Considerations for NG 100G SMF objective
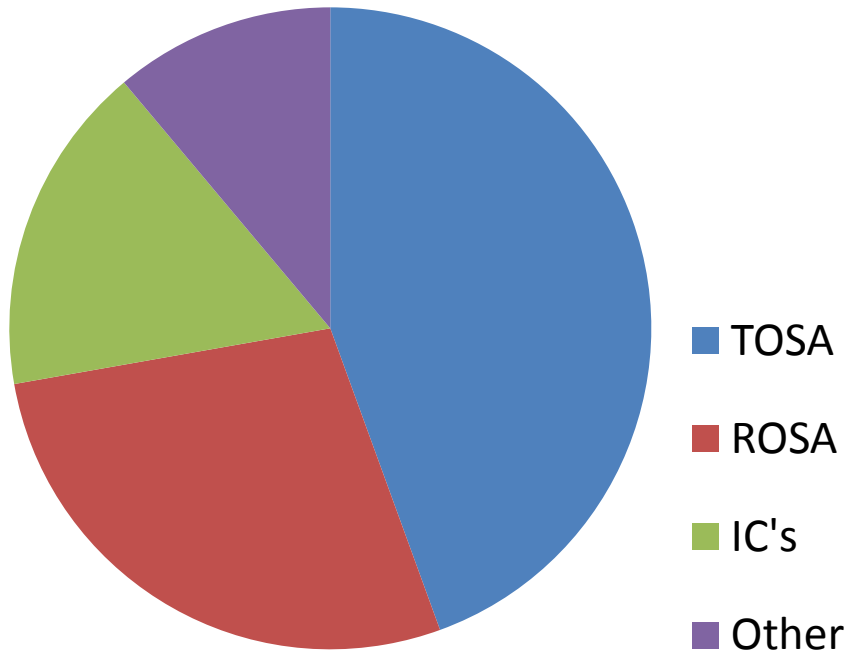
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Cost of SMF Optical Interfaces

BOM Cost Estimate SFP+ 10GBASE-LR

- TOSA
- ROSA
- IC's
- Other

Estimate based on industry sources

- Long term it is projected that most of the cost of an optical module is based upon the optics
  - SFP+ represents a "mature" 10GE form factor
- Important to discuss the costs associated with various optical implementations both short & long term

Possible Directions for NG 100G SMF PMD

Degrees of Freedom
Spatial Multiplexing
Wavelength Multiplexing
More bits / symbol
Symbol Rate

Cost Factors
Number of Fibers
Number of Lasers/Receivers
Wavelengths per fiber
Symbol Rate & IC Complexity

Number of Fibers

- Infrastructure Cost ?*
  - New patch panels
  - Bulkier cables
  - New training for techs
- Fiber & Cabling cost ?*
  - Multi-Fiber cable higher cost
  - Multi-Fiber connectors more costly for same loss
  - New training for techs

Cost Factors
Number of Fibers
Number of Lasers/Receivers
Wavelengths per fiber
Symbol Rate & IC Complexity

*Need more information to qualitatively assign cost

Number of Lasers

- Cost scales w/ packaging
  - Alignment
  - Yield

$$$$

- High Frequency Performance
  - Crosstalk over multiple high speed lanes

$$$

Cost Factors
Number of Fibers
Number of Lasers/Receivers
Wavelengths per fiber
Symbol Rate & IC Complexity

$: are a qualitative assessment of our best view of system implementation costs

Lambda's per fiber

- Wavelength Grid
  – Cooled vs. Uncooled $$$

- Link Budget impact of optical MUX/DMUX $

Cost Factors
Number of Fibers
Number of Lasers/Receivers
Wavelengths per fiber
Symbol Rate & IC Complexity

$: are a qualitative assessment of our best view of system implementation costs

Symbol Rate & IC Complexity

Bits / Symbol

- CDR & Driver Complexity $$$
  - DAC, ADC & processing
- Test Equipment $$$

Symbol Rate

- Reach Implication $ - $$$$

- Component Complexity $$$
  - Frequency dependent loss
  - Package Bandwidths

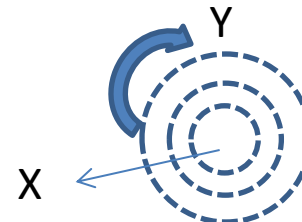| Cost Factors |
| --- |
| **Number of Fibers** |
| **Number of Lasers/Receivers** |
| **Wavelengths per fiber** |
| **Symbol Rate & IC Complexity** |

$: are a qualitative assessment of our best view of system implementation costs

Partial Table of Potential Solutions

Ask from System Viewpoint: Step function cost reduction from 100GBASE-LR4 requires study of costs for various alternate schemes. Solicit feedback from component space on relative costs.

	λ's/fiber	Bits/symbol	# fibers	Symbol Rate	λ spacing
100GBASE-LR4	4	1	1	25	LAN-WDM
Ribbon	1	1	4	25	N/A
CWDM-LR4	4	1	1	25	CWDM
PAM-4-2	2	2	1	25	CWDM or LAN-WDM
PAM-16-1	1	4	1	25	N/A
PAM-M-N	N	$Log_2 M$	1	$100/N / (Log_2 M)$	CWDM or LAN-WDM
xA-yDPSK	1 ?	$Log_2 (X*Y)$	1	$100/N / (Log_2 X*Y)$	N/A ?

X Amplitudes & Y Phases

Conclusion

- 100GBASE-LR4 is only single mode fiber PMD addressing short reach
  - Cost & Density evolution understood by industry

- Step function reduction in system cost necessary to justify new SMF PMD

- Recommend quantification of cost factors to direct the study group