CONNECTING AT THE SPEED OF LIGHT

Coherent Optics- Changing Architectures and Emerging Market Segments

2 October 2023

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Network Operator Problem Statement

How do you continue to scale the network to keep up with growing bandwidth demands without increasing cost and power proportionally?
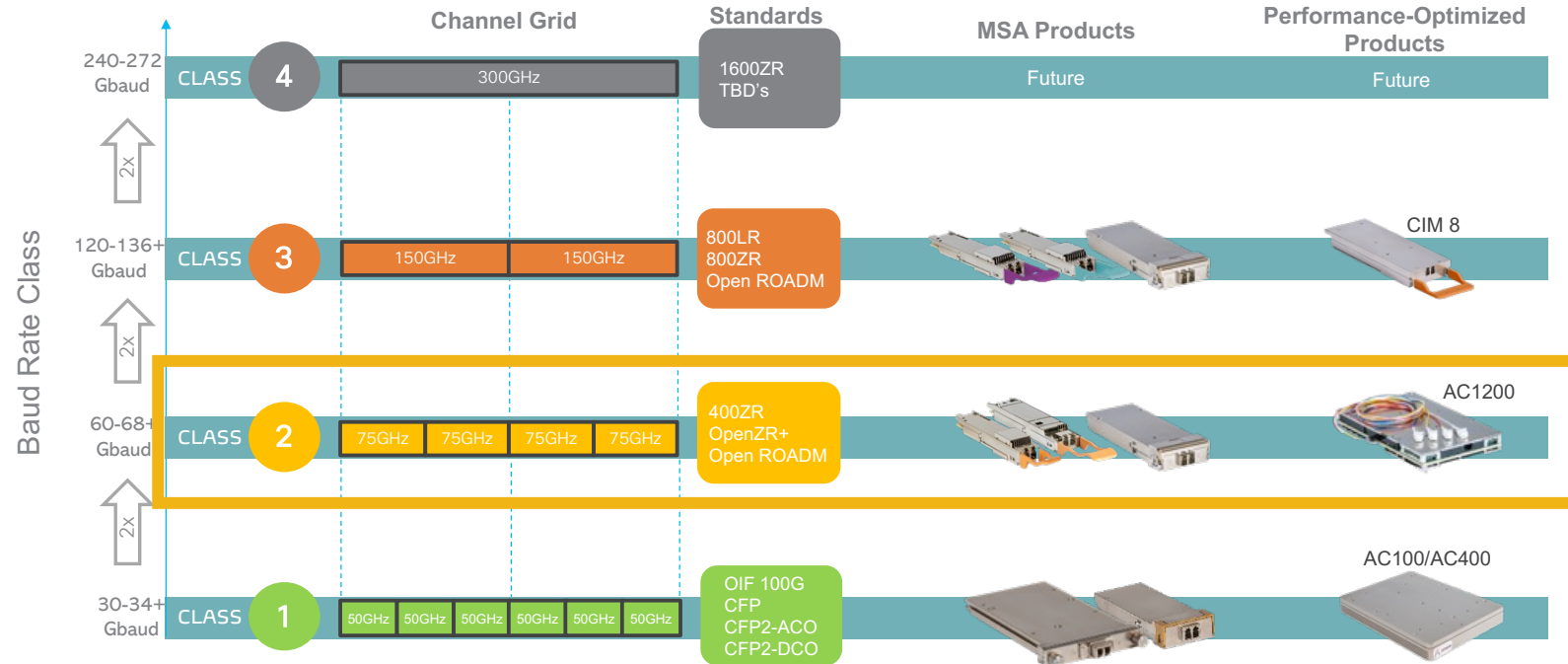
Class 1 Coherent Technology

- Rapid improvements in fiber capacity, as well as power and cost per bit
  - QPSK → 16QAM

- Significant benefits from Moore's Law
  - Digital processing a higher portion of module power

- Industry first pluggable modules

- Limited adoption of interoperable interfaces
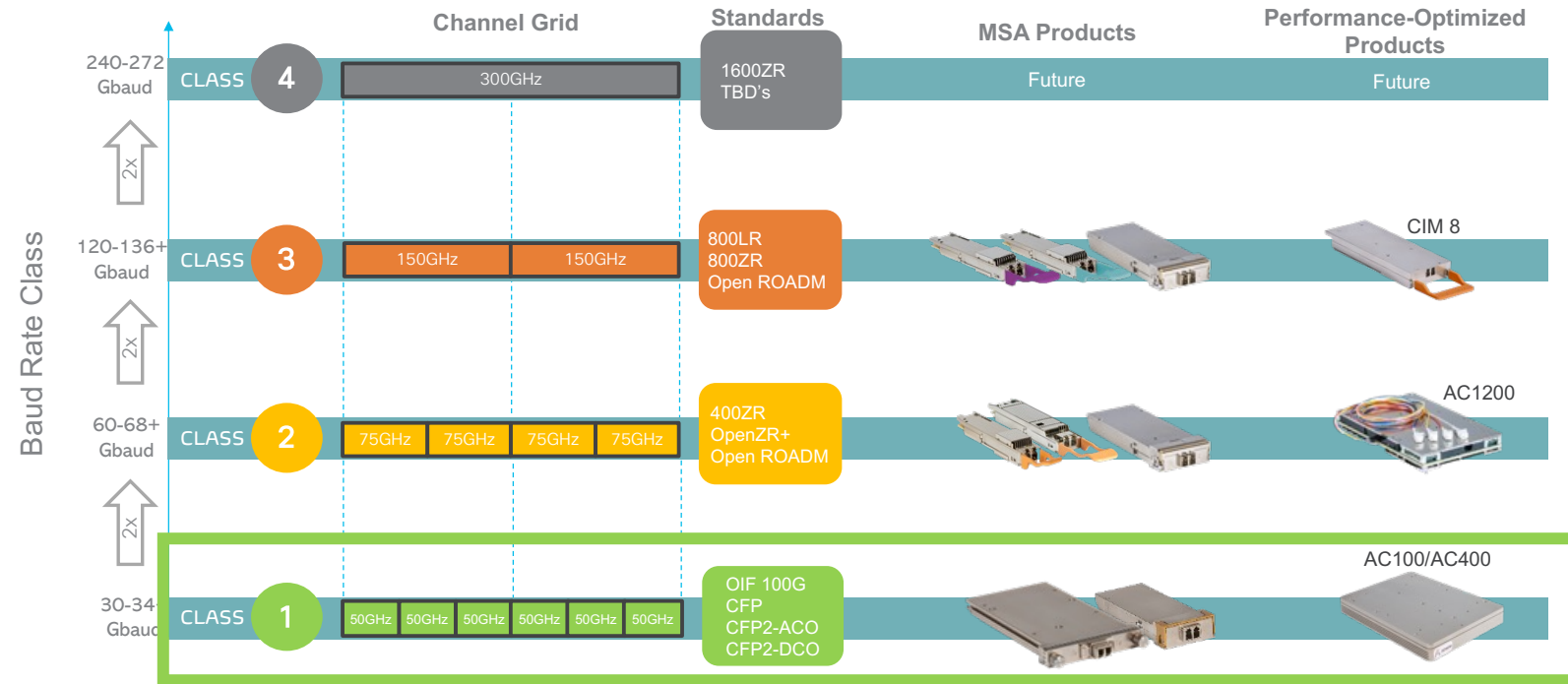
Class 2 Coherent Technology

- Standardized interfaces

- ZR/ZR+ in client form factors enable router-based applications

- First deployments of constellation shaped solutions

- Adaptive baud rates
  - Transmit spectrum closely matched to channel
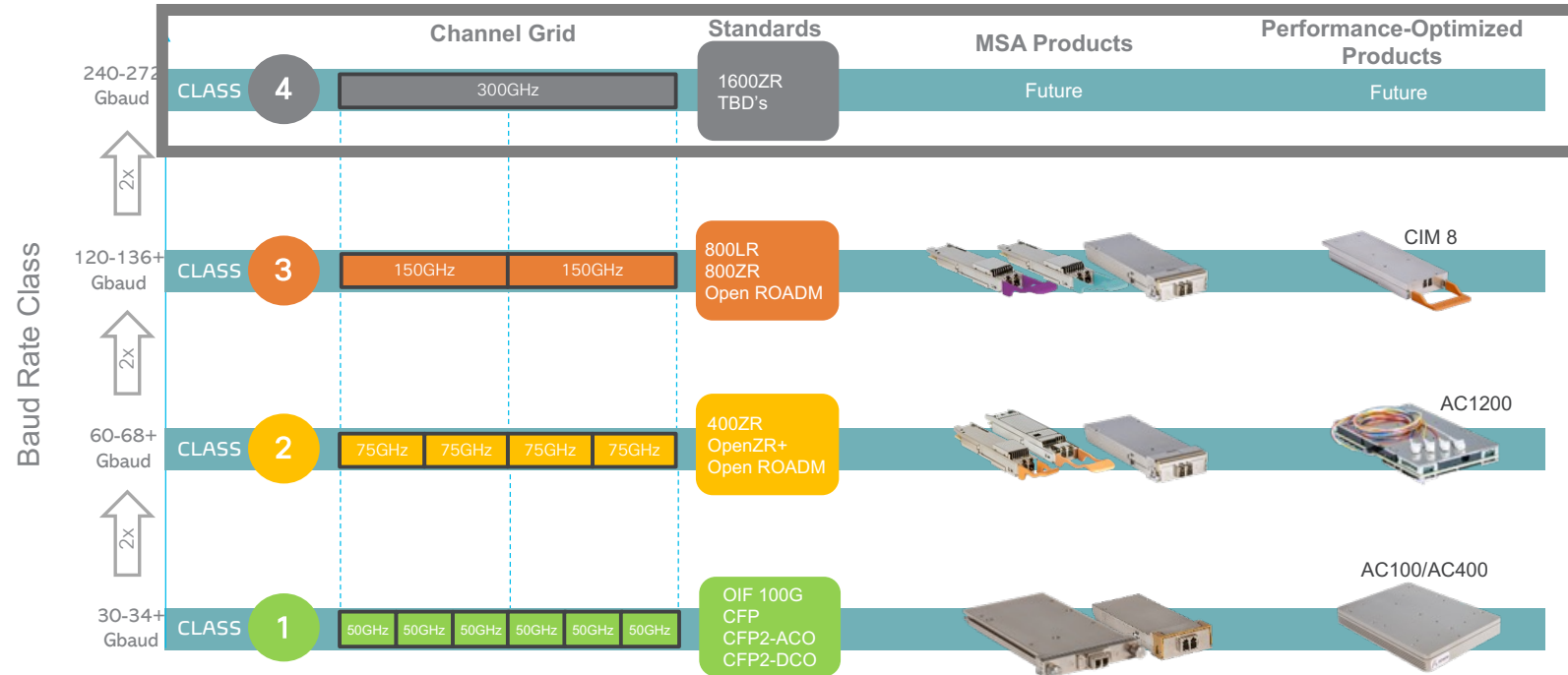
- Pluggable more widely deployed

Class 3 Coherent Technology

- Incremental (~20%) improvements in spectral efficiency

- Interoperable PCS in MSA pluggables

- Improvements in density and cost per bit

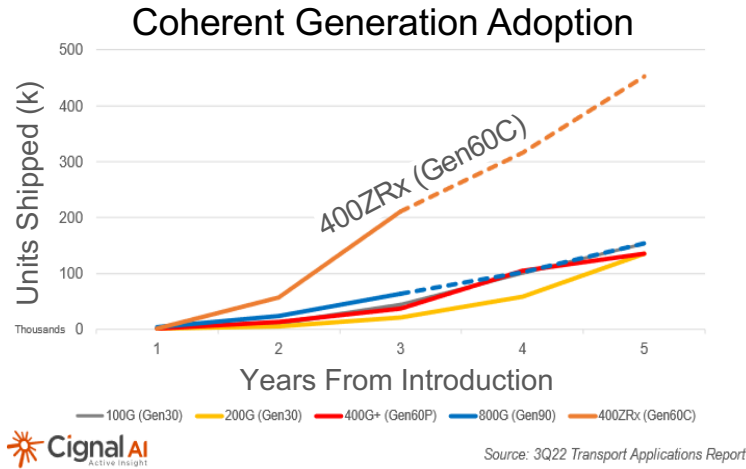- Performance optimized designs introduced in pluggable form factors
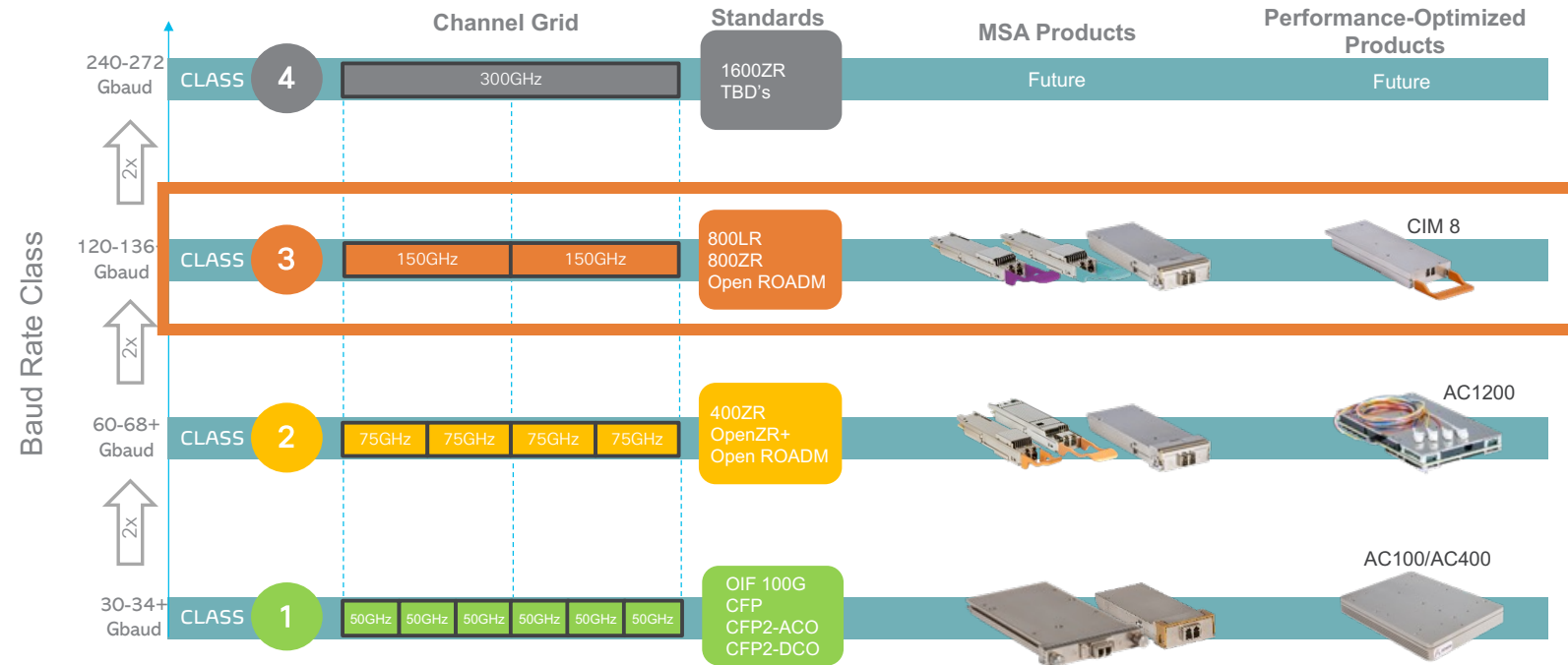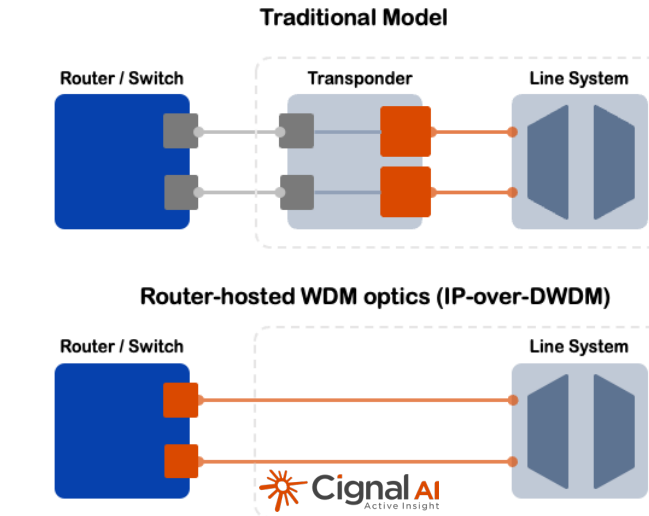
Class 4 Coherent Technology

- 1600ZR effort recently kicked off in OIF
  - Single carrier (~240Gbaud) is preferred to achieve power and cost objectives
  - Targeting small form factor pluggables for router deployments

Baud Rate Class			Channel Grid	Standards	MSA Products	Performance-Optimized Products
240-272 Gbaud	CLASS 4	300GHz		1600ZR TBD's	Future	Future
120-136+ Gbaud	CLASS 3	150GHz	150GHz	800LR 800ZR Open ROADM		CIM 8
60-68+ Gbaud	CLASS 2	75GHz 75GHz	75GHz 75GHz	400ZR OpenZR+ Open ROADM		AC1200
30-34+ Gbaud	CLASS 1	50GHz 50GHz 50GHz	50GHz 50GHz 50GHz	OIF 100G CFP CFP2-ACO CFP2-DCO		AC100/AC400

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Solving the Network Operator's Challenge

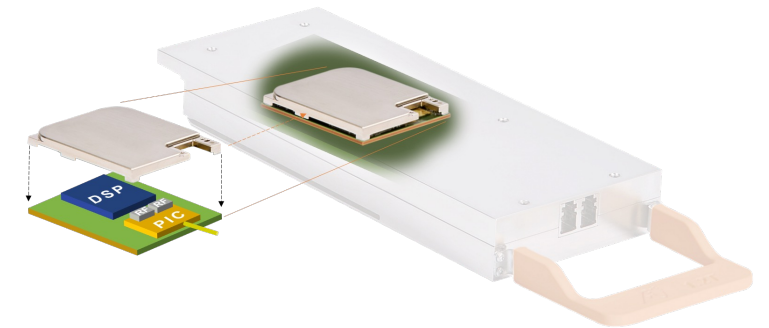### Coherent Generation Adoption

Align development to drive economies of scale

Simplify architectures to save cost and power

Implementations that drive cost and power per bit

It's not just about going further or faster, it's about going further faster....smarter

Evolution of 400G ZR/ZR+

400ZR	400ZR+	Bright 400ZR+	Bright 400LH

400ZR
- OIF
- Narrow scope focused on 400G DCI <120km
- CFEC
- -10dBm transmit power

400ZR+
- OpenZR+
  - Rev 1.0: 100GHz
  - Rev 2.0: 75GHz
- Client multiplexing
- 100G, 200G, 300G and 400G line rates
- oFEC
- -10dBm transmit power

Bright 400ZR+
- OpenZR+ Rev 3.0
- High transmit power
- Improved Tx OSNR
- Broader support for ROADM architectures
  - Co-existence with existing higher launch power channels

Bright 400LH
- Extended performance with PCS for multiple channel plans
- 120Gbaud+
- QPSK interop defined in Open ROADM
- PCS interop under discussion

Extending the network applications that can be addressed by router-based optics

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Extending the ZR/ZR+ Model Beyond 400G

	400G	800G	1.6T
ZR	• OIF 400ZR • CFEC 16QAM • 400G Client/Line	• OIF 800ZR • oFEC 16QAM • 120Gbaud+	• OIF 1600ZR • oFEC 16QAM proposed • 240Gbaud+
ZR+	• OpenZR+ Rev 1.0/2.0 • oFEC QPSK/8QAM/16QAM • 100-400G Client/Line	• Open ROADM/OpenZR+ • oFEC + Interoperable PCS • 120Gbaud+	• Future Standardization
Bright ZR+	• OpenZR+ Rev 3.0 • oFEC • 0dBm launch power	• Open ROADM/OpenZR+ • oFEC + Interoperable PCS • 120Gbaud+ • 0dBm launch power	• Future Standardization
Bright LH	• OpenROADM/OpenZR+ • oFEC + PCS • 120Gbaud+ • Support for multiple channel plans	• Future Standardization	

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Thank You