Maximizing the cost advantage of Ethernet by considering future generations of 400GE

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Overview

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Background:

- Telecom application requires extended reach PMD over SM (e.g. 40km)for inter-building link.

Purpose of this presentation

- To create an appropriate awareness of the needs for extended reach of SM PMD for future generations of 400Gbps IF.
- To raise a question about the technological considerations needed to realize future generations of 400Gbps IF from current generation.

PMD requirement for telecom application

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Telecom applications such as wide-area Ethernet service need the following PMD types.

Requirement and current scope

	Requirement	Coverage by the current scope
Intra-building ・Service node to service node ・Service node to transmission system	～about 10 km over SMF	Already included in current objectives ・at least 2km over SMF ・at least 10km over SMF
Inter-building ・Between service nods in different buildings	～about 40km over SMF	Not included in current objectives

10km reach can cover only about 50% of inter-building links

40km reach can cover almost all cases (excluding some exceptions) of inter-building links.

For close inter-building links, Ethernet transceivers are used if it is more cost-effective than long-haul DWDM system.

#A similar telecom application requirements are shown in “song_x_400_01_0913”.

Market considerations for extended reach interfaces

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[Current situation in wide-area Ethernet NW]

→Ethernet solutions are utilized

- 1G : Proprietary solution for 40km
- 10G : 10G base-ER
- 100G : 100G base-ER4

[Expected situation for 400Gbps interfaces]

- If core SWs's interfaces are upgraded to 400GE, 400Gbps IF will replace existing lower rate 40km interfaces.
- The timeline is not decided and not clear. We can wait technology advancements for future generations.

Feasibility of 40km over SM

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☐ Current status

- 10 km reach seems to be feasible. (“trowbridge_tfa_01_14_0107.pdf”)
- No practical demonstration for 40km reach in 400GE SG at this point.
  (But 40km is a target of some type of transmission technologies)

☐ Additional conditions need to be considered.

- Loss budget for longer fiber and more connectors.
- Wavelength dispersion compensation if it is not negligible.

☐ Expected reach extension approach of 10km transmission technologies

Extended reach transmission would become feasible with adequate technology advances.

- Number of approaches are considered.
- Requirements regarding footprint and power consumptions would be relaxed by CMOS process miniaturization.

Possible approaches of reach extension		Issue	Items to be considered in 1st gen. (Supposition)
SOA	relaxation of power budget requirement	Footprint Power consumption	WDM grid considering SOA bandwidth
APD	Improve receiver sensitivity	Not commercially available at this point	
FEC	Improve robustness against bit error	Latency Power consumption	Overhead consideration for ER transmission possibility

Technology adoption scenarios for extended reach SMF PMDs

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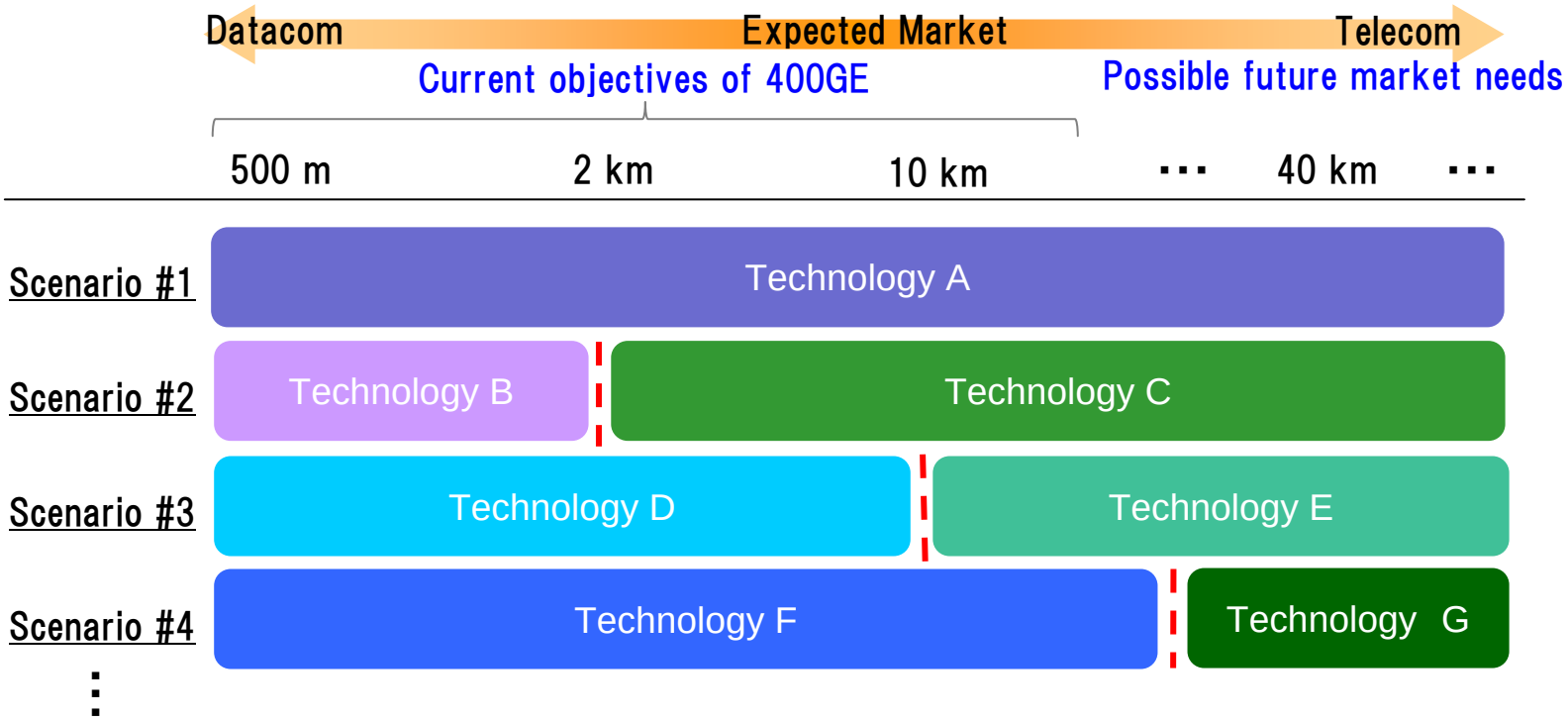
It is not sure that common one key-technology (modulation format e.t.c.) is utilized for all types of SMF PMD.

We have to investigate the optimal technology mapping for all type of PMD including future generations. It would impact the cost advantage of the overall Ethernet market.



Exploit the maximum gain for each domain for cost advantage.

Summary

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- Expected need for extended reach 400Gbps IFs.

- It would be good for Ethernet market to consider employing technologies toward future needs of 400Gbps IFs from the current generation.

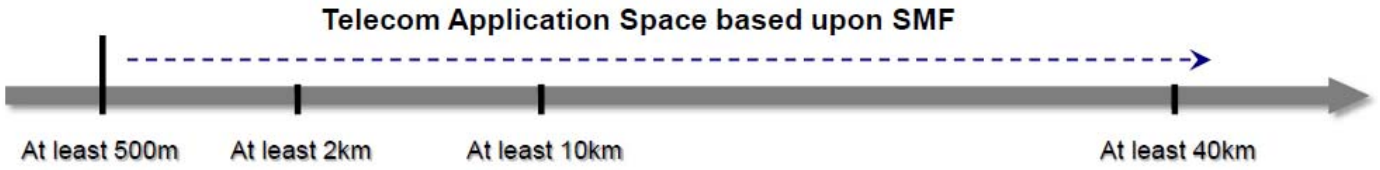
Let's maximize the the cost advantage of the Ethernet by considering future generations of 400GE.

Thank you

Backup slides

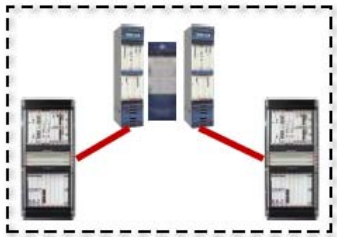
Telecom application in China

Motivation and Application Space of 400GbE SMF



Connections between IP Core Routers and OTN

Connections between IP Routers



- Telecom application is an important domain for the first adoption of 400GbE.
  - ✓ Connections between IP Routers suggest an SMF distance objective of 10km, and additionally 40km for some of the Metro applications. Duplex fiber solutions are regarded necessary for both applications.
  - ✓ Connections between IP Core Routers and OTN equipments, suggest SMF distance objective of 2km. Also in this case Duplex fiber solutions are regarded necessary.
- So we definitely need an SMF distance objective of 10km.
- If we can generate a specification for at least 2km which enables a significantly lower cost solution than for 10km then a 2km SMF objective should be added.

From “song_x_400_01_0913.pdf” IEEE802.3 York Interim meeting September, 2013. (By the courtesy of Huawei)

History of Ethernet LR and ER IF

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□10G : Different optics (wavelength) was adopted for ER

□40G/100G : LR optics is utilized for ER by improving loss budget

	10G base-LR		40G base-LR4		100G base-LR4	
Long reach (10km)	Optics	1.3μm	Optics	1.3μm ×4λ(C-WDM)	Optics	1.3μm×4λ (LAN-WDM)
	Modulation Format	NRZ	Modulation Format	NRZ	Modulation format	NRZ
	rate	10.3G×1	rate	10.3G×4	rate	25.7G×4

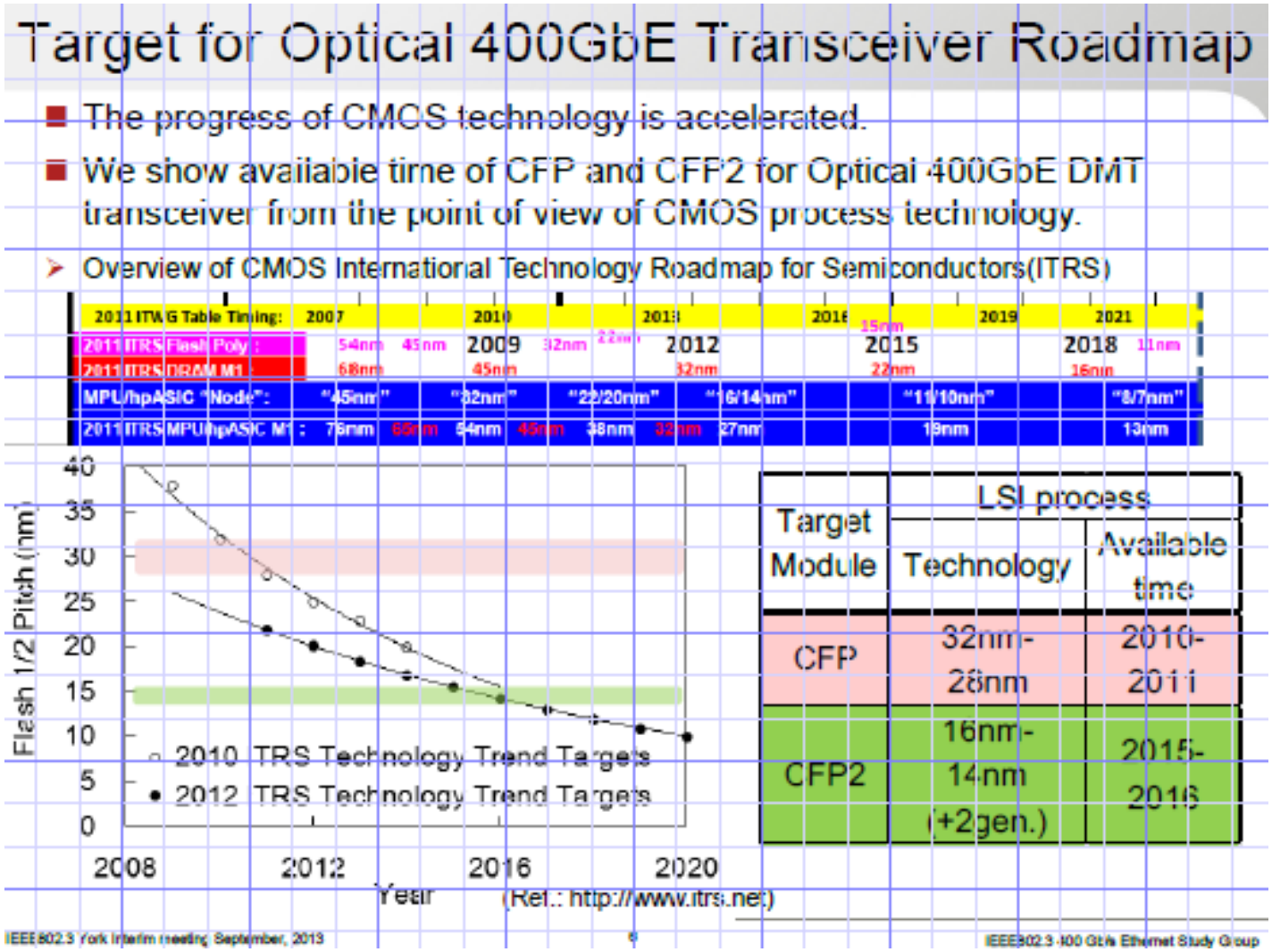
Utilization of different optics

Loss budget improvement with SOA

Loss budget improvement with SOA

	10G base-ER		40G base-ER4		100G base-ER4	
extended reach (30km/40km)	Optics	1.5 μm	Optics	1.3μm×4λ (C-WDM)	Optics	1.3μm×4λ (LAN-WDM)
	Modulation Format	NRZ	Modulation Format	NRZ	Modulation Format	NRZ
	rate	10.3G×1	rate	10.3G×4	rate	25.7G×4

CMOS technology Roadmap



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