

When is 100GbE per Lambda a Compelling Investment?

Joint OIDA and Ethernet Alliance

100GbE per Lambda for Data Center Workshop

P3: Why is 100GbE per Lambda a Compelling Investment?

San Jose, CA

12-13 June 2014

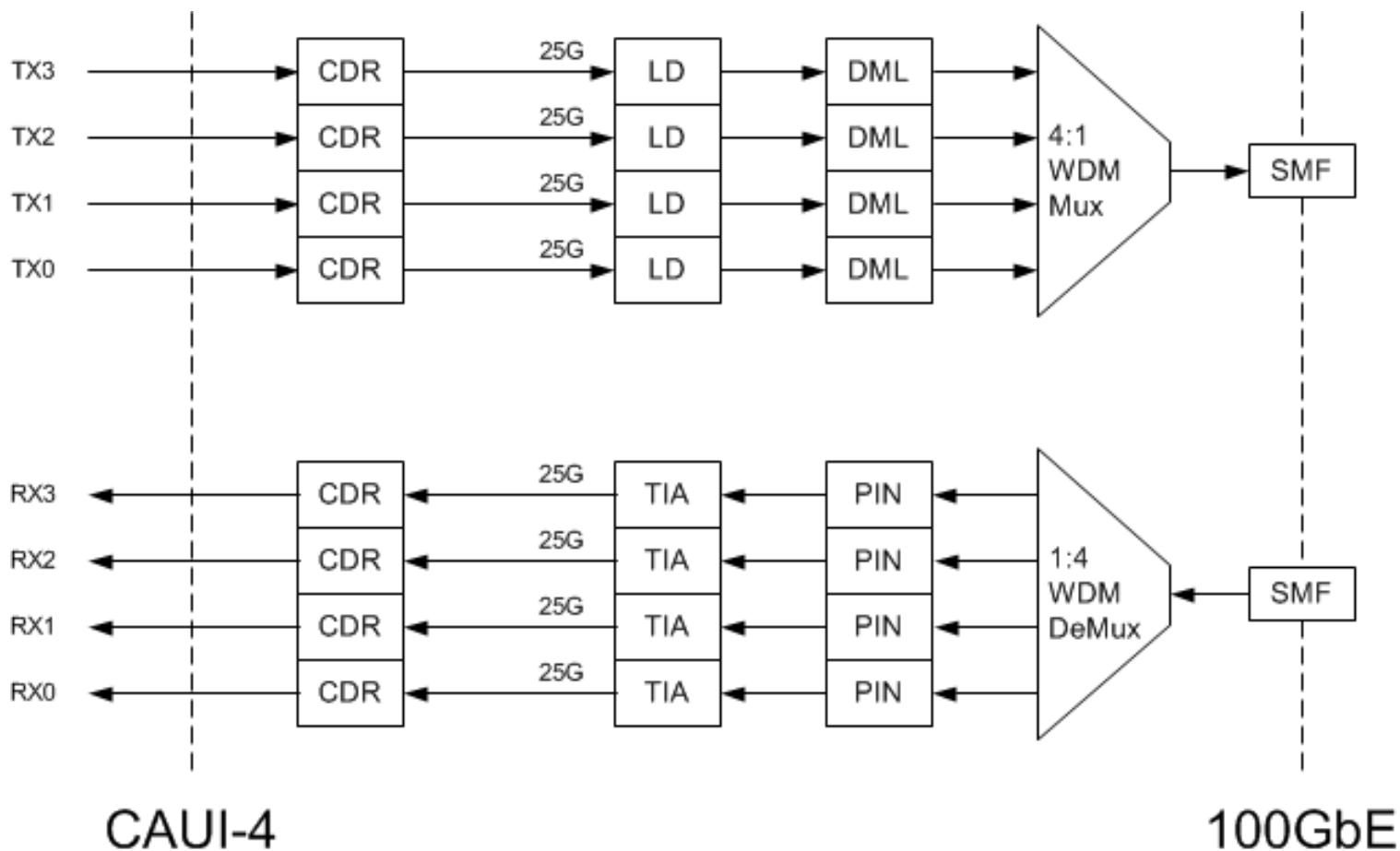
Chris Cole



Outline: 100GbE per Lambda

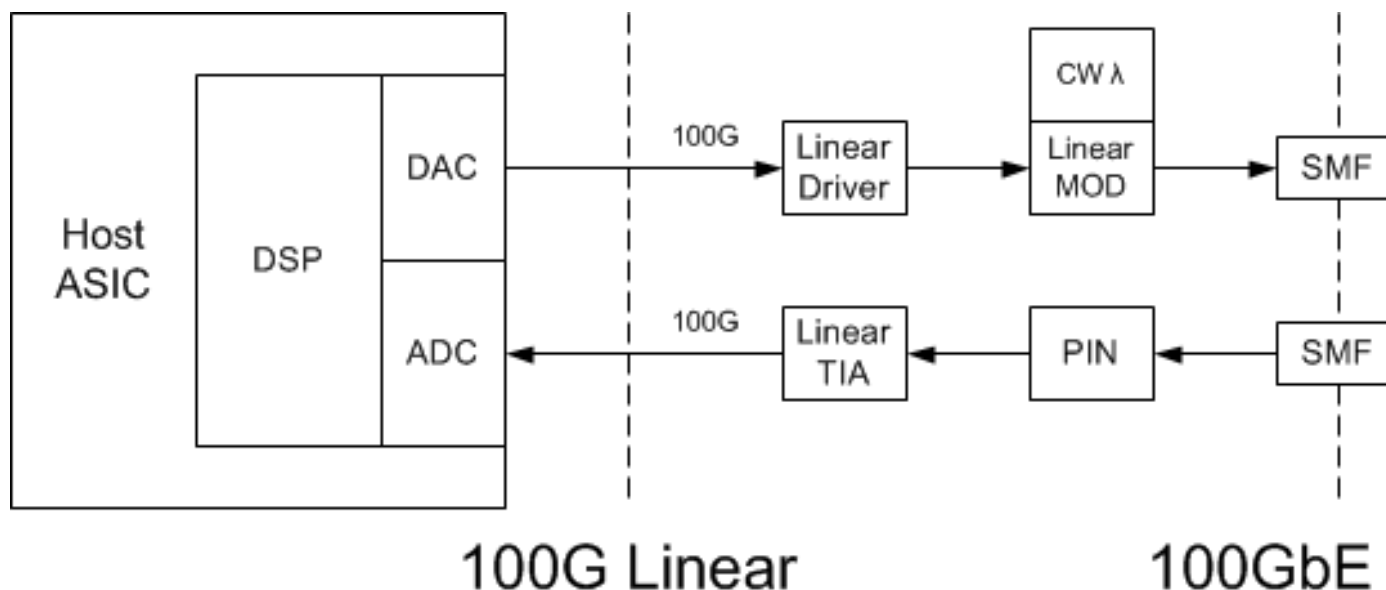
- Roadmap to Ultimate Architecture
- Next Step Alternatives
- Next Step Decision Process
- Next Step Proposal

Today's 100GbE : 4x 25G NRZ λ s



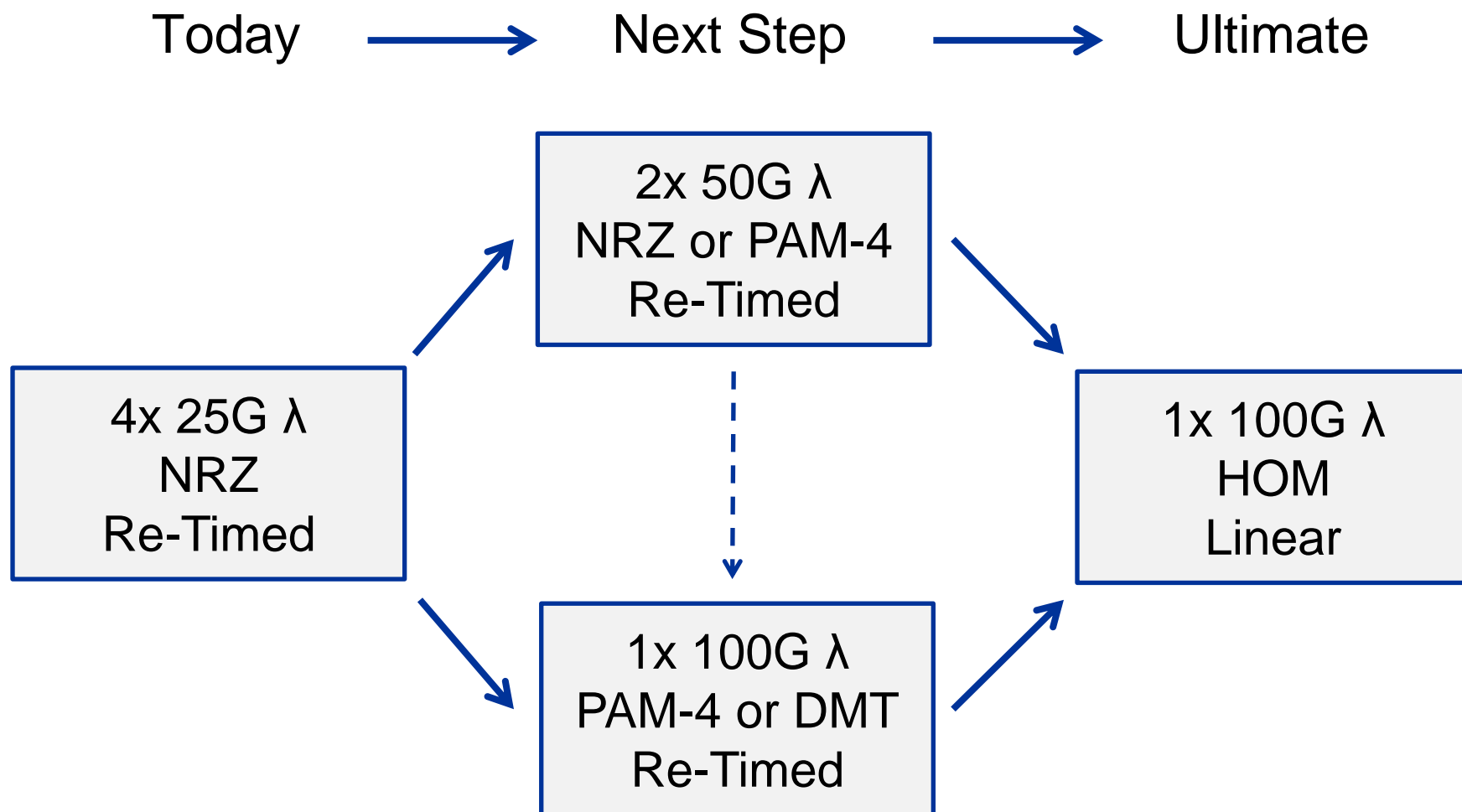
Alternative to 4x DMLs is 4x Modulators & 4x CW lasers

Ultimate 100GbE: 1x 100G HOM λ



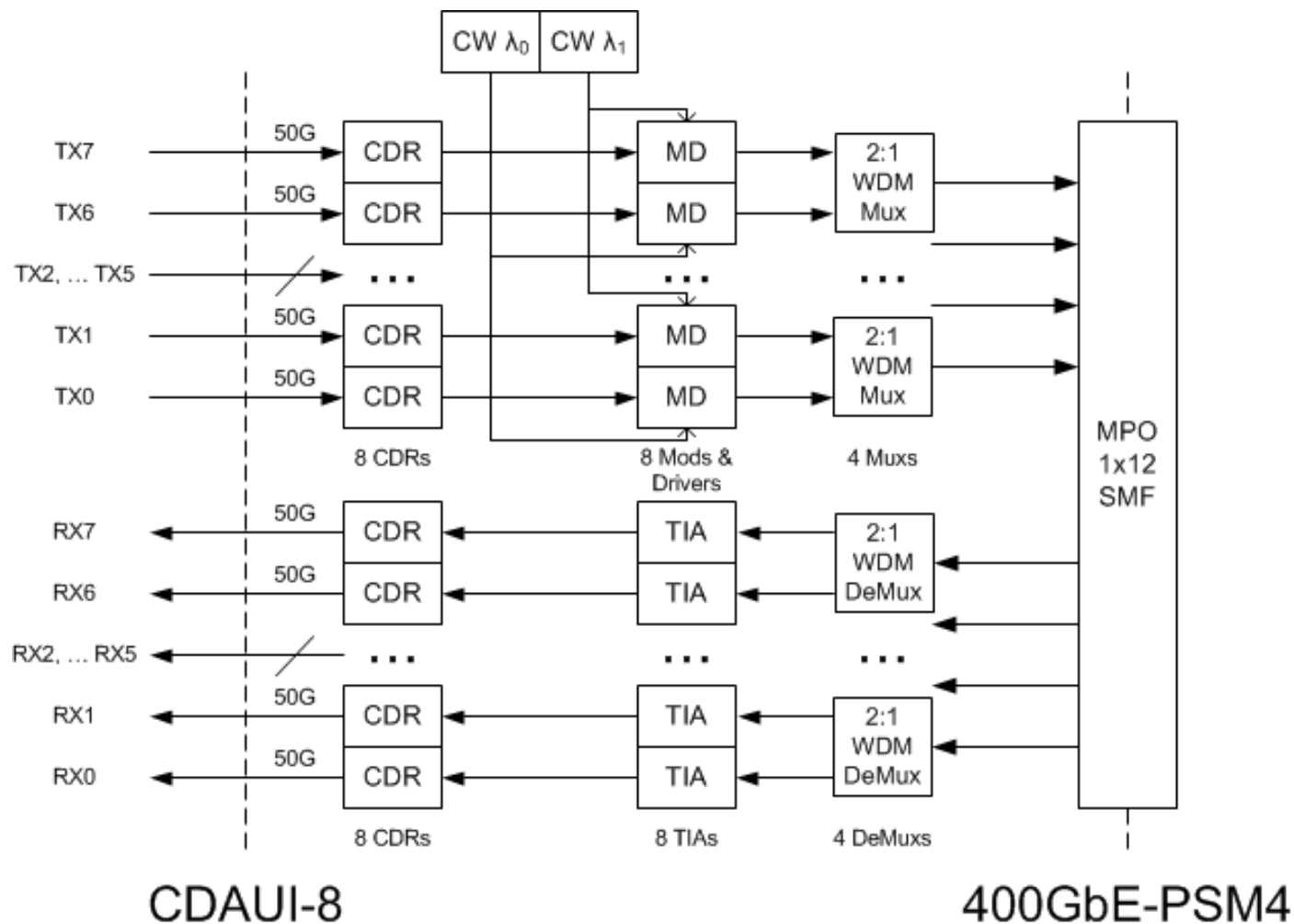
- Size: Enables SFP100 (single 100GbE) or CFP4/QSFP100 (quad 100GbE) modules
- Interface: linear (for which PAM-N has no implementation advantages over other formats like DMT or QAM)
- Timeline: >2020 gated by ASIC 100G I/O technology

Ultimate 100GbE Alternate Paths



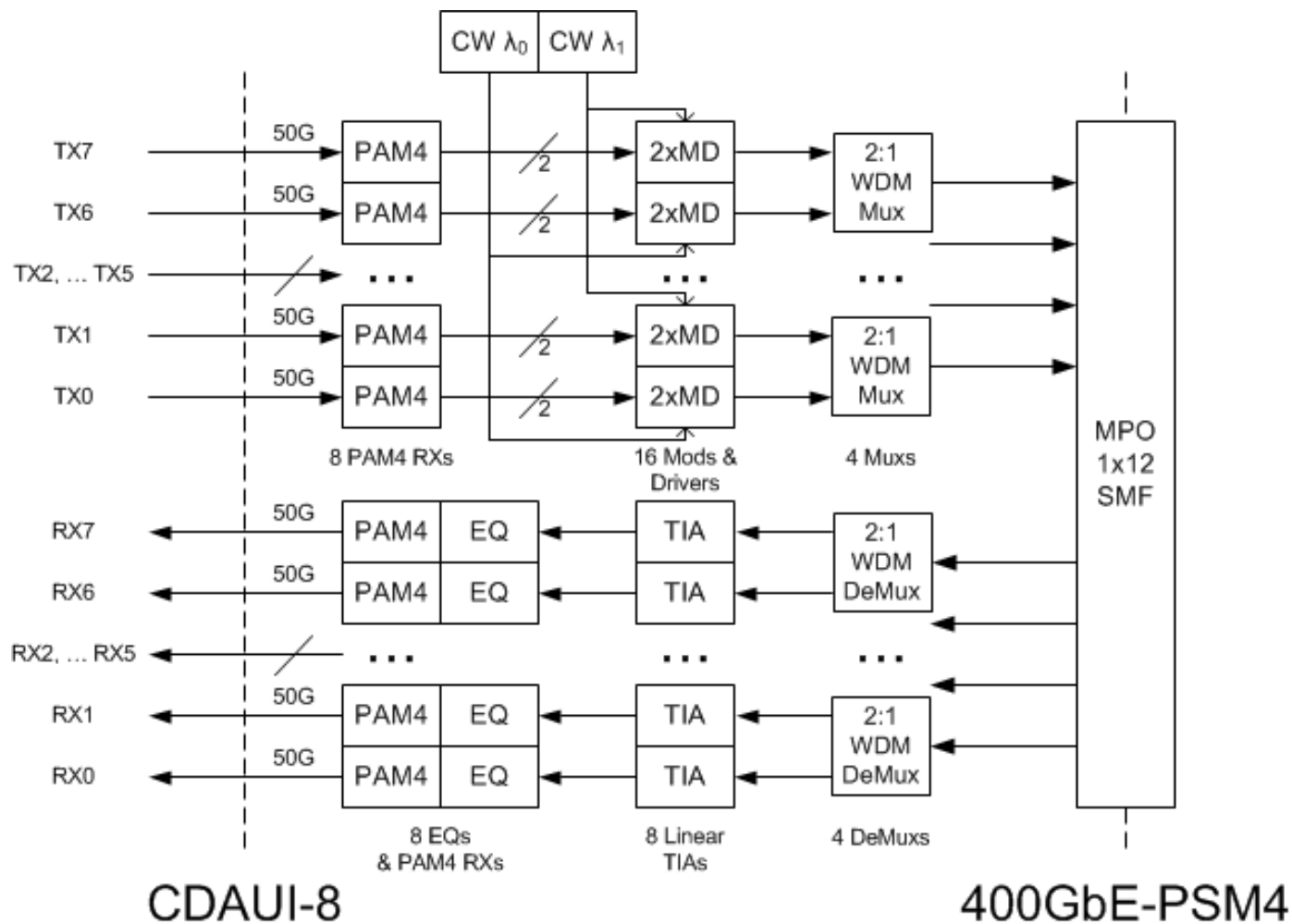
How do we decide the right next step?

Next Step 100GbE Alt.1: 2x 50G NRZ λ s



Quad 100G NRZ alt. 1: $\frac{1}{2}$ (shown) or 1 laser / 100G TX

Next Step 100GbE Alt.2: 2x 50G PAM-4 λ s

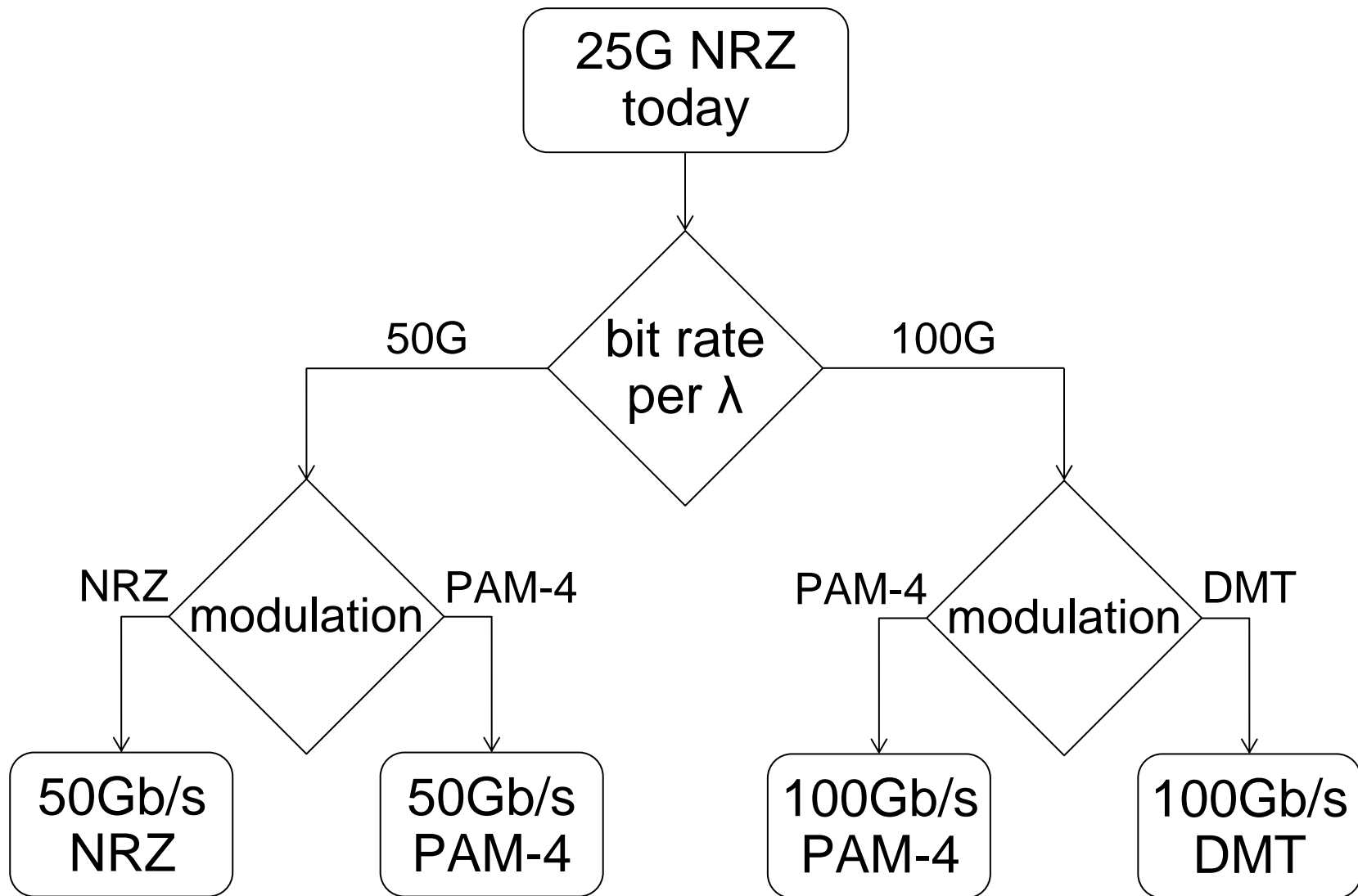


Quad 100G PAM-4 alt2: $\frac{1}{2}$ (shown) or 1 laser / 100G TX

Ultimate 100GbE Power: What Should It Be?

- Gen 1 100GbE-LR4 CFP w/ 4x EML TOSAs: 20W
- Gen 2 100GbE-LR4 CFP2 w/ DML PIC TOSA: 6W
- Gen 3 100GbE-LR4 CFP4 w/ DML PIC TOSA: 4W
- Gen 4 100GbE-LR4 QSFP28 w/ DML PIC TOSA: 3.5W
- Gen 4 100GbE CWDM QSFP28 w/ DML PIC TOSA: 3W
- Gen 5 100GbE 2x50G WDM w/ SiP PIC TOSA: 2W
- Ultimate 100GbE compelling target: 1W
- 1W/100G enables single 100GbE SFP100, and quad 100GbE (400GbE) CFP4/QSFP100

Next Step 100GbE Decision Tree



How to decide 50G/λ vs. 100G/λ Next Step?

- “Let’s learn from history, be honest with ourselves and focus our efforts on the PMDs that really make sense.”
(Gary Nicholl, Mark Nowell, 802.3bs, Norfolk, May’14)
- History lessons:
 - 10GbE & 802.3ae
 - 40GbE & 802.3ba
 - 100GbE & 802.3ba
- Lessons applied:
 - 400GbE (4x100GbE) & 802.3bs

10GbE SMF PMDs & 802.3ae

- 1998: 10G/λ client optics (OC192) w/ 625M I/O introduced
- 1999: HSSG
- 2000-2002: 802.3ae
 - Deployed I/O rate: 2.5G (or 3G)
 - Predicted next I/O rate: 10G
 - Major optical PMD debate: 4x3G/λ vs. 1x10G/λ
 - Adopted PMDs: 4x3G/λ (LX4) and 1x10G/λ (LR)
- >2002
 - XFI & SFI 10G I/O developed
 - 10G I/O becomes high-volume mainstream
 - 1x10G/λ wins

40GbE SMF PMDs & 802.3ba

- 1998: 10G/λ client optics (OC192) w/ 625M I/O introduced
- 2004: 40G/λ client optics (OC768) w/ 2.5G I/O introduced
- 2006-2007: HSSG
- 2008-2010: 802.3ba
 - Deployed I/O rate: 10G
 - Predicted next I/O rate: 25G
 - Major optical PMD debate: 4x10G/λ vs. 1x40G/λ
 - Arguments in favor of 1x40G/λ: 1 laser & free CMOS
 - Adopted PMD: 4x10G/λ (LR4)
- >2010
 - 802.3bg specs. 1x40G/λ for low OpEx Telco modules
 - 4x10G/λ wins; much lower cost than 1x40G/λ

100GbE SMF PMDs & 802.3ba

- 2004: 40G/λ client optics (OC768) w/ 2.5G I/O introduced
- 2006-2007: HSSG
- 2008-2010: 802.3ba
 - Deployed I/O rate: 10G
 - Predicted next I/O rate: 25G
 - Major optical PMD debate: 10x10G/λ vs. 4x25G/λ
 - Gen1 4x25G/λ optics derived from 40G/λ optics
 - Adopted PMD: 4x25G/λ (LR4)
- >2010
 - 10x10G MSA specs. 10x10G/λ for CFP modules
 - 25G I/O becoming high-volume mainstream
 - 4x25G/λ wins

4x 100GbE (400GbE) SMF PMDs & 802.3bs

- 2004: 40G/λ client optics (OC768) w/ 2.5G I/O introduced
- 2011: 25G/λ WDM optics (LR4) w/ 10G I/O introduced
- 2013: 400Gb/s Ethernet Study Group
- 2014-2016(?): 802.3bs
 - Deployed I/O rate: 25G
 - Predicted next I/O rate: 40/50G
 - Major optical PMD debate: 4x 2x50G/λ vs. 4x 1x100G/λ
 - 50G/λ would follow 10, 40, 100GbE precedent
 - Comparable optics in the market
 - No faster /λ rate than predicted next I/O rate
 - 100G/λ would be unprecedented
 - No comparable optics rate in the market
 - 2 generation /λ rate jump, skipping high-volume step

The Most Important Cost Driver: Volume!

- 40/50G I/O will be the next high-volume mainstream rate including for 40/50G server down-links
 - 50G/λ ICs will leverage mainstream 50G SerDes tech.
 - 50G/λ will cleanly connect to 50G I/O
 - (4x) 2x50G/λ is the right next step in the standards
 - 100G/λ optics require long term development starting now to be available for volume shipment >2020
 - 10G/λ was ~10 years to high-volume
 - 25G/λ is ~10 years to high-volume
 - 100G/λ first product development and deployment should be into apps where there is no alternate solution
- Ex. inter-datacenter links <80km (see Beck Mason's presentation in Panel 2, 12 June 2014)

When is 100GbE/λ a Compelling Investment?

Thank you

