

100 Gb/s – How, where, when?

# **Long-haul 100G transmission: the system vendor challenge**

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# Scaling to 100-Gb/s...

Scaling long-haul telecommunication networks to a 100-Gb/s data rate can only be successful if:

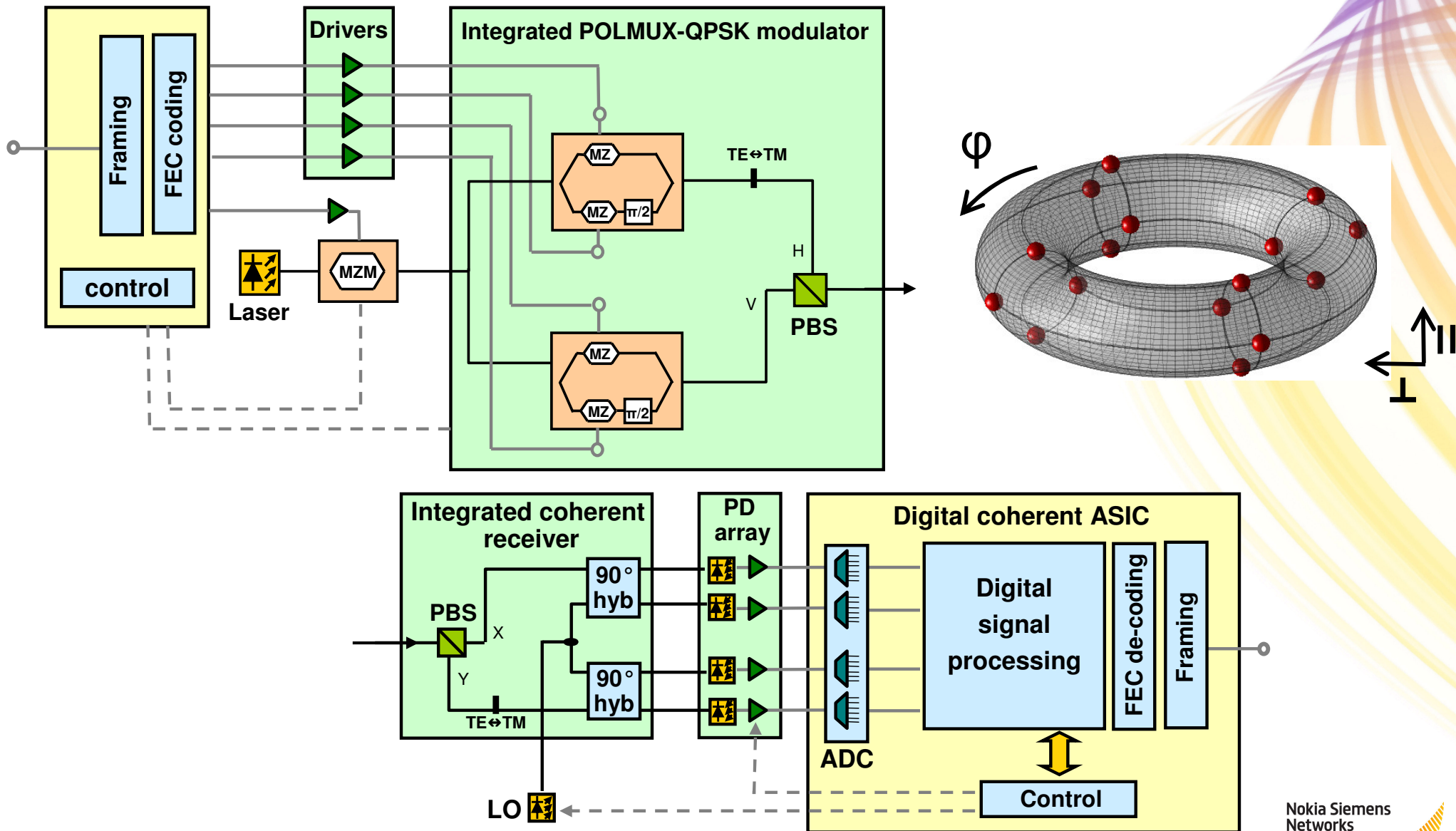
- ➔ The 100-Gb/s transmission format is compatible with already deployed transmission links: **Allow for a seamless upgrade to 100-Gb/s.**
- ➔ The reach of 100-Gb/s is comparable to today's reach at a 40-Gb/s data rate for a newly deployed transmission link: **Ensure compatibility with existing network topologies.**
- ➔ The \$ / bit / km is lower for 100-Gb/s transmission compared to today's 40-Gb/s transmission: **A cost-effective solution at the network level.**

**How do we enable cost-effective 100-Gb/s for volume deployment in the core network?**



# CP-QPSK modulation and digital signal processing

## Coherent-detected Polarization-multiplexed Quadrature Phase Shift Keying



# The three C's

## □ **Capacity: *support the need for traffic growth over the next decade.***

- ➔ Supports a 50-GHz spaced wavelength grid to allow 8+ Tb/s on a single fiber.
- ➔ Supports highly meshed networks with numerous cascaded ROADMs.

## □ **Complexity: *simplify link design and system deployment.***

- ➔ Reduces sensitivity to transmission impairments (optical filtering, CD, PMD).
- ➔ Eliminates the need for optical dispersion-management.
- ➔ Reduces the requirements for fiber measurements upon system planning and turn-up.

## □ **Cost reduction: *lower CAPEX and OPEX on the network level***

- ➔ Eliminates regeneration points through an increase in transmission distance.
- ➔ Increase automation through colorless and directionless add-drop architectures.
- ➔ Reduces footprint and lowers power consumption (*Watt / bit / km*).





# The road to cost-effective 100G

- ❑ **CP-QPSK modulation and digital signal processing shift system complexity from the transmission link towards the transponders.**
  - ➔ To make 100G more cost-effective we primarily need to focus on transponder costs.
- ❑ **Optical and electrical integration are needed to drive down transponder cost.**
  - ➔ Single-chip digital signal processing integrated with high-speed analog-to-digital converters.
  - ➔ Integrated PM-QPSK modulators.
  - ➔ Receiver front-ends, with integrated 90° hybrids, beam splitters and photodiode arrays.
  - ➔ Monolithic integration of active and passive components (both Tx and Rx).
  - ➔ Low-cost pluggable client transponders.

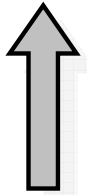
**But only volume and standardization will enable the real cost-effective 100G...**



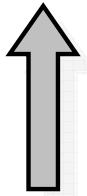
# The 100G ecosphere

The industry needs to build a 100G ecosphere that enables standardization, and drives down development cost and risk.

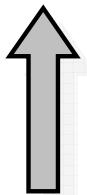
Applications



Systems



Modules



Components



# Conclusion

- ❑ **The road to 100G is not only a jump in capacity... it is as well a jump in system complexity.**
- ❑ **The right mix of technologies can enable cost-effective 100G transmission.**
  - ➔ High performance transmission systems (low noise figure EDFAs, Raman) are needed to maximize reach, and thereby minimize regeneration points.
  - ➔ Highly automated transmission systems (colorless / directionless) can increase the effectiveness of 100G transponders in highly meshed networks.
  - ➔ A strong focus on optical and electrical integration is needed drive down cost and complexity.
- ❑ **Even after initial 100G deployment, the road towards cost-effectiveness will still provides both challenges and opportunities to everybody.**





# THANK YOU!

