



FlexE for DWDM Interconnect

The Ethernet Alliance 2016: The Road to 2026
Ethernet Flexes its Ports
September 29, 2016

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Google's Global Backbone Networks

Internet Backbone, **B2**: 70+ locations in 33 countries



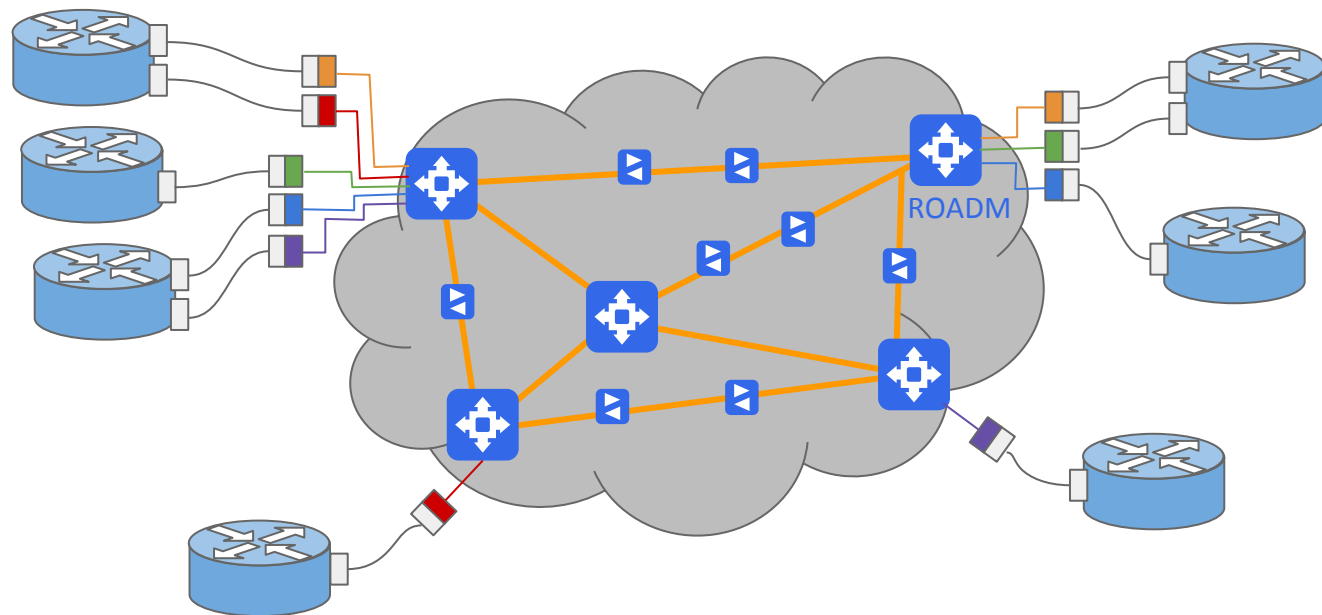
Google

Global Software Defined Inter-DC Backbone, **B4**



Backbone Network Elements

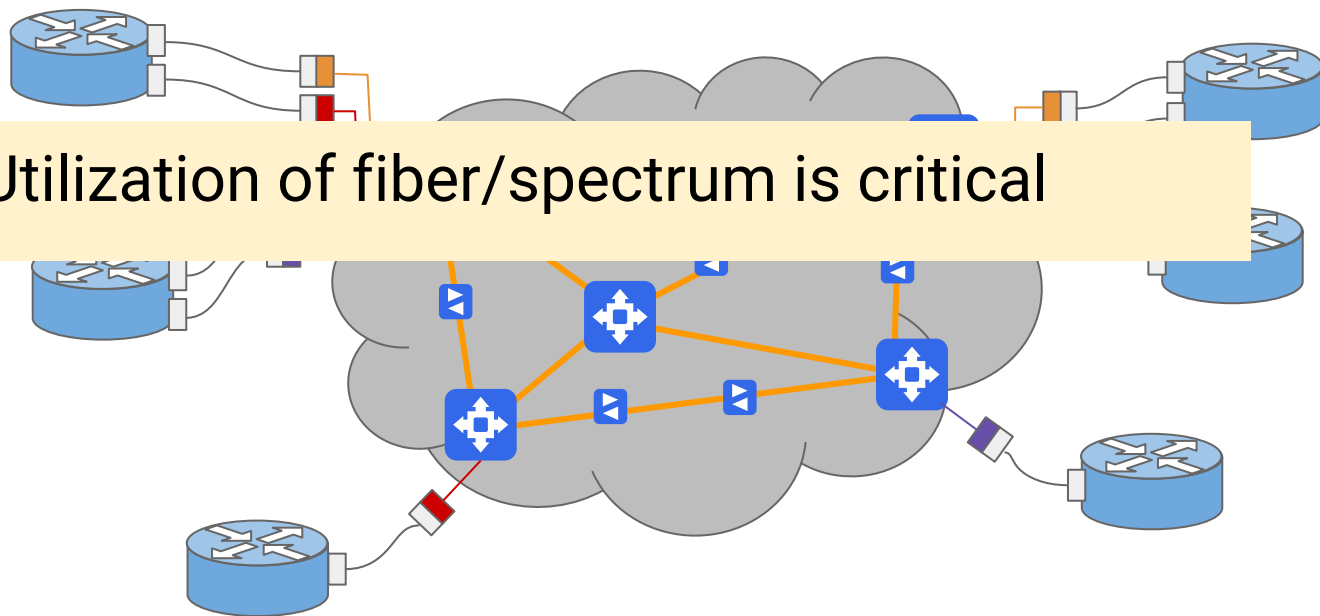
- Fiber & line system: limited resource, long time to acquire additional fiber and/or light fiber pair
- DWDM terminal/transponder: cost dominated by line-side optics
- Router: cost can be lower than other elements



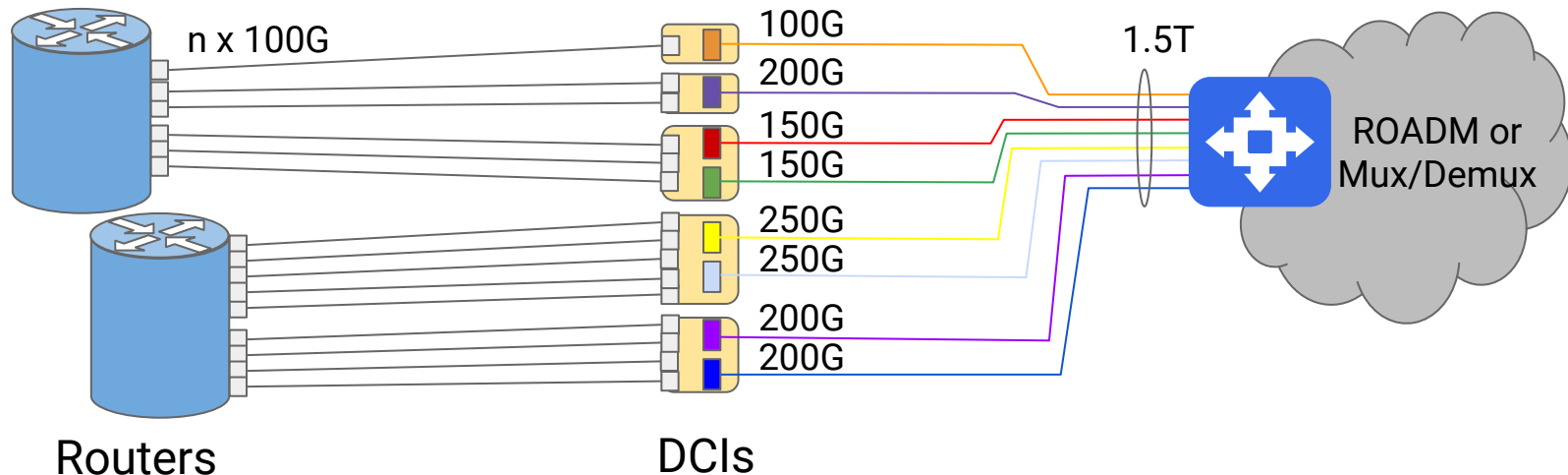
Backbone Network Elements

- Fiber & line system: limited resource, long time to acquire additional fiber and/or light fiber pair
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→ Utilization of fiber/spectrum is critical

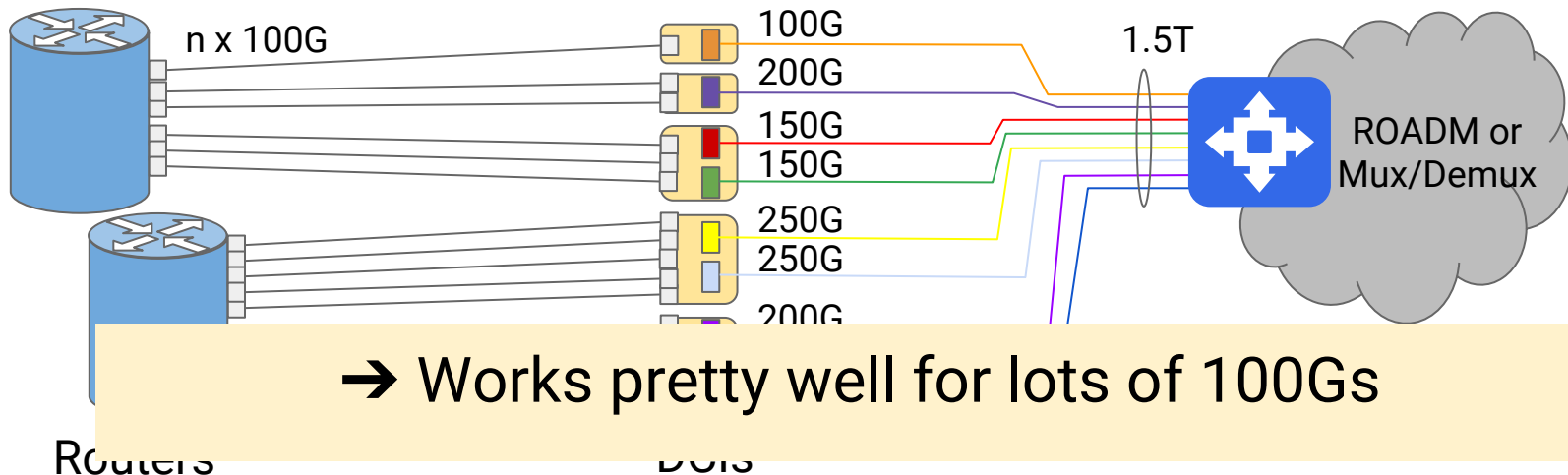


Router<>Transport in 2016



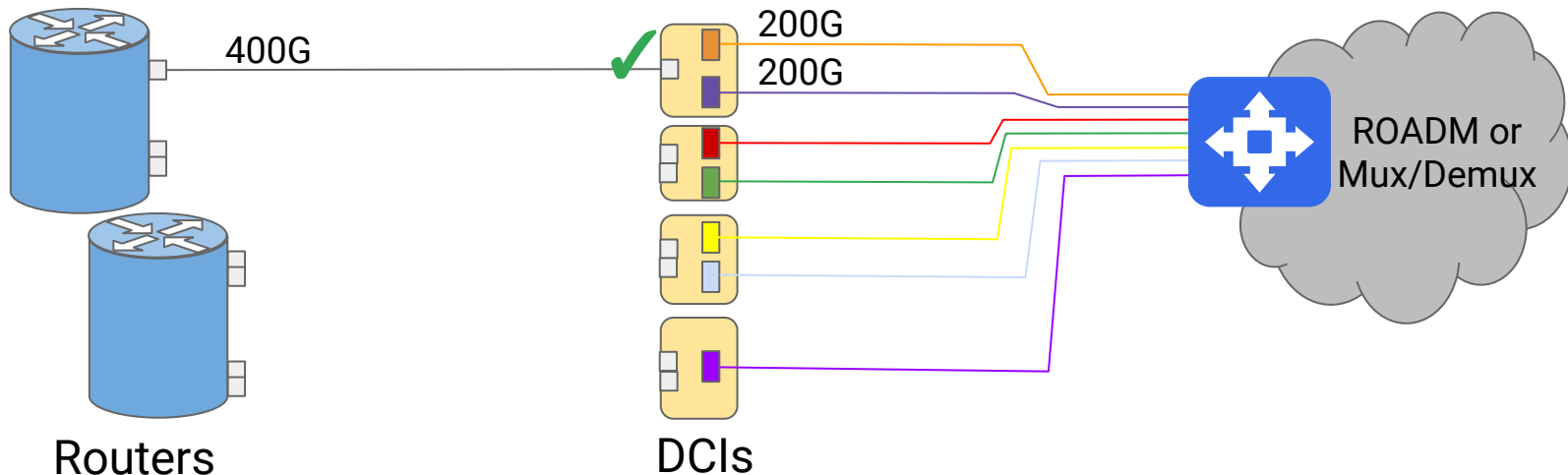
- Data Center Interconnect (DCI) style DWDM transport
 - Low-cost, independent NEs
 - Grooming into 1 or 2 line channels from client ports
- 32-40Gbaud; QPSK, 8-QAM, or 16-QAM modulation
 - Capacity per λ is $f(\text{DSP, distance})$

Router<>Transport in 2016



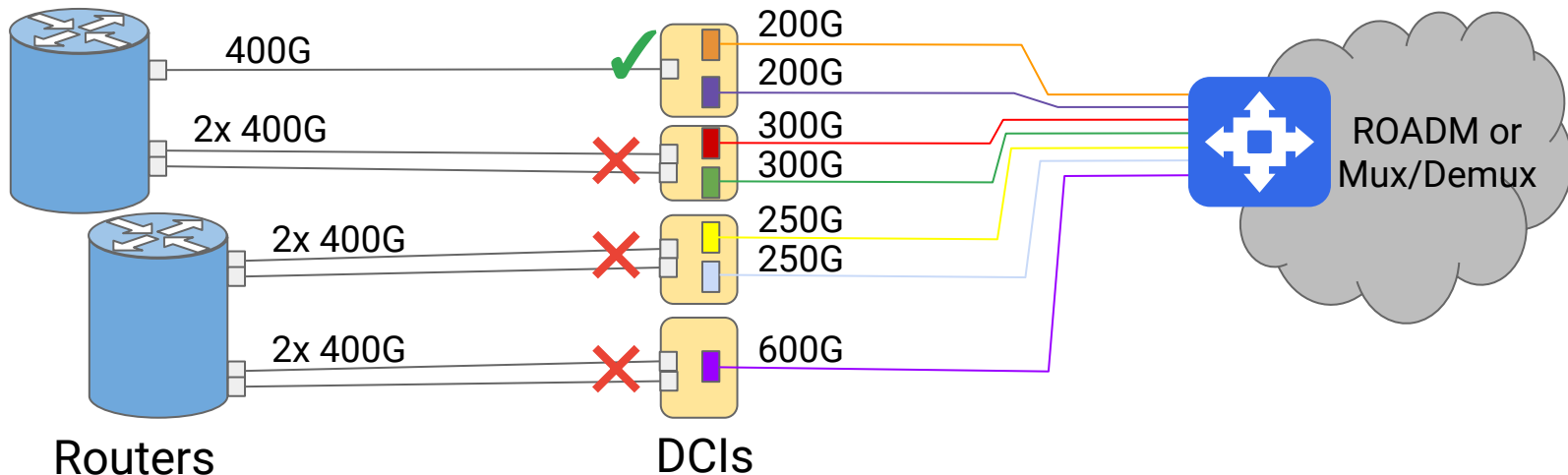
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Looking to ~2018



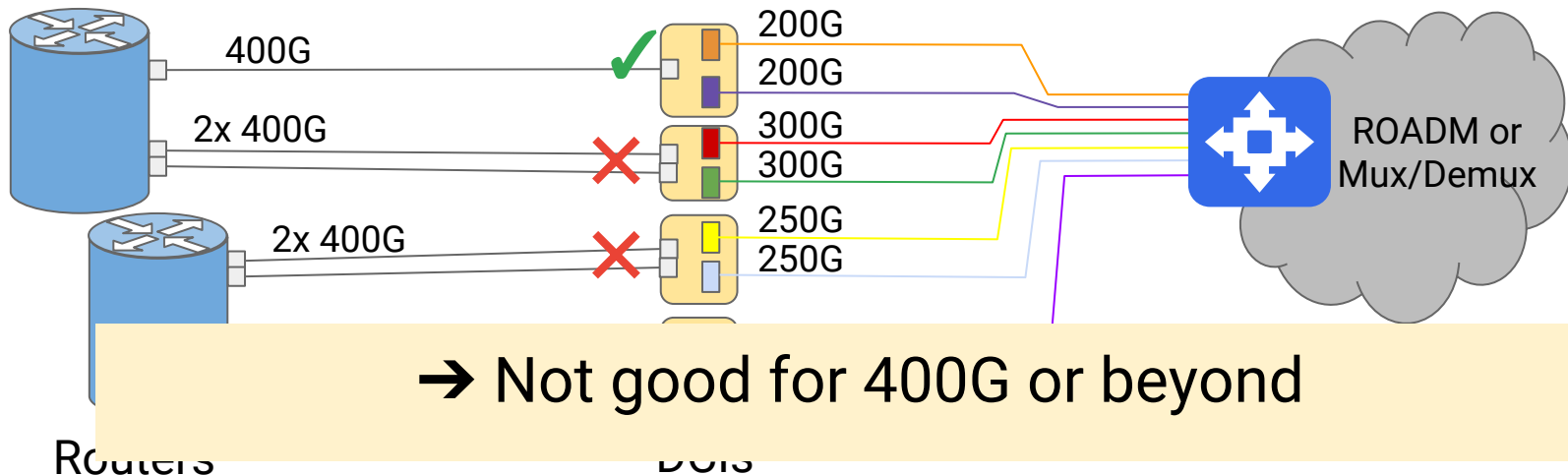
- → 43-64Gbaud; QPSK, 8-QAM, 16-QAM, 32-QAM, 64-QAM modulation
 - Likely will also have adaptive for “in between” modulations

Looking to ~2018



- Don't want to strand transport (DWDM capacity)
- Don't want to throttle router ports as that would require DCI to be packet aware with a buffer

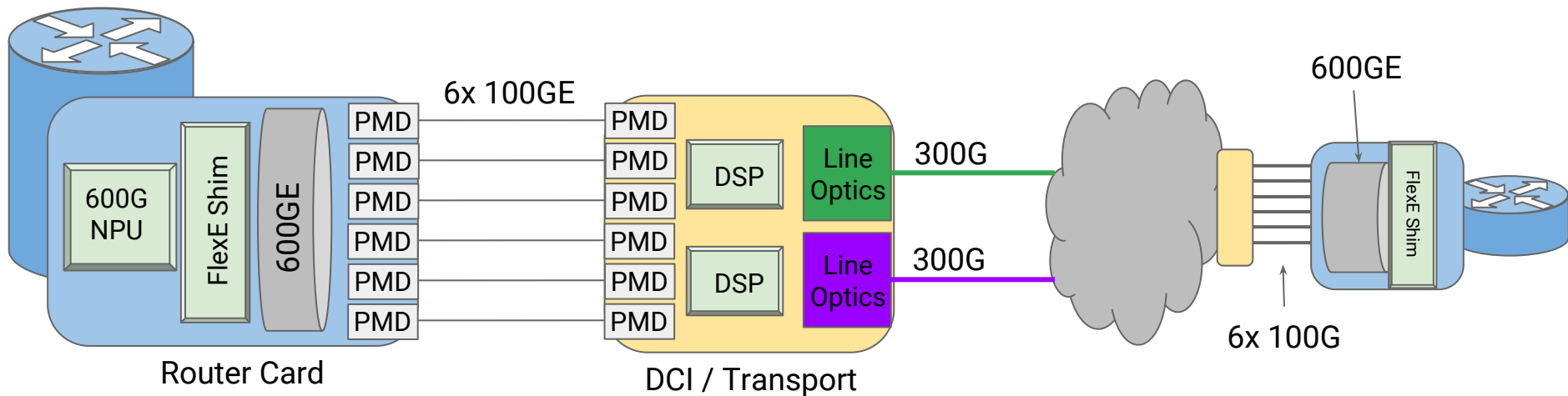
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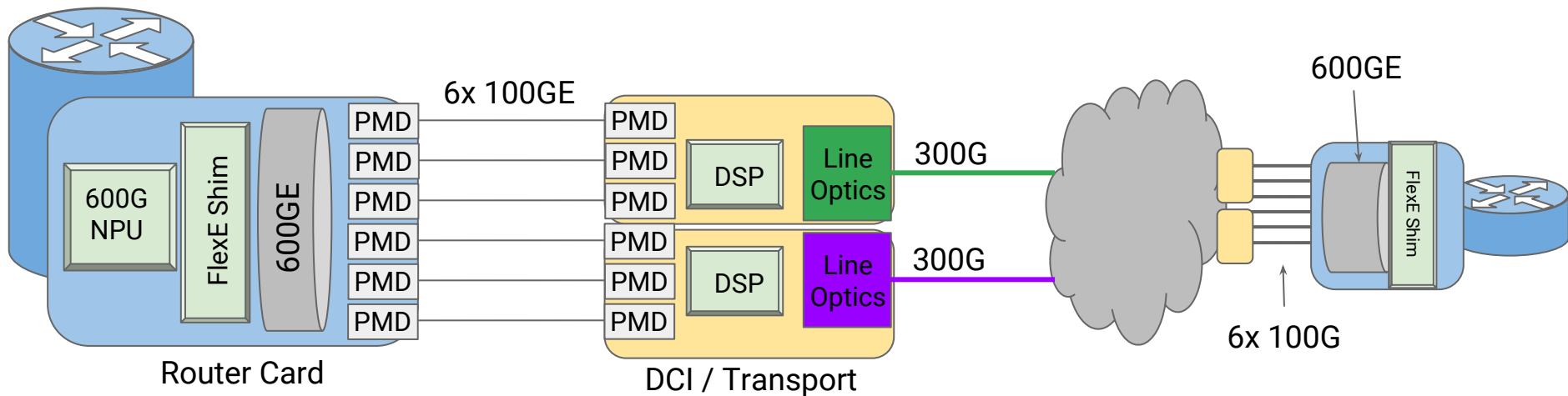
FlexE Bonding

- NPU capacity and router port is growing faster than DSP capacity (line rate)
- Transport does not need to terminate FlexE shim - can use existing transport/DCI



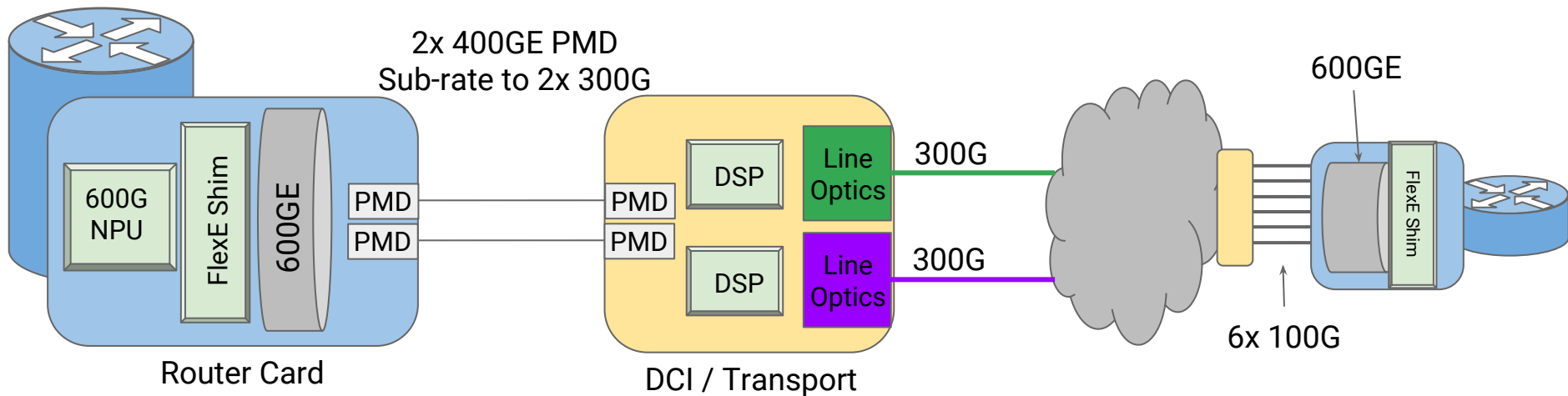
FlexE Bonding

- Can stripe over multiple cards or DCI chassis
 - Even from different vendors



FlexE Sub-rate

- Client PMD is lower cost, OK not to 100% utilize
- Sub-rate require “FlexE aware” DCI, but still don’t need to terminate FlexE Shim



Conclusions

- Flexible rate on line to maximize utilization of expensive resource
- Fixed rate client Ethernet MAC/PHY too constrained for flexible rate line
- FlexE removes these constraints
 - Router adjacency, PHY/transceiver, and line rates are independent
 - Extends service life of transport
 - Allows lowest cost client PHY/transceivers to be used

Thank you