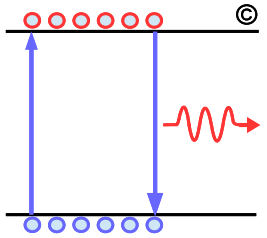

Use Case for 100G C2C-S

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IEEE 802.3ck Meeting

Bangkok

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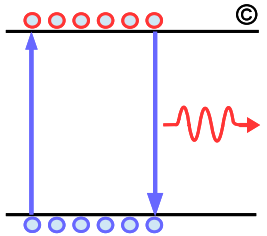
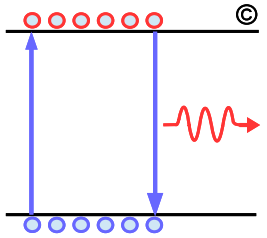
List of Supporters



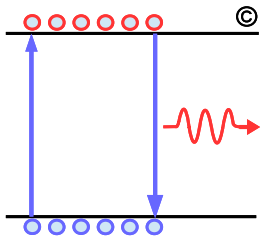
- **Ted Sprague – Infinera**
- **Pirooz Tooyserkani – Cisco**

Background



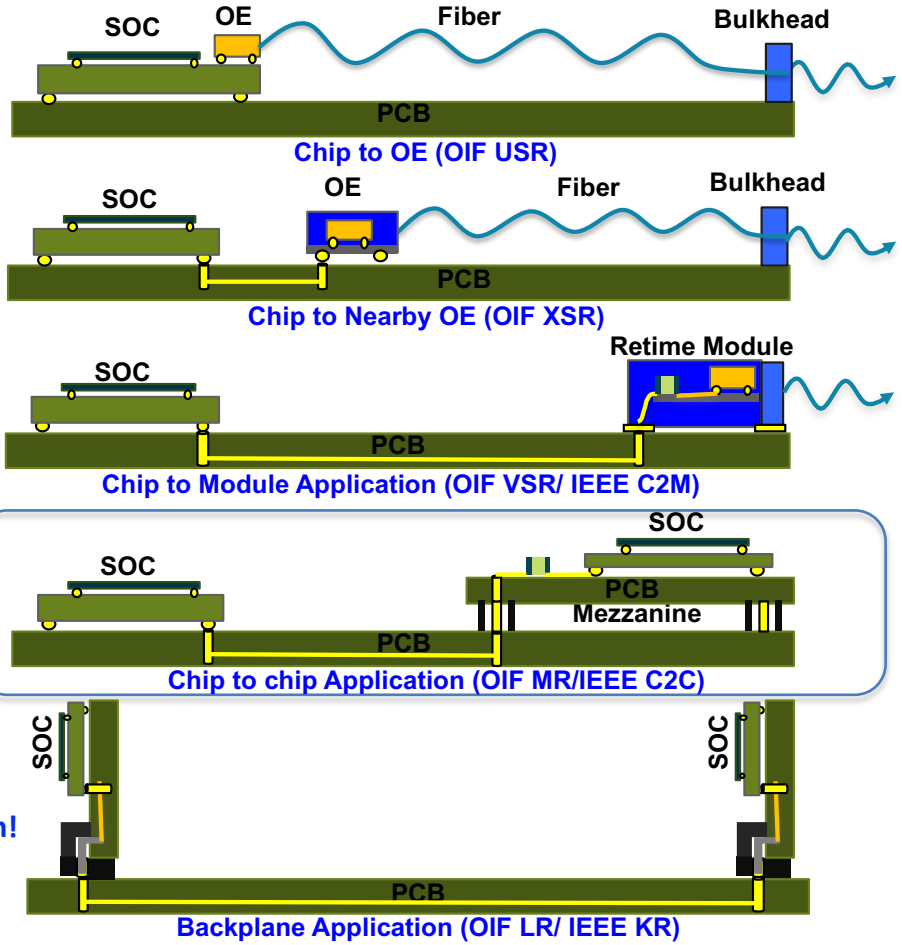
- **Medium reach C2C applications were first defined in OIF by OIF-28G-MR and later in IEEE clause 83D with following attributes:**
  - Intended to be lower power than KR/LR SerDes
  - The interface operates at 1E-12 or 1E-15 without FEC
  - Supports reach up to ~500 mm with one connector (~20 dB at Nyquist)
  - At 53 Gbd 500 mm application is more inline with 100G-KR
- **There is overwhelming support not to change 100GBASE-DR FEC/PCS**
  - Anslow showed that there is some concern with 100 GbE as result of burst error for DFE receiver anslow_3ck_01_0918.pdf
  - Gustlin suggest to use 2 RS (544, 514) interleaved FEC for KR/CR and C2C to overcome the burst error due to heavy DFE use gustlin_3ck_adhoc_01a_100318.pdf
  - Adding interleaved FEC that must be removed prior to transmission on fiber is a unnecessary complexity given that most of the C2C front panel applications can be satisfied even with 250 mm.

Overview of 50G/lane Ecosystems



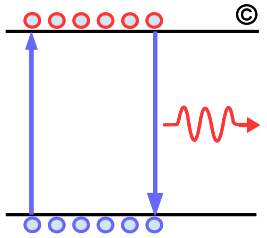
- **OIF defines both NRZ and PAM4 for MR but in IEEE CL120D C2C is defined for PAM4 signaling**
  - Both MR and C2C specifications expected reach are 50 cm plus one connector.

Application	Standard	Modulation	Reach	Loss Ball-ball	Loss Bump-bump
Chip-to-OE (MCM)	OIF-56G-USR	NRZ	< 1cm	2 dB@28 GHz	NA
Chip-to-nearby OE (no connector)	OIF-56G-XSR	NRZ/ PAM4	<7.5 cm[1]	8 dB@28 GHz 4.2 dB@14 GHz	12.2 dB@14 GHz 4.2 dB@14 GHz
Chip-to-module (one connector)	OIF-56G-VSR IEEE CDAUI-8	NRZ/PAM4 PAM4	< 10 cm[2] <20 cm	18 dB@28 GHz 10 dB@13.3 GHz	26 dB@28 GHz 14 dB@13.3 GHz
Chip-to-chip (one connector)	OIF-56G-MR IEEE CDAUI-8	NRZ/PAM4 PAM4	< 50 cm < 50 cm	35.8 dB@28 GHz 20 dB@13.3 GHz	47.8 dB@28 GHz[3] 26 dB@13.3 GHz
Backplane (two connectors)	OIF-56-LR IEEE 200G-KR4	PAM4 PAM4	<100 cm <100 cm	30dB@14.5 GHz 30dB@13.3 GHz	~37dB@14.5 GHz[4] 36dB@13.3 GHz



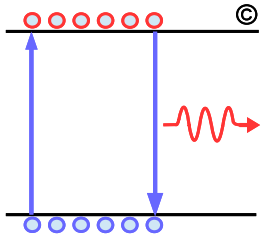
1. OIF XSR definition likely too short for any practical OBO implementation!
2. OIF VSR 10 cm reach assumes 10 cm mid-grade PCB but typical implementation uses Meg6/ Tachyon 100 with ~25 cm!
3. Include 2x6 dB for package loss but 47.8 dB seem beyond equalization capability
4. Include 2x3.5 dB for package loss.

Evolution of Electrical Interfaces

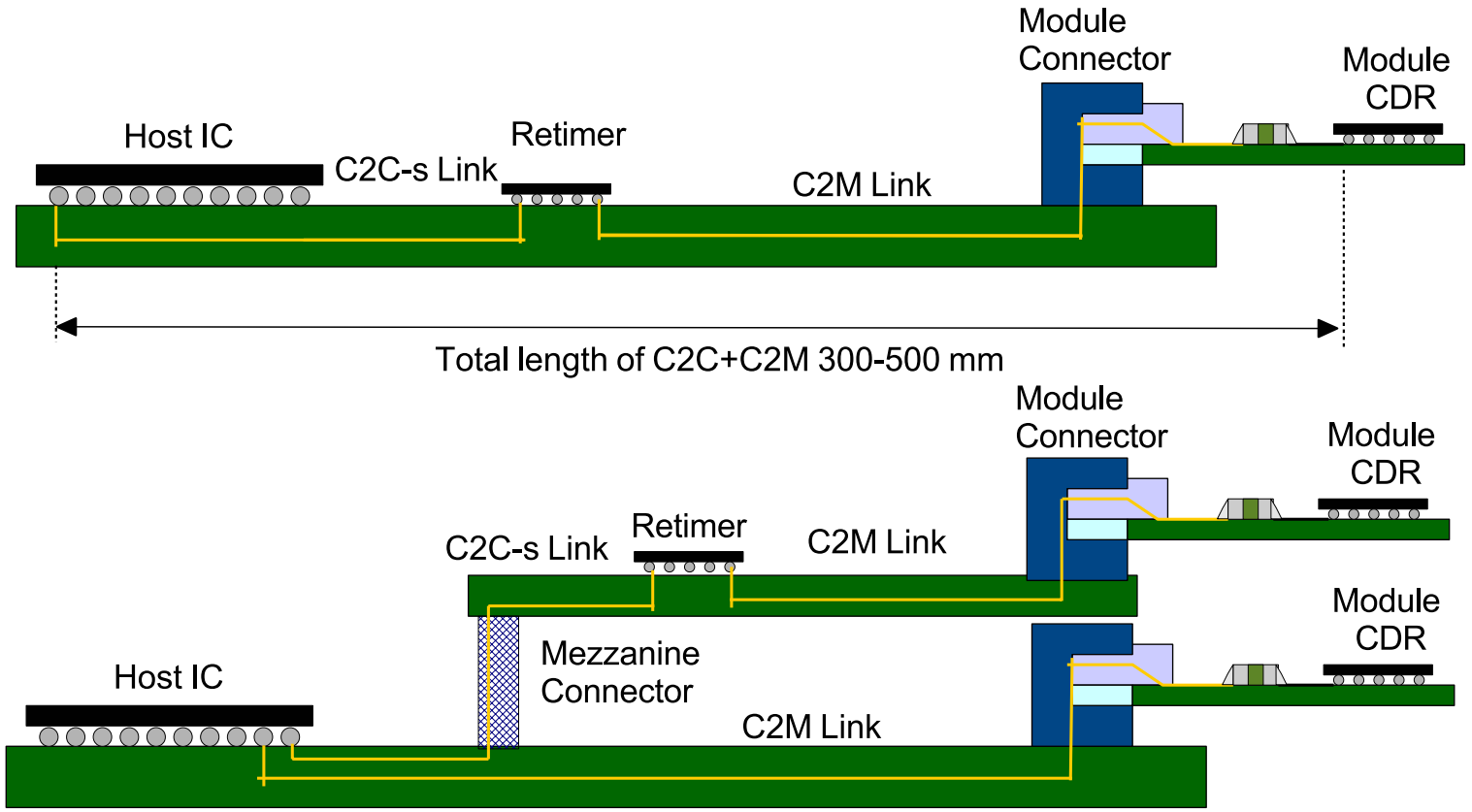


- **Historical KR, CR, and C2M reaches and expected reach/loss at 53 GBd PAM4**
  - KR supported 1 m plus two connectors at 25.78 GBd but due to attenuation at 53 GBd only ~500 mm supported
  - C2C supported 500 mm plus one connector at 25.78 GBd and the same reach can be supported at 53 GBd on Megtron 7 with KR budget
  - CR cable reach was 7 m at 10.3125 GBd but due to attenuation at 53 GBd only 2 m is supported
  - C2M reach was 250 mm on Megtron 6 at 25.78 GBd with 10.2 dB budget (ball-ball) and at 53 GBd with 16 dB just about same reach can be supported on Megtron 7
- **A C2C link with heavy DFE use based on 20-28 dB brings additional complexity/latency as result of FEC conversion or FEC termination prior to transmission on 100GBASE-DR link**
  - To support originally envisioned C2C application with 500 mm plus one connector one has to use 100G-KR
  - One of the key C2C application are retimers placed between ASIC and front panel, where 500 mm is too long
  - ASIC-retimer-module form a multi-segmented link where optical PMD BER can't changed from 2E-4 and any DFE burst error on electrical link may impact optical PMD BER
  - Repurposing C2M for C2C operating with end-end FEC and without heavy DFE use allow avoiding segmented FEC
  - The C2C specifications supporting ~300 mm based on 16 dB C2M budget is call "C2C-S".

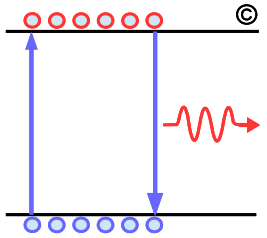
Two Common C2C-S Applications



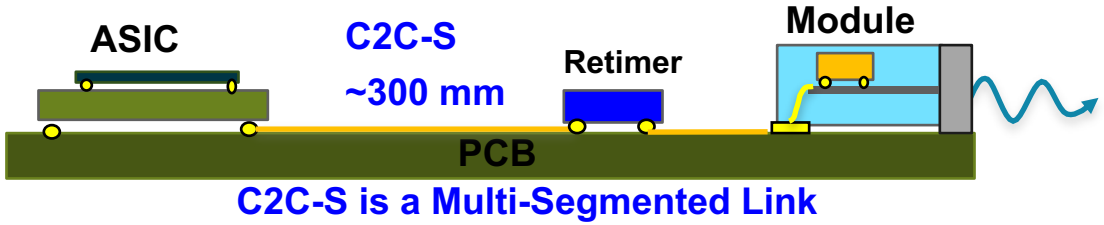
- **These two common C2C-S applications can satisfied with ~300 mm trace and by repurposing 16 dB C2M budget**
  - Connecting to far-side of the ASIC IO may require retimer
  - Modules mounted on mezzanine card.



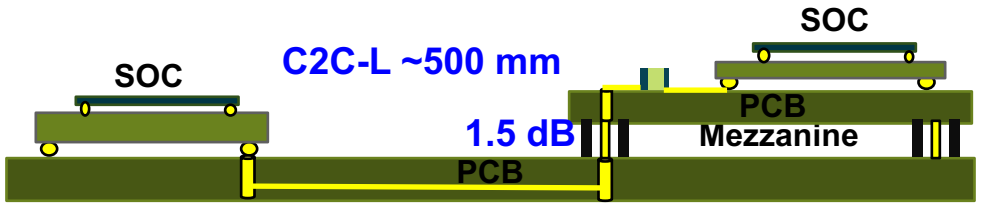
Key Differences Between C2C-S/L and KR



- C2C-S based on 16 dB C2M budget can support following reaches assuming Megtron 7 (1.3 dB/in) ~300 mm on PCB or ~280 mm on PCB with one connector
- C2C-L assuming ~500 mm reach on Megtron 7 (1.3 dB/in) with 1 connector (1.5 dB) results in 27.1 dB ball-ball budget
- KR supports 28 dB ball-ball with two connectors (3 dB) the reach on Megtron 7 (1.3 dB/in) is ~488 mm.



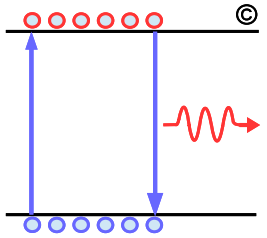
C2C-S is a Multi-Segmented Link



C2C-L is Point-Point Link

KR is Point-Point Link

Summary



- **The historical C2C "C2C-L" applications with 500 mm plus one connector at 53 GBd with estimated 27.1 dB ball-ball is aligned with the task force 100G-KR 28 dB loss budget from ball-ball**
  - The 28 dB ball-ball budget can be used for both C2C-L and KR, C2C-L could even be a subset of KR budget
- **C2C-S is addressing short reach 300 mm multi-segmented links where FEC termination/conversion is un-desirable**
  - A light C2C-S that does not use heavy DFE avoid introducing interleaved FEC that must be removed prior to transmission on 100GBASE-DR links
- **Two of the most common C2C-S use cases are in support of following applications**
  - Retiming far-side of ASIC IOs signals before transmission to front panel modules
  - Retiming signals where optical modules are mounted on a mezzanine card
- **Both of the above applications can be satisfied by repurposing C2M 16 dB budget for C2C-S**
- **Proposes to define C2C-S specifications with up to 16 dB by leveraging C2M without heavy DFE use in support of channels with up to 300 mm on PCB or 250 mm on PCB with one connector**
  - If C2C-L loss is similar to KR 28 dB ball-ball loss then C2C-L can be a subset of KR and the short reach ~300 mm interface can just be called C2C.