Broad Market Potential & Economic Feasibility: 100G Single λ PAM4 500m

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Outline

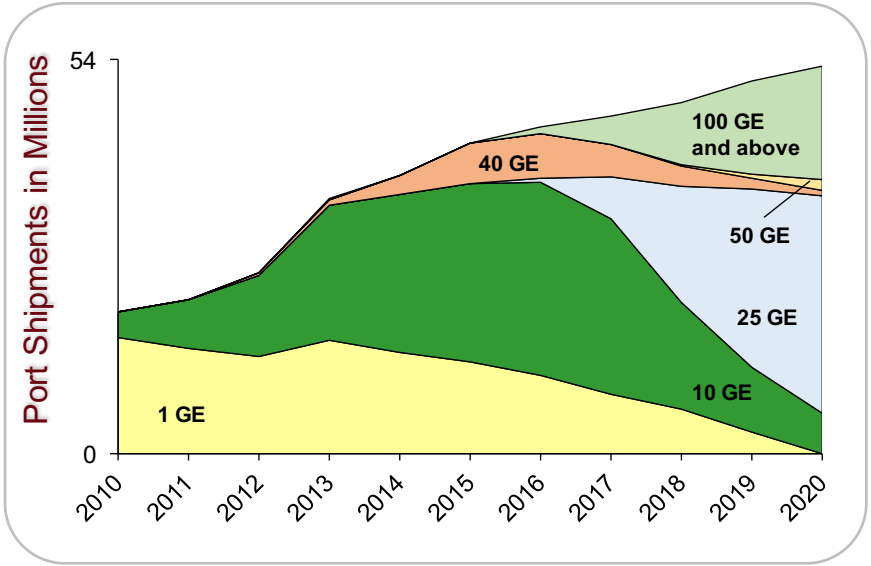
100G Single λ PAM4 500m

1. Broad market potential
   - Ethernet switching
   - Long life expectancy of 100 GbE
   - Ecosystem

2. Economic feasibility
   - Relative cost comparison of 100 GbE optical modules

3. Summary and observations

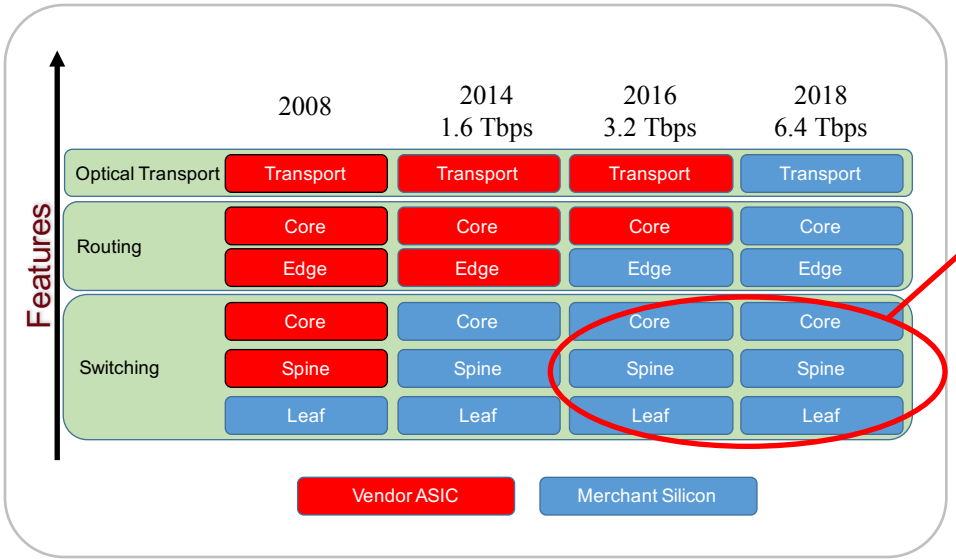
Ethernet Switch – Data Center Port Shipments



Dell'Oro Group | July 2016 Forecast

- Strong demand for 100G
  - > 15M ports in 2020 (copper and optical)
  - Does not include potential volume from 400G DR4 breakout
  - Combination of hyperscale and enterprise
- High volume → Low Cost Solutions
  - Aggressive 100G cost reduction is occurring now
  - Will continue as the market searches for the lowest cost solution
  - Key focus on <2km and <500m optical reaches

Merchant Silicon Influence on Switch Interconnects



Switch ASIC's that support 100GbE

Ecosystem for supporting 100GbE switch-to-switch interconnects will continue into the next generation of ASIC's.

The number of ports used for server access is plateauing while switch-to-switch interconnects are about to expand rapidly

DELL'ORO GROUP | July 2016 Forecast

Broad Market Potential

Server Install Base - End of 2015

DELL'ORO GROUP | July 2016 Forecast

As # of servers increase, and server IO transitions to 25G/ 50G, **switch-to-switch interconnect** must scale up to accommodate increase in traffic

Key focus on 100G low cost & high density

Cloud & Service Providers deploying 100G now

Lower cost 100G will enable Enterprise, to move to 100 GbE switch-to-switch interconnect in the next five years

Broad Market Potential (1 of 2)

- **Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:**
  - **Broad sets of applicability**
  - **Multiple vendors and numerous users**

100GbE is currently being deployed and is forecasted to exceed 15M ports (copper + optical) in 2020.

As volume increases, the hyperscale and enterprise markets will drive a low cost 500m optical solution that can address server-to-switch and switch-to-switch interconnect applications.

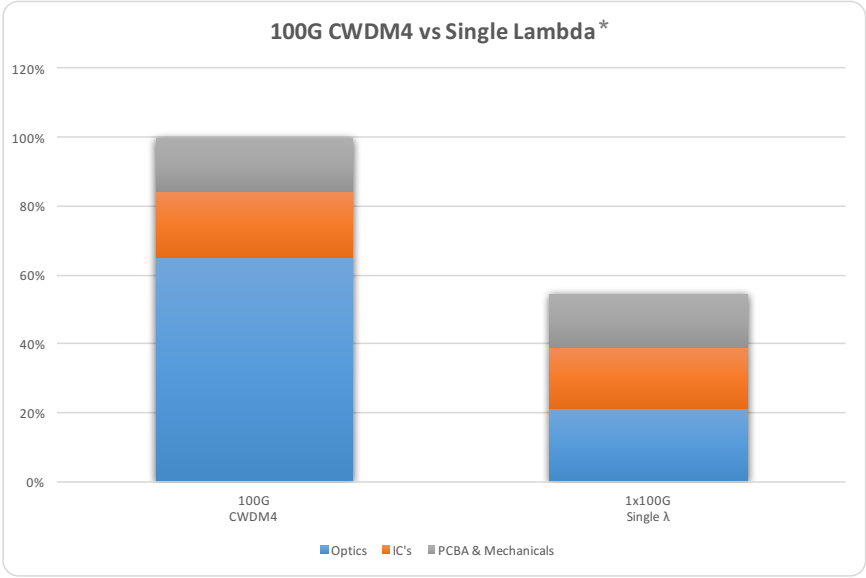
Broad Market Potential (2 of 2)

- **Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:**
  - **Broad sets of applicability.**
  - **Multiple vendors and numerous users**

The high attendance and wide participation in P802.3cd by end users, equipment manufactures, and component suppliers demonstrates that there will be multiple vendors and users.

Economic Feasibility - Relative Cost Comparisons (4λ vs 1λ)

- Optics
  - > 50% of the 4λ optical module cost is due to the optics
  - Significant savings are realized in moving from 4λ to 1λ
    - Assembly, test, alignment, yield
- IC's
  - Relative cost remains nearly constant in moving from 4λ to 1λ
  - Advanced nodes require significant initial investment, but can be amortized over the high volume 100G market
- PCBA & Mechanicals
  - Relative cost remains nearly constant in moving from 4λ to 1λ



* Based on Lumentum data

Transition from 4λ to 1λ results in relative cost reduction > 40%

Note
- CY2019 Relative Cost
- 4λ assumes CWDM4 implementation
- Comparison is at similar volumes

Summary and Observations

- 100G market is growing and forecasted to exceed 15M ports in 2020 (optical and copper)
- Broad market potential highlighted
  - Consisting of Cloud, Enterprise, and Service Providers
- Relative cost data presented to demonstrate savings that can be realized in moving from a 4λ optical module to a 1λ optical module

Single lambda 100G PAM4 is well positioned to provide a low cost, long lasting solution to address the broad market potential for 500m switch-to-switch links