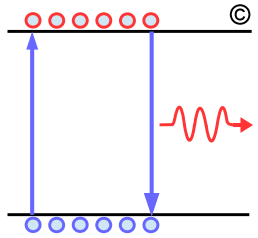

PCS Consideration for 50 GbE and NG 100 GbE

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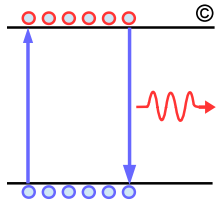
Ghiasi Quantum LLC

NGOATH Plenary Meeting
Macau

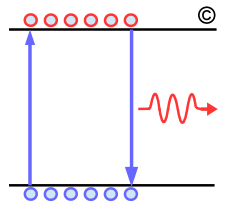
March 15, 2016

50 GbE and NG 100 GbE Compatability Considerations

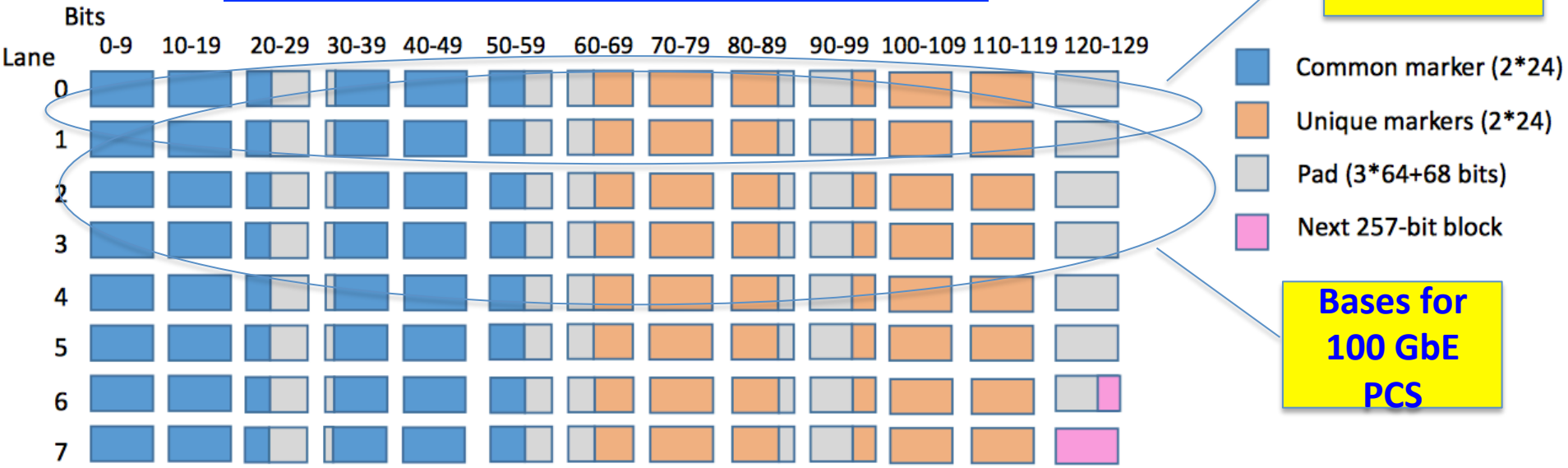


- **25G MSA does have a 50 GbE mode of operation http://25gethernet.org**
  - 25G MSA specification is not public but there is a public overview
    - http://25gethernet.org/sites/default/files/25G%20and%2050G%20Specification%20Overview.pdf
  - 50 GbE is implemented over 2 lanes of 25G as illustrated by
    - http://www.ieee802.org/3/50G/public/adhoc/archive/stone_021716_50GE_NGOATH_adhoc-v2.pdf
  - IEEE 50 GbE to support legacy implementation would require LAUI-2 PMA
- **Transition to 50G/lane optics may happen faster than migration to ASICs with 50G IO**
  - 50 GbE or NG 100 GbE implementation may take advantage of 400 GbE hardware which supports 16x25G electrical but 50G/lane or 100G/lane optics
  - To support flexible migration the 50 GbE PCS and NG 100 GbE PCSs should support respectively 2 and 4 lanes PMAs
- **Full backward compatibility could be provided by a PMA-PMA device as long as the:**
  - 50 GbE PCS supports LAUI-1/2
  - NG 100 GbE PCS supports CAUI-4/2.

Option I: 50 GbE and NGOATH 100 GbE PCS

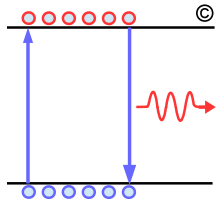


- **Based on 25G PCS lanes as proposed 200 GbE PCS format**
  - http://www.ieee802.org/3/bs/public/adhoc/logic/feb9_16/gustlin_01_0216_logic.pdf



- 50 GbE can be based on 1x257b blocks, pad is filled with free running PRBS9
- 100 GbE can be based on 2x257b blocks, pad is filled with free running PRBS9
  - To provide backward compatibility with 100 GbE per CL82 require more complex PMA-PMA chip
- Implementation will support LAUI-2/1 and CAUI-4/2

Option II: Possible 50 GbE and 100 GbE PCS Format



- **Based on 5G PCS lanes per CL82**
  - For 50 GbE use half number of PCS lanes as was proposed:
    - http://www.ieee802.org/3/50G/public/adhoc/archive/gustlin_020316_50GE_NGOATH_adhoc.pdf
  - May support 25 GbE MSA implementation with simpler PMA chip
  - Implementation will support LAUI-2/1 and CAUI-4/2
  - If RS-FEC (544,514) is required is there value to preserve 5G PCS lane over synergy with .bs PCS?

FEC Lane	Reed-Solomon symbol index (10 bit symbols 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33					
0	AM0 (0 … 63)	AM4	AM8	AM12	AM16	
1	AM0	AM5	AM9	AM13	AM16	
2	AM0	AM6	AM10	AM14	AM16	
3	AM0	AM7	AM11	AM15	AM16	

Bases for 50 GbE PCS With LAUI-2

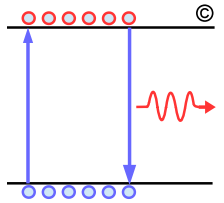
5b pad

Existing 100GbE FEC(528,514)

Bases for 100 GbE PCS with CAUI-2

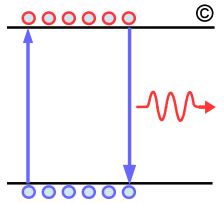
FEC Lane	Reed-Solomon symbol index (10 bit symbols 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31										
0	AM0 (0 … 63)	AM0	AM4	AM6	AM8	AM10	AM12	AM14	AM16	AM18	
1	AM0	AM0	AM5	AM7	AM9	AM11	AM13	AM15	AM17	AM19	

Option III: Possible 50 and 100 GbE PCS Format



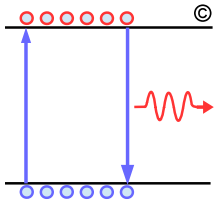
- **Follow CL49 10GBase-R PCS without any AM**
  - No clear advantage
  - No synergy with 100GbE, 200GbE, 400 GbE
  - Will only support CAUI-1 where there is no PMD objective for it
  - Will not support LAUI-2
- **CL49 does not offer viable PCS solution!**

Compatibility and Synergy Interaction with FEC

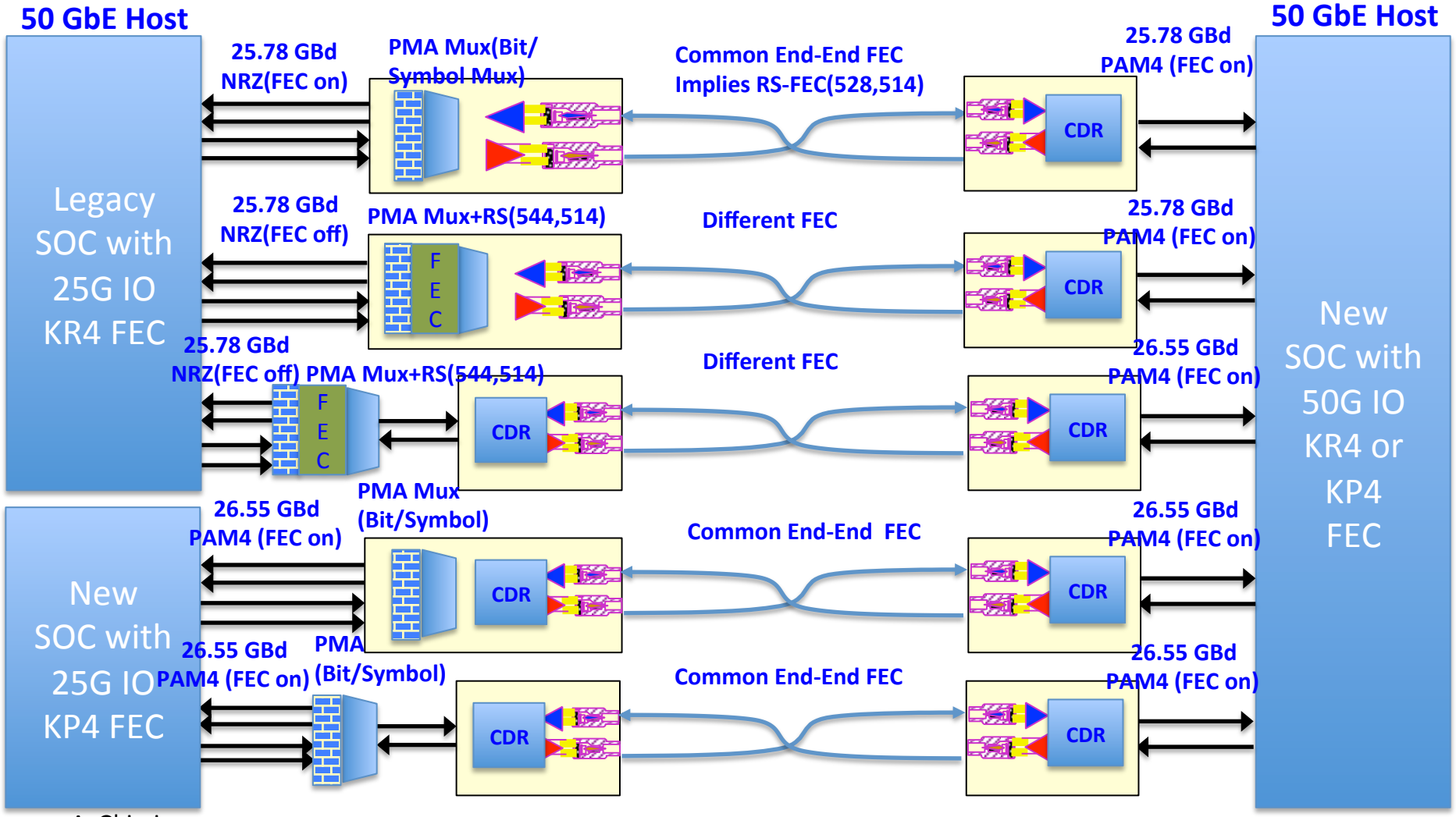


- **During the study group need to investigate ideally a common FEC addressing all 50 GbE PMDs with likely choices:**
  - RS-FEC (528,514)
  - RS-FEC (544,514)
- **During the study phase need to investigate if RS-FEC (528,514) can meet NGOATH 100 GbE PMDs requirements:**
  - If RS-FEC (528,514) can meet NG PMDs requirements then there is stronger case to preserve 5G PCS lane to provide ease of backward compatibility
    - A further complication is the fact that legacy 100 GbE PMD use all of the KR4 FEC gain unless CAUI-2 can operate error free similar to CAUI-4 (1E-15) compatibility with legacy PMDs likely can not be preserved
  - If NG 100GbE PMD require RS-FEC (544,514) then preserving 5G PCS lane is not as much of a value
    - Advantage of KP4 FEC is synergy with CDAUI-8/CCAUI-4 and similarly CAUI-2 can operate at Pre-FEC BER of 1E-6
    - Interfacing legacy 100 GbE PMDs with host having CAUI-2 interface likely will require terminating KR4 FEC then initiating KP4 FEC
- **50G/lane Cu and optical PMDs should drive the FEC choice and coding gain**
  - Bit mux would be preferable but may have a penalty under burst error
  - Symbol mux advantage is that data could come from two logical lanes without penalty
  - LAUI-2 and CAUI-4 require PMA-PMA mux where with appropriate implementation can provide full backward compatibility without sacrificing PMD performance
- **Next will show some of the possible 50 GbE and NGOATH implementations.**

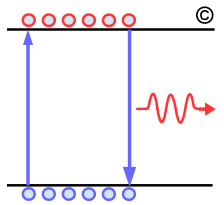
Possible 50 GbE Implementations



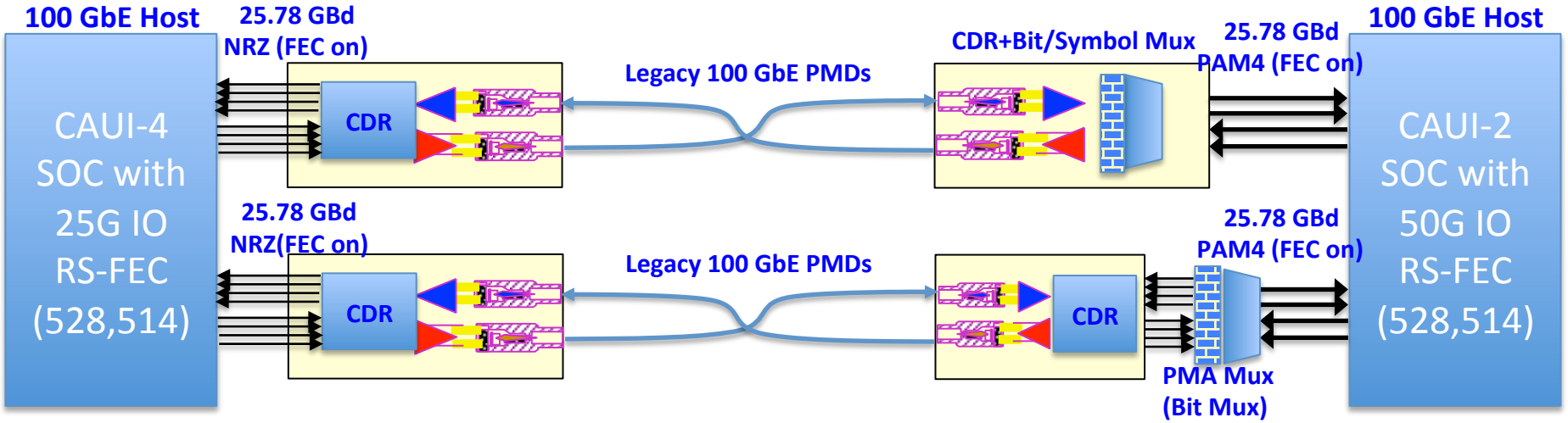
- The key to supporting any existing 50 GbE or early implementation of 50 GbE is to support LAUI-2
- PMA-PMA device can provide full backward compatibility as long as PCS supports breaking traffic over two lanes



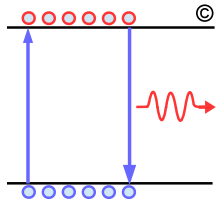
Legacy 100GbE PMDs Assuming Single KR4 FEC is hared with CAUI-2



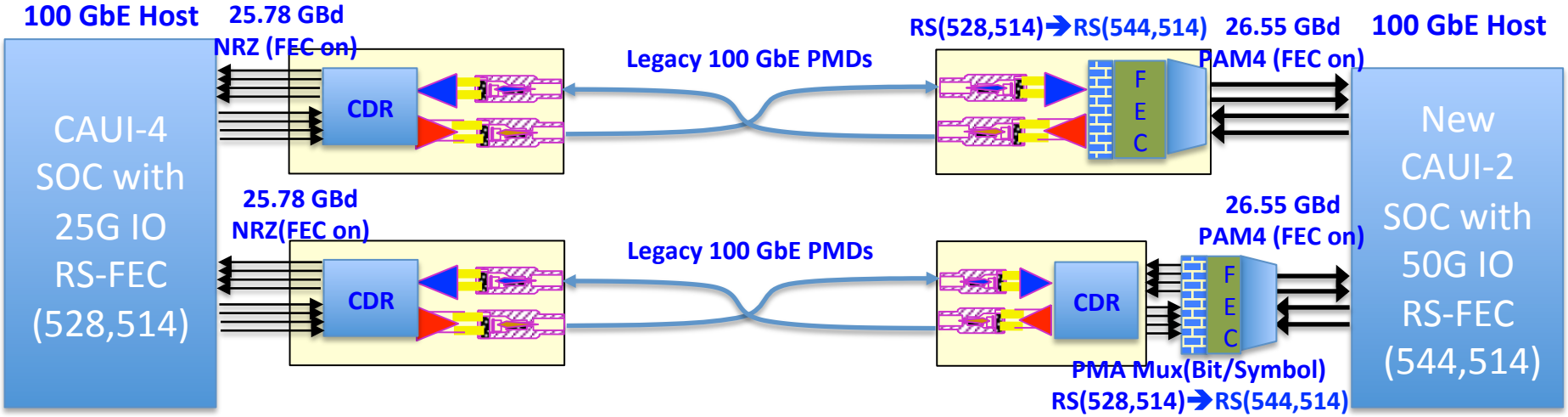
- **KR4 FEC with 20 PCS lanes offers highest level of backward compatibility to CL82 PCS and CL91 KR4-FEC**
- **Architecture shown below likely not be viable if KR4 FEC gain is divided between CAUI-2 and legacy 100 GbE PMD that use the full KR4 FEC gain**
  - To over come this limitation CAUI-2 would have to operate error free similar to CAUI-4 (1E-15).



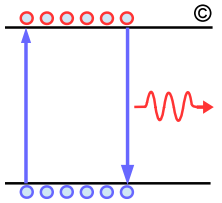
100 GbE Implementations of Legacy PMDs if CAUI-2 uses KP4 FEC



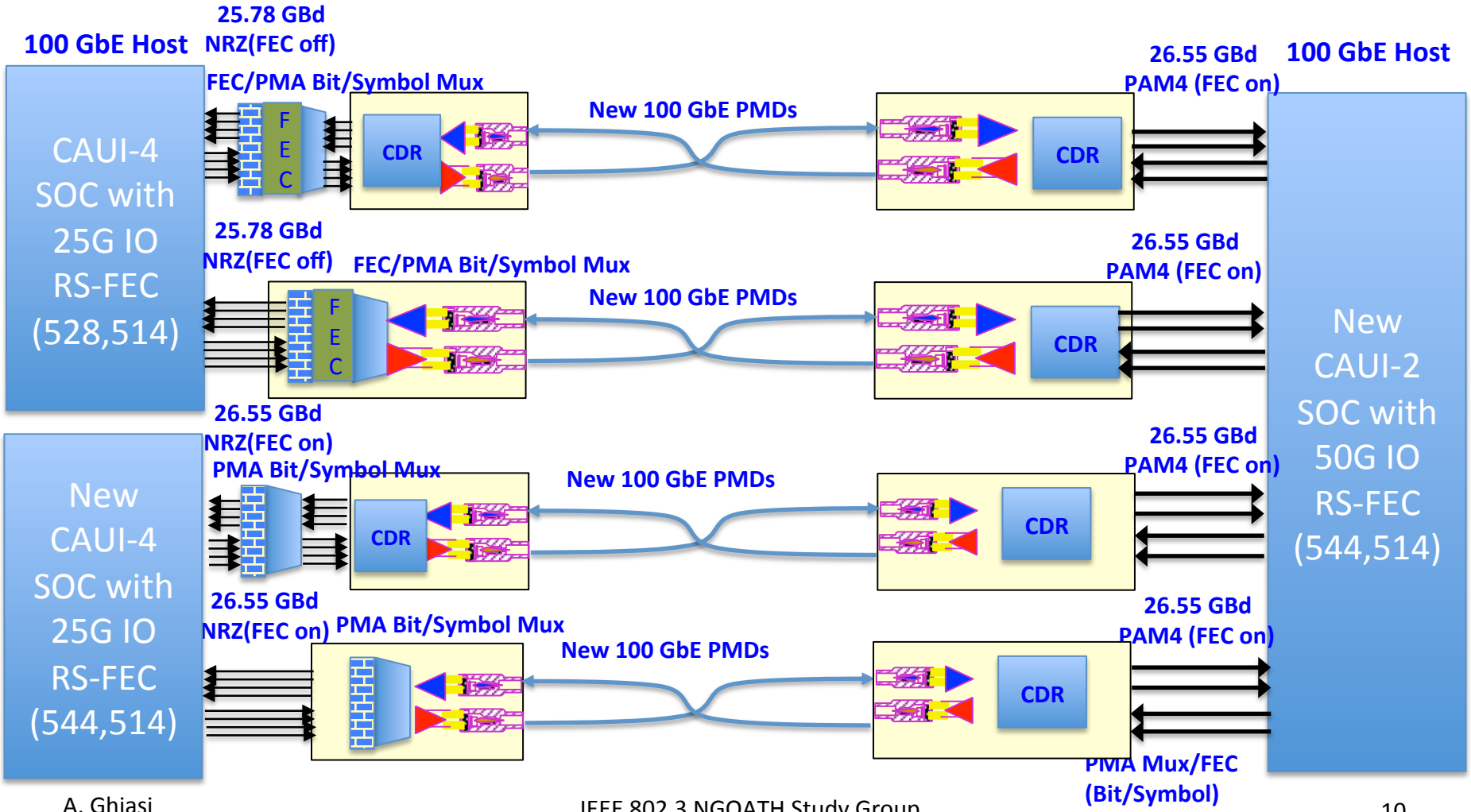
- **During the study phase need to balance the level of backward compatibility with overall synergy**
  - PMA-PMA+FEC device placed in module or on the line card can provide backward compatibility.



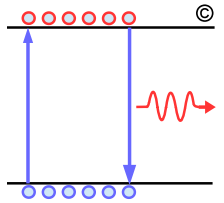
New 100 GbE PMDs Assuming KP4 FEC is Required



- **During the study phase need to balance the level of backward compatibility with overall synergy**
- **PMA-PMA device can provide compatibility**
  - FEC can easily be integrated into PMA-PMA device which can be placed in module or on the line card.



Summary



- **The 50 GbE PMD level of compatibility and synergy should be left to the study group**
- **The NG 100 GbE and level of compatibility and synergy should be left to the study group**
- **Ease of full backward compatibility should not come at expense of sacrificing 50 GbE and NG 100 GbE PMD performance as the backward compatibility can always be solved with the PMA-PMA device**
  - Specific implementation should be left to the task force
  - Need to investigate RS-FEC(528,514) and (544,514) as well as how to form FEC lanes
  - Current 100 GbE PMD uses all of the KR4 FEC gain as CAUI-4 operates error free (1E-15)
    - Unless KR4 FEC has sufficient FEC gain to cover the legacy PMD FEC gain and protect CAUI-2 or LAUI-1 the case to stay with KR4 FEC from compatibility perspective implodes
  - KP4 FEC is a better choice to protect new 50 Gb/s/lane PAM4 PMDs requiring additional FEC gain which needs to be shared with CAUI-2/LAUI-1 links.
- **With Mr. Nowell stating during adhoc call that optional AUI (i.e. LAUI-2) are not out scope**
  - As the preceding figures show only after the FEC decision is made the architectural implementation and AUI choices can be narrowed
  - Specific 50G and 100G AUI should be left to be defined by the study group where compatibility, PCS, and FEC are all considered
  - Including specifics of AUI or PCS in the objective may handcuff us!