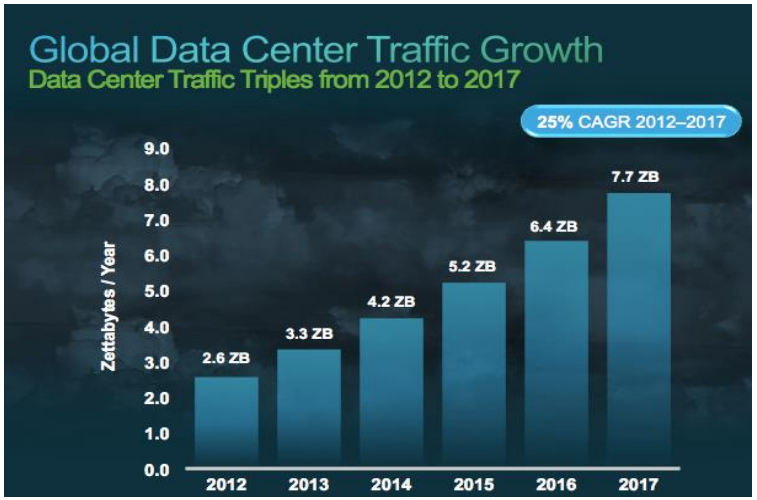
100Gb/s Single Lambda Optics – Why ?

Gary Nicholl, Principal Engineer, TMG Cisco

OIDA 100GbE per Lambda for Data Center Workshop – June 12-13 2014

System Challenges and Trends

- Traffic growth continues at all levels
- System implementation requires innovation on many technology fronts:
  - Optics, ASIC, Power, Thermals, PCB, Serdes, Memory, Packaging, ……



- Optical technology is becoming one of the key challenges for many system implementers:
  - size, power and cost

All optical technologies have matured (are maturing) over time to the lowest size, cost, power

100M→1G→10G→40G→(100G?)

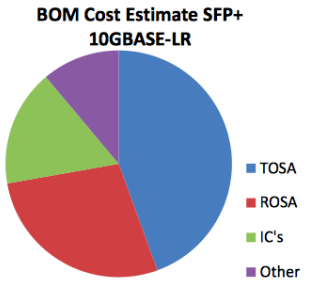
100Gb/s Ethernet Trends

- 100Gb/s Ethernet is in transition.
- For the past 4 years 100GbE has been primarily deployed as a core networking technology
  - A first for Ethernet ☺
  - Port density/cost not the overriding factor
  - Well served by 100G-LR4 optics

- 100Gb/s Ethernet is just starting to move into the data center switching space
  - Enabled by upcoming availability of high 100Gb/s port count merchant switching silicon
  - Port density/cost is now everything
  - Puts increased pressure on size, power, cost of 100Gb/s optics
  - Recent activities on 100G CWDM a response to this

Why is 10OG Single Lambda interesting ?

- The cost of an optical module is dominated by cost of optical components and associated packaging.
- Reducing the optical lane width, reduces the number of optical components and hence the cost
- A single lambda solution is the solution with the lowest optical component count, and has historically resulted in the lowest cost



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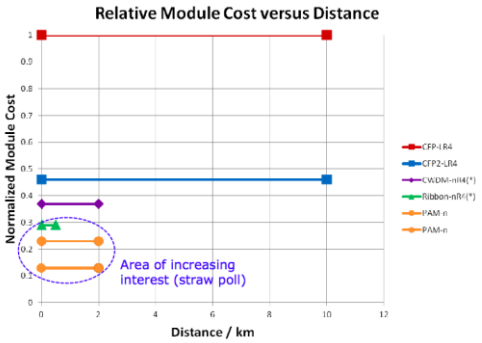

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- The discussion is not if 100Gb/s single lambda is compelling but when:
  - When is it technically feasible ?
  - How hard should we push to make it feasible ?
  - Do we need to do anything else in the interim ?

Some historical proof points …

10 Gigabit Ethernet

Initial industry focus was on 10GBase-LX4 (4x3.125G CWDM)

Starting point→ Leverage 2.5G optics, 10G was too challenging/costly

Industry conclusion → packaging complexity kills CWDM vs. 10G serial

40G & 100G Long-Haul DWDM Coherent Optics

Non-coherent 40G extremely costly to implement (and operate) due to complex optical solution required.

Coherent approach shifted complexity from optical domain to digital domain. Result in increased performance, and a solution that was vastly simpler to operate (plug and play).

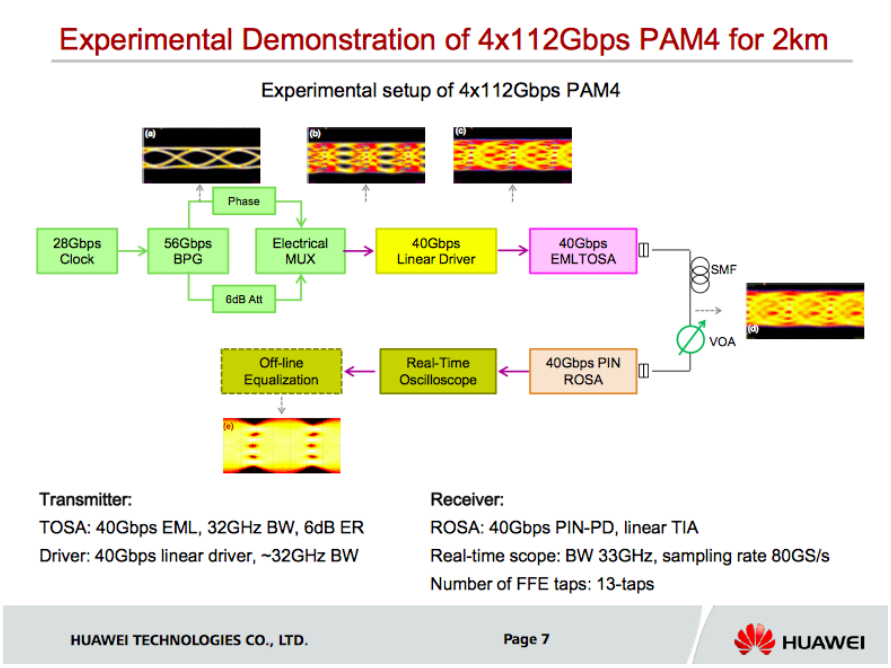
Industry conclusion → Paradigm shift in thinking. Shifted complexity from optics to electronics. Enabled 100G > …

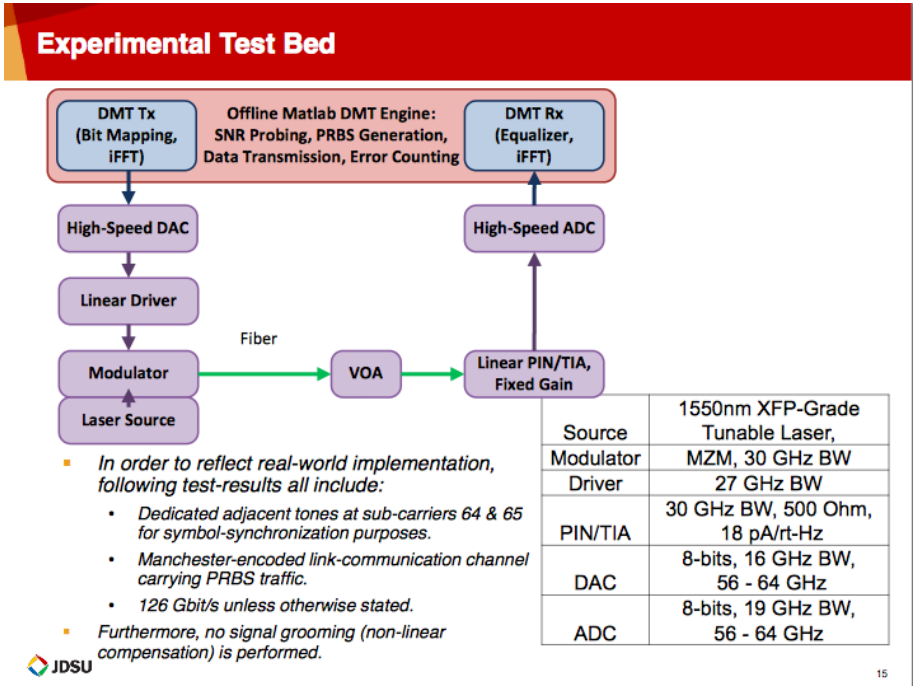
But what about 40G Single Lambda ?

- All this talk about low cost 100G single lambda sounds great, but what about 40G I hear your cry !
- Today for 40GbE we have both a 40G-FR single lambda solution, and a 40G-LR4 four lambda solution.
- BUT 40G-LR4 is still significantly cheaper than 40G-FR. Why ? Does this invalidate your arguments for 100G single lambda ?
  - 40G-LR4 had the luxury to leverage a large 10G technology eco-system driven by the success of 10GbE (in it's 4th or 5th generation of deployment when 40GbE was introduced)
  - 40G-FR could only leverage small 40G serial eco-system (OC-768)
  - Places a much high barrier of entry to 40G serial
- 100GbE is quite different
  - None of the proposed solutions (4x25, 2x50 or 1x100) leverage a large mature technology eco-system
  - It is much more level playing field

100G Single Lambda Feasibility …

- Starting to see some 100G single lambda technical feasibility demonstrations at the IEEE 802.3bs 400GbE TF.





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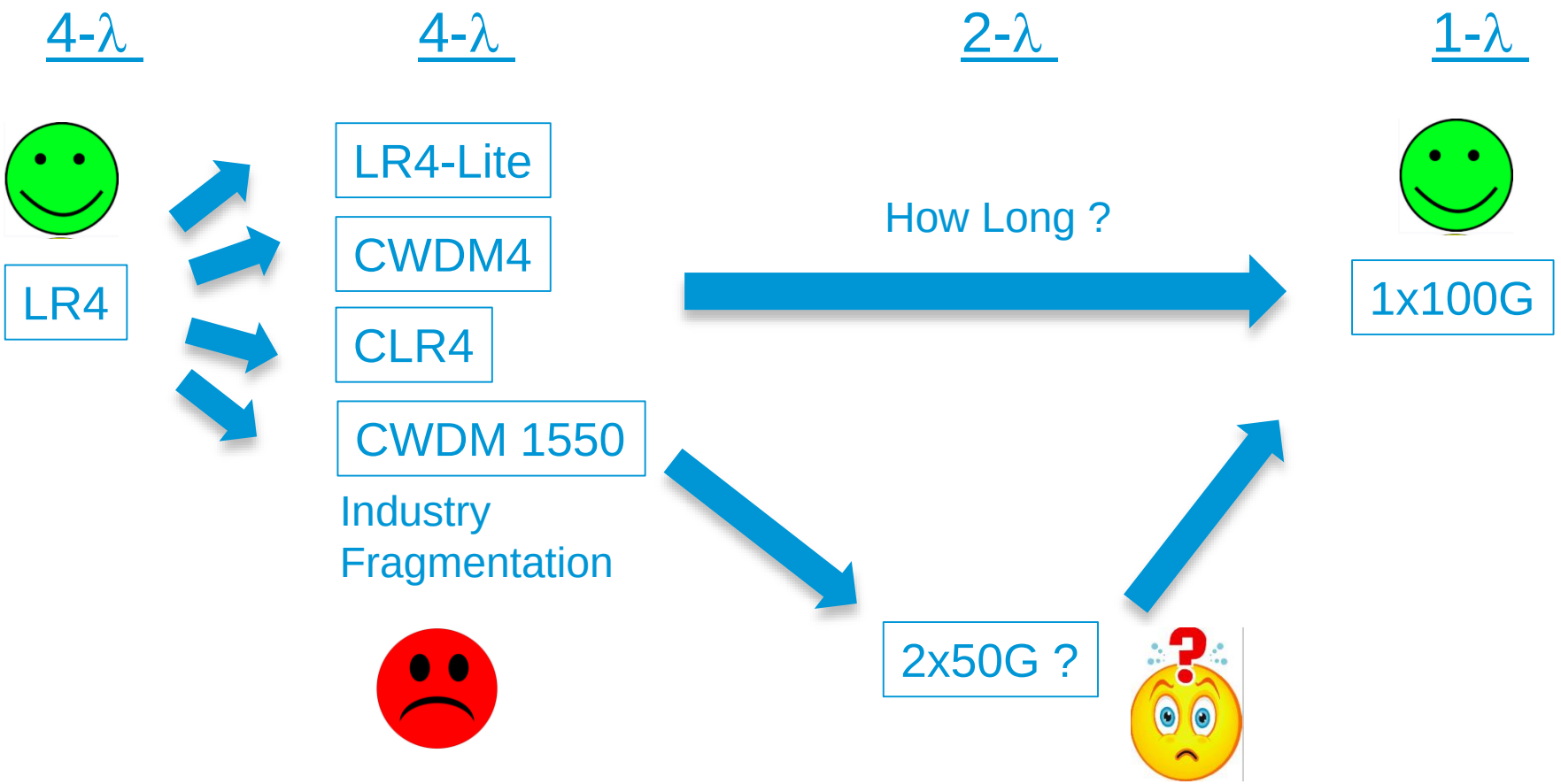
100GbE SMF Roadmap



A word on Interoperability ….

Electrical interfaces

Critical concern for component and system vendors

Each iteration represents significant resource investment

Impacts size, cost, power

Does not affect optical interoperability

Optical interfaces

Critical concern for network operators

Multiple non-interoperable iterations represent significant resource investment

(but for some… cost trumps interop ?)

10GBASE-LR: 16x622Mb/s→ XAUI → XFI → SFI

Takeaway: More aggressive industry stance on optical interface has longer term benefit.

In Conclusion ……

The question is not really if 100Gb/s single lambda is compelling, but when is 100Gb/s single lambda compelling:

- When is it technically feasible ?
- How hard should we push to make it feasible ?
- Do we need to do anything else in the interim ?

Thank You