MAKING CONNECTIONS

SEMICONDUCTOR TECHNOLOGY TAKES SILICON PHOTONICS TO THE NEXT LEVEL



hough silicon photonics research began in the late 1980s, it's only been since the early 2000s, and with help from Department of Defense small business contracts, that the field has come into its own.

Chumash Maxim / Shutterstoo

At the most basic level, silicon photonics is the manipulation of light within a silicon substrate. Through this process, using photons instead of electrons, data can be transferred between computer chips at the speed of light. This means that

information is carried as light pulses through optical fibers between microchips before being converted back into data, moving more information much faster than wires or electrical connections. Optical interconnects can even operate within the chips themselves.

As with any developing technology, the challenges as it has evolved have been numerous, stemming largely from the need to build microchips for high-volume

manufacturability even while maintaining superior performance and affordability.

According to a March, 2018, press release, "Luxtera, Inc. is the world leader in Silicon Photonics. It is the first company to overcome the complex technical obstacles involved with integrat-

ing high performance optics directly with silicon electronics on a mainstream CMOS chip, bringing direct 'fiber to the chip' connectivity to market." But how did a company grow from relatively humble beginnings to being the first business to ship millions of silicon photonics transceivers to the largest hyperscale data center

companies in the world? "Hard work and luck," was Vice President of Engineering Peter De Dobbelaere's answer.

In 2003, and in collaboration with the California Institute of Technology (Caltech), Luxtera received an Air Force Small Business Technology Transfer contract (STTR) to leverage semiconductor technology for the phoPhotos courtesy Luxtera



Between 2009 and 2011, Luxtera's products were primarily used in the Department of Defense.

tonics industry. Luxtera co-founders Alex Dickinson and Cary Gunn, and Director of Process Development Thierry Pinguet, worked on the initial research project together with Caltech research administrator Richard Seligman.

De Dobbelaere explained that the STTR contract was a small but influential investment in the company's early development of photonic integrated circuits, a technology wherein both high-speed electronics and photonics are implemented on the same chip. While this was a promising idea, it also complicated the process. Eventually, Luxtera separated the electronics and photonics components into separate chips, taking a hybrid

> approach to integration. The early technology was later redeveloped into the platform that Luxtera currently uses to generate photonic integrated circuits. Their work is now deployed in the world's most enormous hyperscale cloud-data centers.

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enable the initial stages of Luxtera's exploration into the vast technology space of optics integration in silicon. It led to some key learnings in Luxtera's early history, allowing the company to develop silicon photonics integration through several iterations and approaches," said Greg Young, CEO of Luxtera.

> The original intent of the Air Force STTR was to enable the exploration of semiconductor technology for photonics products, which allowed Luxtera to perform highly innovative research in this emerging field. The results helped shape Luxtera's early thinking. In turn, the general development of the technology led to the use of Luxtera's optical



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interconnects by the Department of Defense and the Department of Energy. Between 2009 and 2011 the product was mostly used within high performance computing (HPC) systems including military systems. The company was later able to commercialize the product for the civilian market, and now

provides the optical interconnects that link immense commercial server sets.

Aside from the hard work and luck cited by De Dobbelaere, the company credits various players with contributing to its enormous success. Luxtera began doing research in 2001, was supported in 2003 by this STTR, and heavily funded by the Defense Advanced Research Projects Agency (DARPA) until 2006. Receiving government funding allowed Luxtera to do the

vital, high-risk research behind their breakthrough technology. That early work was the proving ground that eventually led the industry to invest in scaling the technology into commercialization and volume production. Luxtera built its first commercial products in 2008, and



Peter De Dobbelaere



they are now intently focused on broadening the technology into a diverse line of products. De Dobbelaere mentioned the development of technology which allowed the optical interconnects to be manufactured and prototyped in-house as another key success factor. Luxtera now contracts out its manufacturing

Greg Young

due to high volume demands, but the ability to research, develop and manufacture all under one roof enabled the company to productize their technology.

"Communications links, or interconnects, are the biggest bottleneck in data center and communications networks. Large data centers and telecom operators experience this problem acutely at massive scale. Luxtera is changing this paradigm, making its impact on the market with critical, and cost-effective solutions for

> networks," Young explained. "We see a future where computing is fundamentally changed by light's ability to move data. Luxtera's story of photonic integration will continue, providing a path to direct optical connection between a large variety of critical computer networks."

Luxtera, Inc.

Modernization Priority: Microelectronics

Pasadena, CA • STTR contract: F49620-03-C-0072 • Agency: Air Force • Topic: AF02T017, Nanophotonic Integrated Circuits