



Spanning SERDES Across Reaches

- Finding the Best Modulation Approach

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IEEE802.3bs 400GE
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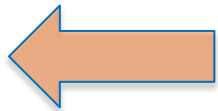
Overview

- What are the reaches and how should we cover those?
- Looks like C2EO is really the nPPI or eL'PPI in this case.
- Propose basic channel models for C2M and C2C.

Where is IEEE802.3bs 400GE in the Modulation Wars?

The following simplified process steps are used to build consensus:

- Defining / Discussing Reach
- System Architecture
- **Channel Loss**
- **Modulation**
- Equalization
- Error Correction
- Power








We Are About Here

Reach and Modulation

Looking at the 5 basic reach definitions talked about most
How to cover reach with the best coverage of SERDES cores



Length, Loss & Applications

IL		
	< 10mm/0.4in	USR
	< 50mm/2.0in	XSR LPPI
	< 200mm/7.9in	VSR C2M
	< 500mm/19.7in	MR C2C
	< 1000mm/39.4in	LR C2F

1.5dB@14GHz
3dB@28GHz

Bump-to-bump
Inside MCM or
3D Stack

4dB@14GHz
8dB@28GHz

Ball-to-ball
Across PCB

10dB@14GHz
20dB@28GHz

Ball-to-ball

20dB@14GHz
40dB@28GHz






Ball-to-ball

35dB@14GHz

Ball-to-ball

Length, Loss & Applications

IL

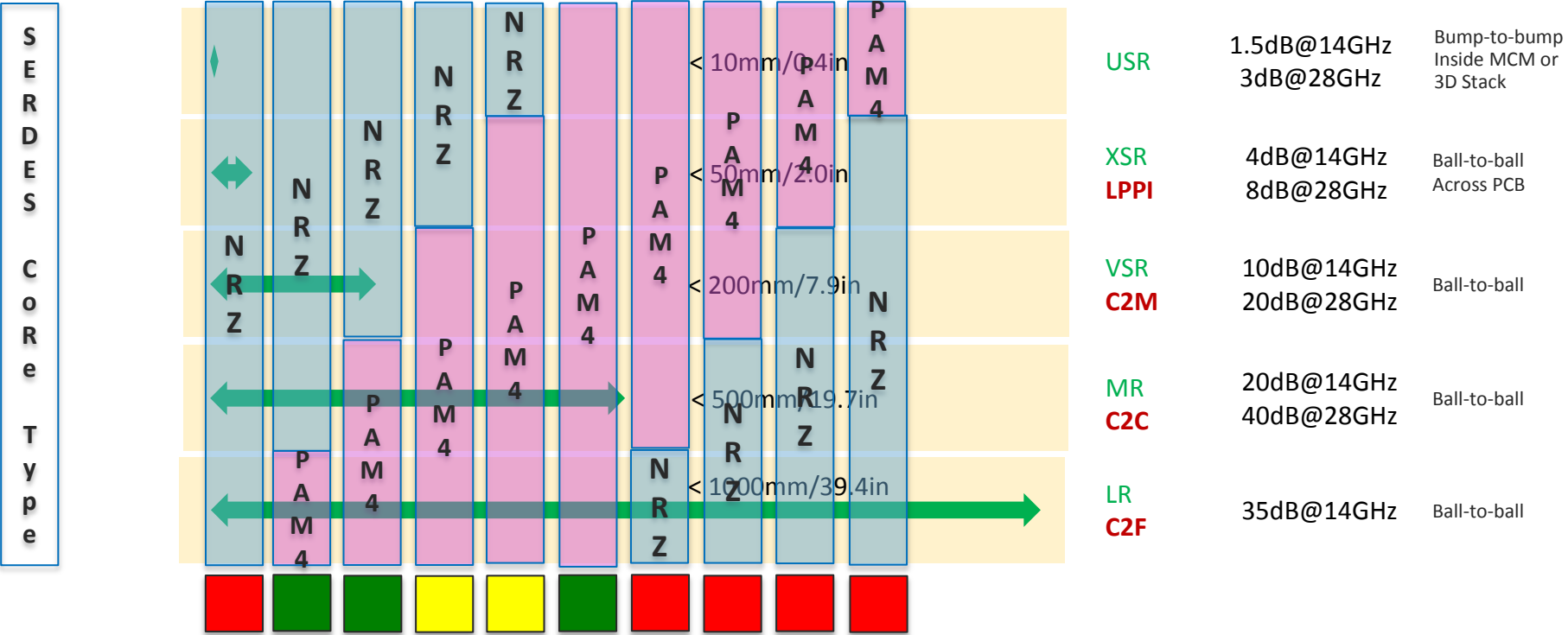
		< 10mm/0.4in	USR	1.5dB@14GHz 3dB@28GHz	Bump-to-bump Inside MCM or 3D Stack
Maybe?? Is it needed		< 50mm/2.0in	XSR LPPI	4dB@14GHz 8dB@28GHz	Ball-to-ball Across PCB
From chip to module		< 200mm/7.9in	VSR C2M	10dB@14GHz 20dB@28GHz	Ball-to-ball
From chip to chip		< 500mm/19.7in	MR C2C	20dB@14GHz 40dB@28GHz	Ball-to-ball
		< 1000mm/39.4in	LR C2F	35dB@14GHz	Ball-to-ball

Modulation is Tough Love

- If we focus on one reach, the conversation around modulation and power is easy.
- If we focus on our system design today, tomorrow, and out to 2017, the conversation turns to tough love!
- The next slide lays out some possible directions for picking modulation.

We think the discussion comes down to this – even though we are only focused on C2M and C2C

IL



Not Really Practical

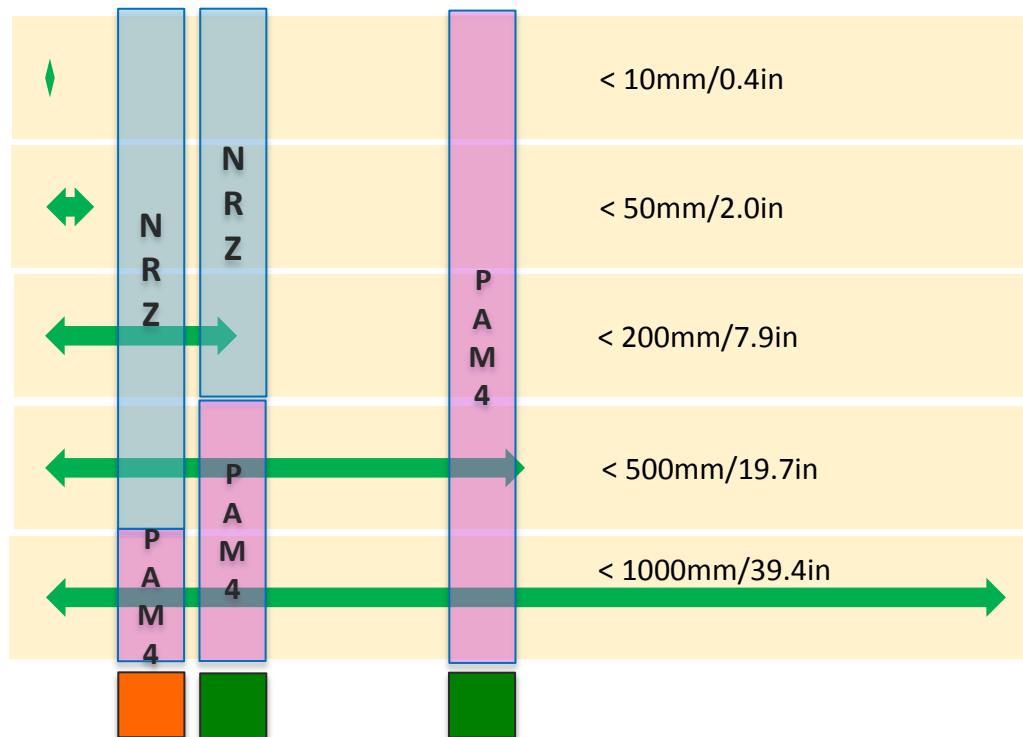
Compatibility Concerns

Feasible Technology – Min
Compatibility Concern

Tough Love – Choices for 50Gb/s Modulation Strategy

IL

SERDES
CORE
TYPE



USR

1.5dB@14GHz
3dB@28GHz

Bump-to-bump
Inside MCM or
3D Stack

XSR
LPPI

4dB@14GHz
8dB@28GHz

Ball-to-ball
Across PCB

VSR
C2M

10dB@14GHz
20dB@28GHz

Ball-to-ball

MR
C2C

20dB@14GHz
40dB@28GHz

Ball-to-ball

LR
C2F

35dB@14GHz

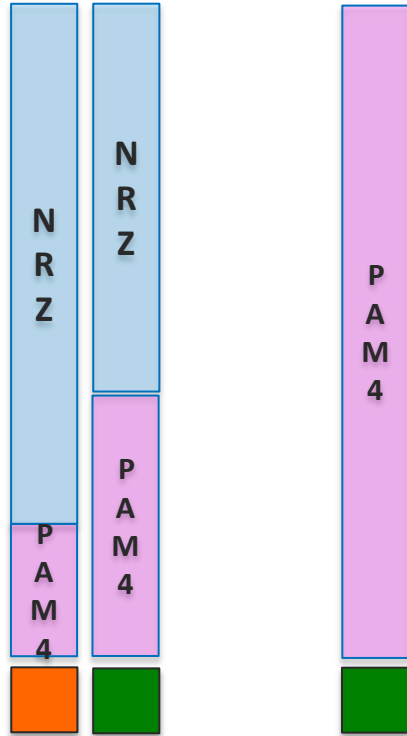
Ball-to-ball

C2C Reach is a Worry

Safe Bet Across
Technologies

Choices for 50Gb/s Modulation Strategy

SERDES
CORE
TYPE



- 1 – NRZ for LPPI / C2M / C2C
 - Long term covering C2F with PAM4 and covering USR with NRZ
 - Might be a challenge for C2M
 - Preserves SI test equipment and strategies in the lab
 - Optics can stay NRZ
- 2 – NRZ for LPPI / C2M and PAM4 for C2C
 - Long term covering C2F with PAM4 and covering USR with NRZ
 - Compatibility between C2C and C2F
 - Complicates test equipment and SI strategy in some cases
 - Optics can stay NRZ
- 3 – PAM4 for LPPI / C2M / C2C
 - Compatibility across all reaches
 - Changes test equipment and SI strategies, but not sure the extent
 - Optics has to move to PAM4 unless a conversion step is specified

Confirming Action Item from Sept 2014 Meeting

Length, Loss & Application: Technologies for 50Gb/s

These Values are under discussion

Application	Length	Loss	Modulation	pJ/bit	DFE?	FEC?
LPPI(XSR)	< 2in	<4dB@14GHz	PAM-4	TBD	TBD	TBD
		<8dB@28GHz	NRZ	TBD	TBD	TBD
C2M (VSR)	2-8in	4-10dB@14GHz	PAM-4	TBD	TBD	TBD
		8-20dB@28GHz	NRZ	TBD	TBD	TBD
C2C (MR)	8-20in	10-20dB@14GHz	PAM-4	TBD	TBD	TBD
		20-40dB@28GHz	NRZ	TBD	TBD	TBD

Knowing the reach definition allows us to begin understanding the next steps in the consensus building process

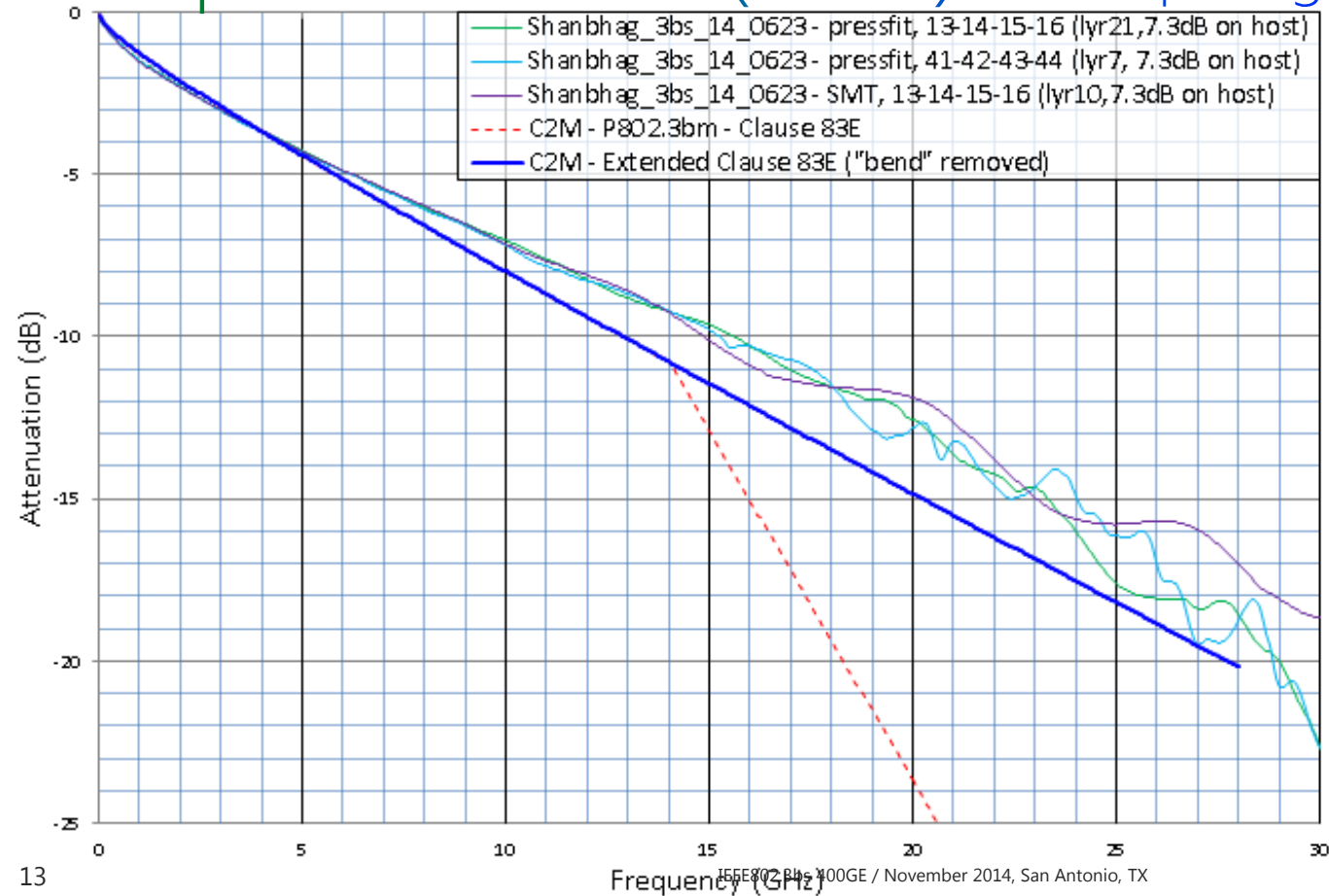
- System Architecture
- Channel Loss
- Modulation
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Proposal for Basic C2M and C2C Channel Limits Based on Reach

Looking at some possible limit lines to guide channel definitions for modulation simulation



Chip-to-Module (C2M) – Comparing channel data



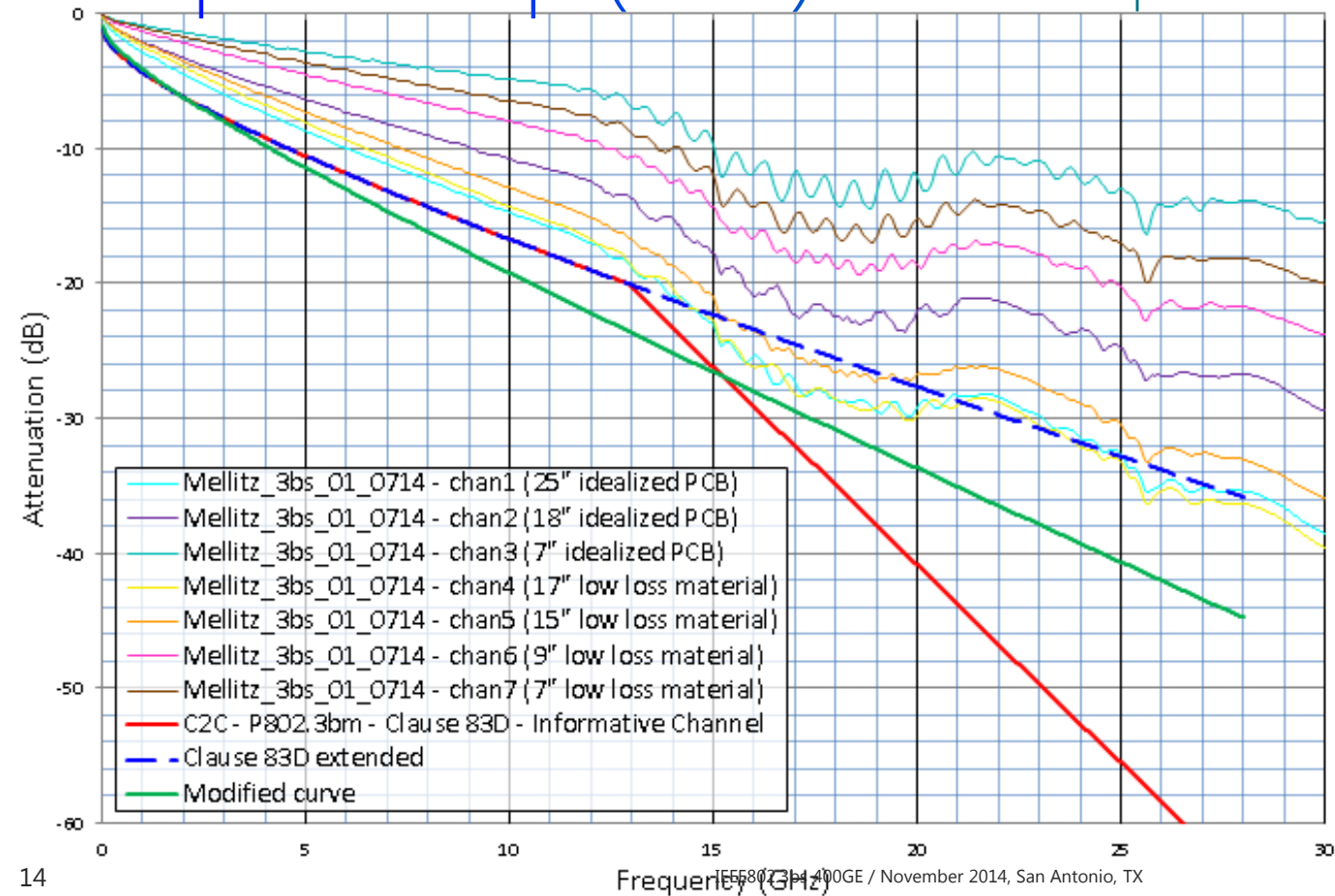
Notes:

← TE Channels developed using HFSS/ADS modeling tools.

← The 4" host trace is and should be supported at mid-loss materials by 100G standards... 7" is certainly seen in designs, but industries seem to recognize and adjust with material and design tradeoffs.

Propose: Use extended CAUI4 C2M-like channels for Modulation discussion/comparison

Chip-to-Chip (C2C) – Let's compare to channel data.



Notes:

← Channels are public on the .3bs webpage... all channels include connector and an 8% impedance variation from motherboard to daughtercard.

← Are these channels right to use for modulation discussion?

← Is ILD pessimistic for educated 50G channel design?

Proposed Basic Channel Limit Lines

Equations plotted for C2M and C2C

802.3bm draft – C2M equation (red curve)

$$Insertion_loss(f) \leq \left\{ \begin{array}{ll} 1.076(0.075 + 0.537\sqrt{f} + 0.566f) & 0.01 \leq f < 14 \\ 1.076(-18 + 2f) & 14 \leq f < 18.75 \end{array} \right\} \text{ (dB)} \quad (83E-1)$$

802.3bm draft – C2C equation (red curve) *although, standard uses COM as the normative spec, the following is offered as the informative “limit” line

$$Insertion_loss(f) \leq \left\{ \begin{array}{ll} 1.083 + 2.543\sqrt{f} + 0.761f & 0.01 \leq f < 12.89 \\ -17.851 + 2.936f & 12.89 \leq f < 25.78 \end{array} \right\} \text{ (dB)} \quad (83D-1)$$

C2M and C2C “extended curve” (blue curves)

Use These Equations

Simply extend first portion of above curves for full frequency range; omit 14-18.75G and 12.89-25.78G equations, respectively.

Suggested/modified curve drawn in C2C (green curve)

$$0.9 + 2.1\sqrt{f} + 1.17f$$

Summary / Continuing the Debate

- What are the reaches and how should we cover those?
- Looks like C2EO is really the nPPI or eL'PPI in this case.
- Propose basic channel models for C2M and C2C.
- Need to pick a modulation strategy for 50Gb/s.

Thank you!

From:

- Vasu Parthasarathy - Broadcom
- Beth Kochuparambil – Cisco Systems
- Vivek Telang - Broadcom
- Joel Goergen – Cisco Systems

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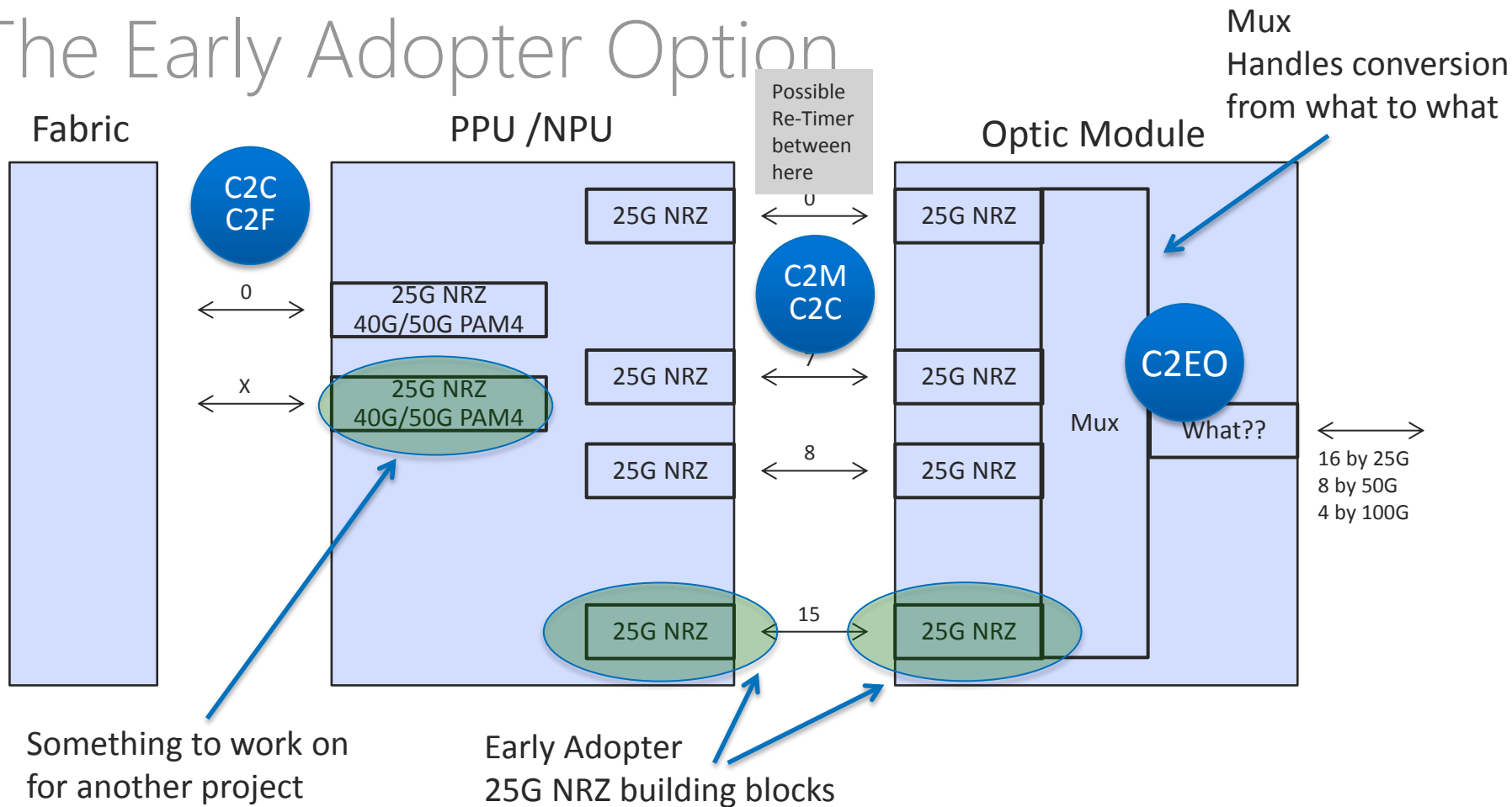
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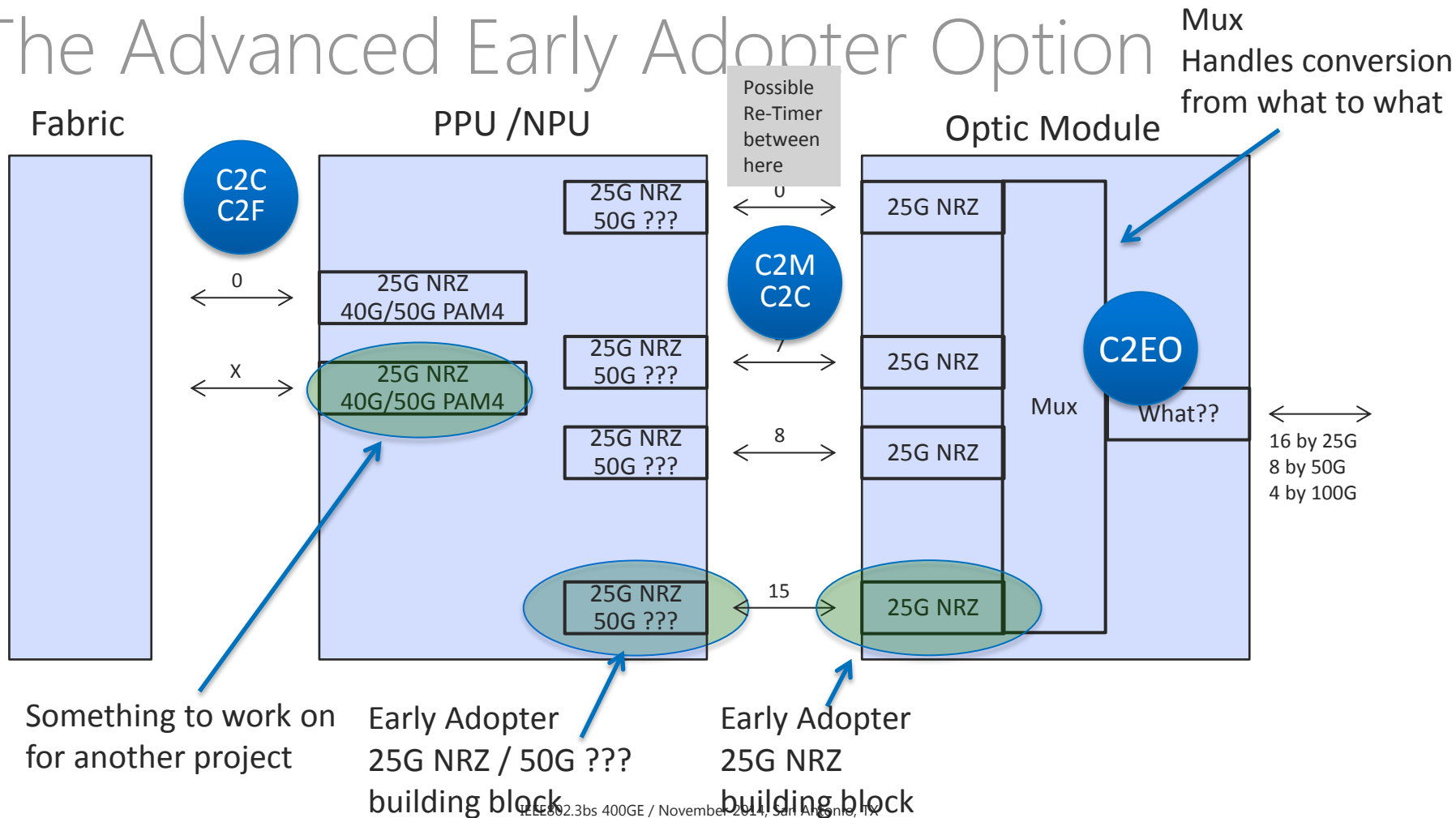
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Back Up Slides

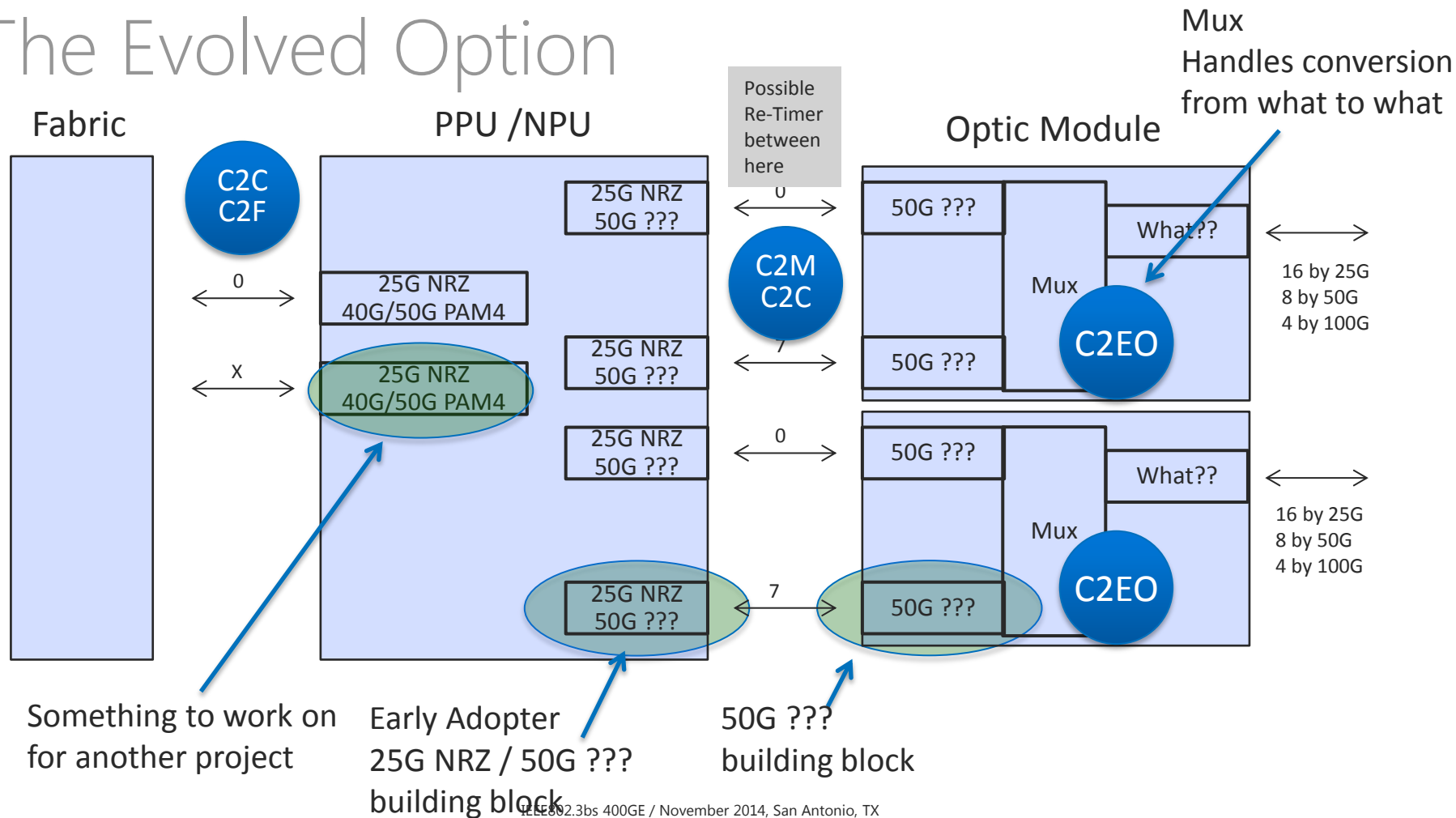
The Early Adopter Option



The Advanced Early Adopter Option



The Evolved Option



The Maybe-Some-day Option

