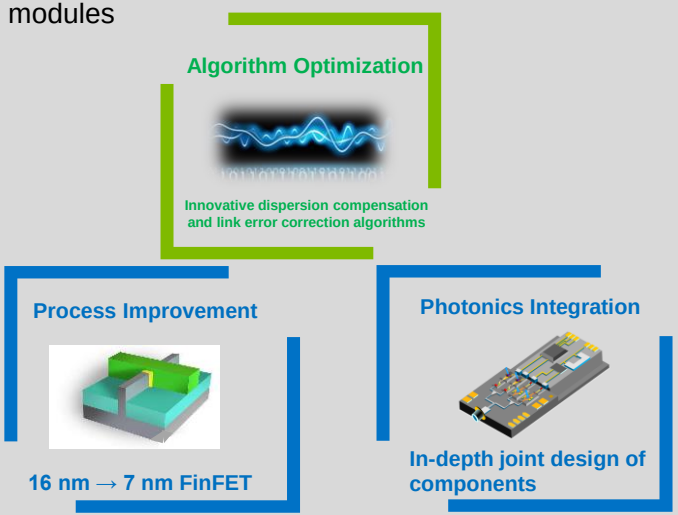
② FlexRate with multiple code types

③ High-speed interconnection



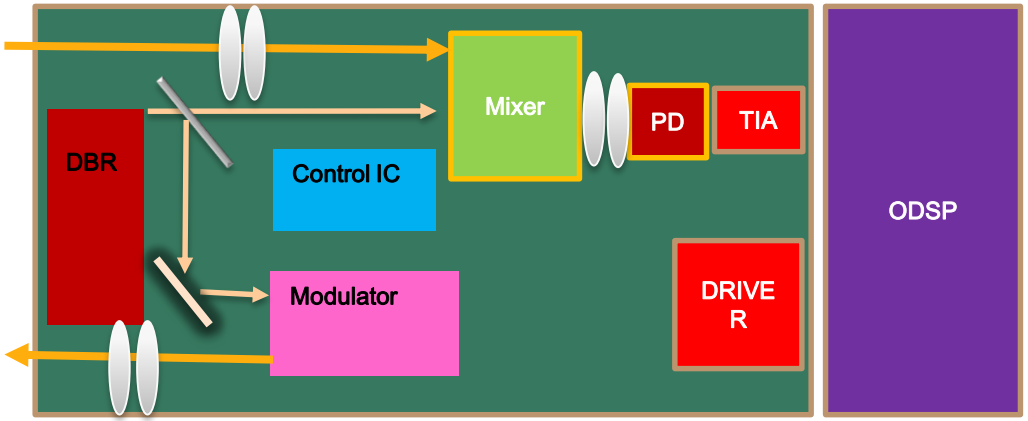
Extremely performance

④ Core technologies that support low power consumption of optical modules

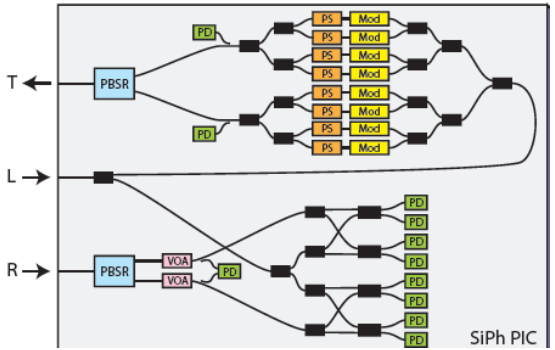


Lower power consumption

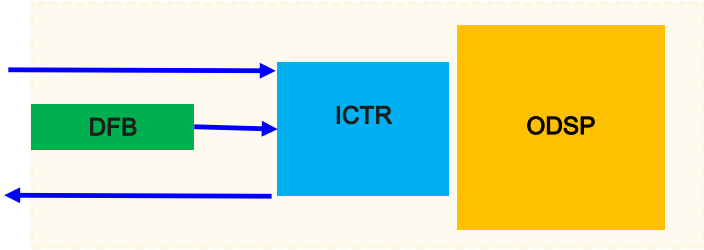
Technology: Innovation Research for Photonics



Divided Design



Integration chip



Co-Package Design

Thank you