

---

# PHOTONICS DATA & M&A THE FUNDAMENTALS

SEPTEMBER 2016 RESEARCH REPORT

MIKE POWELL, MANAGING PARTNER, RENEVO CAPITAL LIMITED

---

The logo for Renevo Capital Limited, featuring the letters 'RCL' in a large, white, sans-serif font, with 'RENEVO CAPITAL LIMITED' in a smaller, white, sans-serif font directly below it, all set against a solid blue square background.

RCL  
RENEVO CAPITAL LIMITED

# Key takeaways

## The story of Photonics

---

Narinda Kapany “the father of fiber optics” commenced his pioneering research in fiber optics at the Imperial College London, working with Harold Hopkins, an English physicist. In 1954 he demonstrated for the first time at its Department of Physics that light can travel in bent glass fibers.

It quickly became known what light could travel considerable distances in such fibers and transmit information. The age of fiber optic communications was born.

Today engineers and physicists are taught that photons (particles of light), unlike electrons, interact only weakly with matter, which gives rise to their ability to carry information long distances. Fortunately this is only partly true and it can be made possible for photons to interact strongly with certain types of matter and structures. This enables photons to be created, controlled and detected, which makes them ideal for use in communications systems.

Further developments in materials followed that culminated in the U.S. military using fiber optics for improved communications and tactical systems control with a fiber optic telephone link being installed by the U.S. Navy onboard the USS Little Rock in the early 1970’s, rapidly followed by further military system deployments. Encouraged by the success of these applications, military R&D programs were funded to develop longer fiber cables, and ruggedized, high-performance components resulting in numerous demonstration systems ranging from aircraft to undersea applications. At about the same time in 1969 ARPANET (the precursor to the internet) was brought into existence and merged with the rollout of the first commercial fiber communications systems. The modern internet was born and photonics cemented as a critical technology for the communications industry.

Materials, component and system development continued apace increasing the carrying capacity and functional capability of fiber communications which penetrated into many markets, especially high capacity markets, where transmission lengths were over a few hundred meters. In this time photonic components were manufactured in the tens of thousand a month, heavily dependent on manual

assembly spawning the Chinese fiber components industry. In 2001 the telecom boom turned to bust and the growth in fiber communications was dented. The low cost manufacturing base largely outsourced to China enabled companies to reduce prices and survive. However innovation continued albeit with less capital invested and often driven by university and quasi-governmental entities.

By 2007 strong gross margin was starting to return to the industry and developments meant that the race for increased transmission distance and carrying capacity had continued apace, as had the complexity of components, active and passive. Fiber networks were being becoming increasingly complex and had moved far beyond simple point to point links. They were also predominantly carrying data traffic rather than telecoms voice traffic. The worlds of datacom and telecom had merged.

Some of the most interesting developments in this period occurred in the area of integration of the multiple component types into wafers of semiconductor materials such that photonic components are now associated with communications lengths of 1000km down to 100um. The distinction between photonic components and electronic components is starting to blur typified by the large semiconductor and equipment companies acquiring what had previously been considered photonics components and modules companies.

While it is well documented that semiconductors are struggling to keep up with Moore’s law and the rate of data traffic and storage growth, the carrying capacity and capability of photonics appears to be keeping pace with these demands, with a resurgence of innovation coupled with value generation being demonstrated in the industry. This presages what promises to be a bright future for continued investment in the field and a strengthening M&A market.

# Index

---

1. Photonics in Communications Overview
2. Market overview
3. Photonic communications fundamentals
4. M&A drivers for photonics companies
5. Historical Photonic M&A transactions
6. Photonics Ecosystem
7. Key companies
8. RCL Contact details
9. Appendix I: Glossary of Photonics Terms (MAP)

---

# PHOTONICS IN COMMUNICATIONS

---



# Photonics in Communications Overview

## The story of Photonics

---

Narinda Kapany “the father of fiber optics” commenced his pioneering research in fiber optics at the Imperial College London, working with Harold Hopkins, an English physicist. In 1954 he demonstrated for the first time at its Department of Physics that light can travel in bent glass fibers.

It quickly became known what light could travel considerable distances in such fibers and transmit information. The age of fiber optic communications was born.

Today engineers and physicists are taught that photons (particles of light), unlike electrons, interact only weakly with matter, which gives rise to their ability to carry information long distances. Fortunately this is only partly true and it can be made possible for photons to interact strongly with certain types of matter and structures. This enables photons to be created, controlled and detected, which makes them ideal for use in communications systems.

Further developments in materials followed that culminated in the U.S. military using fiber optics for improved communications and tactical systems control with a fiber optic telephone link being installed by the U.S. Navy onboard the USS Little Rock in the early 1970’s, rapidly followed by further military system deployments. Encouraged by the success of these applications, military R&D programs were funded to develop longer fiber cables, and ruggedized, high-performance components resulting in numerous demonstration systems ranging from aircraft to undersea applications. At about the same time in 1969 ARPANET (the precursor to the internet) was brought into existence and merged with the rollout of the first commercial fiber communications systems. The modern internet was born and photonics cemented as a critical technology for the communications industry.

Materials, component and system development continued apace increasing the carrying capacity and functional capability of fiber communications which penetrated into many markets, especially high capacity markets, where transmission lengths were over a few hundred meters. In this time photonic components were manufactured in the tens of thousand a month, heavily dependent on manual

assembly spawning the Chinese fiber components industry. In 2001 the telecom boom turned to bust and the growth in fiber communications was dented. The low cost manufacturing base largely outsourced to China enabled companies to reduce prices and survive. However innovation continued albeit with less capital invested and often driven by university and quasi-governmental entities.

By 2007 strong gross margin was starting to return to the industry and developments meant that the race for increased transmission distance and carrying capacity had continued apace, as had the complexity of components, active and passive. Fiber networks were being becoming increasingly complex and had moved far beyond simple point to point links. They were also predominantly carrying data traffic rather than telecoms voice traffic. The worlds of datacom and telecom had merged.

Some of the most interesting developments in this period occurred in the area of integration of the multiple component types into wafers of semiconductor materials such that photonic components are now associated with communications lengths of 1000km down to 100um. The distinction between photonic components and electronic components is starting to blur typified by the large semiconductor and equipment companies acquiring what had previously been considered photonics components and modules companies.

While it is well documented that semiconductors are struggling to keep up with Moore’s law and the rate of data traffic and storage growth, the carrying capacity and capability of photonics appears to be keeping pace with these demands, with a resurgence of innovation coupled with value generation being demonstrated in the industry. This presages what promises to be a bright future for continued investment in the field and a strengthening M&A market.

---

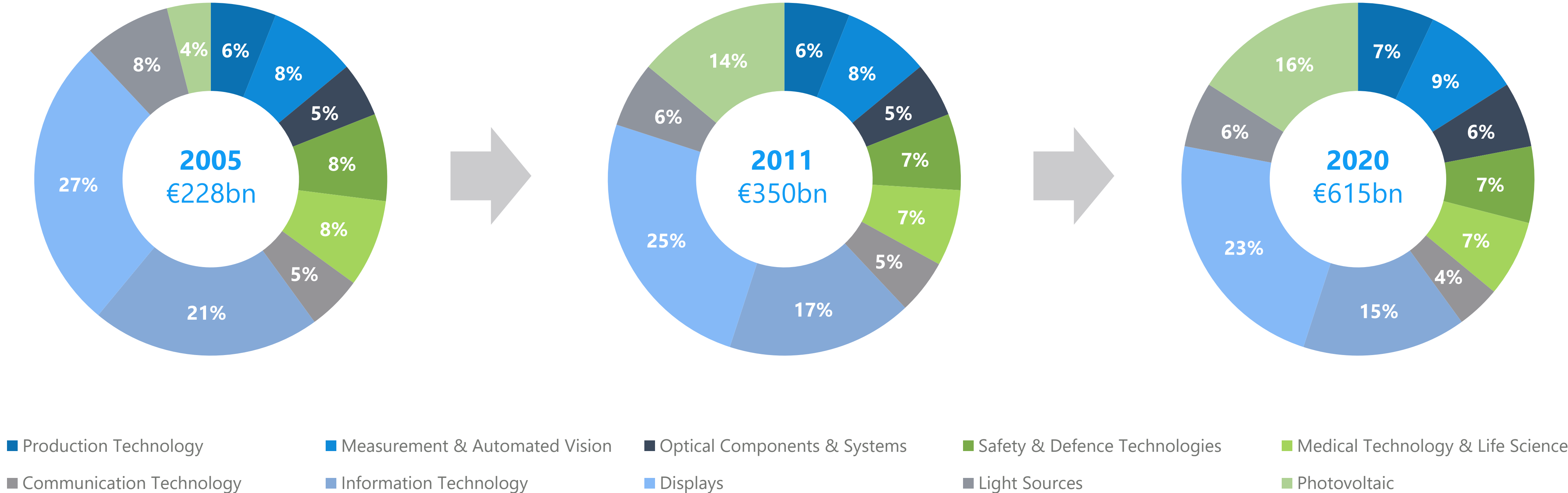
# MARKET OVERVIEW

---

# Photonics Market Wider Than Communications

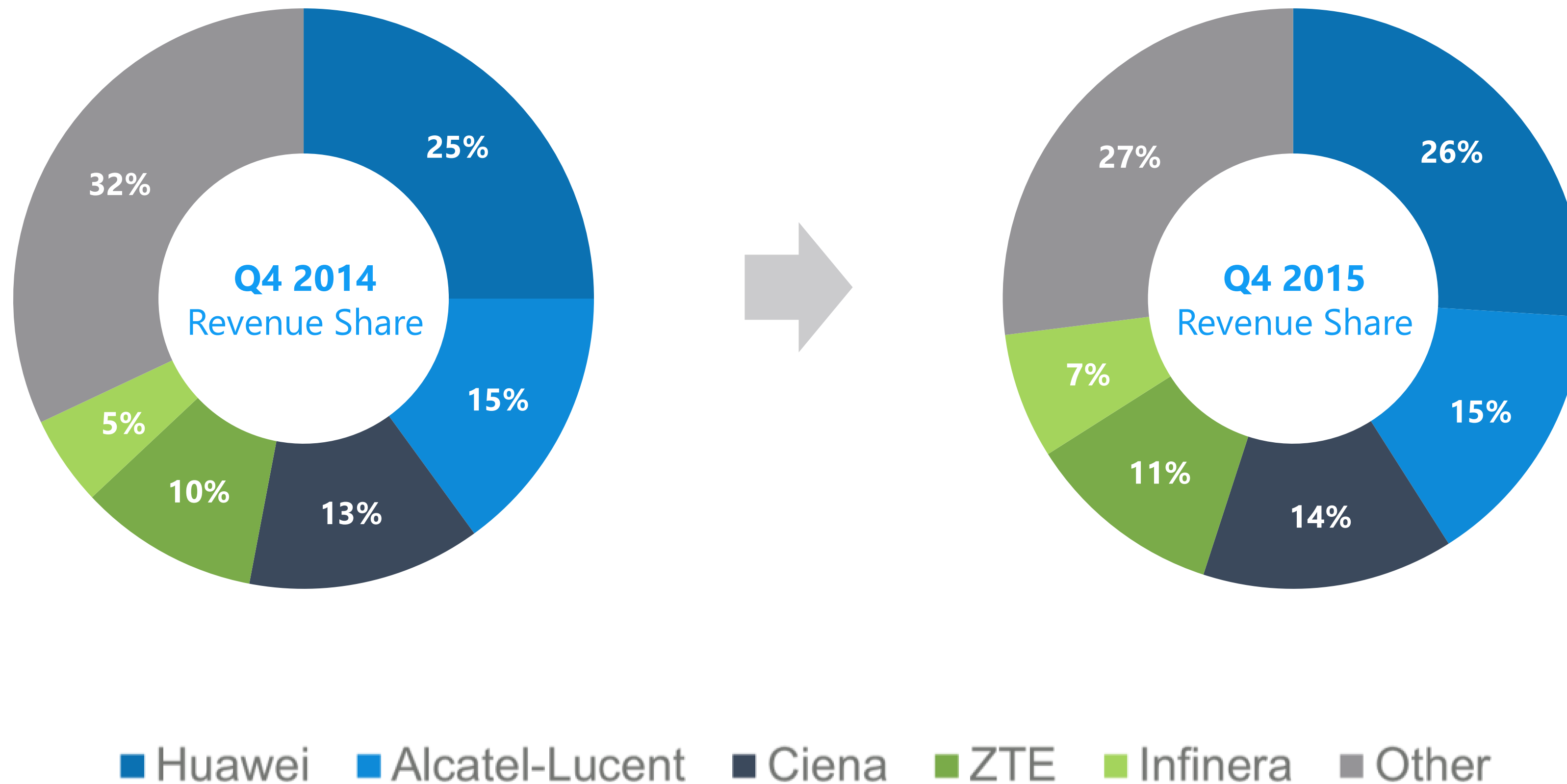
Total photonics market currently estimated at over **€350 billion per year**

- The entire photonics market is subject to regular, disruptive technological change.
- Disruptive changes are present in all sectors of the Photonics market and cross fertilise into other areas of the photonics market.
- The Communication Technology and Information Technology sub sectors are becoming increasingly difficult to differentiate
- The Photovoltaic sub sector has experienced the largest growth of all markets within Photonics and is expected to continue



# Photonics Market for Communications

The global optical network equipment market totalled [\\$12.5 billion in 2015<sup>1</sup>](#), remains dominated by 5 key players



<sup>1</sup>IHS Optical Network Hardware Market Tracker report Feb 2016



---

# PHOTONICS COMMUNICATIONS FUNDAMENTALS

---

# What is a Network?

Photonics communication is just one type of network

## Abstract Definition



A **LARGE SYSTEM** CONSISTING OF MANY **SIMILAR PARTS** THAT ARE **CONNECTED** TOGETHER TO **ALLOW MOVEMENT OR COMMUNICATION** BETWEEN OR ALONG THE PARTS, OR BETWEEN THE PARTS AND A CONTROL CENTRE

## More Specifically...

A data network is a network which allows computers to exchange data. In computer networks, networked computing devices exchange data with each other either directly, or indirectly through one or more network nodes. Network nodes are computer devices that originate, route and terminate the data. The connections between nodes are established using either cable media or wireless transmission media.

Data networks differ in the transmission medium used to carry their signals, the communications protocols to organize network traffic, the network's size, topology and organizational intent.

Data networks support an enormous number of applications such as access to the World Wide Web, video, digital audio, shared use of application and storage servers, printers, and fax machines, and use of email and instant messaging applications as well as many others. In most cases, application-specific communications protocols are layered (i.e. carried as payload) over other more general communications protocols.

*Its clear that the telecom and datacom networks of the world wide web are different aspects of the same thing. As such, it has become difficult to differentiate between communications and information technology photonics.*

# Photonic Presence in Comms Networks

Photonic communications technology is present throughout communications applications

## Long Haul

The initial volume market for photonics communications technology. For communication lengths >80Km it is the dominant technology. Typically point to point high capacity multi fiber, using coherent communication.

## Enterprise Wan

Comprised of a wide variety of photonics equipment & standards. Enterprise wans are increasingly virtual.

## Metro

Second main market for Fiber communications. Dominant technology for 2-80Km links. Typically point to point, usually WDM high capacity fibres arranged in communication rings.

## Mobile

Photonics is currently the dominant technology connecting wireless infrastructure. Wireless techniques are often mooted as potentially rivaling photonics but is yet to transpire.

## Datacenter

Has evolved into a separate market with its own unique requirements of very high capacity sub 2Km links with high levels of traffic switching required. Photonics is evolving into the dominant interconnect technology.

## Access

In some countries Photonics communications dominates this space through PON technology. In the developed world copper is dominant as operators try to sweat their legacy infrastructure.

## LAN

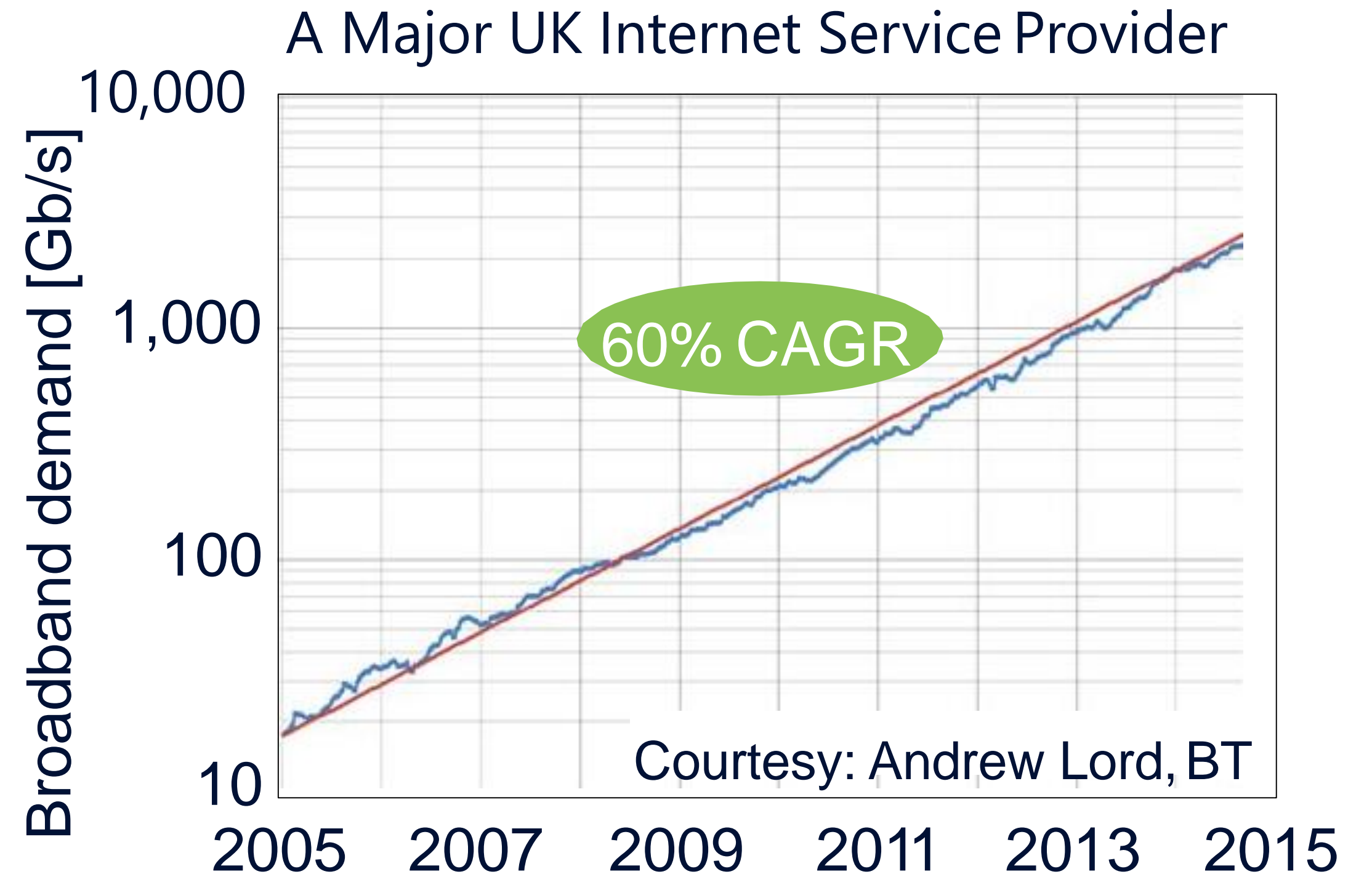
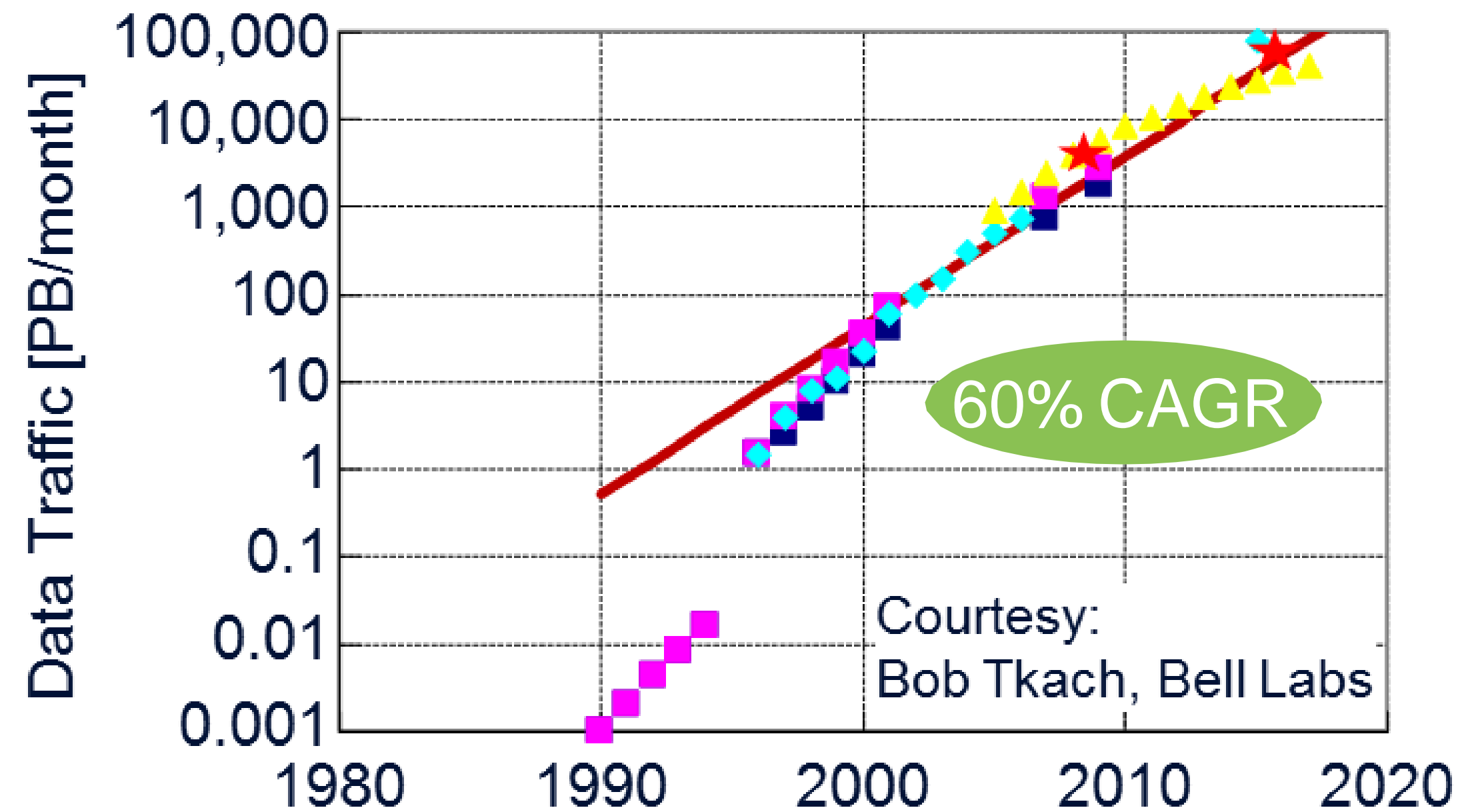
Multiple photonics implementation of the Ethernet standard vie with coaxial and wireless technology in this space.

## Chip Level

The requirements of compute and switch interconnect, especially in the datacenter has driven advances in photonics technology that make inter and intra chip photonics networking an optimal solution that is commercially emergent.

# The Fundamental Photonics Datacom Drivers

Photonics communications has its own version of Moore's Law - Seemingly endless demand for information is driving network traffic growth, stimulating the emergence of disruptive technology to satisfy this demand. Factors such as enforcement of net neutrality rules, increasing demand and generation of video content, plus the explosion in connected devices from the IoT suggests that this multi-decade trend will accelerate.



■ ■ MINTS – Minnesota Internet Traffic Study, <http://www.dtc.umn.edu/mints/home.php>

▲ Swanson-Gilder – “Estimating the Exaflood,” Jan. 2008.

★ Cisco Forecast – “Cisco Visual Networking Index, Forecast and Methodology,” 2013. IDC – “Worldwide Internet Broadband Bandwidth Demand 2012 – 2015 Forecast”

© Nokia2016

---

# PHOTONICS M&A DRIVERS

---



# M&A Trends and Drivers in Photonics

No single Photonics solution

---

## TRENDS

- Photonics is immature compared to Electronics
- It is still open to regular disruptive advances which tend to happen in smaller innovations groups
- Product run sizes are only just starting to break into the millions per year unlike electronics where multimillion run sizes are common.
- As a consequence the advantages of waferscale integration is only just starting to come to fruition.
- Photonics is still driven by esoteric knowledge. Limited groups of engineers combining, System knowledge, software, Photonic, electronics, RF, Mechanical, production engineering in a single cohesive team tackling a pressing market problem

## ADDITIONAL DRIVERS

- Drive to closed ecosystems.
- Vertical Integration
- Semiconductor companies combining with Photonic companies.
- Specialization of equipment companies
- Cloud
- Virtualization

*These attributes and forces suggest that Photonics M&A will increasingly be driven by larger companies acquiring innovation and mergers between larger entities as they verticalise in an attempt to great closed ecosystems.*

---

# PHOTONICS ECOSYSTEM

---

# Representative Photonics Ecosystem

## HARDWARE

## SOFTWARE

### NETWORK LAYER



### NETWORK EQUIPMENT



### MODULES/ COMPONENTS



### INNOVATION LAYER



### MATERIALS



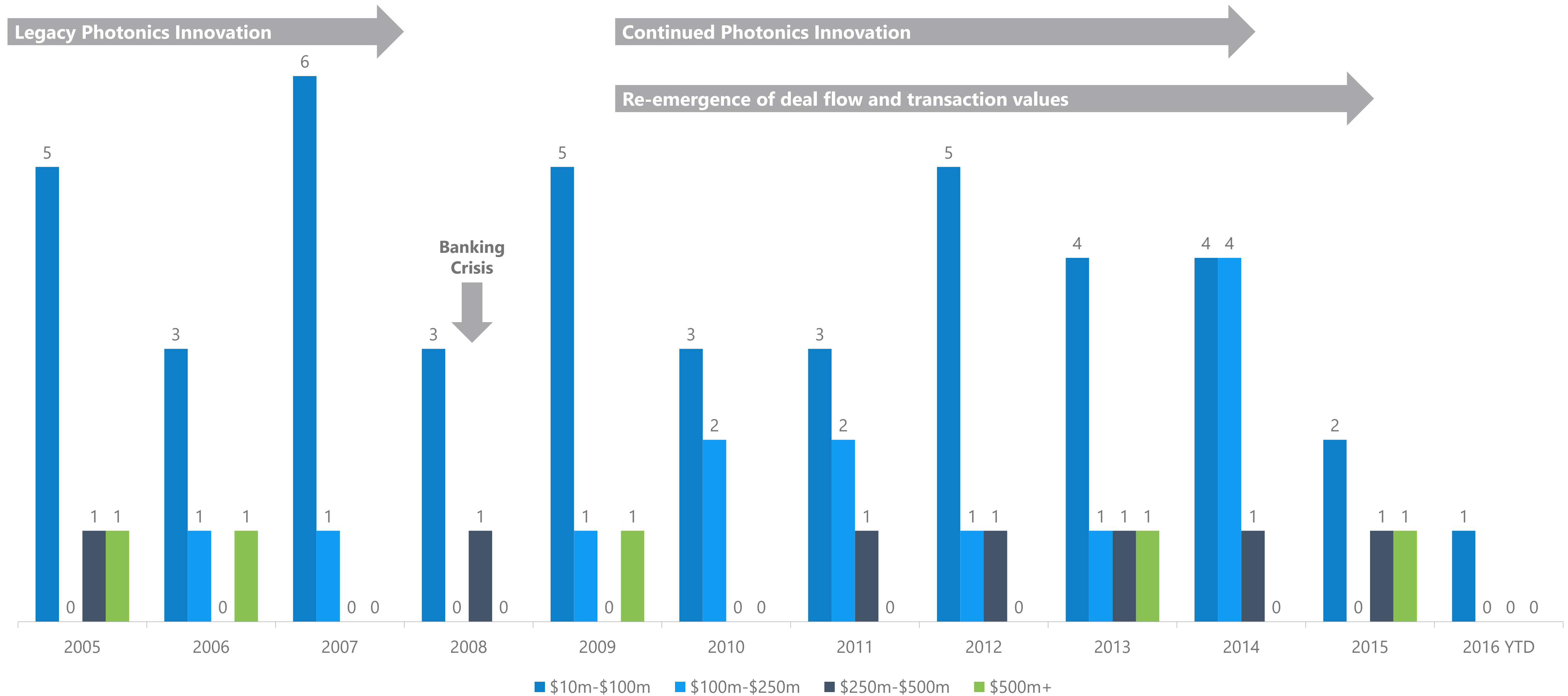
---

# HISTORIC PHOTONICS M&A TRANSACTIONS

---

# Photonics M&A Volume

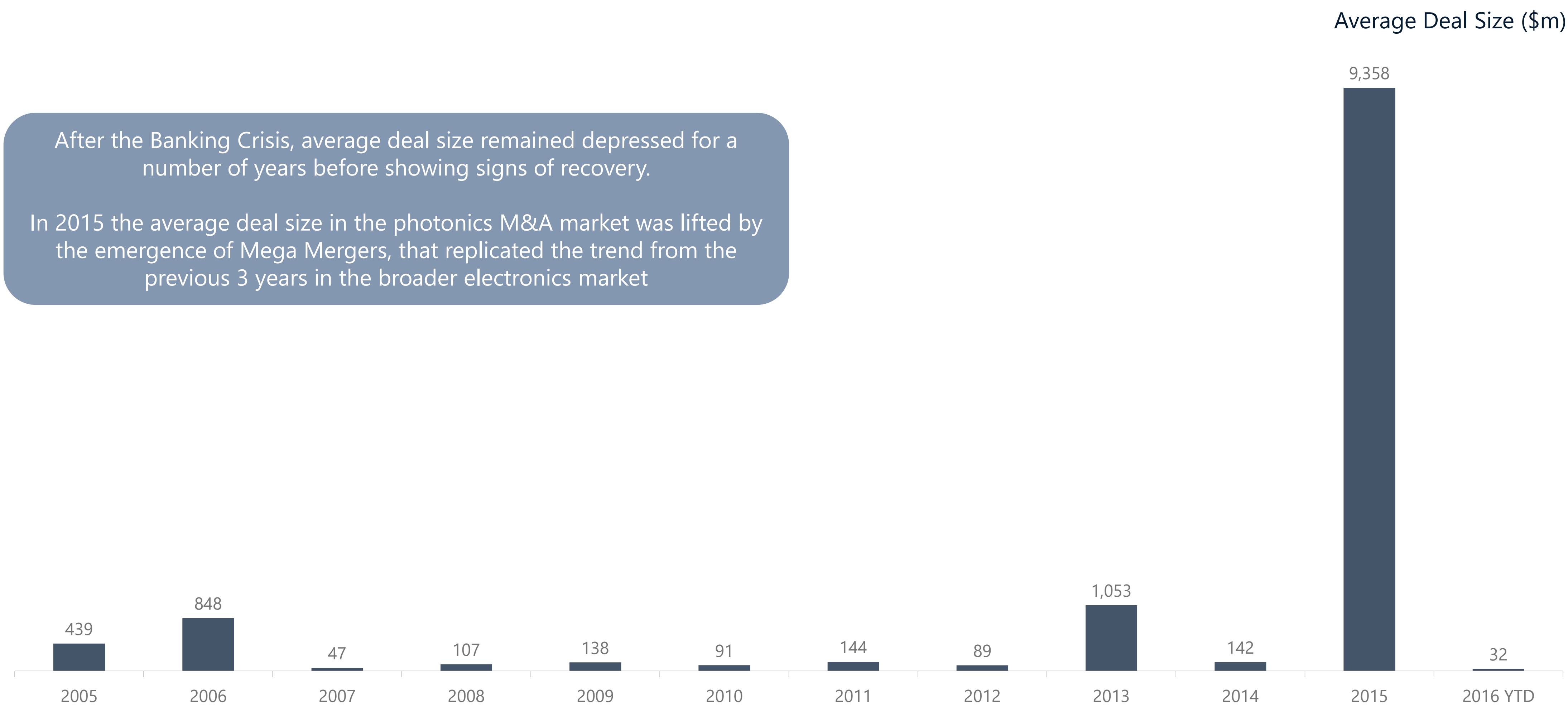
70 Photonics M&A Transactions totaling \$57Bn in the last 10 years





# Photonics M&A Average Deal Size

70 Photonics M&A Transactions in the last 10 years



After the Banking Crisis, average deal size remained depressed for a number of years before showing signs of recovery.

In 2015 the average deal size in the photonics M&A market was lifted by the emergence of Mega Mergers, that replicated the trend from the previous 3 years in the broader electronics market

# M&A Transaction Details

Page 1 of 4

Announced	Acquirer	Target	Target Description	Deal Size	EV/Rev	EV/EBITDA
22-Feb-05	Cisco Systems Inc.	Vihana, Inc.	Semiconductor design services	\$30.0m	n.a.	n.a.
07-Mar-05	GC Holdings, Inc [dba Gemfire Corporation]	Newport Opticom, Inc. (parallel switching assets)	Silica planar light circuits	\$10.0m	n.a.	n.a.
09-Mar-05	Advanced Photonix Inc.	Picotronix Inc. [dba Picometrix]	Optical receiver components	\$10.6m	3.0x	n.a.
14-Mar-05	Winbond Electronics Corporation	National Semiconductor Corporation (APC division)	I/O & embedded IC manufacturer	\$65.0m	n.a.	n.a.
11-May-05	CyOptics, Inc.	TriQuint (optoelectronics division)	Optical components & optical chips	\$32.0m	n.a.	n.a.
15-Aug-05	KKR/Silver Lake Partners	Agilent Technologies (semiconductor business)	Semiconductor component & test equipment	\$2,660.0m	1.3x	n.a.
23-Sep-05	Candover Investments plc	Thales Group (High Tech Optics)	Photonic components & military optics	\$268.7m	n.a.	n.a.
20-Jul-06	IQE plc	EMCORE Corporation (Electronic Materials & Device)	Semiconductor electronic components	\$16.0m	1.3x	160.0x
03-Aug-06	AppliedMicro Circuits Corporation	Quake Technologies, Inc.	Ethernet IC designer	\$69.0m	n.a.	n.a.
11-Sep-06	Cortina Systems Inc.	Intel Corporation (optical network components)	Optical network components business	\$115.0m	n.a.	n.a.
20-Sep-06	Essex Corporation	Adaptive Optics Associates, Inc	Optical component designer & manufacturer	\$40.3m	n.a.	n.a.
04-Dec-06	LSI Logic Corporation	Agere Systems, Inc.	Integrated circuit designer & manufacturer	\$4,000.0m	n.a.	33.6x
27-Feb-07	JDS Uniphase Corporation	Picolight, Inc	Optical network transceiver manufacturer	\$115.0m	n.a.	n.a.
05-Mar-07	GE Global Research	Avanex France S.A.	Fiber optic network enablement	\$20.0m	n.a.	n.a.
20-Mar-07	CyOptics, Inc.	Apogee Photonics, Inc.	Electroabsorption modulators & transmission lasers	\$0m	n.a.	n.a.
20-Mar-07	CyOptics, Inc.	Apogee Photonics, Inc.	Electroabsorption modulators & transmission lasers	\$0m	n.a.	n.a.
26-Mar-07	Finisar Corporation	AZNA, LLC	Optical transmitter systems manufacturer	\$19.7m	n.a.	n.a.
27-Mar-07	Optium Corp.	Kailight Photonics, Inc.	Optical communications network components	\$35.0m	n.a.	n.a.

# M&A Transaction Details

Page 2 of 4

Announced	Acquirer	Target	Target Description	Deal Size	EV/Rev	EV/EBITDA
02-Apr-07	Avago Technologies Ltd.	Infineon Technologies AG (Polymer Optical Fiber (POF))	Polymer optical fiber (POF)	\$22.5m	n.a.	n.a.
18-Apr-07	Silicon Motion Inc.	Future Communications IC, Inc	Telecom receiver & transmitter IC	\$90.0m	n.a.	n.a.
20-Dec-07	RF Micro Devices, Inc.	Filtronic plc (Filtronic compound semiconductors business)	Semiconductor foundry & wafer fabrication	\$25.2m	0.4x	n.a.
17-Jan-08	Enablence Technologies Inc [fka Pacific Northwest Partners Ltd]	ANDevices, Inc.	Optical components & semiconductor foundry	\$13.5m	n.a.	n.a.
27-Mar-08	GigOptix Inc. [fka iTerra Communications LLC]	Lumera Corporation	Electro-optic components manufacturer	\$43.8m	13.1x	n.a.
01-Jul-08	Dainippon Screen Mfg. Co., Ltd	Silicon Light Machines	Optical MEMs systems manufacturer	\$11.0m	n.a.	n.a.
10-Jul-08	GSI Group Inc.	Excel Technology, Inc.	Laser and optical systems	\$360.0m	2.2x	66.7x
27-Jan-09	Bookham Inc.	Avanex Corp.	Fiber optic network hardware	\$35.4m	0.2x	n.a.
03-Feb-09	PerkinElmer Inc.	Opto Technology Inc.	LED semiconductor component provider	\$21.0m	n.a.	n.a.
24-Apr-09	Tallwood Venture Capital	Ikanos Communications, Inc.	Fiber-optic network ICs provider	\$45.0m	0.4x	n.a.
04-Jun-09	General Dynamics Advanced Information Systems	Axsys Technologies, Inc.	Optical components & camera provider	\$643.0m	2.6x	13.1x
10-Nov-09	GigOptix Inc. [fka iTerra Communications LLC]	ChipX, Inc.	ASIC semiconductor designer & manufacturer	\$12.4m	0.5x	n.a.
11-Nov-09	Ignis ASA	GC Holdings, Inc [dba Gemfire Corporation]	Photonic IC & device developer	\$27.2m	n.a.	n.a.
18-Nov-09	Semtech Corporation	Sierra Monolithics Inc.	Communications semiconductor designer	\$180.0m	n.a.	n.a.
04-Jan-10	II-VI Incorporated	Photop Technologies	Photonic components provider	\$95.3m	n.a.	n.a.
03-Feb-10	Tangshan Caofeidian Investment Corporation	EMCORE Corporation (fiber optics business)	Semiconductor designer & manufacturer assets	\$27.8m	0.2x	n.a.
16-Sep-10	Calix	Occam Networks, Inc.	Ethernet switching systems provider	\$171.0m	2.0x	n.a.
26-Oct-10	Francisco Partners	Source Photonics Inc	Photonic components designer & manufacturer	\$146.0m	n.a.	n.a.

# M&A Transaction Details

Page 3 of 4

Announced	Acquirer	Target	Target Description	Deal Size	EV/Rev	EV/EBITDA
26-Nov-10	Ignis ASA	SmartOptics AS	Optical networking components provider	\$15.4m	1.4x	n.a.
22-Mar-11	Finisar Corporation	Ignis ASA	Norwegian optical components manufacturer	\$112.0m	n.a.	n.a.
06-Apr-11	Gennum Corporation	Nanotech Semiconductor Ltd	Fiber-optic communications semiconductor designer	\$34.0m	n.a.	n.a.
11-May-11	IDEX Corporation	CVI Melles Griot	Optical component & assembly provider	\$400.0m	2.2x	n.a.
08-Jul-11	Newport Corporation	Ophir Optronics Ltd	Photonic components provider	\$230.0m	2.1x	11.6x
29-Sep-11	NeoPhotonics Corporation	Santur Corporation	Photonic components provider	\$39.2m	n.a.	n.a.
13-Oct-11	Eurazeo	3S PHOTONICS [fka Alcatel Optronics]	French photonic components provider	\$50.4m	n.a.	n.a.
25-Jan-12	Huawei Technologies Co. Ltd.	CIP TECHNOLOGIES	Photonic components designer & manufacturer	\$0m	n.a.	n.a.
24-Feb-12	Cisco Systems Inc.	Lightwire, Inc. [fka SiOptical]	Photonic components provider	\$271.0m	n.a.	n.a.
02-Mar-12	DigitalOptics Corp	Vista Point Technologies (camera module manufacturing assets)	Optical components manufacturing assets	\$23.0m	n.a.	n.a.
06-Mar-12	Photronics, Inc.	Micron Technology, Inc. (nanoFab building)	Semiconductor manufacturing facility assets	\$35.0m	n.a.	n.a.
26-Mar-12	Oclaro [fka Bookham Inc.]	Opnext, Inc.	Optical components designer & manufacturer	\$180.0m	n.a.	n.a.
28-Mar-12	Sumitomo Electric Device Innovations USA Inc	EMCORE Corporation (VCSEL assets)	Photonic components provider assets	\$17.0m	n.a.	n.a.
01-Nov-12	II-VI Incorporated	M Cubed Technologies, Inc.	Optical components manufacturer	\$71.4m	n.a.	n.a.
26-Nov-12	II-VI Incorporated	Oclaro Inc [fka Bookham Inc.](thin film filter business and Interleaver	Optical component manufacturer assets	\$27.0m	n.a.	n.a.
22-Jan-13	NeoPhotonics Corporation	LAPIS Semiconductor Co Ltd (optical business unit)	Photonic components manufacturer assets	\$36.8m	n.a.	n.a.
11-Apr-13	Avago Technologies Ltd.	CyOptics, Inc.	Photonic components designer & manufacturer	\$400.0m	n.a.	n.a.
15-May-13	Mellanox Technologies Inc.	Kotura, Inc.	Photonic components designer & manufacturer	\$82.0m	n.a.	n.a.

# M&A Transaction Details

Page 4 of 4

Announced	Acquirer	Target	Target Description	Deal Size	EV/Rev	EV/EBITDA
04-Jun-13	Mellanox Technologies Inc.	IPtronics A/S	Danish optical interconnects designer	\$47.5m	n.a.	n.a.
09-Sep-13	Huawei Technologies Co. Ltd.	Caliopa	Silicon-based optical transceivers	\$0m	n.a.	n.a.
12-Sep-13	II-VI Incorporated	Oclaro [fka Bookham Inc.] (semiconductor laser business)	Switzerland-based semiconductor laser business	\$115.0m	n.a.	n.a.
10-Oct-13	II-VI Incorporated	Oclaro [fka Bookham Inc.] (amplifier and micro-optics)	Amplifier & micro-optics businesses division	\$88.6m	n.a.	n.a.
16-Dec-13	Avago Technologies Ltd.	LSI Corporation	Storage & networking semiconductor provider	\$6,600.0m	2.6x	23.5x
11-Jul-14	Vishay Intertechnology Inc.	Capella Microsystems Inc.	Optical IC design services	\$205.0m	n.a.	13.5x
30-Jul-14	Inphi Corporation [NYSE:IPHI]	Cortina Systems Inc. (assets)	Communications & networking semiconductor IP	\$126.0m	1.4x	n.a.
30-Jul-14	Cavium Inc. [fka Cavium Networks]	Xpliant	Semiconductor & ethernet switches designer	\$75.0m	n.a.	n.a.
06-Oct-14	MaxLinear Inc.	Physpeed Corporation	Ethernet integrated circuit provider	\$11.0m	n.a.	n.a.
18-Nov-14	M/A-COM Technology Solutions Inc. [aka MACOM]	BinOptics Corporation	Indium phosphide laser manufacturer	\$230.0m	11.9x	n.a.
19-Nov-14	Koch Industries	Oplink Communications Inc.	Optical networking components manufacturer	\$445.0m	n.a.	48.1x
02-Feb-15	Luna Innovations Inc.	Advanced Photonix Inc.	Optical semiconductor & sensor manufacturing	\$20.0m	n.a.	n.a.
28-May-15	Avago Technologies Ltd.	Broadcom Corporation	Networking & communications semiconductor designer	\$37,000.0m	n.a.	40.6x
14-Aug-15	Infinera Corporation [fka Zepton Networks]	Transmode AB [fka Transmode Systems AB]	Sweden-based optical networking infrastructure	\$350.6m	n.a.	19.5x
17-Nov-15	M/A-COM Technology Solutions Inc. [aka MACOM]	FiBest Limited [INTEGRAL Corporation]	Japanese optical networking components	\$60.0m	n.a.	n.a.
19-Jan-16	Ciena Corporation	TeraXion Inc. (high-speed photonics components assets)	Photonics components & IP assets	\$32.0m	n.a.	n.a.
<b>Mean</b>				<b>\$812.9m</b>	<b>2.7x</b>	<b>43.0x</b>
<b>Median</b>				<b>\$46.3m</b>	<b>1.7x</b>	<b>28.6x</b>








---

# KEY COMPANIES

---

# Key Photonics Companies






1 of 11

Company	Description	Size	Last Three Acquisitions
	Provides high-speed coherent interconnect products in the Americas, Europe, the Middle East, Africa, and the Asia Pacific region. Its products include a series of low-power coherent digital signal processors and silicon photonic integrated circuits integrated into families of optical interconnect modules with transmission speeds ranging from 40 to 400 gigabits per second for use in long-haul, metro, and inter-data centre markets. Founded in 2009 and is headquartered in Maynard, Massachusetts.	Mkt Cap: \$3.3B Cash: \$159M Debt: Nil LTM Revenue: \$335M	Total Acquisitions since January 2010: n.a.
	Engages in the retail sale of consumer products. It also offers cloud infrastructure services, such as compute, storage and content delivery, database, and networking services; platform services that include analytics, enterprise applications, mobile services, and Internet of Things; and developer tools, management tools, security and identity services, and application services. Founded in 1994 and headquartered in Seattle, Washington.	Mkt Cap: \$395.4B Cash: \$16.5B Debt: \$17.9B LTM Revenue: \$120.6B	Total Acquisitions since January 2010: 37 Jul-2016: Cloud9, a provider of open source cloud-based IDE SaaS Apr-2016: Orbeus, a provider of AI-enabled image recognition SaaS Feb-2016: EMVANTAGE Payments, a provider of online payments processing
	Manufactures fibre-optic networking products primarily for Internet data centre, cable television (CATV), and fibre-to-the-home (FTTH) networking end-markets. It offers optical modules, optical transceivers, lasers, transmitters, and turn-key equipment, as well as headend, node, and distribution equipment. Founded in 1997 and headquartered in Sugar Land, Texas	Mkt Cap: \$367M Cash: \$42M Debt: \$87M LTM Revenue: \$216M	Total Acquisitions since January 2010: n.a.
	Manufactures and markets mobile communication and media devices, personal computers, and portable digital music players to consumers, small and mid-sized businesses, education, and enterprise and government customers. The company also sells related software, services, accessories, networking solutions, and third-party digital content and applications. Apple was founded in 1977 and headquartered in Cupertino, California.	Mkt Cap: \$632.3B Cash: \$62.6B Debt: \$84.9B LTM Revenue: \$220.3B	Total Acquisitions since January 2010: 55 Sep-2016: Tuplejump Software, a provider of big data analytics machine learning software Aug-2016: Glimpse, a provider of electronic health record management SaaS Aug-2016: Turi, a provider of open source, machine learning software, for \$200M
	Offers silicon solutions for next-generation cloud infrastructure and data centres; and connectivity products for edge, metro, and long haul communications equipment in the United States and internationally. The company offers X-Gen family of server processors based on the ARMv8 64-bit instruction set architecture (ISA), which targets mainstream cloud and data centre infrastructure, including hyper scale, telco, enterprise, and high performance computing. Founded in 1979 and headquartered in Santa Clara, California	Mkt Cap: \$547M Cash: \$82M Debt: Nil LTM Revenue: \$163M	Total Acquisitions since January 2010: 1 Aug-2010: Acquired TPACK, a provider of silicon ICs that provide data transport and switching functions, for \$37M

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies






2 of 11

Company	Description	Size	Last Three Acquisitions
	Aria Networks offers a predictive real-time Capacity Optimisation and Management product for SDN and NFV solutions	Privately owned Raised \$9M to date	Total Acquisitions since January 2010: n.a.
	Ascom Holding AG, through its subsidiaries, provides communication solutions worldwide. The company operates in two divisions, Wireless Solutions and Security Solutions.	Mkt Cap: \$620M Cash: \$34M Debt: \$26M LTM Revenue: \$393M	Total Acquisitions since January 2010: 1  Dec-2015: Acquired UMS, a company for the development of medical software systems
	Designs and develops programmable network switch silicon, systems and software. The Company is backed by Andreessen Horowitz, Lightspeed Venture Partners and Sequoia Capital. Founded in 2013 and headquartered in Palo Alto, California.	Privately owned Raised \$132M to date	Total Acquisitions since January 2010: n.a.
	Develops and supplies a range of analog and digital semiconductor connectivity solutions. Its product portfolio comprises broadband access and modems, enterprise and network processors, wireless infrastructure, wireless connectivity, Ethernet communication and switching, and set-top box and media processors. Founded in 2005 and headquartered in Irvine, California.	Mkt Cap: \$67.7B Cash: \$2.0B Debt: \$13.7B LTM Revenue: \$10.9B	Total Acquisitions since January 2010: 5  May-2016: MagnaCom, a developer of modulation technology Dec-2015: DensBits, a developer of NAND flash-based storage system technologies, for \$20M May-2015: \$37.0B merger with Avago
	Canonical is a computer software company that markets commercial support and related services for Ubuntu and related projects.	Privately owned	Total Acquisitions since January 2010: n.a.

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies

3 of 11






Company	Description	Size	Last Three Acquisitions
	Provides equipment, software, and services that support the transport, switching, aggregation, service delivery, and management of voice, video, and data traffic on communications networks worldwide. The company's Converged Packet Optical segment offers networking solutions optimized for the convergence of coherent optical transport, OTN switching, and packet switching. Founded in 1992 and headquartered in Hanover, Maryland.	Mkt Cap: \$2.9B Cash: \$1.2B Debt: \$1.5B LTM Revenue: \$2.6B	Total Acquisitions since January 2010: 2  Jan-2016: TeraXion, the high speed photonics components assets, for \$32M May-2015: Cyan, a provider of SDN and delivery systems, for \$400M
	Manufactures and sells Internet Protocol based networking and products related to the communications and information technology industry. It provides switching products, including fixed-configuration and modular switches, and storage products that provide connectivity to end users, workstations, IP phones, wireless access points, and servers; and next-generation network routing products that interconnect public and private wireline and mobile networks for mobile, data, voice, and video applications. Founded in 1984 and is based in San Jose, California.	Mkt Cap: \$152.1B Cash: \$65.8B Debt: \$28.6B LTM Revenue: \$49.2B	Total Acquisitions since January 2010: 56  Aug-2016: ContainerX, a provider of Docker-based application container management software Jun-2016: CloudLock, a provider of access control and compliance SaaS, for \$293M Mar-2016: Synata, a provider of enterprise cloud search SaaS
	ClariPhy Communications, Inc., a fabless semiconductor company, develops mixed-signal CMOS integrated circuits for optical networking and communication applications. It offers CL1011, a XAUI-based Ethernet transceiver for enterprise networks and datacenters; and CL1012, a clock and data recovery integrated circuit for metro and long haul telecom networks.	Privately owned Raised \$92M to date	Total Acquisitions since January 2010: n.a.
	ClearPath Networks provides software-defined technologies to service providers that differentiate their connectivity propositions and end-customers experience.	Privately owned	Total Acquisitions since January 2010: n.a.
	Develops integrated optical components and sub-systems for networking and communication applications in the United States and China. It offers transceivers for 100GBASE Ethernet links, data centre interconnections, 100GE enterprise switches and routers, carrier grade 100GE core routers, point-to-point and ring applications, 40GBASE Ethernet links, QDR/DDR Infiniband links, and other applications. Founded in 2001 and headquartered in Yokneam, Israel.	Privately owned Raised \$85M to date	Total Acquisitions since January 2010: n.a.

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available



# Key Photonics Companies

4 of 11






Company	Description	Size	Last Three Acquisitions
	Manufactures silicon chips for networking devices. The company's carrier-grade routers are a new breed of scale-out routers, enabling SDN-based, simplified architectures in service provider networks. Founded in 2006 and headquartered in Netanya, Israel.	Privately owned Raised \$177M to date	Total Acquisitions since January 2010: n.a.
	d-tech Corporation provides IT related data storage expertise, application availability via in-depth clustering knowledge and disaster recovery solutions. It offers consultation and provision of hardware and software addressing every aspect of complex IT environments. The company was founded in 1998 and is headquartered in Dallas, Texas.	Privately owned	Total Acquisitions since January 2010: n.a.
	EFFECT Photonics B.V. is spin out from the Technical University of Eindhoven (TU/e) and is a leader in the in the design and development of optical components using multichannel Photonic Integrated Circuits (PICs) in Indium Phosphide for mobile networks and datacentres. Headquartered in Eindhoven, The Netherlands, the birthplace of Philips, with additional R&D in South West UK and sales partners worldwide.	Privately owned	Total Acquisitions since January 2010: n.a.
	Operates as a mobile application and Website that enables people to connect, share, discover, and communicate each other on mobile devices and personal computers worldwide. Its solutions include Instagram, a mobile application that enables people to take photos or videos, customise them with filter effects, and share them with friends in a photo feed or send them directly to friends; Messenger, a messaging application for mobile and Web on various platforms and devices. Founded in 2004 and headquartered in Menlo Park, California.	Mkt Cap: \$370.6B Cash: \$23.9B Debt: Nil LTM Revenue: \$22.1B	Total Acquisitions since January 2010: 72  Sep-2016: Nascent Objects, a provider of modular electronic 3D printing software May-2016: Two Big Ears, a provider of virtual reality audio software Mar-2016: Masquerade Technologies, a video selfie animation app
	Provides optical subsystems and components for data communication and telecommunication applications. Its optical subsystems primarily consist of transmitters, receivers, transceivers, transponders, and active optical cables that provide the fundamental optical-electrical or optoelectronic interface for interconnecting the electronic equipment used in communication networks. Founded in 1987 and headquartered in Sunnyvale, California.	Mkt Cap: \$3.3B Cash: \$594M Debt: \$232M LTM Revenue: \$1.3B	Total Acquisitions since January 2010: 7  Sep-2014: LightSmyth, a provider of polarization-insensitive transmission gratings Jan-2014: U2t Photonics, a manufacturer of optoelectronic and ultra-high speed optical components, for \$27M Jul-2013: RED-C, a manufacturer of erbium doped fibre amplification solutions, for \$24M

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available



# Key Photonics Companies






5 of 11

Company	Description	Size	Last Three Acquisitions
	Manufactures Mg/Al casing and mechanic parts, thermal modules, and consumer electronic products. The company's products and solutions include system assembly of 3C products, mechanical design, processing, and sales. It offers thermal modules for O/T, NB, server, and other 3C products. The company's Mg and alloy products include portable computer enclosures, mobile phone enclosures, and 3C product enclosures. Founded in 1979 and is headquartered in New Taipei City, Taiwan.	Mkt Cap: \$4.1B Cash: \$2.6B Debt: \$204M LTM Revenue: \$2.8B	Total Acquisitions since January 2010: n.a.
	Designs and manufactures semiconductors for the technology sector. It offers direct and indirect supplementary, post-wafer-manufacturing, prototyping, mask, APM framework, supply chain management, and turnkey services. The lead investor is Mubadala Technology. Founded in 2009 and headquartered in Santa Clara, California	Privately owned	Total Acquisitions since January 2010: 1  Oct-2014: IBM Microelectronics Business, which comprises IP and technologies
	Go!Foton Corporation engages in designing, processing, producing, distributing, and selling optical components for communications, imaging and scanning, biotechnology/medical, industrial, and fiber optic and photonic instrumentation markets in the United States and internationally. The company was incorporated in 1980 and is based in Somerset, New Jersey with regional sales offices in San Jose, California; and Hoogerheide, the Netherlands.	Privately owned	Total Acquisitions since January 2010: n.a.
	Provides online advertising services and operates through Google and other bets segments. The Google segment includes principal Internet products, such as Search, Ads, Commerce, Maps, YouTube, Apps, Cloud, Android, Chrome, and Google Play, as well as technical infrastructure and newer efforts, such as Virtual Reality. It also sells hardware products comprising Chromecast, Chromebooks, and Nexus. Founded in 1998 and is based in Mountain View, California.	Mkt Cap: \$549.1B Cash: \$76.9B Debt: \$6.3B LTM Revenue: \$81.8B	Total Acquisitions since January 2010: 162  Oct-2016: FameBit, an online YouTube video advertisement service Sep-2016: Speakit, a speech recognition API Sep-2016: Urban Engines, a provider of mapping, analytics and visualisation software
	Provides IT infrastructure services, such as IT outsourcing, integrated technology, cloud, and technology support services. Its Systems Hardware segment offers infrastructure technologies, such as servers for businesses, organizations, and technical computing applications; and data storage products and solutions. IBM was founded in 1910 and is based in Armonk, New York.	Mkt Cap: \$147.5B Cash: \$10.6B Debt: \$44.5B LTM Revenue: \$80.3B	Total Acquisitions since January 2010: 73  Jun-2016: Ez Legacy, a provider of enterprise application management software Mar-2016: Bluewolf, offers Salesforce cloud integration, for \$240M Mar-2016: Optevia, a CRM SaaS integrator

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies






6 of 11

Company	Description	Size	Last Three Acquisitions
 <b>Infinera</b>	Provides optical transport networking equipment, software, and services. The company offers Infinera DTN-X family of platforms for subsea, long-haul, regional, and metro mesh networks; Infinera DTN platform for subsea, long-haul, and regional mesh networks that support a range of Ethernet and optical transport network client interfaces; and Infinera FlexILS Line System platform that connects various Infinera platforms over long distance fibre optic cable. Founded in 2000 and headquartered in Sunnyvale, California.	Mkt Cap: \$1.3B Cash: \$258M Debt: \$128M LTM Revenue: \$996M	Total Acquisitions since January 2010: 1  Apr-2015: Transmode, a provider of packet-optical networking solutions, for \$351M
 <b>INNO LIGHT</b>	Designs, builds, and markets high-end optical transceivers. The company offers 10G solutions, including SFP+ Ethernet, SFP+ SONET, SFP+ xWDM, XFP xWDM, and XFP solutions; and 40G solutions, including QSFP+ solutions. InnoLight Technology offers its products for customers in areas, such as cloud computing, data centres, data communication, and long-distance transmission. Founded in 2008 and headquartered in Suzhou, China.	Privately owned Raised \$39M to date LTM Revenue: \$152M	Total Acquisitions since January 2010: n.a.  Sep-2016: Acquired by Shandong Zhongji Electrical Equipment for \$420M
 <b>Innovium</b>	Develops and deploys semiconductor solutions for data centres in the United States and internationally. It offers networking infrastructure solutions, such as laser-focused semiconductor solutions to meet the critical needs of customers. The company was incorporated in 2014 and is based in San Jose, California	Privately owned Raised \$50M to date	Total Acquisitions since January 2010: n.a.
 <b>Inphi</b>	Provides high-speed analog and mixed signal semiconductor solutions for the communications, datacenter, and computing markets worldwide. Founded in 2000 and headquartered in Santa Clara, California.	Mkt Cap: \$1.6B Cash: \$328M Debt: \$177M LTM Revenue: \$269M	Total Acquisitions since January 2010: 2  Jul-2014: Cortina Systems, the communications and networking semiconductor IP assets, for \$126M Jun-2010: Winyatek Technology, a provider of disk controllers
 <b>intel</b>	Manufactures and sells integrated digital technology platforms. The company's platforms are used in various computing applications comprising notebooks, 2 in 1 systems, desktops, servers, tablets, smartphones, wireless and wired connectivity products. It offers microprocessors that process system data and control other devices in the system; chipsets, which send data between the microprocessor and input, display, and storage devices. Intel was founded in 1968 and is based in Santa Clara, California.	Mkt Cap: \$175.7B Cash: \$17.9B Debt: \$28.9B LTM Revenue: \$56.6B	Total Acquisitions since January 2010: 65  Sep 2016: Soft Machines, a developer of architecture-based microprocessors and system-on-chip products, for \$270M Sep-2016: Movidius, a provider of mobile image processing semiconductors Aug-2016: Nervana Systems, a provider of deep learning SaaS and processors, for \$400m

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies

7 of 11






Company	Description	Size	Last Three Acquisitions
	<p>Offers various routing products, including ACX series universal access routers to deploy new high-bandwidth services; MX series Ethernet routers that functions as a universal edge platform; M series edge routers; PTX series packet transport routers; T series routers; and NorthStar controllers. The company also provides various switching products comprising EX series Ethernet switches to address the access, aggregation, and core layer switching requirements of micro branch, branch office, and campus and data centre environments. Founded in 1996 and is based in Sunnyvale, California.</p>	<p>Mkt Cap: \$9.0B Cash: \$2.3B Debt: \$2.1B LTM Revenue: \$4.9B</p>	<p>Total Acquisitions since January 2010: 12  Aug-2016: Aurrion, a provider of silicon photonics systems Jan-2016: BTI Systems, a provider of network infrastructure software, for \$65M Dec-2013: WANDL, a provider of network modelling and simulation software</p>
	<p>Develops and manufactures optical components for telecom, datacom, and optical storage industries. Its products include QSFP TOSA/ROSA, DWDM CFP, and custom photonic integrated circuits for various applications ranging from parallel transceivers to coherent TXs and RXs. The company was founded in 2009 and is based in Newark, California.</p>	<p>Privately owned Raised \$72M to date</p>	<p>Total Acquisitions since January 2010: 1  Mar-2013: GC Holdings, a manufacturer of integrated optic platforms and polymers</p>
	<p>KOTURA, Inc. provides silicon photonics, designs, manufactures and markets CMOS optical components that enable optics to migrate throughout the communications industry. They also provide custom chip design, fabrication, and packaging services.</p>	<p>Privately owned Raised \$39M to date</p>	<p>Total Acquisitions since January 2010: n.a.</p>
	<p>Operates as a development stage, electro-optical device and organic nonlinear materials company. It develops organic application specific electro-optic polymers and organic non-linear all-optical polymers that have high electro-optic and optical activity. The company intends to sell its products to electro-optic device manufacturers. Founded in 1991 and headquartered in Longmont, Colorado.</p>	<p>Mkt Cap: \$43M Cash: \$2M Debt: Nil LTM Revenue: \$43M</p>	<p>Total Acquisitions since January 2010: n.a.</p>
	<p>Manufactures and sells optical and photonic products through its two business segments, optical communications and commercial lasers. The Optical Communications segment offers components, modules, and subsystems that enable the transmission and transport of video, audio, and text data over high-capacity fibre optic cables. The Commercial Lasers segment offers diode, direct-diode, diode-pumped solid-state, fibre, and gas lasers. Lumentum is headquartered in Milptas, California.</p>	<p>Mkt Cap: \$2.5B Cash: \$157M Debt: Nil LTM Revenue: \$903M</p>	<p>Total Acquisitions since January 2010: n.a.  Aug-215: spun out from JDS Uniphase</p>

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available



# Key Photonics Companies






8 of 11

Company	Description	Size	Last Three Acquisitions
	A fabless semiconductor company that designs and builds front panel and embedded optical modules based on its silicon photonics technology for use in network, server, and mobile infrastructure markets. Its product include LUX62608 OptoPHYs, which are 200G (8x26G) embedded optical modules that offer the flexibility of field replaceable and pluggable optical transceivers by interfacing to systems via a 100-pin small form factor connector. Founded in 2001 and is based in Carlsbad, California.	Privately owned Raised \$91M to date	Total Acquisitions since January 2010: n.a.
	Manufactures, and markets analog RF, microwave, millimeter wave, and photonic semiconductor products. The company offers a portfolio of standard and custom devices, which include integrated circuits, multi-chip modules, power pallets and transistors, diodes, amplifiers, switches and switch limiters, passive and active components, optoelectronic and photonic semiconductors. It was founded in 2009 and based in Lowell, Massachusetts.	Mkt Cap: \$2.1B Cash: \$91M Debt: \$345M LTM Revenue: \$504M	Total Acquisitions since January 2010: 3 Dec-2015: Aeroflex, acquired the diode assets, for \$38M Nov-2015: FiBest, a manufacturer of optical networking components, for \$60M Nov-2013: Mindspeed Technologies, a networking semiconductor designer
	A fabless semiconductor company that designs, manufactures, and sells interconnect products and solutions. The company's products are used for computing, storage, and communications applications in the high-performance computing, Web 2.0, storage, financial services, enterprise data centre, and cloud markets. Its products facilitate data transmission between servers, storage systems, communications infrastructure equipment, and other embedded systems. Founded in 1999 and headquartered in Yokneam, Israel.	Mkt Cap: \$2.0B Cash: \$277M Debt: \$268M LTM Revenue: \$760M	Total Acquisitions since January 2010: 5 Sep-2015: EZchip Semiconductor, a designer of ethernet network processors, for \$811M Jun-2014: Integrity Project, a provider of embedded software and driver development Jun-2013: Iptronics, an optical interconnects designer, for \$48M
	Develops, licenses, and supports software products, services, and devices worldwide. The company's Productivity and Business Processes segment offers Office 365 commercial products and services for businesses, including Office, Exchange, SharePoint, and Skype. Its Intelligent Cloud segment licenses server products and cloud services, such as SQL Server, Windows Server, Visual Studio, System Center, and related CALs, as well as Azure, a cloud platform with computing, networking and storage. Founded in 1975 and headquartered in Redmond, Washington.	Mkt Cap: \$444.5B Cash: \$113.0B Debt: \$54.0B LTM Revenue: \$85.3B	Total Acquisitions since January 2010: 68 Aug-2016: Genee, a provider of calendar scheduling SaaS Aug-2016: Beam Interactive, an interactive game streaming service Jun-2016: Wand Labs, a mobile messaging application
	Develops hybrid photonic integrated optoelectronic products that transmit, receive, and switch high speed digital optical signals for communications networks. It offers high speed products, including transmitter, receiver, and switching products for 100G (gigabits per second) and optical transmission applications over distances of 2 to 2,000 kilometers; and optical components for coherent systems, including narrow linewidth tunable transmit and local oscillator lasers (NLW-ITLA). Founded in 1996 and is based in San Jose, California.	Mkt Cap: \$631M Cash: \$111M Debt: \$45M LTM Revenue: \$371M	Total Acquisitions since January 2010: 3 Nov-2015: EigenLight, a manufacturer of fibre optic power monitors Oct-2014: Emcore, Tunable Laser and Transceiver assets, for \$17M Sep-2011: Santur, a manufacturer of parallel array devices and photonics ICs, for \$52M

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies

9 of 11






Company	Description	Size	Last Three Acquisitions
	<p>Operates in five business groups: Mobile Networks, Fixed Networks, IP/Optical Networks, Applications and Analytics, and Nokia Technologies. It offers IP/optical networking solutions, such as IP routing and optical transport systems, software, and services; and packet-optimised and optical transport solutions. Further, the company provides software applications and platforms comprising customer and network operations software; network management and self-organising networks. Founded in 1865 and headquartered in Espoo, Finland.</p>	<p>Mkt Cap: \$29.4B Cash: \$12.3B Debt: \$4.3B LTM Revenue: \$19.5B</p>	<p>Total Acquisitions since January 2010: 27</p> <p>Oct-2016: ETA Devices, a fabless semiconductor design to enable power amplification Jun-2016: Gainspeed, a provider of distributed access architecture and virtual cable access platform Apr-2016: Withings, a manufacturer of wearable health and activity trackers, for \$191M</p>
	<p>Manufactures and markets lasers and optical components, modules, and subsystems for the optical communications, industrial, and consumer laser markets. The company's products generate, detect, combine, and separate light signals in optical communications networks. It offers client side transceivers, including pluggable transceivers; line side transceivers; tunable laser transmitters, such as discrete lasers and co-packaged laser modulators. Founded in 1988 and is headquartered in San Jose, California.</p>	<p>Mkt Cap: \$1.4B Cash: \$96M Debt: \$68M LTM Revenue: \$408M</p>	<p>Total Acquisitions since January 2010: 2</p> <p>Mar-2012: Opnext, an optical components designer, for \$180M Jul-2010: Mintera, a provider of optical transmission systems, for \$12M</p>
	<p>Designs semi-conductor products for consumer, data centre, high performance computing, military, industrial, and mobility applications in the United States and Canada. It focuses on the design and development of III-V semiconductor devices, processes, and products based on the semiconductor planar opto-electronic technology. POET Technologies is headquartered in Toronto, Canada.</p>	<p>Mkt Cap: \$107M Cash: \$13M Debt: Nil LTM Revenue: \$1M</p>	<p>Total Acquisitions since January 2010: 2</p> <p>May-2016: BB Photonics, a developer of photonic integrated components for high speed data networks, for \$2M Apr-2016: DenseLight Semiconductors, a manufacturer of photonic optical light source products, for \$15M</p>
	<p>Manufactures multi-terabit interconnect solutions for datacentre and communications networks in the telecommunications and information technology industries. It offers quantum dot multi-wavelength laser technology, and advanced digital and photonics integrated circuit technologies for the optical interconnect solutions. Founded in 2012 and is based in Ottawa, Canada.</p>	<p>Privately owned Raised \$35M to date</p>	<p>Total Acquisitions since January 2010: n.a.</p>
	<p>Developed an integrated optics technology where CMOS electronics controls an optical switching fabric which breaks traditional switch backplane bandwidth product limitations and allows an architecture that is compatible with current and future port data capacities. It is low power and highly scalable, which are key requirements for efficient hyper-scale switches that are needed in current and roadmap data centres. Founded in 2013 and headquartered in Oxford, UK.</p>	<p>Privately owned Raised \$51M to date</p>	<p>Total Acquisitions since January 2010: n.a.</p>

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available



# Key Photonics Companies


10 of 11

Company	Description	Size	Last Three Acquisitions
	<p>Sicoya develops silicon photonics based Application Specific Photonic Integrated Circuits (ASPICs) for optical data center interconnects outperforming legacy copper based solutions and first generation optical transceivers. The company's products comprise novel patented modulator concepts and co-integration of ultra-small optical and electrical circuits into one single chip to enable the delivery of mobile devices, social networking, cloud computing, and virtual reality applications.</p>	<p>Privately owned Raised \$4M to date</p>	<p>Total Acquisitions since January 2010: n.a.</p>
	<p>A fabless semiconductor company that develops and markets silicon photonic integrated circuit products. The company offers 100G-CWDM system-on-chip fully integrated opto-electronic S-roC receiver ICs and S-toC transmitter ICs. It also provides Skorpios' Template Assisted Bonding, a platform to address various applications that include high-speed video, data, and voice communications for networking and cloud computing. The company was founded in 2009 and is based in Albuquerque, New Mexico.</p>	<p>Privately owned Raised \$68M to date</p>	<p>Total Acquisitions since January 2010: 1 Nov-2015: RedTail Microwave, a manufacturer of microwave integrated circuit and module solutions</p>
	<p>Operates through five segments: Automotive, Information and Communications, Electronics, Environment and Energy, and Industrial Materials. The company offers optical fibres and optical fibre cables; optical connectors; optical fibre amplifiers; H-PCF; optical transceiver modules, optical devices, and wireless devices; fusion splicers and tools; passive products; termination/splicing box and closures; network-related devices. Founded in 1897 and headquartered in Osaka, Japan.</p>	<p>Mkt Cap: \$11.4B Cash: \$2.0B Debt: \$4.9B LTM Revenue: \$27.7B</p>	<p>Total Acquisitions since January 2010: 5 Sep-2014: Sumiden Hitachi Cable, a manufacturer of power, optical fibre and communication wires Nov-2013: J-Power Systems, a developer of electric power cables Jan-2013: Broad Net Mux, a manufacturer of digital cable TV systems</p>
	<p>Tehuti Networks Ltd. is a privately held fabless semiconductor company that has developed, a TCP/IP acceleration devices and adapters with the optimal balance of price, performance and power to enable volume adoption of 10 Gigabit Ethernet (GbE). Tehuti's 10GbE controller can operate in a partial offload mode (Stateless) to simplify integration and optimize performance.</p>	<p>Privately owned Raised \$10M to date</p>	<p>Total Acquisitions since January 2010: n.a.</p>
	<p>Provides digital imaging and semiconductor products and solutions for customers worldwide. It offers imaging products, such as CD and CMOS image sensors, cameras, X-ray detectors, frame grabbers, vision software and systems, and custom solutions for markets and applications. The company also manufactures MEMS products for use in pressure and inertial sensors, silicon microphones, micro-mirrors, TSVs, and RF MEMs. Founded in 1980 and is based in Waterloo, Canada.</p>	<p>Subsidiary of Teledyne Technologies</p>	<p>Total Acquisitions since January 2010: 2 Apr-2016: CARIS-Universal Systems, a developer of software for processing and visualising sonar data Apr-2012: Teledyne Optech, a manufacturer of advanced lidar and camera survey instruments</p>

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Key Photonics Companies

11 of 11

Company	Description	Size	Last Three Acquisitions
	Designs and develops programmable devices and associated technologies. Its programmable devices comprise integrated circuits (ICs) in the form of programmable logic devices (PLDs), such as programmable system on chips, and three dimensional ICs; software design tools to program the PLDs; targeted reference designs; printed circuit boards; and intellectual property. Founded in 1984 and headquartered in San Jose, California.	Mkt Cap: \$12.7B Cash: \$3.5B Debt: \$1.6B LTM Revenue: \$2.2B	Total Acquisitions since January 2010: 6 Sep-2012: Modesat Communications, semiconductor IP assets Aug-2012: Petalogix, a provider of semiconductor software development software May-2011: Sarance Technologies, a provider of ASIC and FPGA IP cores

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

# Photonics Communications

## Key Conferences

Event	When	Where
OFC	Feb/Mar annually	California
Photonics West	Jan/Feb annually	California
OECC	July annually	Pacific Rim
ECOC	Sept annually	Europe
ACP	Nov annually	China

Source: Company Website, Company Press Releases, Capital IQ, 451 Group, 10K, 10Q  
Notes: Market capitalisation as of 12<sup>th</sup> October 2016; Financials are latest available

---

# ABOUT RCL

---

# Michael Powell

Managing Partner

---



**MICHAEL POWELL**  
MANAGING PARTNER

Mike Powell is the Managing Director and Partner of Renevo Capital Limited. Focusing on the TMT and advanced materials sectors. He has advised multiple companies on M&A, financing, corporate strategy and tactics. Extremely well connected internationally in Europe, the North Americas and China, he has particular focus on photonics and efficiency technologies and brings 30 years of senior level experience, leading, advising, managing and negotiating corporate projects and transactions for both private and public companies.

Prior to his experience in technology M&A banking and the founding of Renevo Capital Limited, Mike had an extensive background operationally in technology business, starting as a defense contractor with GEC Marconi.

He then entered a period of serial entrepreneurship, founding, funding, growing and ultimately selling three business: IOC international PLC, K2 Optronics Inc and Pelikon Ltd.

He managed IOC as CEO from start-up to its subsequent float on the London AIM stock exchange in 1997, and in 2000. He subsequently sold it to NASDAQ quoted SDLI before moving to the bay area to found K2 Optronics which was later sold to Emcore. In 2002 Mike returned to the UK and joined the founding team of Pelikon as CEO. In 2008 he sold Pelikon to NASDAQ listed MFLEX.

Mike has a degree in Physics from Imperial College and is a keen athlete, competing regularly in triathlons. He is also a level 2 qualified Triathlon coach.

 [Mike.Powell@renevocap.com](mailto:Mike.Powell@renevocap.com)

 +44 7989 384590