

Extended Reach Optics Strawman (CFI)

John D'Ambrosia, Futurewei

IEEE 802.3 NG-ECDC Ad Hoc

IEEE 802 Nov 2016 Plenary, San Antonio, Tx, USA

Introduction

- This slide deck is intended as a strawman / starting point for a CFI Proposal on “Extended Reach Optics.”
- Includes data from past NG-ECDC presentations.
- Issues raised during these discussions have also been included.
 - What is rate?
 - What is reach?
- Need closure on rates / reaches to target.

SMF Optical Ethernet Standards In-Development

		25 G	50 G	NG 100G	200G	400G
SMF	500 m			1x100G	4x50G	4x100G
	2 km		1x50G		4x50G	8x50G
	10 km	1x25G	1x50G		4x50G	8x50G
	40 km	1x25G				
	> 40 km					

IEEE P802.3bs

IEEE P802.3cc

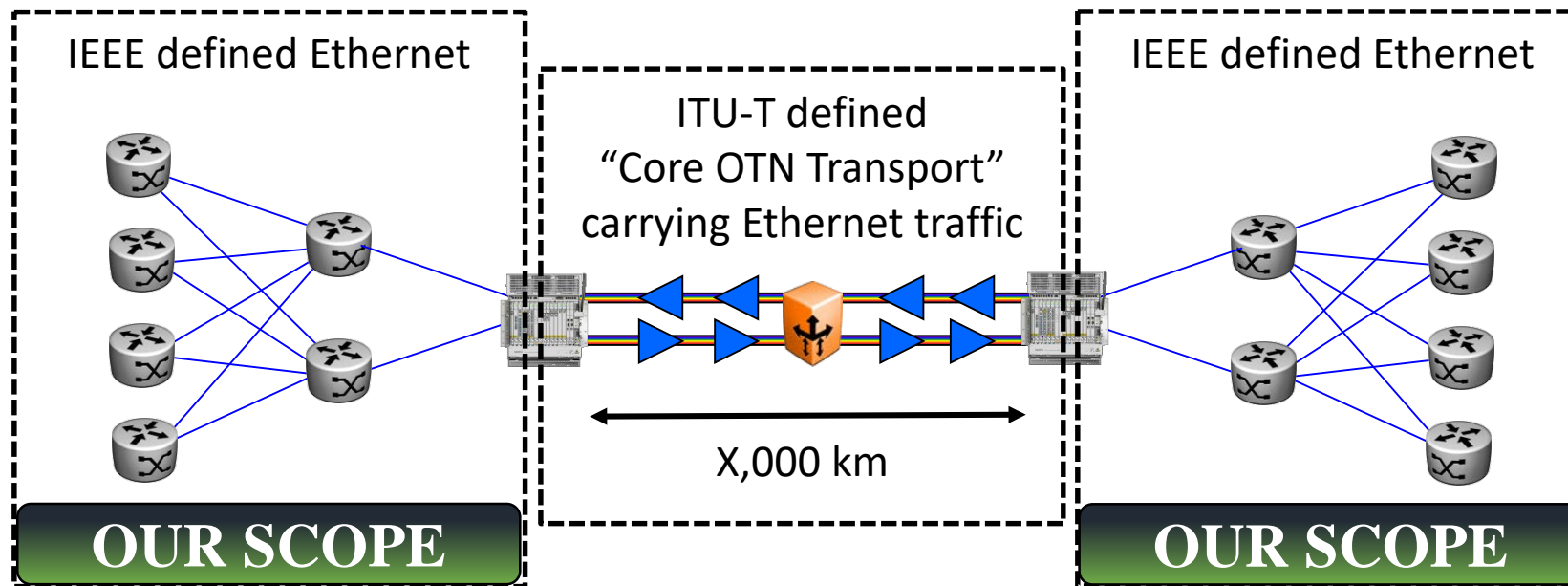
IEEE P802.cd

Objective for this Meeting

- To measure the interest in starting a study group to address Extended Reach Higher Speed Optical PMDs
- We don't need to
 - Fully explore the problem
 - Debate strengths and weaknesses of solutions
 - Choose any one solution
 - Create PAR or five criteria
 - Create a standard or specification
- Anyone in the room may speak / vote
- RESPECT... give it, get it

What Are We Talking About?

- At highest rates Ethernet is becoming dominant traffic for client- and line-side
 - “Core OTN Transport” is defined by the ITU-T
- Interdependent problems, but not interchangeable solutions



Agenda

- Presentations
 - “The Need,” xx.
 - “Technical Challenges,” xx.
 - “Why Now,” John D’Ambrosia, Futurewei.
- Straw Polls

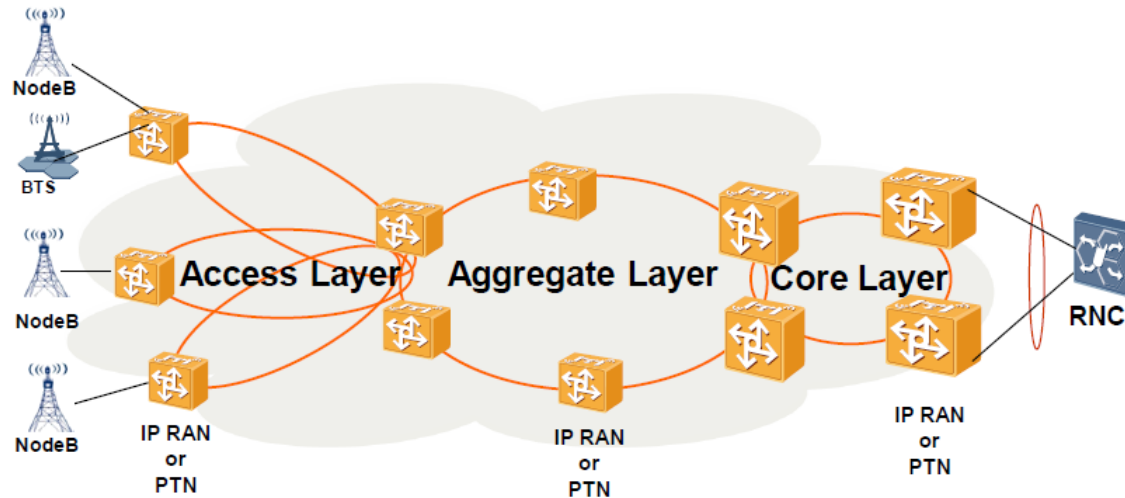
The Need

The Need for Extended Reach Optics

- 50GbE – campus / metro interconnect (wang_ecdc_01_0716) – offers 2x speed increase over 25GbE
- Mobile Backhaul Networks 200GE & 400GE for metro transport aggregation layer network (zhao_ecdc_01_0716)
 - 4G / 5G
- Inter-building Usage (>10km, 40km, 80km)
 - Example – MSK-IX (dambrosia_ecdc_01_0516)
 - Example - Metro Data Center Interconnect (booth_ecdc_01_0716)

Mobile Backhaul

40km Reach in Mobile Backhaul Network



- In [huang_ecdc_01_0716](#) and observation from shipment in Carrier network, 40km volume is increasing

Statistics for 10GE & 100GE Modules used in PTN, as of June, 2016				
Transmission Distance	<2km	10km	40km	80km
10GE distribution	0.28%	44.46%	44.05%	11.20%
100GE distribution (more than 15K modules)	0	56.43%	34.59%	8.97%

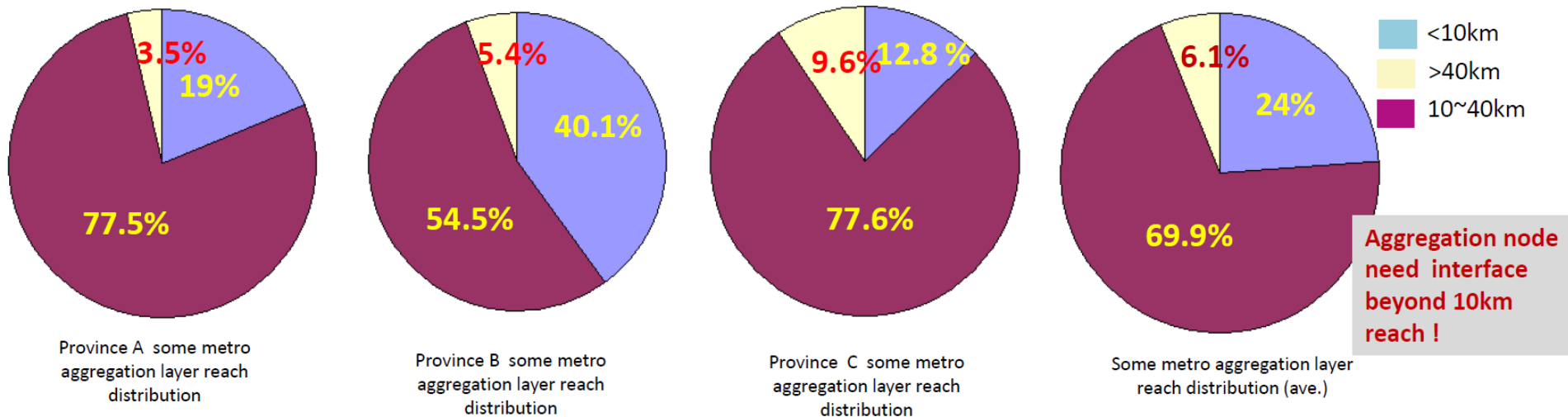
Carrier Input – Reach Targets

CAICT 中国信通院

Aggregation node distance from actual networks

As metro core usually use WDM/OTN to extend reach distance of Ethernet interface, therefore current aggregation layer transmission distance is crucial to the future higher bitrate interface, such as 200GE and 400GE, etc.

Furthermore, each metro network may has its own distribution characteristic of reach distance, and some metro aggregation layer node distance from actual networks in China are investigated, and these nodes would has the requirement to deploy link capability more than 10GE.



Source: Wenyu Zhao, CAICT<

http://www.ieee802.org/3/ad_hoc/ngrates/public/16_07/zhao_ecdc_01_0716.pdf

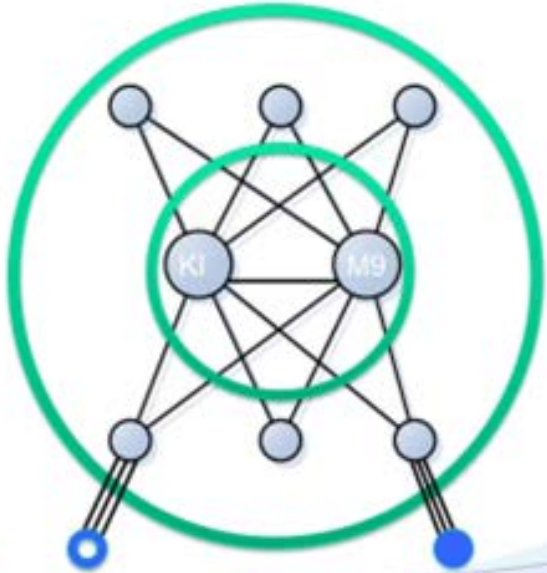
IEEE 802.3 NG-ECDC Ad Hoc, July, 2016, San Diego

Inter-Building Connections

Industry Discussions- MSK-IX

Double Core Specifics

- MLAG interaction between KI & M9 (~40km distance)
- Passive 10G DWDM solution between core, predictable network size
- Smooth migration from old equipment to a new one
- Ring-topology concept:
 - Tier 0 – connect core to each other,
 - Tier 1 – core datacenters and switches,
 - Tier 2 – edge datacenters.
- Current capacity between several Tier1 switches and Core: 640Gbps (n x 10G) with Future plans 100G+ links between them.
- **Need solution for 100G+ optical transceivers between Core & Tier1 up to 40 km**



MSK-IX

Courtesy: Alexander Ilin, MSK-IX

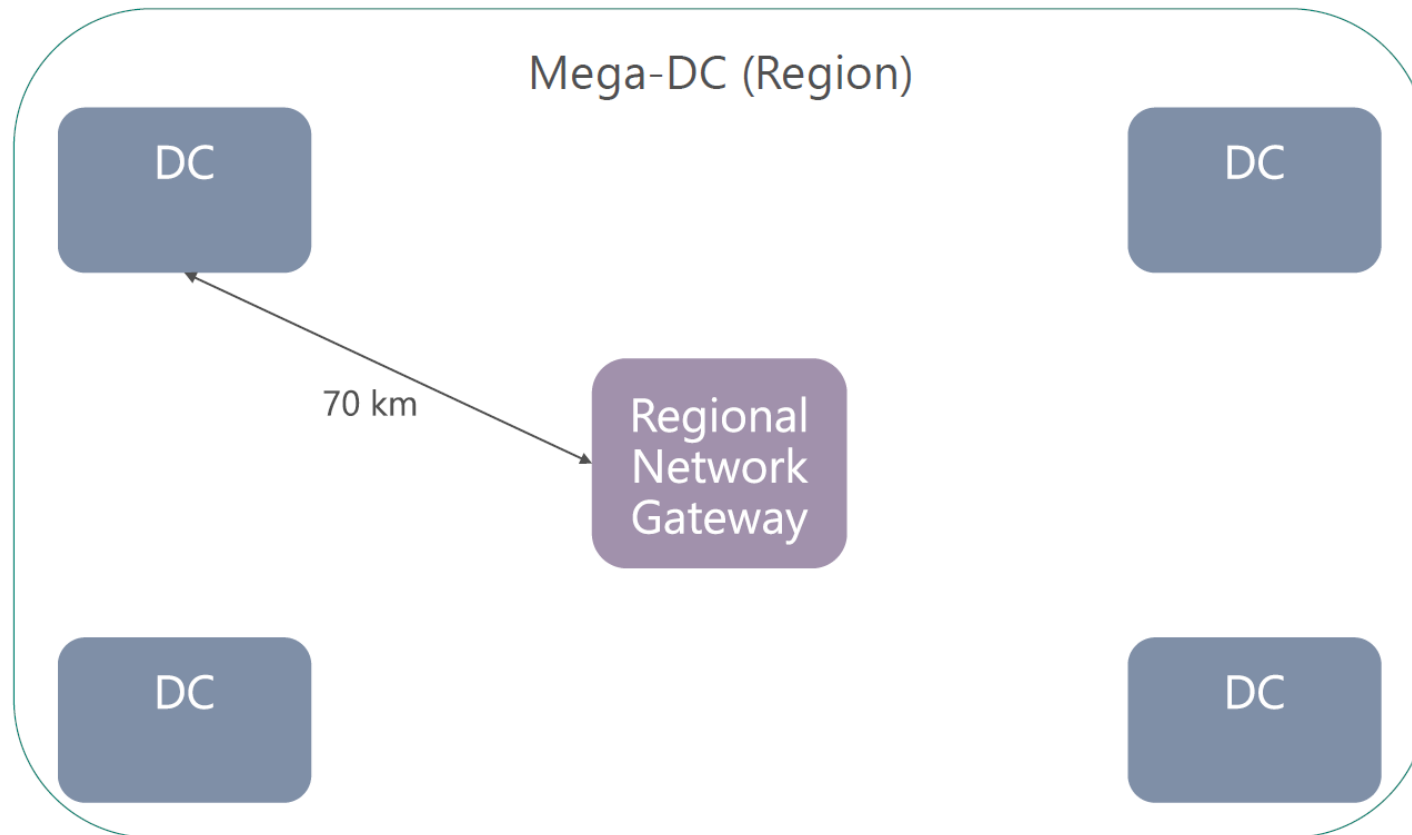
IEEE 802.3 NG-ECDC Ad Hoc, IEEE 802.3 May 2016 Interim, Whistler, BC, Canada

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Source: John D'Ambrosia, Futurewei,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_05/dambrosia_ecdc_01_0516.pdf

Regional Data Center Architecture

Mega Data Center Architecture v2.0



Source: Brad Booth, Microsoft,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_07/booth_ecdc_01_0716.pdf

Mobile Bandwidth Drivers

Re-visiting Cisco VNI*

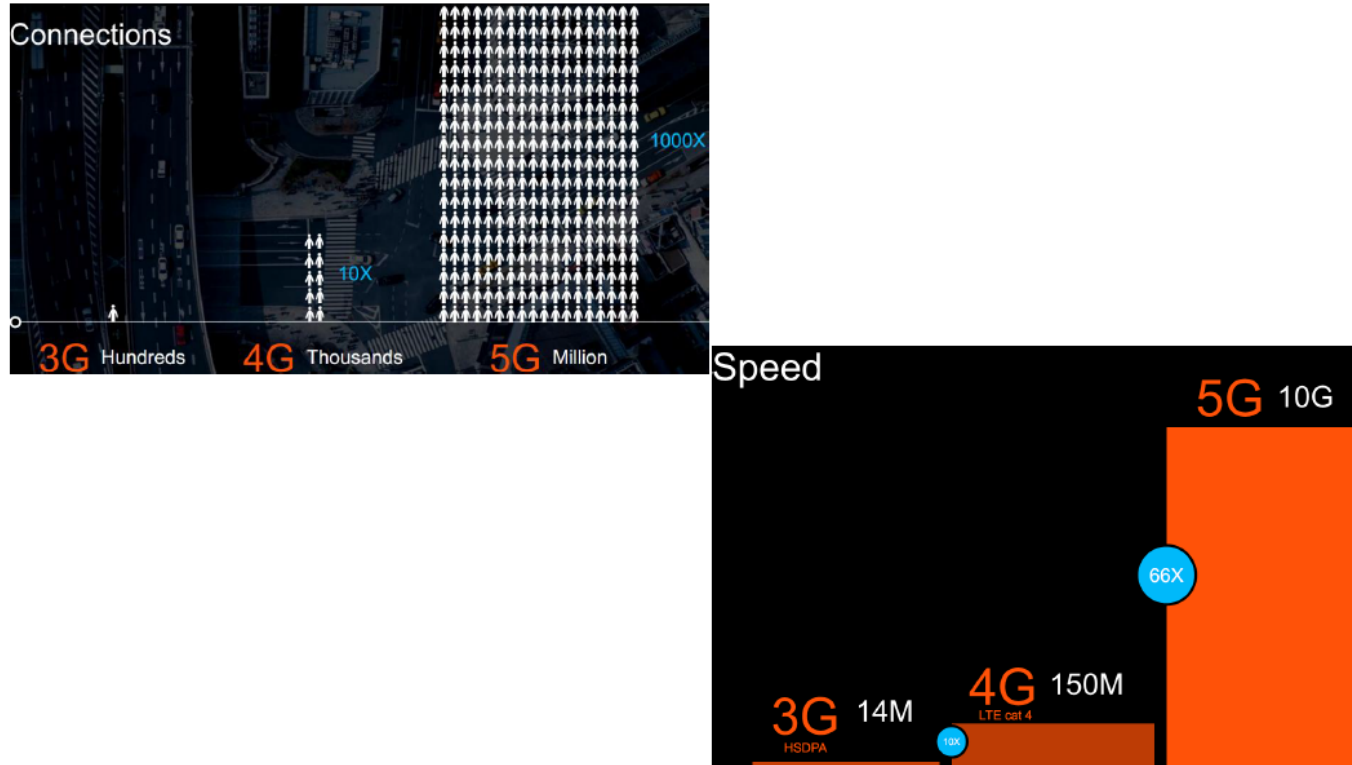
- Some interesting global forecasts
 - Mobile data traffic (2015 – 2020)
 - 8x growth – 53% CAGR
 - 30.6 Exabytes/ month (up from 3.7 Exabytes)
 - Avg mobile connection 3326 megabytes / month (up from 495 megabytes)
 - Video 75% of global mobile data traffic (up from 55%)
 - Smart Phones (2015 – 2020)
 - 5.6 billion (up from 3.0 billion)
 - Average 10.5GB / month (up from 2.0GB)

- Clearly something is up and Ethernet needs to be prepared.

*Source: <http://www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html>

Comparing Mobile Generations

5G KPI Comparing to 3G/4G



[http://www.huawei.com/minisite/5g/img/5G_Road%20to%20a%20Super-Connected%20World\(Ken%20Hu%20MWC15%20Keynote\)_final.pdf](http://www.huawei.com/minisite/5g/img/5G_Road%20to%20a%20Super-Connected%20World(Ken%20Hu%20MWC15%20Keynote)_final.pdf)

Source: Xinyuan Wang, Huawei,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_09/wang_ecdc_01_0916.pdf

5G Mobile Network Services

- Enhanced Mobile Broadband
 - HD Video
 - Virtual Reality (VR)
 - Augmented Reality (AR)
- Ultra-Reliable and Low-latency Communications (uRLLC), such as:
 - Assisted and Automated driving
 - Remote management
- Massive Machine Type Communications (mMTC), such as:
 - Smart city
 - Smart agriculture

Network Bandwidth Required of VR

- Bandwidth needed of 4K/8K video and VR depend on Quality requirement
 - Typical Video Bit Rate = (Resolution × Bits per Pixel × Frame per Second) ÷ Compression
 - Bandwidth Requirement = Typical Video Bit Rate × 1.5

VR Quality	Entry-Level VR	Advanced VR	Ultimate VR
Video Resolution	360-degree 4K 2D (3840*1920)	360-degree 12K 2D (11520*5760)	360-degree 24K 3D (23040*11520)
Resolution per Eye	960*960, FOV 90° Using low-price VR glasses	3840*3840, FOV 120° Using professional VR headset	7680*7680, FOV 120° Using professional VR headset
Bits per Pixel	8	10	12
Compression Ratio*	120	150	200(2D), 350(3D)
Frames per Second	30	60	120
Typical Video Bit Rate	15Mbps	265Mbps	2.18Gbps
Bandwidth Requirement**	25Mbps	398Mbps	3.28Gbps

*Assuming H.265 encoding. Numbers are based on experience.
 The compression ratio for 3D video is higher because the contents for two eyes are highly correlated.
 **Typical bandwidth requirement is 1.5x video bit rate, based on experience and test.

- Multiple subscribers per site to statistics multiplex on Ethernet interface in Backhaul network

Source: Xinyuan Wang, Huawei,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_11/wang_ecdc_01a_1116.pdf

Market Forecast

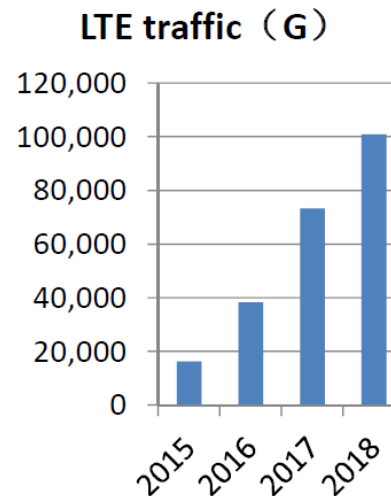
Carrier Input

Present status and forecast

- According to our survey, long distance module is a mandatory requirement for us

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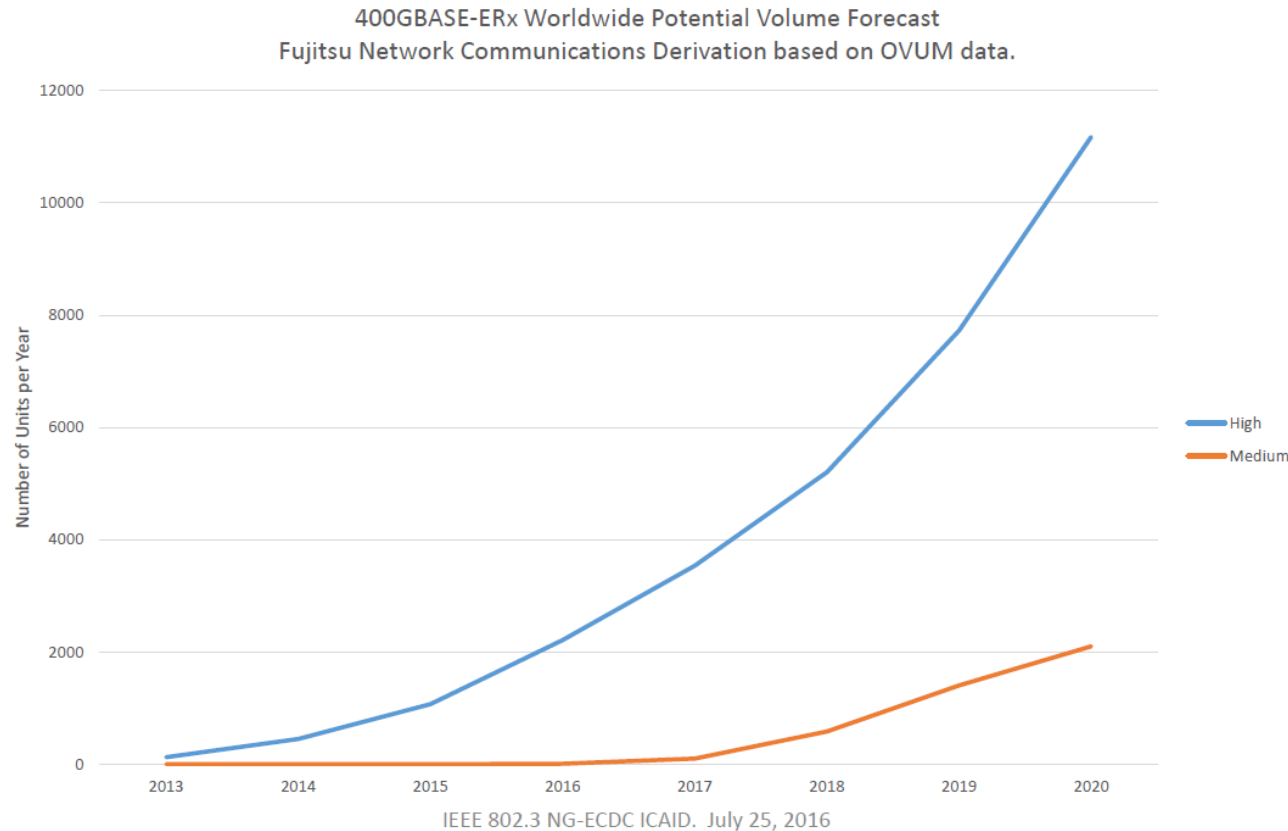
- According to the increase of LTE traffic, as LTE backhaul network, PTN will face 4~5 times traffic in 2017 or 2018.
- Then we will have to use 400GE interface in the same scenario and take the same percentage with 100GE and 10GE.
- In 2018~2019, we expected the requirement for 400GE ER modules will be more than 10K.



Source: Huang/ Cheng, China Mobile,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_07/huang_ec_dc_01_0716.pdf

Forecast

Broad Market Forecast



- This is not a data center volume application
- However, current forecast is to an approximate estimate of completion of a standard, assuming near future CFI

Source: Tom McDermott, Fujitsu,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_07/mcdermott_ecdc_01_0716.pdf

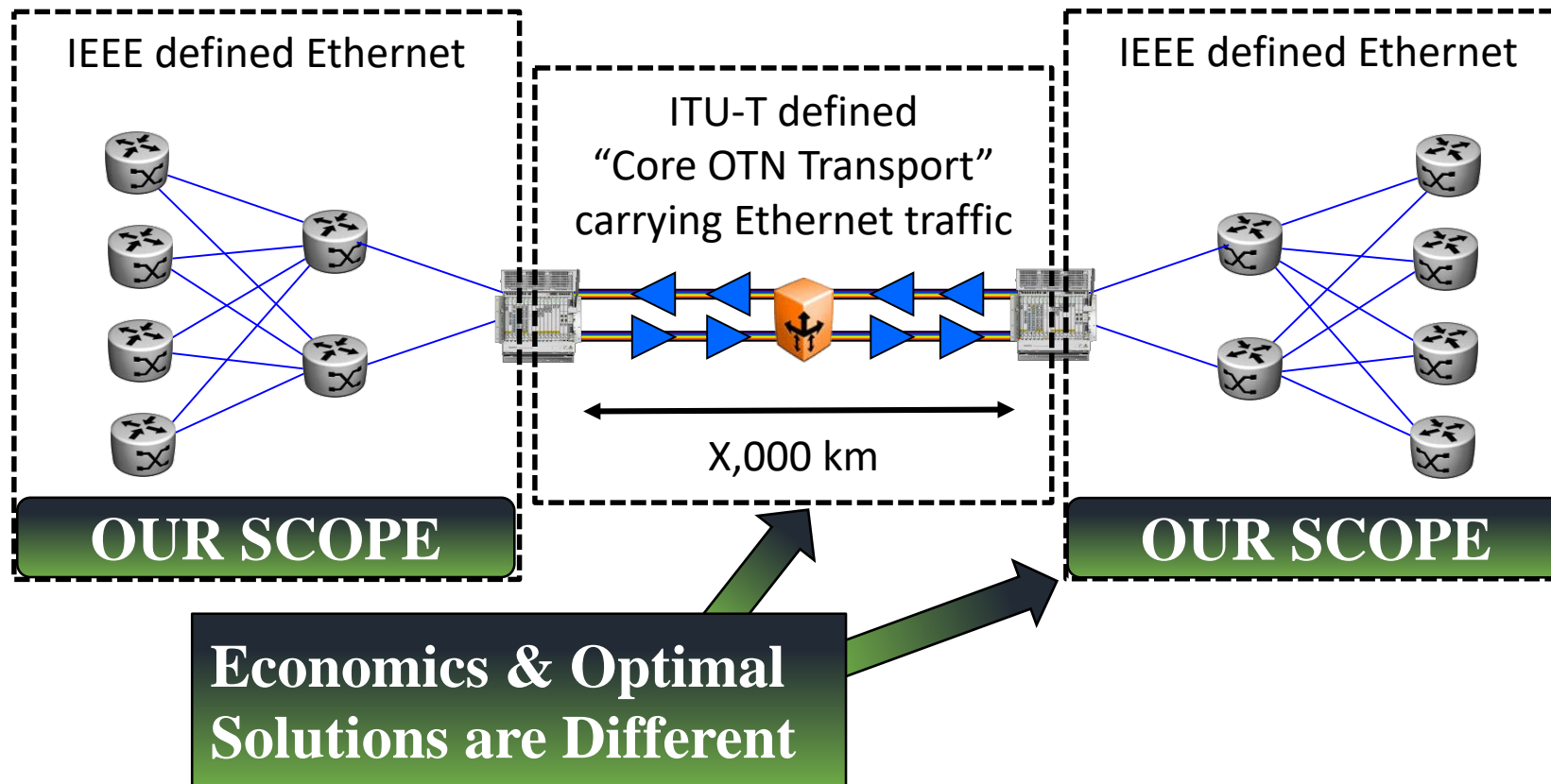
Forecast Data

- Placeholder – Dale Murray, LightCounting

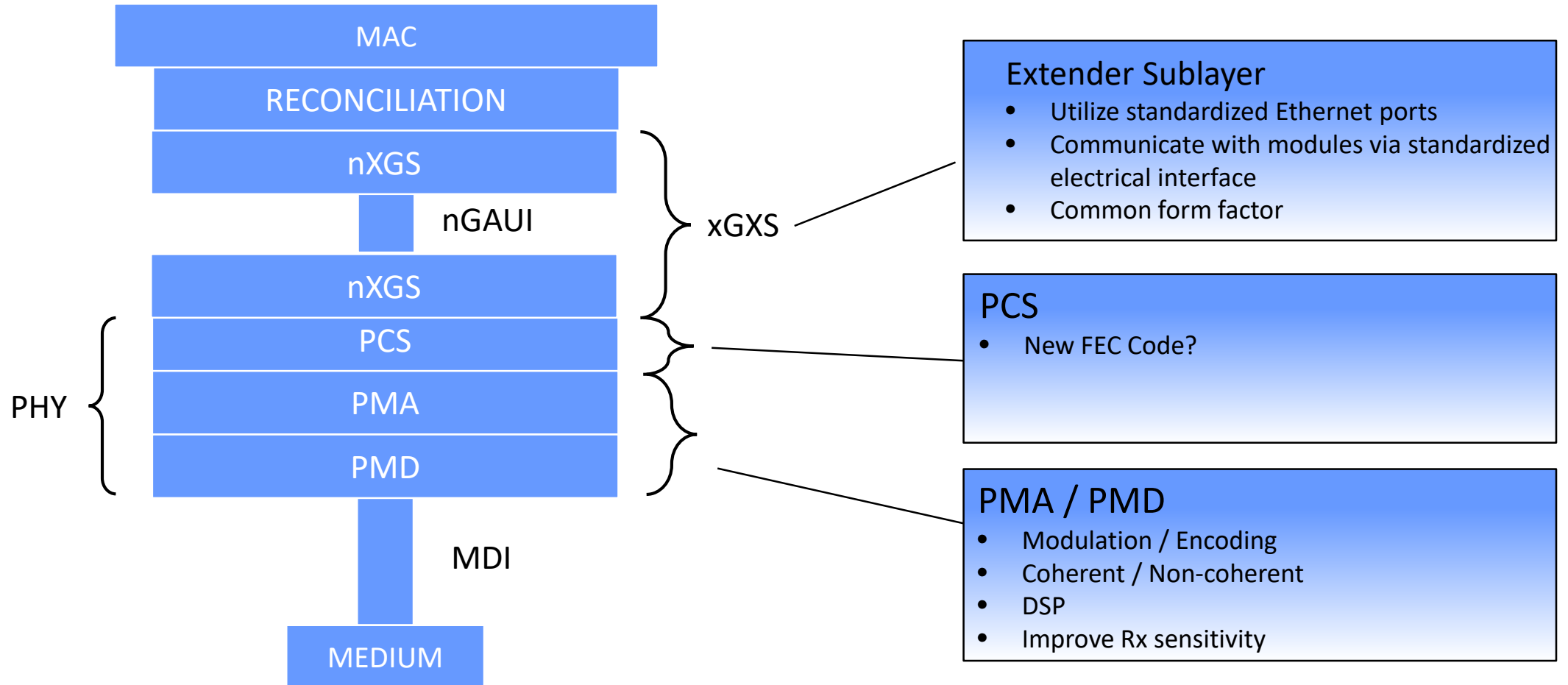
Technical challenges

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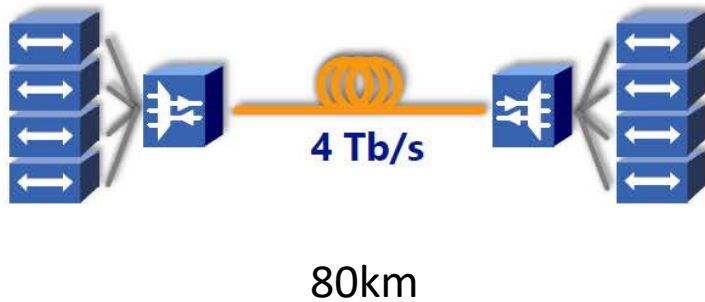


Tools at our Disposal

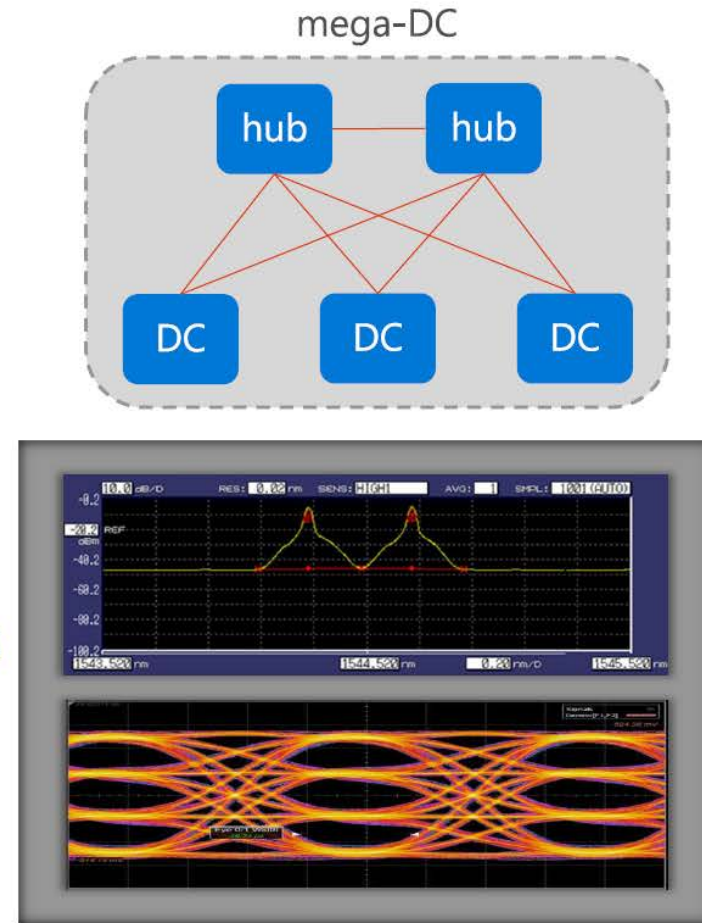


Madison Generation 1.0

- 100G per module
 - Dual- λ , 25 Gbaud PAM4 modulation
- Direct-detect demodulation (i.e. non-coherent)
- Silicon photonics-based optics
- FEC/DSP technology
- QSFP28 form-factor ≤ 4.5 W/plug



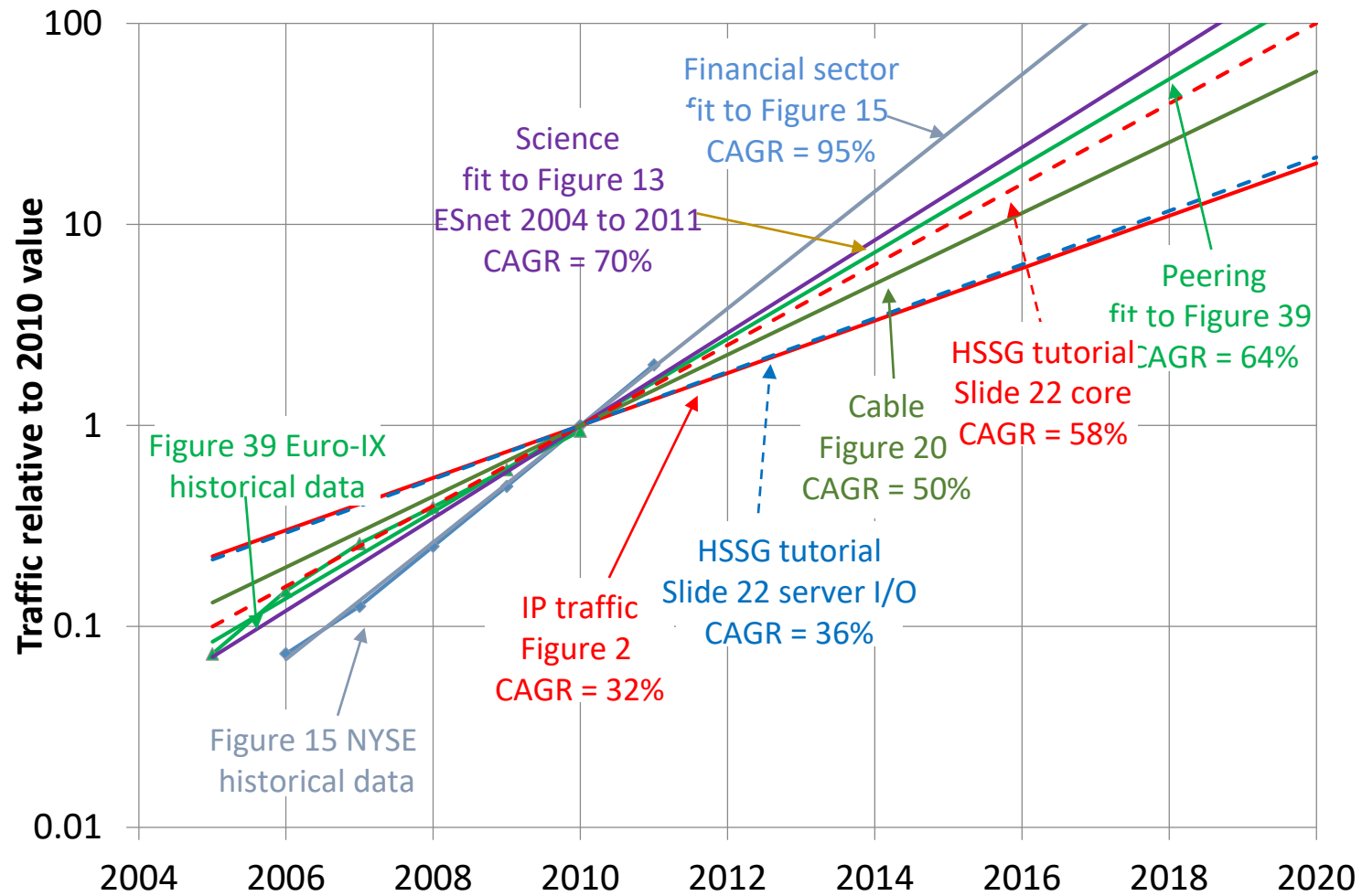
PAM4



Source: Brad Booth, Microsoft, http://www.ieee802.org/3/ad_hoc/ngrates/public/16_07/booth_ecdc_01_0716.pdf

Why now

Findings of IEEE 802.3 BWA Ad Hoc



Source: http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf

The Need for Extended Reach Optics

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Reach requirement and feasibility

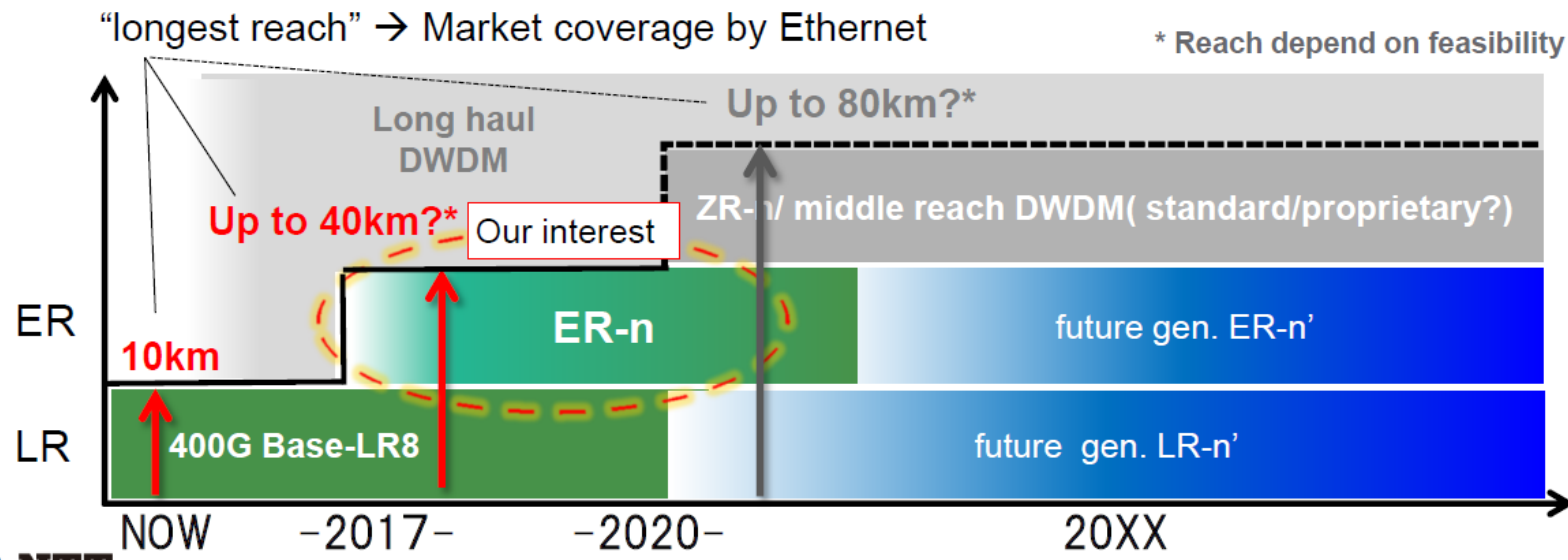


■ Reach requirement

- “The longer, the better” for the longest reach
 - >10km reach will bring more flexibilities in network architecture
- Market experience have proved there is a requirement up to 80km
- Likely 40km is a sweet spot in the current network architecture

■ Feasibility

- “The longer, the better” always faces technology limit.
- Technology limit depends on the timing we assume.



Source: Yoshiaki Sone, NTT,
http://www.ieee802.org/3/ad_hoc/ngrates/public/16_01/sone_ecdc_01c_0116.pdf

Summary

Contributors

- John D'Ambrosia, Futurewei

- IEEE 802.3 NG-ECDC Ad Hoc

Supporters Across the Eco-System

- TBD

- TBD

Straw Polls

Call-For-Interest

- Should a Study Group be formed for “ xxx”?

Y:

N:

A:

Room Count: xx

Participation

- I would participate in the “xx” Study Group in IEEE 802.3.

Tally:

- My company would support participation in the “xx” Study Group in IEEE 802.3

Tally:

Future Work

- Ask 802.3 on Thursday
 - Form XX SG
- If approved, on Friday
 - Request 802 EC informed of XX SG
 - First XX Gb/s Ethernet SG meeting, week of May 2017 IEEE 802.3 Interim.

Thank You!

Media		10G	25G	40G	50G	100G (G1)	100G (G2)	100G (Gn)	200G	400G
PCB Traces			1X25G	4X10G	1x50G	10x10G	4X25G	2x50G	4x50G	16X25G 8x50G
BP		1x10G	1X25G	4x10G	1x50G		4X25G	2x50G	4x50G	
Cu Cable		1x10G	1X25G	4x10G	1x50G	10x10G	4X25G	2x50G	4x50G	
MMF		1x10G	1X25G	4x10G	1x50G	10x10G	4X25G	2x50G	4x50G	16X25G
SMF	500m							1x100G	4x50G	4x100G
	2km			1x40G	1x50G				4x50G	8x50G
	10km	1x10G	1x25G	4x10G	1x50G	4x25G			4x50G	8x50G
	40km	1x10G	1X25G	4x10G		4x25G				
	80km	-ZR (No std)								

Media		10G	25G	40G	50G	100G (G1)	100G (G2)	100G (Gn)	200G	400G
PCB Traces			1X25G	4X10G	1x50G	10x10G	4X25G	2x50G	4x50G	16X25G 8x50G
BP		1x10G	1X25G	4x10G	1x50G		4X25G	2x50G	4x50G	
Cu Cable		1x10G	1X25G	4x10G	1x50G	10x10G	4X25G	2x50G	4x50G	
MMF		1x10G	1X25G	4x10G	1x50G	10x10G	4X25G	2x50G	4x50G	16X25G
SMF	500m							1x100G	4x50G	4x100G
	2km			1x40G	1x50G				4x50G	8x50G
	10km	1x10G	1x25G	4x10G	1x50G	4x25G			4x50G	8x50G
	40km	1x10G	1X25G	4x10G	?	4x25G		?	?	?
	80km	-ZR (No std)			?	?			?	?