Case for inclusion of a 200GBASE-DR/FR objective

Rob Stone, Facebook

Supporters

- Brad Booth, Microsoft
- Brian Welch, Cisco
- Jeffrey Maki, Juniper Networks
- Kapil Shrikhande, Innovium
- Mark Nowell, Cisco
- Scott Schube, Intel

IEEE 802.3 Ethernet Optical Landscape (based on >=50 Gb/s signaling per lane, excluding ZR)

Ethernet Rate	Signaling Rate	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
100 Gb/s	50 Gb/s		Over 2 pair				
	100 Gb/s	**Over 1 pair****	**Over 1 pair****	Over 1 λ (pair)	Over 1 λ (pair)	Over 1 λ (pair)	
200 Gb/s	50 Gb/s		Over 4 pair	Over 4 pair			
	50 Gb/s				Over 4 λ's	Over 4 λ's	Over 4 λ's
	100 Gb/s	**Over 2 pair***	**Over 2 pair***				
400 Gb/s	50 Gb/s		Over 8 pairs Over 4 pairs (4.2)				
	50 Gb/s				Over 8 λ's	Over 8 λ's	Over 8 λ's
	100 Gb/s	**Over 4 pair****	**Over 4 pair****	Over 4 pairs			
	100 Gb/s				Over 4 λ's	Over 4 λ's (6km)	
800 Gb/s*	100 Gb/s	**Over 8 pairs**	**Over 8 pairs**	**Over 8 pairs**			
	200 Gb/s			**Over 4 pairs**	**Over 4 pairs**		
	200 Gb/s				**Over 4 λ's**		
	TBD					**Over single SMF in each direction**	**Over single SMF in each direction**

*- Objectives for B400G Study Group
** - Objectives for IEEE P802.3db

From: *dambrosia_b400g_01b_210524*

IEEE 802.3 Ethernet Optical Landscape (based on >=50 Gb/s signaling per lane, excluding ZR)

Ethernet Rate	Signaling Rate	MMF 50m	MMF 100m	SMF 500m	SMF 2km	SMF 10km	SMF 40km
100 Gb/s	50 Gb/s		Over 2 pair				
	100 Gb/s	**Over 1 pair****	**Over 1 pair****	Over 1 λ (pair)	Over 1 λ (pair)	Over 1 λ (pair)	
200 Gb/s	50 Gb/s		Over 4 pair	Over 4 pair			
	50 Gb/s				Over 4 λ's	Over 4 λ's	Over 4 λ's
	100 Gb/s	**Over 2 pair****	**Over 2 pair****				
	200 Gb/s			**Over 1 pair**	**Over 1 λ (pair)**		
400 Gb/s	50 Gb/s		Over 8 pairs Over 4 pairs (4.2)				
	50 Gb/s				Over 8 λ's	Over 8 λ's	Over 8 λ's
	100 Gb/s	**Over 4 pair****	**Over 4 pair****	Over 4 pairs			
	100 Gb/s				Over 4 λ's	Over 4 λ's (6km)	
800 Gb/s*	100 Gb/s	**Over 8 pairs**	**Over 8 pairs**	**Over 8 pairs**			
	200 Gb/s			**Over 4 pairs**	**Over 4 pairs**		
	200 Gb/s				**Over 4 λ's**		
	TBD					**Over single SMF in each direction**	**Over single SMF in each direction**

*- Objectives for B400G Study Group
** - Objectives for IEEE P802.3db

Arrows intended to show breakout uses of likely modules, rather than PMDs

Note on Naming Convention Used

- **800GBASE-DR4**
  - **800 Gb/s over 4 pairs of SMF with lengths up to at least 500 m**
- **800GBASE-DR4+**
  - **800 Gb/s over 4 pairs of SMF with lengths up to at least 2km**
- **200GBASE-DR**
  - **200 Gb/s over a single SMF in each direction with lengths up to at least 500m**
- **200GBASE-FR**
  - **200 Gb/s over a single SMF in each direction with lengths up to at least 2km**
  - **(For consistency with 100GBASE-FR)**

- *Note: this is just for clarity, not looking to start a discussion on nomenclature ☺*

The case for single-mode breakout

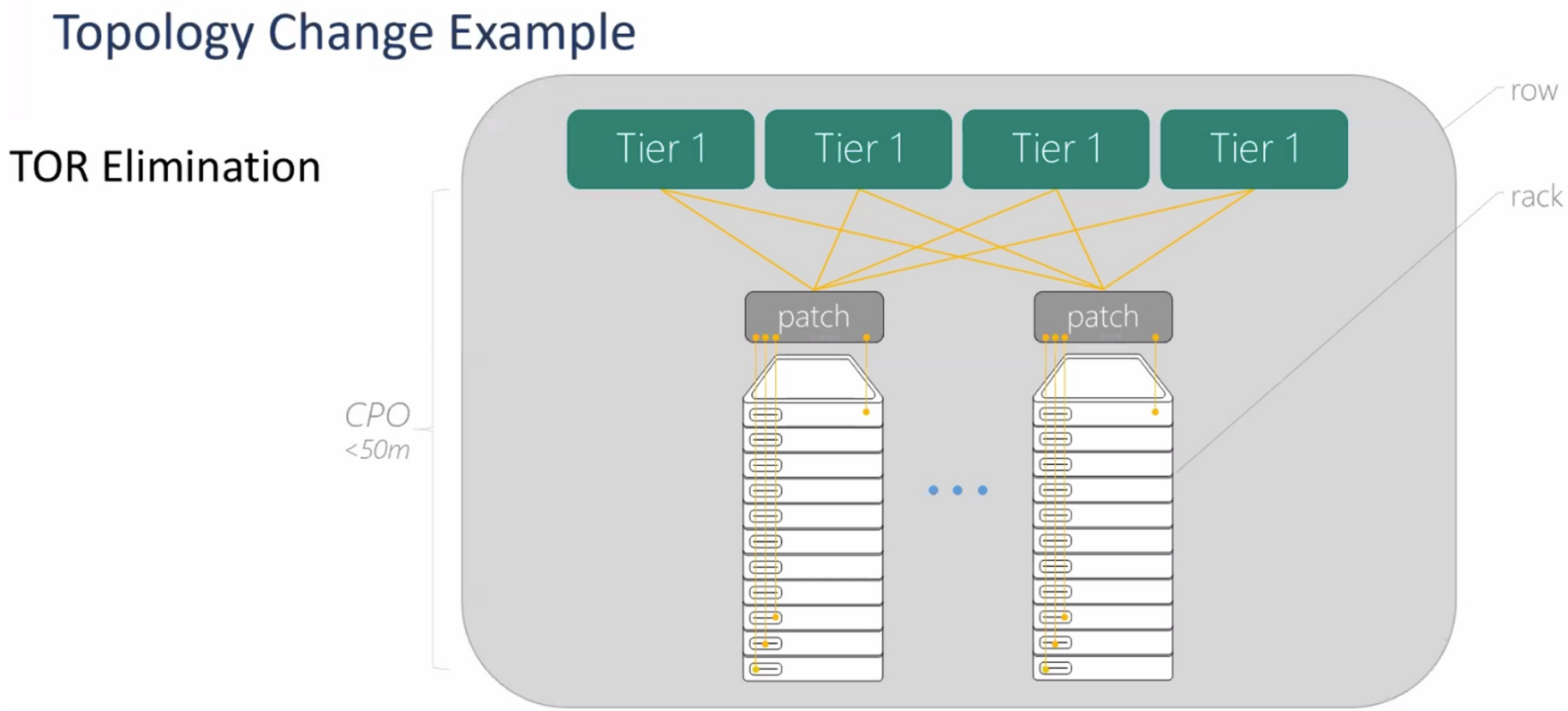
- Single mode breakout of multi-lane devices has been common in prior generations of technology
  - 100G-PSM4 → 25GBASE-LR
  - 400GBASE-DR4 → 100GBASE-DR/FR
- Re-use of this existing fiber infrastructure as an upgrade path with next generation PHYs is attractive:
  - 800GBASE-DR4/DR4+ → 200GBASE-DR/FR
- Intention: technology re-use of 800GBASE-DR4/DR4+ adopted objective

Breakout Use-Cases for Optical Modules

- Higher number of ports per switch
  - e.g. a 32 x 8 lane module switch can be used as up to 256 x single lane ports using breakout
  - This enables higher device radix (*R*)
    - Flatter networks (less hops between endpoints – e.g:)
      - *R* = 256 → 32,768 endpoints in 2 tier network (3 hops above ToR)
      - *R* = 32 → 512 endpoints in 2 tier network, ~ 32k requires additional tier of 256 switches (and 5 hops above ToR)
    - Higher resilience to link failures (due to more paths)
    - More efficient queueing (can match server speed to fabric speed)

More detail – use cases for breakout

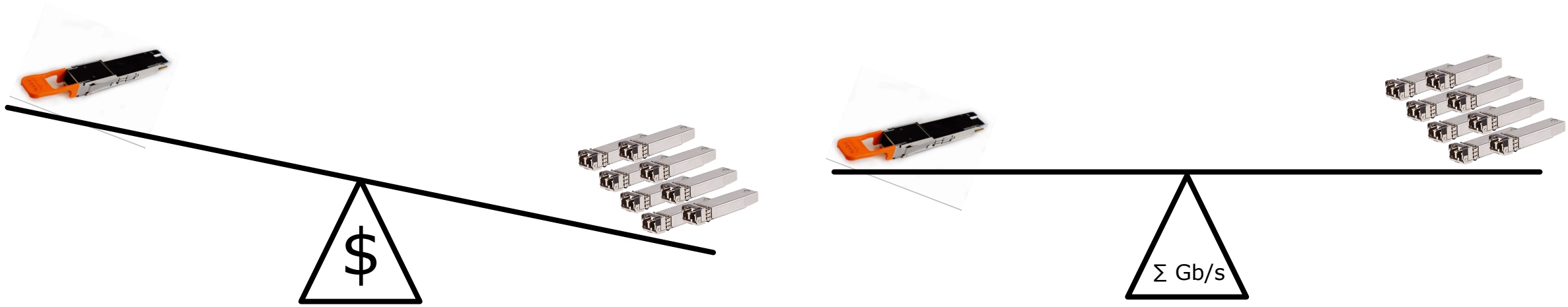
- **EoR / MoR (elimination of ToR)**



Source: Brad Booth, OFC 2021 – "Inside the Data Center"

Breakout Use-Cases for Optical Modules

- **Enable cost effective lower port speeds**
  - **$ (8-lane module) < $ (8 x single lane modules)**
  - **Leverage optical integration, amortize packaging and test cost**



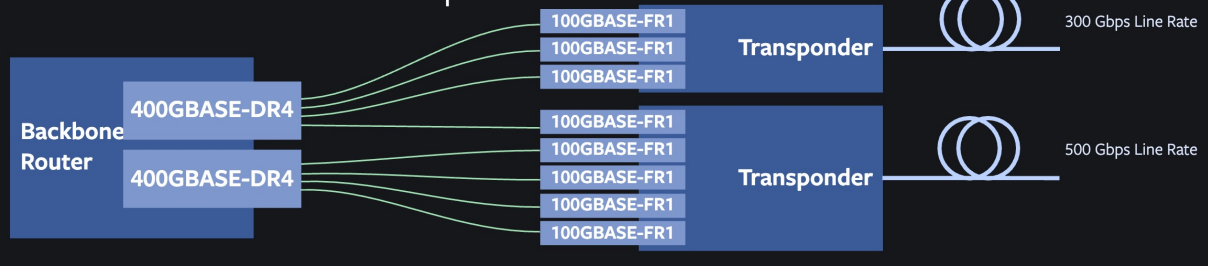
Lower cost / Gb/s for breakout modules

Breakout Use-Cases for Optical Modules

- **Flexible Client Interfaces from DC to Transport Equipment**
  - **Note: Although Router module shows 400GBASE-DR4 / 800GBASE-DR8/4, *strictly* PMD is identical on both ends of link (i.e. 100GBASE-FR1 / 200GBASE-FR)**

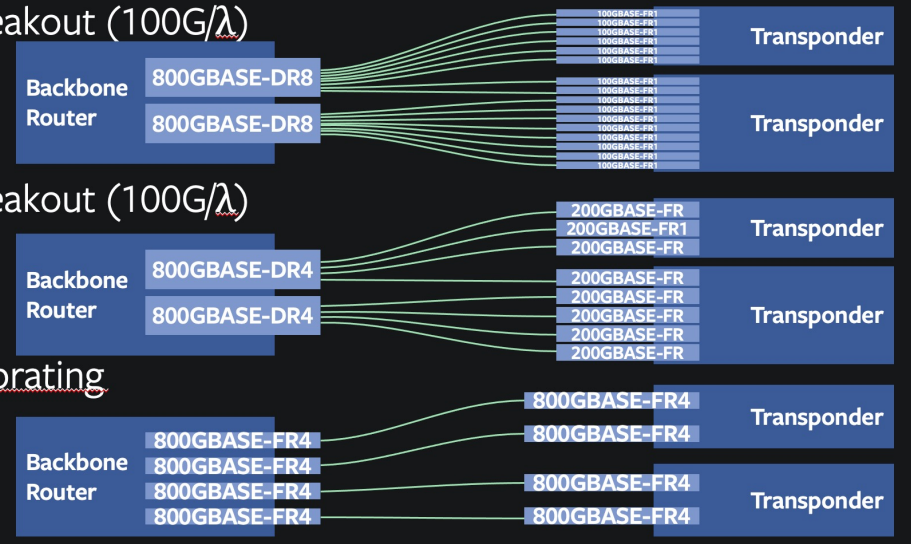
Managing Granularity: Gen 5 (Today)

- Fine granularity of modulation improves fiber utilization
  - SNR is link (distance) dependent
  - Consistent channel spacing improves efficiency in switched network
- Solution: Breakout cables
  - Backbone router uses 400GBASE-DR4
  - Patch panel with MPO to LC breakout
  - 100GBASE-FR1 on transponder



Managing Granularity: Gen 6 (Next-Gen)

- Option 1: Breakout (100G/λ)
- Option 2: Breakout (100G/λ)
- Option 3: Subrating



Source: Jeff Rahn, Facebook, OFC 2021 – "High Baud Rate Modulation: Applications for Next-Generation Backbone Networks" – edited for nomenclature consistency

Conclusion

- Multiple applications exist for use of breakout of multi-lane parallel single mode PHYs
- Additional technical work appears minimal given adopted objectives (800G over 4 pairs SMF)
- For complete end-user solution, we should include appropriate support for 200 GbE single-mode breakout in the objectives

Proposal

- **Add objective within B400G for 200GBASE-DR/FR to support breakout options**

Thanks!