

Siemens Networks GmbH & Co. KG

Technical and economic feasibility of a 1×100G serial LAN PHY

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Higher Speed Study Group

Outline

- **Classification among the various 100G alternatives**
- **1×100G transmission experiments**
 - 107-Gb/s ETDM receiver (ECOC '06)
 - 107-Gb/s full-ETDM transmission (OFC' 07, accepted)
- **Five criteria**
 - Broad market potential
 - Compatibility with IEEE Std. 802.3
 - Distinct identity
 - Technical feasibility
 - Economic feasibility
- **Conclusion**

Classification among the various 100G alternatives

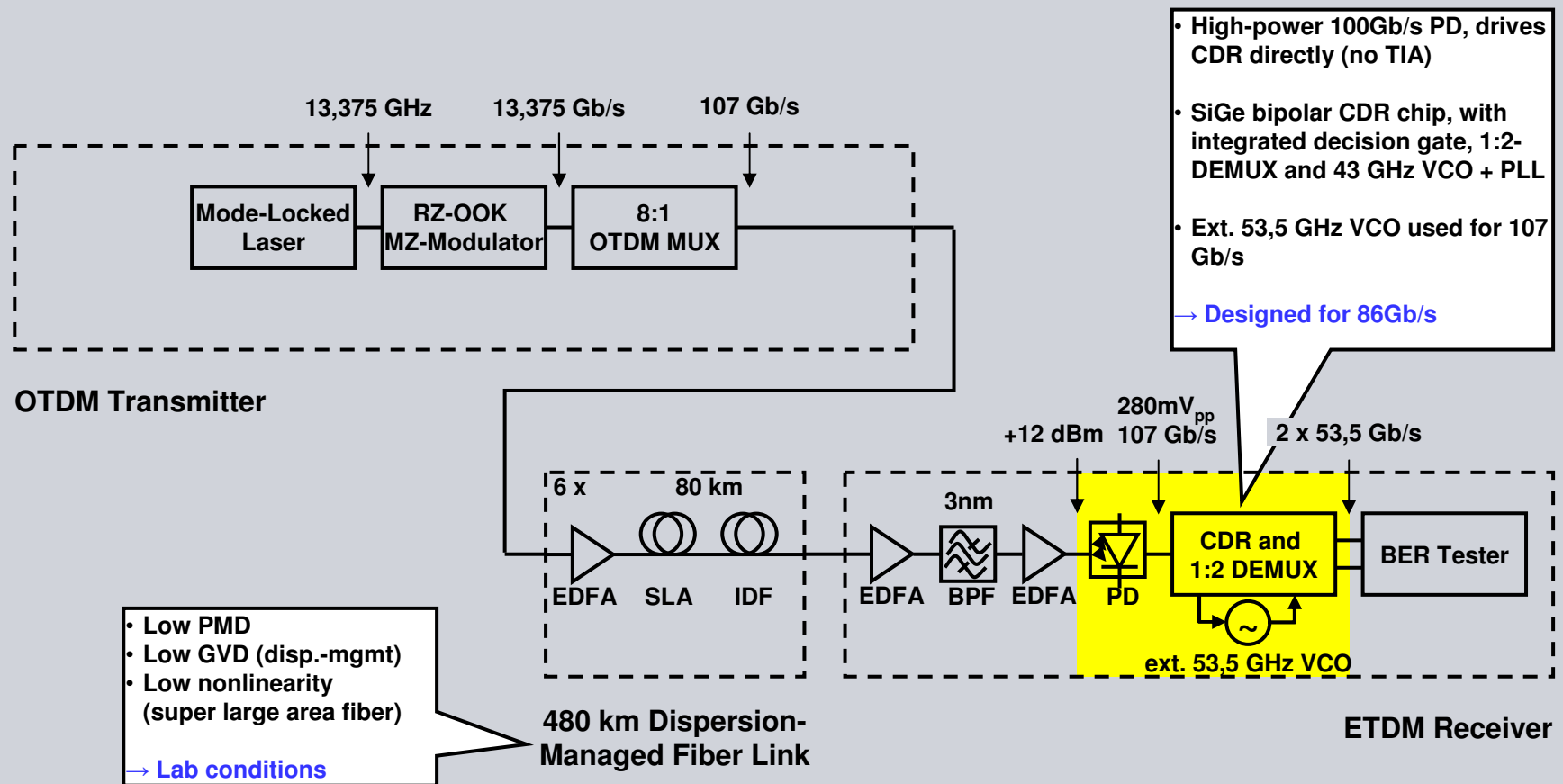


Reach (technical) feasibility of 100GE alternatives

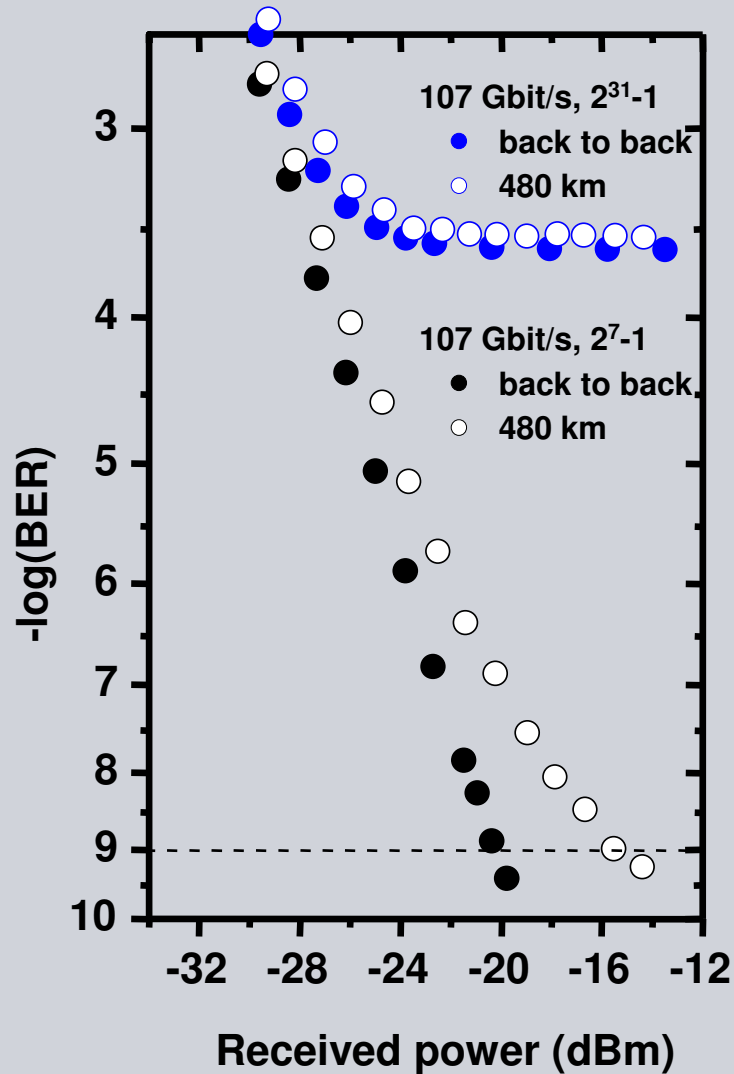
SMF	10km 1310nm	40km 1310nm	10km 1550nm	40km 1550nm
10G DML	yes (10λ span needs semi-cooling)	yes (need new DML & RX APD/SOA)	yes (need new DML)	maybe (need new DML)
10G EML	yes	yes (need RX APD/SOA)	yes	yes
20G/25G DML	yes (need new DML)	maybe (need new DML & RX SOA)	maybe (need new DML)	no
20G/25G EML	yes (need new EML)	yes (need new EML & RX SOA)	yes	yes (need RX DC)
50G DML	no	no	no	no
50G EML	yes (need I/Q ML)	yes (need I/Q ML, RX DC & SOA)	yes (need I/Q ML & RX DC)	yes (need I/Q ML & RX DC)
100G EML			yes (need new EML & RX DC)	maybe (need new EML & RX DC)

107-Gb/s ETDM receiver (ECOC '06)

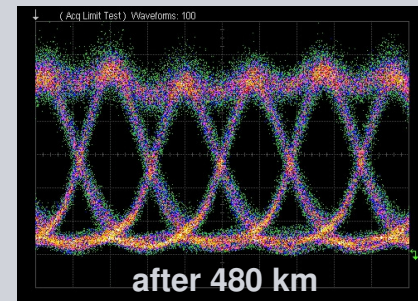
- 107-Gb/s ETDM receiver over 480-km fiber demonstrated



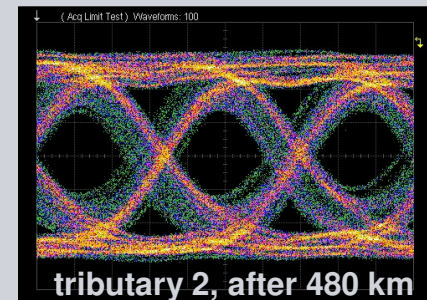
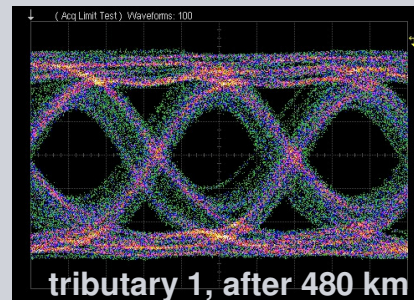
107-Gb/s ETDM receiver (ECOC '06)



107 Gbit/s electrical eye



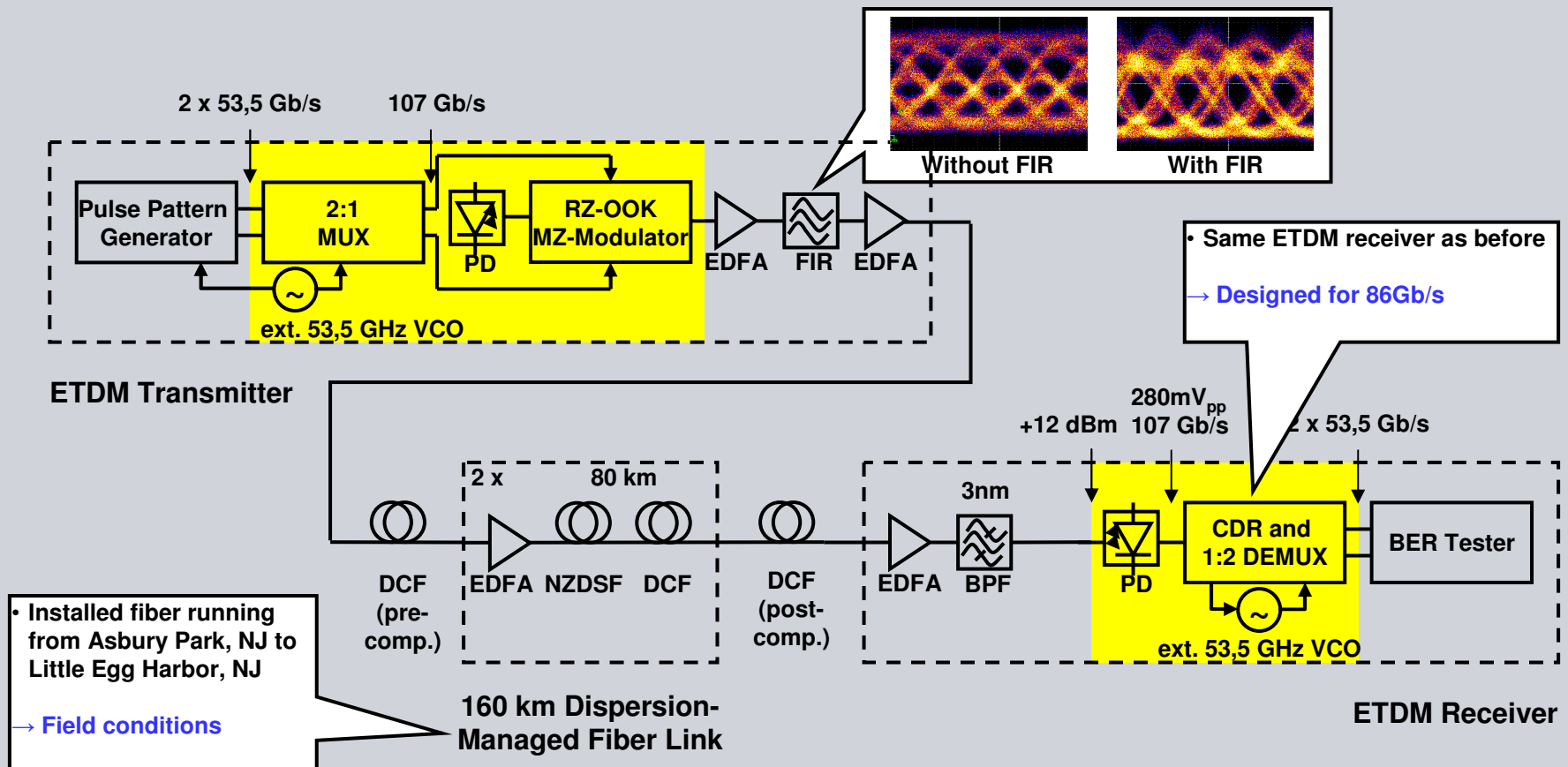
Demultiplexed 53.5 Gbit/s electrical eyes



- Error-free performance after 480 km
- Performance degradation for longer PRBS word length, but BER still below FEC limit

107-Gb/s full-ETDM transmission (OFC' 07)

- 107-Gb/s full-ETDM transmission over 160-km field installed fiber demonstrated for the first time

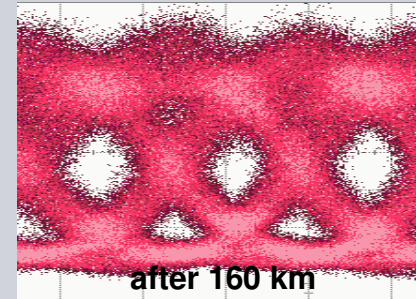


107-Gb/s full-ETDM transmission (OFC' 07)

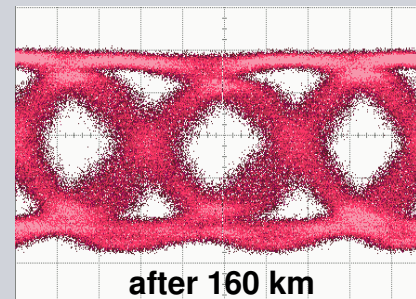
	Q-factor Tributary 1 / 2	OSNR
Back- to-back	10.4 dB / 10.5 dB	42 dB
After 160 km	9.6 dB / 9.7 dB	35.6 dB

15,6 dB = BER 10⁻⁹
 16,9 dB = BER 10⁻¹²

107 Gbit/s optical eye



107 Gbit/s electrical eye



- Due to limitations of the precision time base of the oscilloscope, the eye diagrams taken at 107 Gb/s are distorted by a large jitter (caused by the scope)

Five Criteria: Technical Feasibility

- **Demonstrated feasibility; reports - - working models**
 - Presented research on the feasibility of 107 Gb/s full-ETDM physical layer signaling on fiber optic media
 - Partially components designed for 86 Gb/s operation were used
 - Component requirements can be relaxed when applied to a reach of 10km instead of 160km field installed fiber
 - Less launch power / loss / amplification / noise
 - Less PMD / GVD-induced distortion
 - FEC may not be required (then data rate reduces to 100 Gb/s)
- **Proven technology, reasonable testing**
- **Confidence in reliability**
 - The transmission experiments conform to typical reliability requirements of transport networks
 - Based on these findings, the reliability of Ethernet components and systems can be extrapolated in the target environments with a high degree of confidence

Five Criteria: Economic Feasibility

- **Cost factors known, reliable data**
 - The cost factors for Transport components and systems are well known
 - Can be used as a starting point for quantifying the cost factors of Ethernet components and systems

- **Reasonable cost for performance expected**
 - Simple transmitter and receiver assemblies
 - Easy to manage
 - Low power consumption
 - Upper bound on relative cost is 5x cost / 10x performance
 - Quantified for long-haul case, most likely lower for short-haul

- **Total Installation costs considered**
 - Customers will in many cases be able to re-use existing SMF, at the cost of additional passive dispersion compensation

Summary

- **Presented two 1×100G serial transmission experiments**
- **Conclusion**
 - A 1×100G serial LAN PHY for 10km reach is technically and economically feasible, since transmission works for distances of 160 km (field conditions) and 480 km (lab conditions) and partially 86 Gb/s components were used
 - An upper bound on relative cost, which was derived for long-haul requirements, is 5x cost for 10x performance
- **Thank you!**

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