# 40 Gb/s Ethernet optimized for client applications in the carrier environment: TECHNICAL FEASIBILITY

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New Orleans, January 2010

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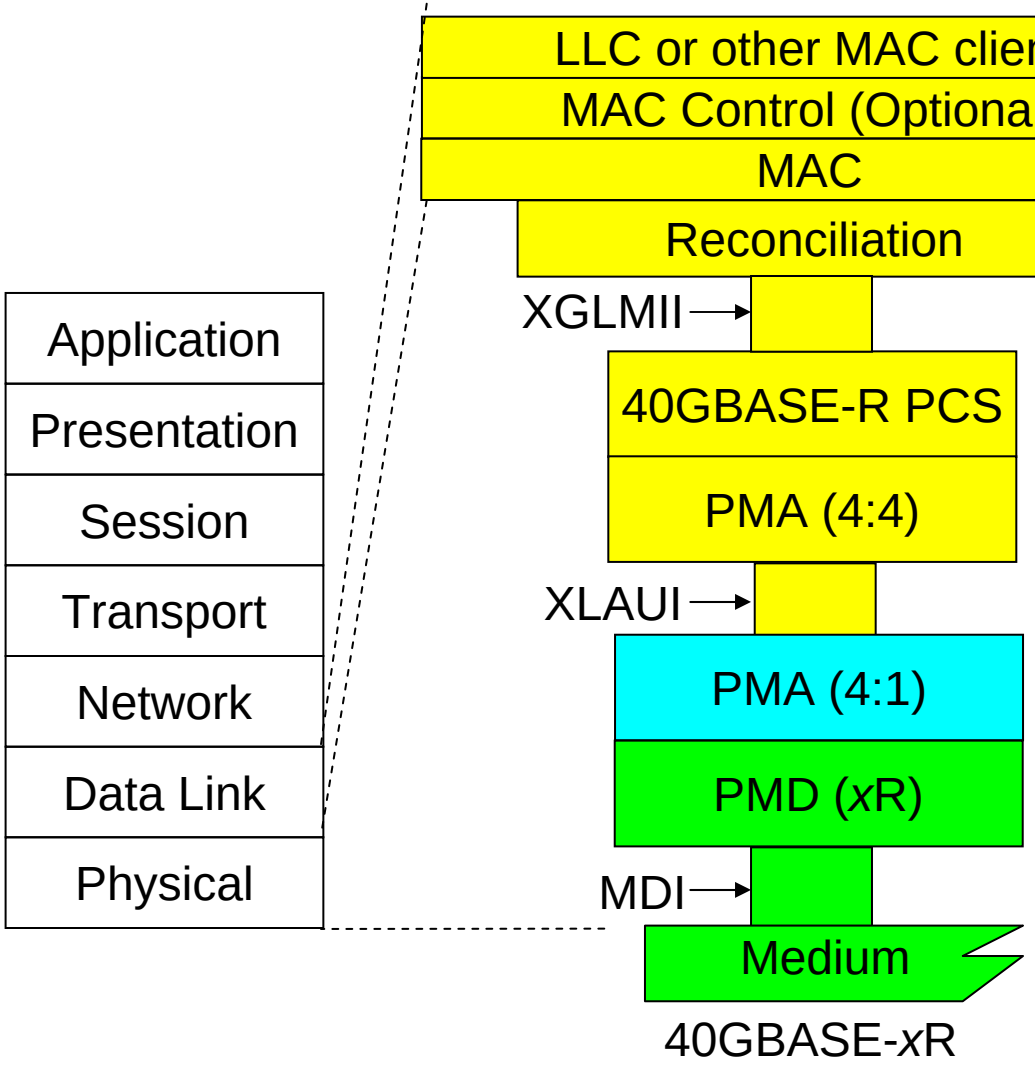
# 40GBASE-xR Technical Feasibility




✓ Proven in P802.3ba

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✓ Proven in P802.3ba, Cl. 83

✓ Demonstrated and proven by ITU-T G.693 40G VSR interface deployment

# 40GbE SMF PMD References

The following HSSG and P802.3ba TF presentations addressed technical feasibility of 40GbE SMF PMD approaches:

http://www.ieee802.org/3/ba/public/....

- hiramoto_01_0908
- mori_01_0908
- mori_02_0908
- traverso_02_0708
- isono_01_0508
- jewell_03_0508
- barbieri_01_0308
- simsarian_01_0308
- traverso_04_0308
- traverso_40_01_0208

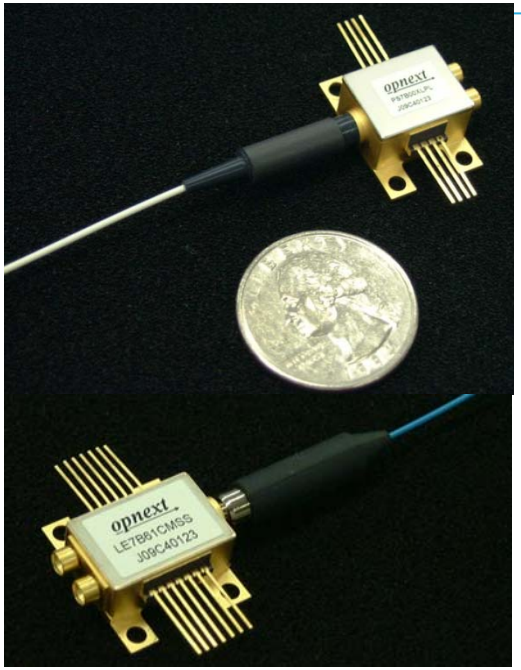
# 40Gbps SMF Optical Budgets Exist

| | VSR2000-3R2 (1550nm)* | VSR2000-3R1 (1310nm) | P1I1-3D1 (1310nm) |
|---|---|---|---|
| Wavelength | 1530-1565 | 1290 - 1330 | 1307 - 1317 |
| Pout | +3 to 0 | +3 to 0 | +4 to 0 |
| ER | 8.2 | 8.2 | 8.2 |
| Psens | -6 | -5 | -7 |
| Distance | 2km | 2km | 10km |
| Attenuation | 4 | 4 | 6 |
| Penalty | 2 | 1 | 1 |
| Document | G.693 | G.693 | G.959.1 |

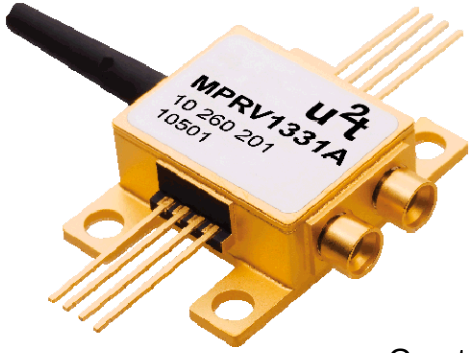
* VSR2000-3R2 is the only interface known to be deployed

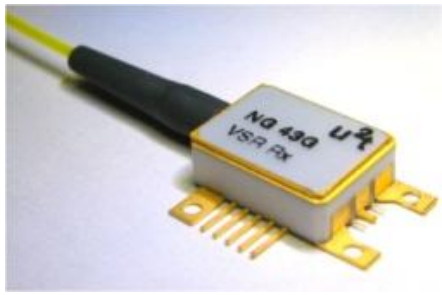
- Supports multiple rates/protocols: OTU3/STM-256/OC-768/40G POS.
- Opportunity for IEEE to leverage past work and select optimized solution for marketplace.

# 40Gbps Supply Chain Established: Optics




Courtesy: Opnext

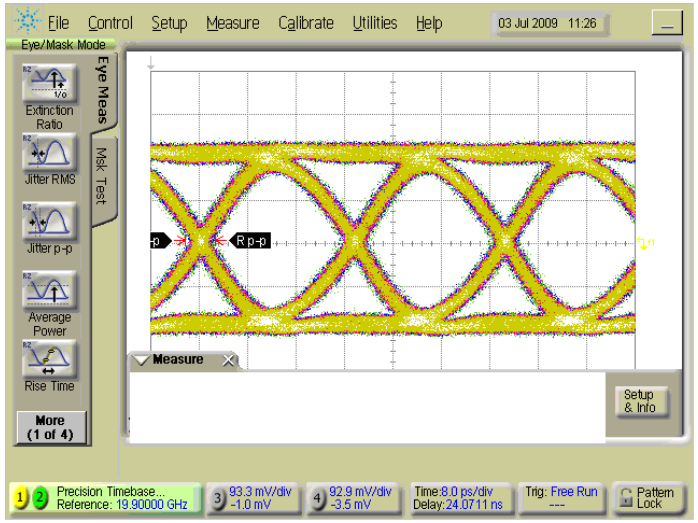



Courtesy: u²t Photonics

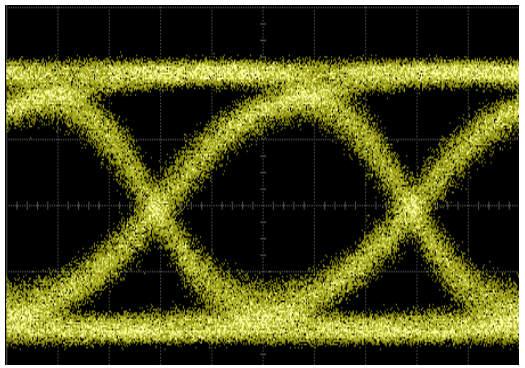
- XLMD MSA V1.0 established in 2008 for 40Gbps transmitter and receive optical subassemblies.
- Multiple optical subassemblies available from multiple suppliers.
- Component suppliers developing compact packaging with advanced cost reduced interconnect technologies.

# 40Gbps Supply Chain Established: Analog & Digital ICs




Courtesy: Semtech

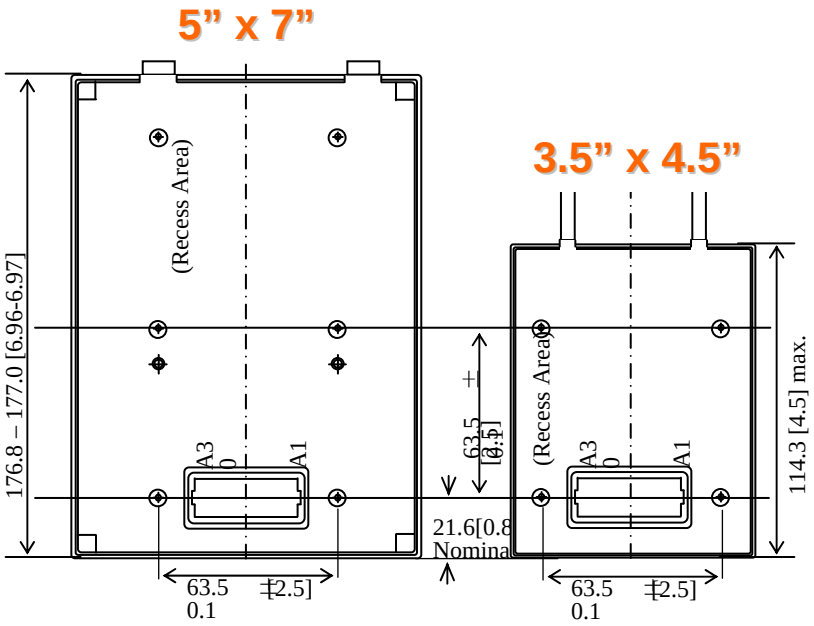
*40G TIA*



Courtesy: Inphi

- 40Gbps SerDes commercially available.
  - 3rd Generation ICs offering superior performance with reduced power .
- 40Gbps analog ICs for interfacing to the optics commercially available.
  - Driver ICs & Transimpedance amplifiers with efficient gain & high bandwidth available.
- Multiple rates/protocols supported: OTU3/STM-256/OC-768/40G POS.

# 40Gbps Supply Chain Established: Module



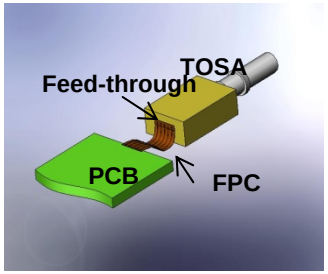

Courtesy: Opnext


Courtesy: Finisar

- 40Gbps optical modules commercially available from multiple suppliers.
- Modules based upon 300pin MSA:
  - 1st Generation larger size (5”x7”) shipping since 2004.
  - 2nd Generation smaller size & more robust controls & features.
- Multiple rates/protocols supported: OTU3/STM-256/OC-768/40G POS.

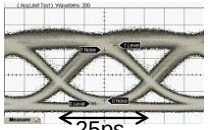
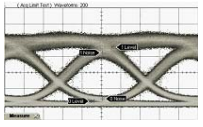
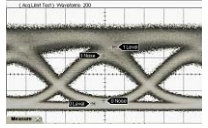
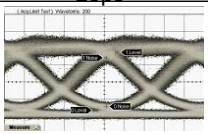
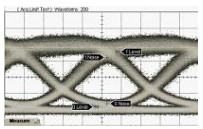
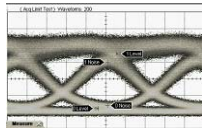
# New Technology on the Horizon

- Advanced Optics
  - Uncooled transmitter technology demonstrated.




Courtesy: Opnext

λ=1290 nm, Chip on Carrier, 43 Gbps, NRZ, $2^7$-1 PRBS

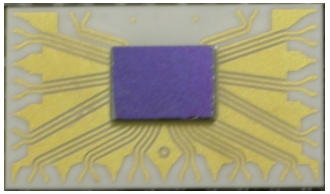
| $T_{LD}$ | 25ºC | 55ºC | 85ºC |
|---|---|---|---|
| DER | 7.47 dB | 8.68 dB | 9.09 dB |
| Pmod | 8.42 dBm | 7.69 dBm | 2.93 dBm |
| VOH | -1.8 V | -1.1 V | -0.3 V |
| BTB |  |  |  |
| 10-km SMF |  |  |  |



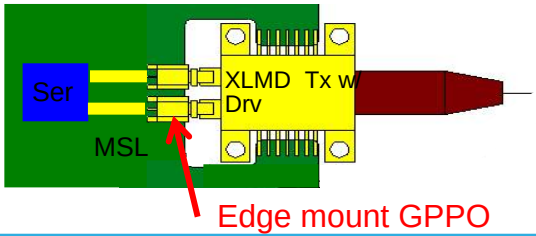
NRZ: Non Return to Zero, PRBS: Pseudo Random Bit Stream

200-Waveforms

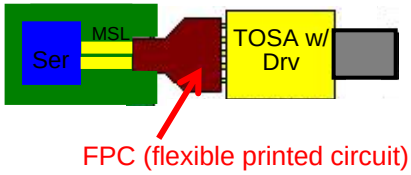
- Advances in Electronics
  - New lower power structures for Bi-CMOS.
  - High responsivity transimpedance amplifiers emerging.
  - Low cost yet high performance packaging.



**GPPO edge mount connectors**




**FPC interconnection**



# Summary

- Technical feasibility studies of a 40GbE SMF PMD have been presented and reviewed in previous IEEE P802.3ba work.
- 40Gb/s SMF optical budget established and demonstrated by deployed ITU-T G.693 VSR2000-3R2 links in carrier transport networks.
- 40Gb/s supply chains exist for:
  - optical Tx/Rx components;
  - analog and digital ICs;
  - OTU3/STM-256/OC-768/40G POS optical transponder modules.
- Industry advances in 40G optics and electronics technologies have been achieved and documented.
- CONCLUSION: 40GbE SMF PMD has been demonstrated and proven technically feasible.

# Proposed TF Response

- **Demonstrated system feasibility**
- **Proven technology, reasonable testing**
- **Confidence in reliability**

- The operation of an IEEE 802.3 MAC at 40Gb/s has been established by IEEE P802.3ba.
- The principle of building 40G optical PMDs has been proven both technically and operationally feasible by the deployment of ITU-T/SONET-based OTU3/STM-256/OC-768 optical transport interfaces in carrier networks.
- The technology to be utilized in the proposed project will rely on the work of previous IEEE 802.3 standards and activities as well as ITU-T Recommendations. The proposed 40G PMD is expected to leverage and extend available 40GBASE-R and ITU-T G.693 40G VSR technologies. It is recognized these relevant technologies have advanced since the inception of work on related standards.
- The reliability of Ethernet components and systems in the target environments can be projected with a high degree of confidence based on existing 40G deployment experience.