



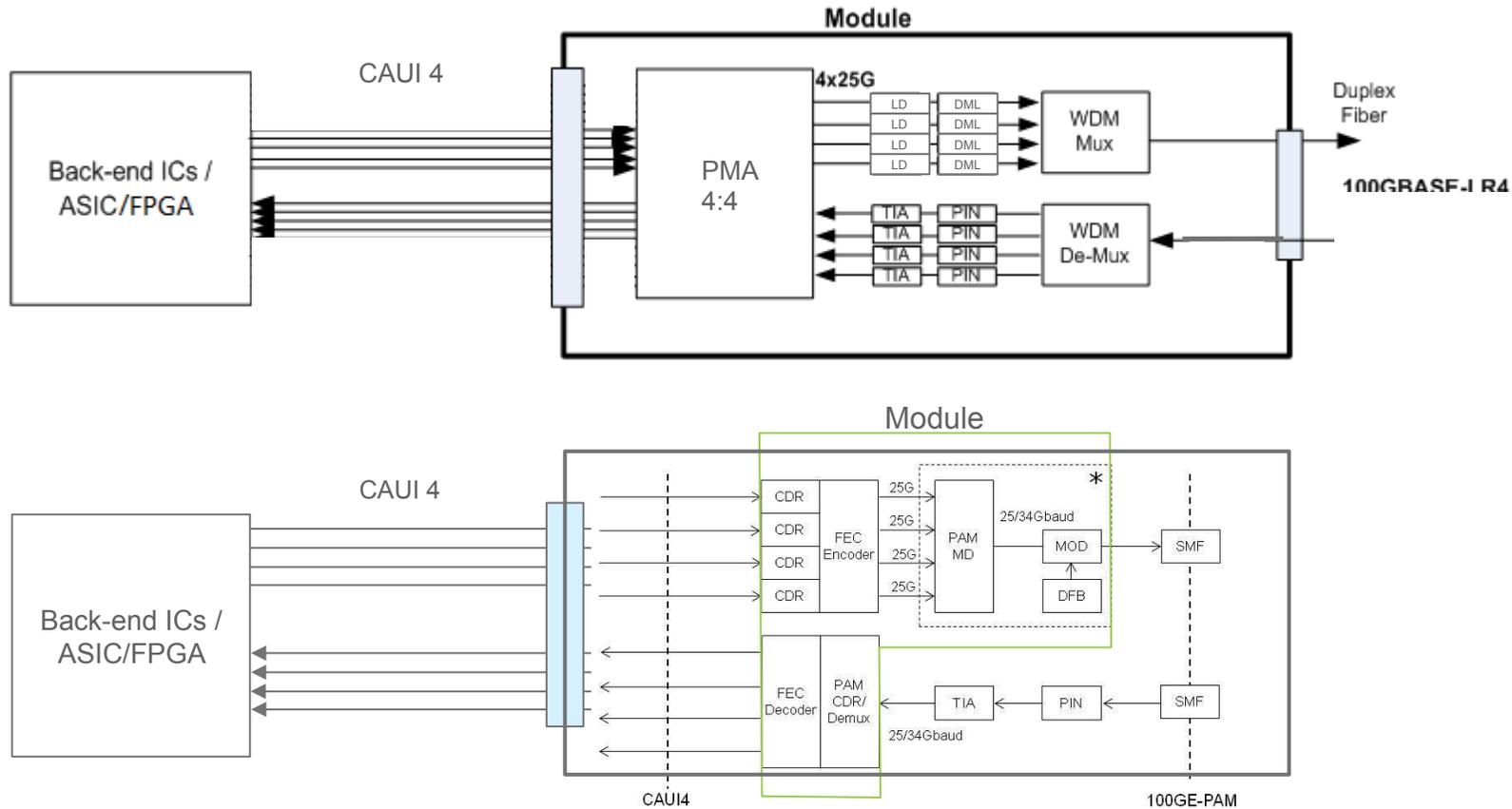
Relative Cost Analysis SMF Optics

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Relative Cost Analysis - SMF

- IEEE Cost discussion should be based on relative cost aspects of architectural elements
- Assumptions about implementation are acceptable
- Experts can agree, or advise on relative costs
- Subject should focus on architecture
- Objective of RCA is to achieve consensus on relative cost and how it relates to Economic Feasibility

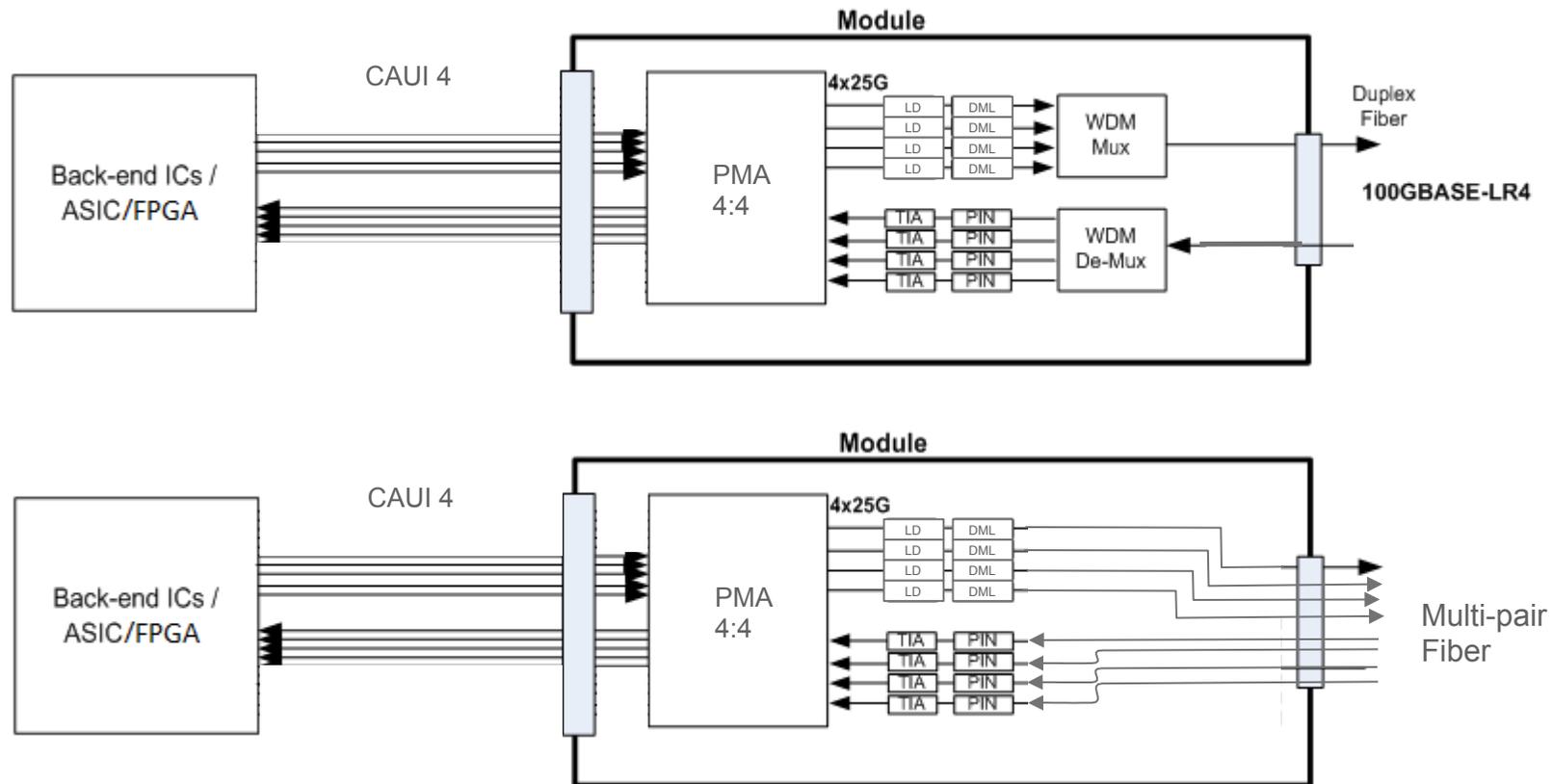
Architectural Models LR4 vs PAMn



* Multiple Implementations possible

- LR4 module TX modified post-presentation based on feedback by Chris Cole

Architectural Models LR4 vs Multi-Pair Fiber



- LR4 & Multi-fiber modules TX modified post-presentation based on feedback by Chris Cole

Relative Cost Analysis

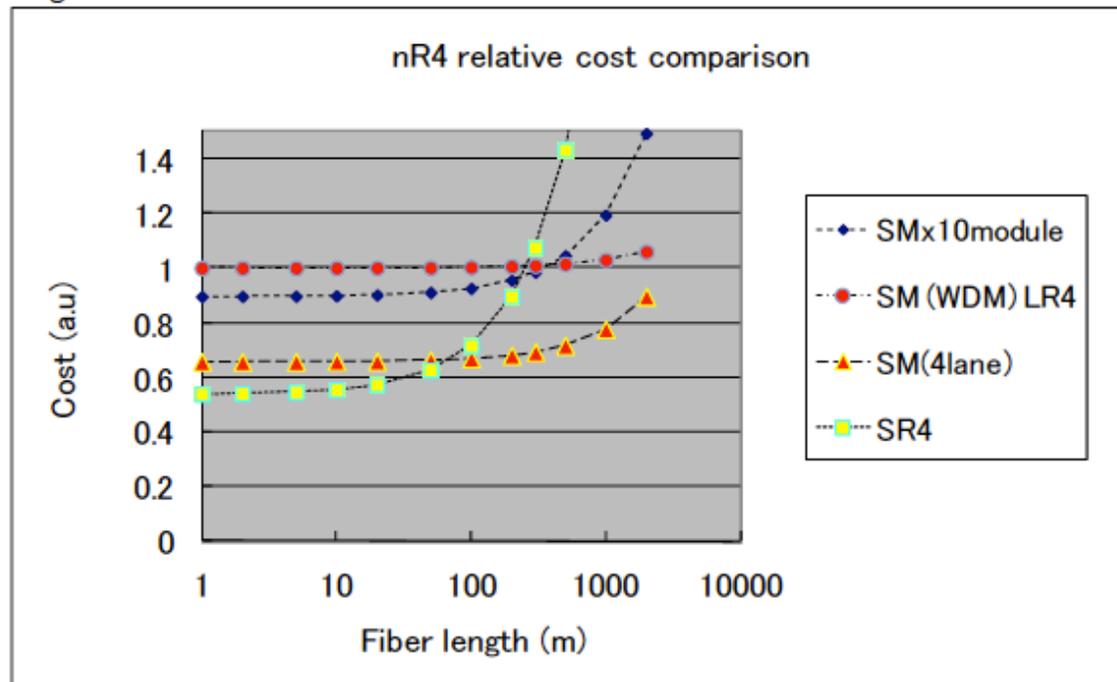
Component	LR4	PAMn	Parallel Fiber
Backend Si	1	1	1
CDR/Coding Si	1	.6	1
RX Optics	1	.25	.5
TX Optics	1	.25	.75
Connectors	1	1	1.5
Fiber	1	1	1.1
Cumulative *	1	.4*	.6*

* I am not an optical component expert, this is strictly for example purposes

Example of appropriate RCA Presentation

Relative Cost Analysis

- Compared total cost including module cost, connector cost and fiber cost. As references, cost for 10 x 10GBASE-LR SFP+ is added.
- It is observed that fiber + connector cost does not contribute much in the case of SMF. It is module cost itself which matters.
- In the case of SMF, cost difference between 1 SMF and 4 SMFs are trivial. On the other hand, O-Mux/DeMux make the cost difference between WDM LR4 and parallel nR4 significant.



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Example of appropriate RCA Presentation

Module Cost Analysis - Example

Transceiver Building Blocks	CFP LR4 (circa 2012)		CFP2 LR4		CFP2 PAM	
	Description	Cost	Description	Cost	Description	Cost
Tx (TOSA)	4x discrete EML	1	4xDML, integrated w/MUX in TOSA	0.32	Multiple Implementations	0.18 - 0.02
Rx (ROSA)	Integrated ROSA	1	Integrated ROSA	1	PIN/TIA	0.35
Opt Mux	Thin film	1	Integrated in TOSA	N/A	None Required	N/A
Opt Dmux	Thin film, Integrated in ROSA.	N/A	Integrated in ROSA	N/A	None Required	N/A
Serdes	10x10→4x25 Gb gearbox (CMOS)	1	4x25 Gb CDR (CMOS)		PAM Serdes	
Laser driver IC	4x25 Gb EML driver	1	4x25 Gb DML driver			N/A (*)
Misc	PCBA, housing, connector, IC, etc	1	PCBA, housing, connector, IC, etc		PCBA, housing, connector, IC, etc	
Assembly /Test	Assembly/test time and yield	1	Assembly/test time and yield		Assembly/test time and yield	
Module Cost		1		0.46		0.23-0.13

Note: Recommend avoiding reference to shipping products but rather stick to architectural/generational references

Modified per verbal content that occurred during presentation.

Note: This is where I think the relative cost for Economic Feasibility matters (4 lane LR4 vs 4 lane alternative)

ie: ~ 0.5x to ~ 0.25x.

- Detailed cost analysis was performed on all aspects driving module cost
- Only Tx/Rx optics details shown above as tend to be dominate cost driver
- (*) Some implementations may include an external modulator driver

Ref: nicholl_01_0112_NG100GOPTX.pdf



Thank You!