CIR
ENLIGHTENED ANALYSIS

400 Gbps MSAs in 2023

OFC 2018 – State of the Industry Analyst Panel

Lawrence Gasman

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Lawrence Gasman founded CIR, Inc. in 1978 and is acknowledged worldwide as an expert on telecommunications and data communications.

In addition to heading the CIR research team, Lawrence has carried out a wide range of consulting assignments for major equipment and components firms. He has also helped found two other industry analyst firms and has written numerous articles and books on advanced technology commercialization.

Lawrence holds a bachelor's degree in mathematics from the University of Manchester and advanced degrees from the London School of Economics and the London Business School

About CIR

- *CIR has been providing market analysis to the optical networking business since 1985. We bring our experience and long history to the latest wave of optical networking; networks operating up to the Terabit level and using the latest protocol suites such as 400 GigE, OTN, etc.*
- *CIR reports provide both qualitative appraisals of the latest optical technologies and quantitative analyses of their long-term revenue potential. Our analysis takes into consideration diverse factors such as network topology, financial results, real estate statistics, technology adoption patterns and pricing trends*
- *Companies rely on CIR reports and consulting services because the forecasts are credible, the coverage is balanced and the insights are rock-solid. Leaders of strategic planning, marketing, sales, engineering and finance groups make up CIR's user base. CIR also offers due diligence services to the financial community*

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- *Semtech Corp.*
- *Sony Corporation*
- *Sumitomo Electric Device Innovations USA*
- *TE Connectivity*
- *Volex*
- *Xilinx*
- *Zeiss Optical*

By 2023 400G Will be a Data Center Technology

- **A switch to data communications:** Telecom/enterprise markets have led early adoption of high data rates. Growth in cloud computing implies massive growth for hyperscale data centers, whose needs will now lead the 400G market in volume

- **100G in the data center ubiquitous:** Driver for 400G in data centers is widespread deployment of 100G connections. Rapid increase in machine-to-machine traffic due to server virtualization and SDNs. 2017 was the "hockey-stick" year for 100GigE –struggle to meet demand

- **Speed of deployment for 400G:** The first 400 G solutions are available. 400G deployment will speed up as component technology matures, especially in terms of density and low power.

400G Changes Components Industry by 2023

- **Need for telecom component technology in the data center:** 400G in data center interconnects (DCIs) changes module innovation and deployment

- **Changing technical requirements:** Need telecom technologies at high volumes and low costs. Telecom required environmental, reliability and longevity specs. 400G DCIs lower such specs. Focus is now on high density, low power consumption, lower cost per bit, and large-scale manufacturing capabilities

- **New economics:** Cost reduction include innovative module assembly, silicon photonics, smaller modules and reducing the number of lanes/wavelengths

- **Changing investment requirements:** With 400G we have an inflection point and need for substantial investment. Conventional wisdom says this will mean further consolidation, but the situation seems also to favor start-ups who promise low-cost per bit and innovative high-volume manufacturing.

Component by 2023: Modulation and Lasers

- **Higher-order modulation:** DSPs will support 400G and 600G with 64 QAM modulation. Next level of modulation provides four-level pulse amplitude modulation (PAM4) -- two bits per symbol, doubling data rate without doubling the bandwidth required compared to conventional NRZ.

- PAM4 components need greater linearity in the modulated laser source/ detector, higher extinction ratio, low relative intensity noise (RIN), greater output power, and higher responsivity

- **Lasers:** In moving from NRZ to PAM4, the variation of the DML drive current intensity leads to a lack of linearity, additional noise, and low extinction ratio. There are emerging DML technologies that promise better performance. Also new TOSA and ROSA designs are emerging that leverage the use of wafer-level integration in assembly, packaging, and testing, based on both silicon photonics and InP.

Evolution of Form Factors Until 2023

- The first 400G optical modules for use in data center and enterprise applications are becoming available in the CFP8 form factor. The next generation will use QSFP-DD or OSFP

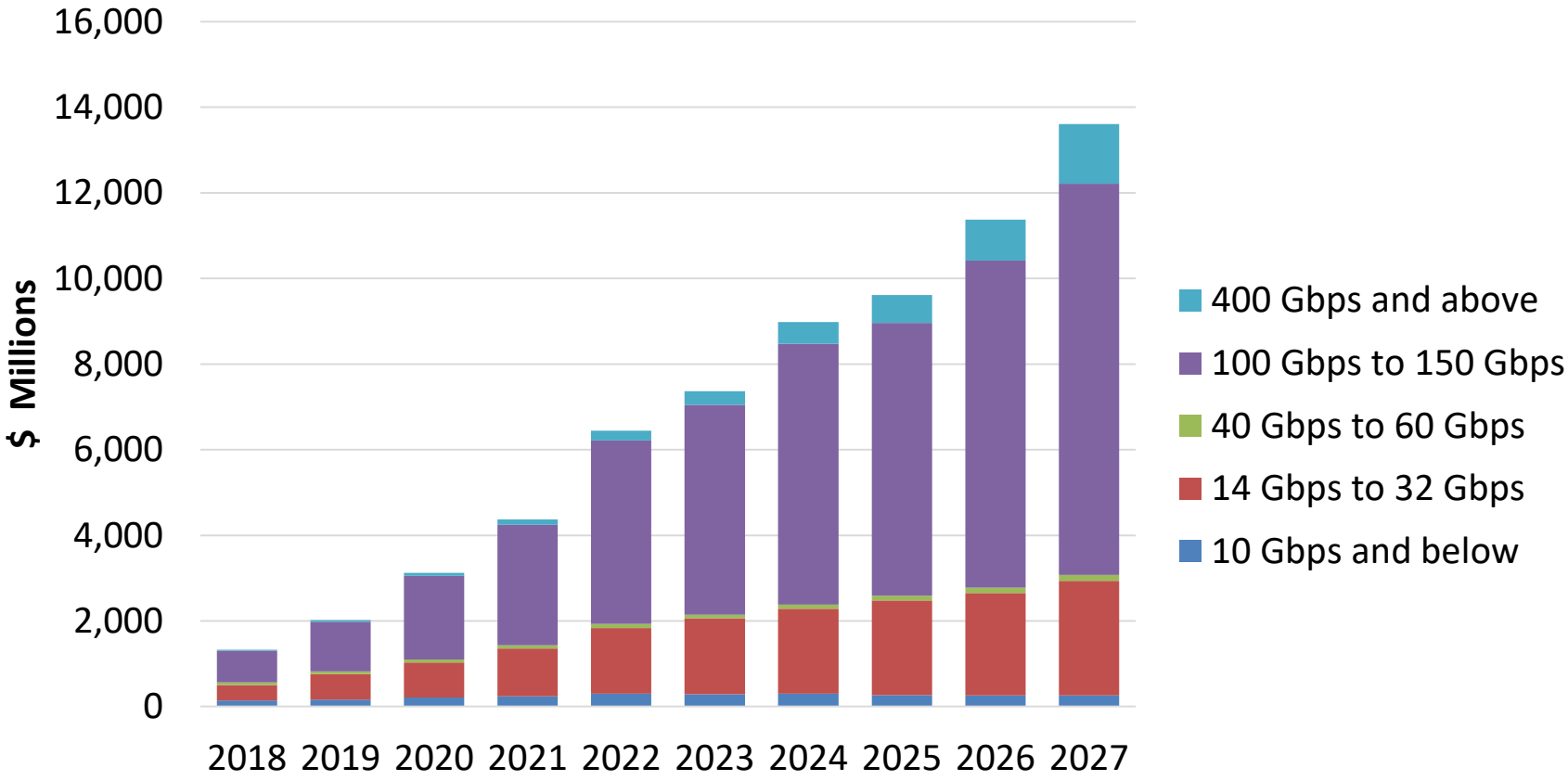
- 400G interfaces will evolve through two generations of SERDES technologies. First generation will be based on 50G lanes. What the industry is aiming is 100G SERDES, but these won't emerge until the 2020s

- QSFP-DD vs OSFP – looks like QSFP will be the standard option. OSFP is bigger 32 ports per 1U box faceplate are possible versus the 36 ports of QSFP-DD. QSFP-DD ready before the OSFP. But OSFP comes with that heat sink.

- AOCs will endure at 400 Gbps

- Will COBO really start at 400 Gbps?

Ten-Year Forecast of AOCs by Speed ($ Millions)

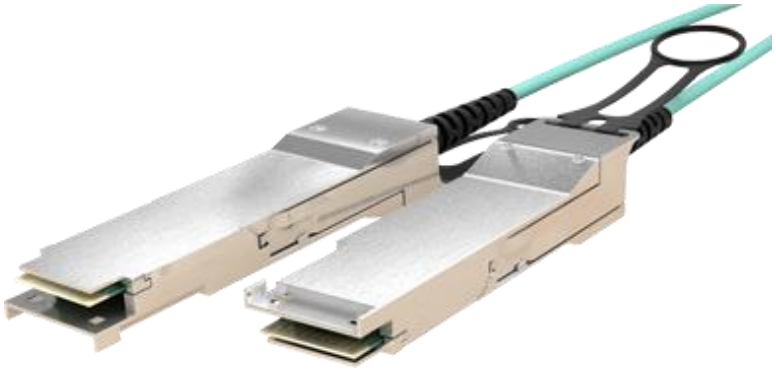


China : the Future of of 400G?

- Still plenty of Chinese companies that simply sell commodity products at low cost
- Beginning to match the West/Japan in terms of quality and marketing
- Many can now supply 100 G with ease and they may be the first with 400G AOCs

Related CIR Reports

- **Active Optical Cables: Markets and Opportunities, 2018-2027**
- **The Embedded Optics Market: COBO And Its Alternatives – 2017-2026**
- **A 400G market report in Q3**



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More details of reports
Robert Nolan
804-938-0030
rob@cir-inc.com

PO Box 4353
Charlottesville, VA 22905
434-872-9008
434-872-9014
www.cir-inc.com