Estimations of 800GE PCS and PMA Skew Limits

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Background and Introduction

- Discussion for new maximum skew values
  - ran_3df_03_230130.pdf studied the skew limits history, and proposed new values
  - Nicholl's study analyzed the worst case skew of modern FPGA, and proposed new values for PCS TX to SP1 and SP6 to PCS RX

- This presentation provides 800GE PCS and PMA Skew Limits based our FPGA die skew analysis, and studies of package and PCB trace based on the latest technologies

FPGA TX/RX Die Skew Analysis

- FIFO Fill and SerDes
  - Our worst case skew is in line with Nicholl's study .

	Nicholl's study	This Study
TX/RX FIFO	2.4 ns	2.4 ns
SerDes	2.4 ns	2.4 ns

Package Traces Mismatch

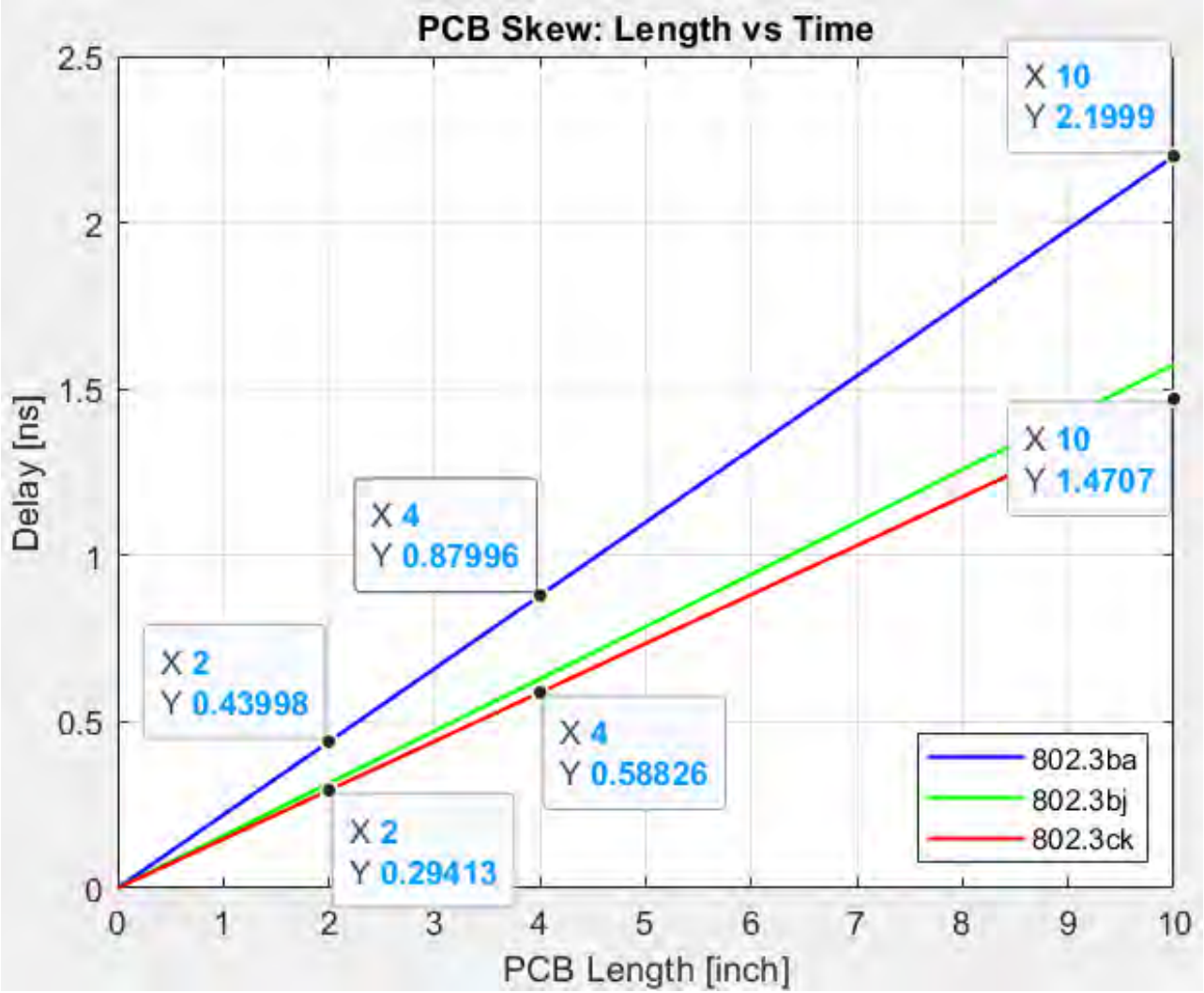
- Use 802.3ck COM package models
  - tau = 6.141e-3 ns/mm for 802.3ck
- Max TX package skew
  - (31-12)mm * tau = 0.116 ns
- Max RX package skew
  - (29-12)mm * tau = 0.104 ns

- Proposal
  - 0.2 ns

PCB Traces Mismatch (1/2)

- Current spec is based on 0.22 ns/inch propagation speed
  - This is carried over from 802.3ba time, and much slower than 802.3bj and 802.3ck PCBs
- PCB tau of 802.3bj and ck
  - 802.3bj (Table 92-12): tau = 6.191e-3 ns/mm
  - 802.3ck (Table 162-21): tau = 5.79e-3 ns/mm

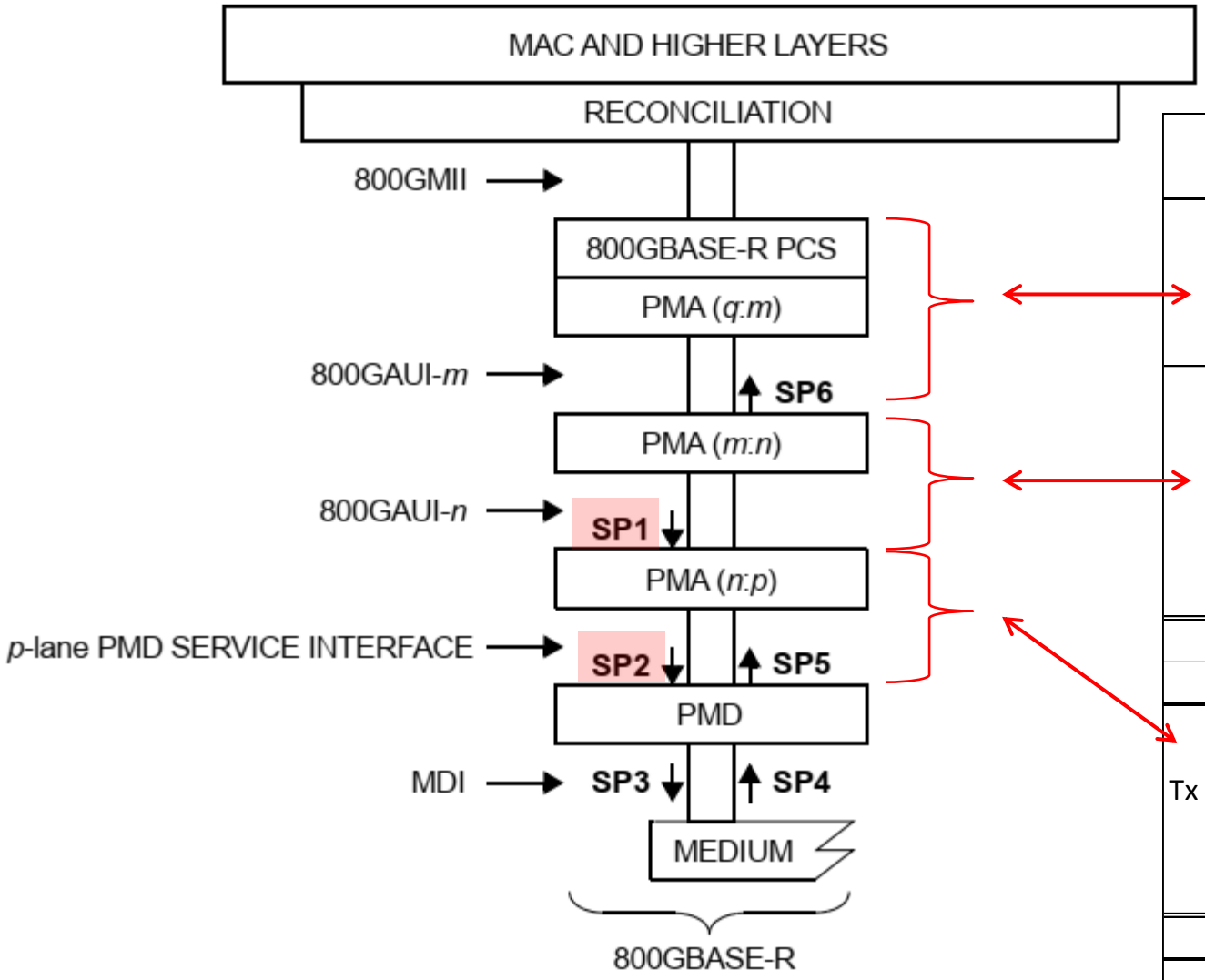
PCB Traces Mismatch (2/2)



- Proposal
  - 4” trace skew: 0.6 ns (from 802.3ba’ 0.88ns)
  - 2” trace skew: 0.3 ns (from 802.3bs’s 0.44ns)

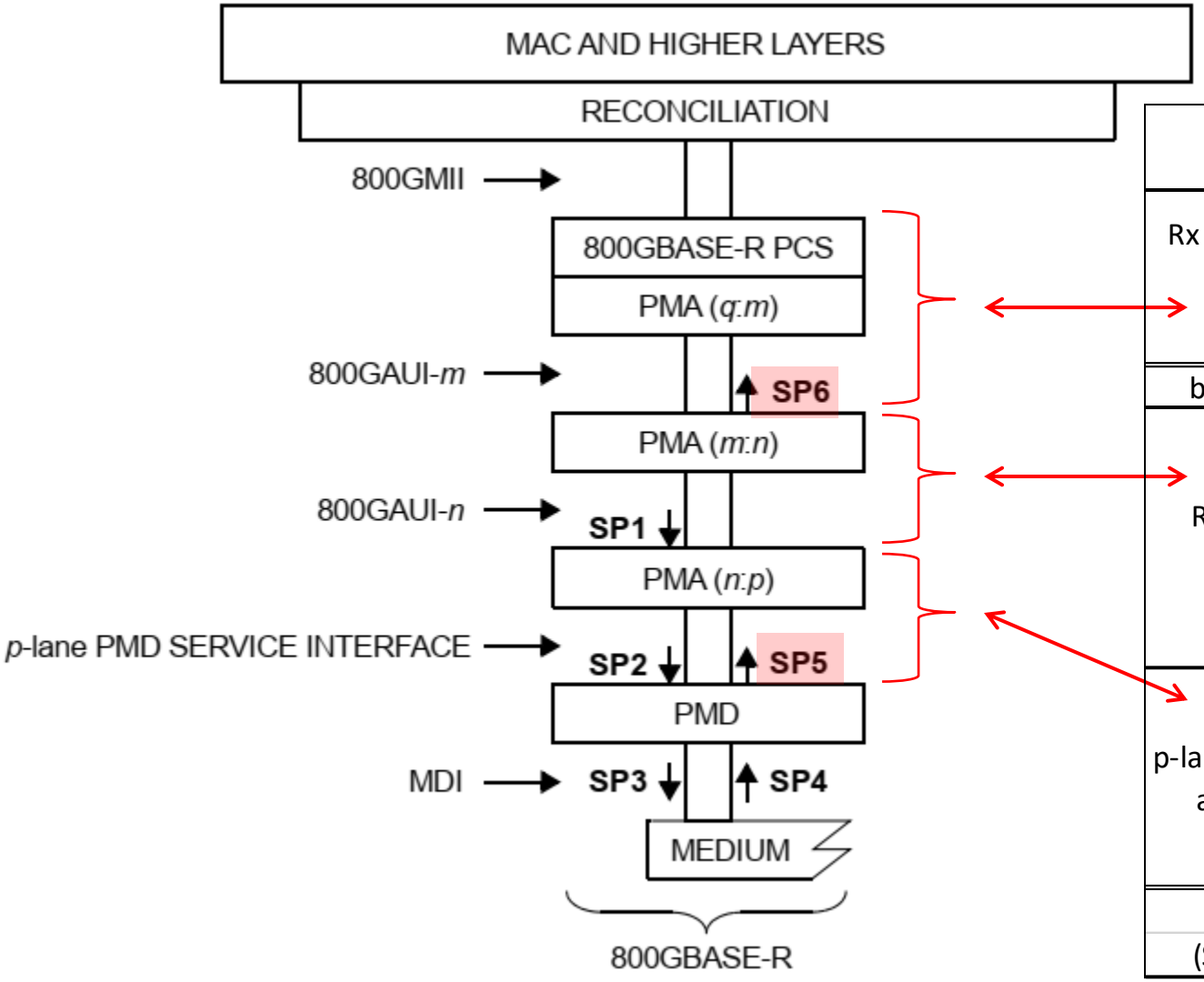
Note: Skew due to rise/fall time variation caused by parasitic C/L variation of 53GBd, 19ps/UI signals would be negligibly small compared with the skew due to PCB traces variation

TX Side Skews Estimation



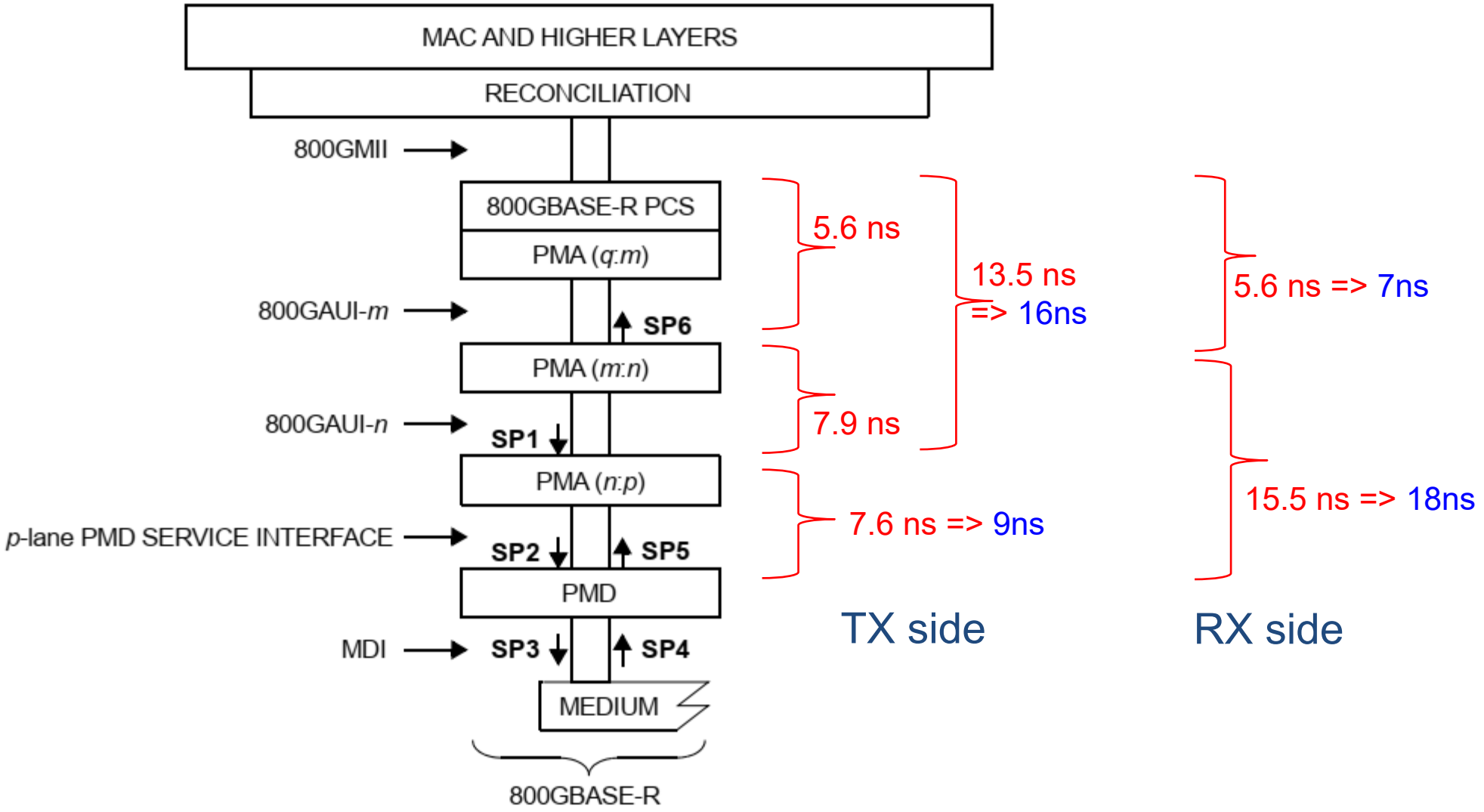
Link Segment	Max Skew [ns]		Notes
	Elemental	Sum	
Tx PCS (incl. FEC), PMA(q:m) and 800GAUI-m	2.4	5.6	FIFO fill difference
	2.4		Serializer
	0.2		Package traces mismatch
	0.6		PCB traces mismatch (up to 4")
Tx PMA(m:n) and 800GAUI-n	0.2	7.9	Package traces mismatch
	2.4		Deserializer
	2.4		FIFO fill difference
	2.4		Serializer
	0.2		Package traces mismatch
	0.3		PCB traces mismatch (up to 2")
SP1		13.5	Tx PCS to SP1
SP1 with some margin		16	<New Spec Proposal>
Tx PMA(n:p) and p-lane PMD SERVICE IF	0.2	7.6	Package traces mismatch
	2.4		Deserializer
	2.4		FIFO fill difference
	2.4		Serializer
	0.2		EIC to PIC package traces
(SP2 - SP1) with some margin		9	<New Spec Proposal>
SP2 with some margin		25	<New Spec Proposal>

RX Side Skews Estimation



Link Segment	Max Skew [ns]		Notes
	Elemental	Sum	
Rx PCS (incl. FEC), Rx PMA(q:m) and 800GAUI-m	2.4	5.6	FIFO fill difference
	2.4		Deserializer
	0.2		Package traces mismatch
	0.6		PCB traces mismatch (up to 4")
between SP6 and Rx PCS with		7	<New Spec Proposal>
Rx PMA(m:n) and 800GAUI-n	0.2	7.9	Package traces mismatch
	2.4		Serializer
	2.4		FIFO fill difference
	2.4		Deserializer
	0.2		Package traces mismatch
	0.3		PCB traces mismatch (up to 2")
p-lane PMD SERVICE IF and Rx PMA(n:p)	0.2	7.6	Package traces mismatch
	2.4		Serializer
	2.4		FIFO fill difference
	2.4		Deserializer
	0.2		PIC to EIC package traces
SP6 - SP5		15.5	raw estimate
(SP6 - SP5) with some margin		18	<New Spec Proposal>

Skew Estimation Summary



New Maximum Skew Spec Proposal

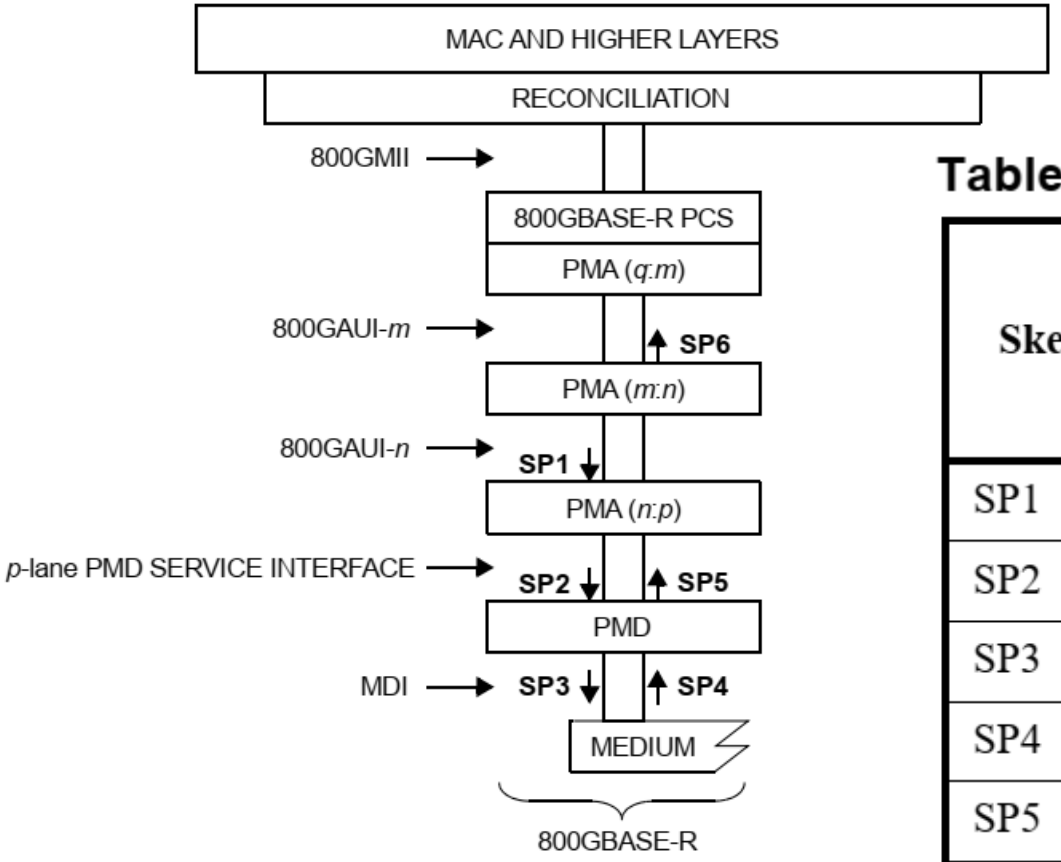


Table 169–5—Summary of Skew constraints **(8023df_D2.0)**

Skew points	Maximum Skew (ns)[a]	
SP1	29	⇨ 16
SP2	43	⇨ 25
SP3	54	⇨ 36
SP4	134	⇨ 116
SP5	145	⇨ 127
SP6	160	⇨ 145
At PCS receive	180	⇨ 152

Note1: the skew between SP2 and SP3.
SP3 and SP4, SP4 and SP5 are unchanged in this analysis and proposal.

Note2: Considering 14ns between SP1 and SP2, the current spec of 15ns between SP5 and SP6 seems too tight.

Skew Variation Proposal: Keep Unchanged

Table 169–6—Summary of Skew Variation constraints (8023df_D2.0)

Skew points	Maximum Skew Variation (ns)	Maximum Skew Variation for 53.125 GBd PMD lane (UI)[a]	Notes[b]
SP1	0.2	N/A	See 173.4.3
SP2	0.4	≈ 21	See 173.4.3, 124.3.2, 162.6.2, 163.6.2, 167.3.2
SP3	0.6	≈ 32	See 173.4.3, 124.3.2, 162.6.2, 163.6.2, 167.3.2
SP4	3.4	≈ 181	See 173.4.3, 124.3.2, 162.6.2, 163.6.2, 167.3.2
SP5	3.6	≈ 191	See 173.4.3, 124.3.2, 162.6.2, 163.6.2, 167.3.2
SP6	3.8	N/A	See 173.4.3
At PCS receive	4	N/A	See 173.4.3

[a] The symbol ≈ indicates approximate equivalent of maximum Skew Variation in UI based on 1 UI equals 18.82353 ps at PMD lane signaling rate of 53.125 GBd.

[b] Should there be a discrepancy between this table and the Skew requirements of the relevant sublayer clause, the sublayer clause prevails.