

Startup Profiles

DinoPlusAl

DinoplusAI was founded in October 2017 to develop latency-optimized AI processors to enable future's real-time and ultra-low latency applications. The company has raised \$6.5M.

VR headset users will experience nausea when the latency between users moving their eye position to video showing up is over 20 ms. Ideally, VR latency should be no more than 7 ms, if not zero. Ultra-low latency, ideally at single-digit ms, also significantly benefits manufacturing, remote operation and medicine. Sub 1ms ultra-low latency is essential for very fast control loop in manufacturing, according to an experiment by Ericsson together with the Fraunhofer Institute for Production Technology. Autonomous driving also requires low latency as road conditions need to be captured, sensed and processed in real-time.

DinoPlusAI is developing latencyoptimized AI processors with upper bounded ultra-low latency, in addition to throughput performance and low energy consumption. The company's





Trex processor is the first in the industry focused on latency optimization groundup, according to the company.

The DinoplusAI processor platform is highly consistent and predictable, and has achieved the industry's lowest latency at low batch size, according to the company, which is critical in AI applications. DinoPlusAI has verified Trex chipset performance against a large set of deep learning models, ranging from popular CNN models to LSTM models for speech recognition. The DinoplusAI processor, with superior DeepBench LSTM performance, enables more than 4,000 real-time audio streams with a computation latency of less than 1ms for Rokid's acoustic model, an industry leading cloud speech recognition algorithm.

The processor is able to shorten the latency to 1/100x and lower power consumption by 1/6x, compared to Nvidia's V100 series, when processing Resnet-50 model at 70K images per second. It is able to process 5,000 frames per second at INT8 precision with batch 1 inference for SSD Mobilenet V1 model, compared to only 34 frames per second for Nvidia GeForce GTX Titan X system. It is also able to process 4,000 speech

SEMI's N. American Equipment Billings



recognition streams simultaneously while consuming only 45W. This performance demonstrates 13x performance improvement and 1/6x energy consumption reduction compared to Nvidia's Tesla V100, according to the company.

The DinoplusAI processor platform combines the SiFive RISC-V E34 Management Core with a proprietary AI engine from DinoplusAI. In addition, SiFive's Custom SoC Division will provide RTL-to-physical design. SiFive will integrate DinoplusAI AI IP blocks into its 16nm FinFET design platform based on the SiFive RISC-V E34 management core to deliver a complete silicon solution.

DinoplusAI has received \$8M in LOI POs from customers Ford, Inspur, Rokid, Perceptin, and Megvii.

Dr. Sam Heidari, Executive Chairman (previously Chairman and CEO of Quantenna)

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- Jay Hu, Founder and CEO (previously Architect & Founder at cNeuron Technology and Senior Principal Engineer at Cadence)
- Tong Wu, Founder & CTO (previously Senior Technical Lead at Cisco / Insieme Networks and software development engineer at Lab126)
- Patrick Ang, VP of Business Development (previously Executive Director at Infinitedge Partners, VP of Marketing at Quintic, EVP at UniRAM and CEO at PicoNetics)

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Nonlinear Materials

Nonlinear Materials (NLM) was founded in August 2018 to develop electro-optic materials and production methods for cloud computing providers, semiconductor companies, and telecom equipment manufacturers. NLM has an exclusive license for key electro-optic (EO) material patents from the University of Washington. The patents were licensed to NLM by CoMotion, the collaborative innovation hub at the University of Washington (UW).

The new EO materials were developed by the research groups of Professor Larry Dalton and Professor Bruce Robinson in the Department of Chemistry at UW based on over 20 years of research at UW, both within those groups and in the 2002-2012 UW-led National Science Foundation Science and Technology Center on Materials and Devices for Information Technology Research (NSF STC-MDITR). UW researchers have collaborated with researchers at ETH Zurich, Karlsruhe Institute of Technology, KU Leuven, Purdue University, Virginia Commonwealth University, US Air Force Research Laboratory, and other institutions on testing and device integration of UW-developed EO materials.

Today's commercially available electro-optic materials are typically crystalline compounds such as lithium niobate, which are power hungry, physically large and difficult to integrate directly on chips. According to NLM, these materials also have very little room for improvement. NLM's organic electro-optic (OEO) materials can achieve > 10x the performance of lithium niobate.

NLM's platform allows major chip and computer manufacturers to integrate low-power, high-speed optical computing components into existing production lines. Prototype devices using NLM materials already run 100x faster than standard microprocessors and use 1000x less power than what is consumed in running existing infrastructure.

The company's initial target is optical transport in datacenters. Beyond that, the company will target optical chip interconnects by introducing electro-optic materials into CMOS semiconductors, with interconnections between the CPU, GPU and memory chips. Electro-Optic materials can also be combined with electronics within CPU and GPU chip designs. The ultimate vision is optical processing featuring all-optical chip designs encompassing GPU, CPU, and memory.

The company expects NLM-enabled multi-Tb/s transceivers to operate at least 10X faster than current technology, while also being less expensive, smaller, and having lower energy consumption. The global optical modulator market was \$2 billion in 2017 and is expected to reach \$22.6 billion in 2024 driven by the availability and cost effectiveness of THz modulators.

Arrays of plasmonic MZI devices can be assembled in large logical arrays to perform high speed neural net functions, enabled by the THz speeds achievable with NLM materials, in a small footprint and at very low energy consumption. NLM-enabled Plasmonic Bio-Sensors will allow bio-sensors to be made smaller and less expensive, to the point of being disposable.

NLM has joined the 5G Open Innovation Lab (www.5GOILab.com), an ecosystem for developers, enterprises, carriers, and technology leaders focused on helping startups utilize 5G to develop new capabilities, products, and market categories. NLM will work closely with the Lab's founding partners, including Intel, T-Mobile, and others. Specifically, NLM brings their optical computing materials platform for enabling high speed and energy-efficient 5G technology in a shift away from traditional conductor computing.

To commercialize the technology, NLM has assembled a core team of research scientists, technology startup leaders, and strategic advisors. NLM has high-performance EO materials available today, with even higher-performance EO materials in development. Polariton (see July 2020 issue), a developer of plasmonic electro-optic modulators, uses NLM HLD materials. NLM. offer organic electro-optic materials for sale and licensing, consulting on materials integration and process development, R&D of novel nonlinear materials, and joint development with device manufacturers and fabrication facilities.

- Paul Nye, Chairman and President (35 years technology startup experience; Partner at Triad Venture Foundry; Co-founder & CEO of Information Optics, a high-speed optical memory company)
- Gerard Zytnicki, Co-founder & CEO (30 years technology experience including 27 at Microsoft in senior level product and engineering roles)
- Lewis Johnson, Ph.D., Co-founder & Chief Scientific Officer (Research

Scientist in the University of Washington Department of Chemistry)

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Paragraf

Paragraf was founded in 2015 to develop a process for depositing single-atom thick, 2D materials, including graphene, directly onto silicon, silicon-carbide, sapphire, gallium-nitride and other semiconductor-compatible substrates. Based near Cambridge, U.K., Paragraf was spun-out from the Centre for Gallium Nitride group of Professor Sir Colin Humphreys in the Department of Materials Science at the University of Cambridge. The company has 40 employees.

In 2018, Paragraf closed a £2.9 million seed round led by Cambridge Enterprise, the commercialization arm of the University of Cambridge, with the participation of Parkwalk Advisors, Amadeus Capital Partners, IQ Capital Partners and angel investors. In 2019, Paragraf raised £16.2m in Series A funding led by led by Parkwalk and including Draper Esprit, IQ Capital, Amadeus, Cambridge Enterprise, and angel investors.

Paragraf has completed a successful seed phase, delivering a manufacturing facility, graphene layer production and first device prototypes significantly ahead of plan. The funding will see Paragraf's first graphene-based products reach the market, transitioning the company into a commercial, revenue-generating entity. The company has raised £19.1m to date. Additional capital will be raised to enable the company to rapidly scale and bring many more graphene-based products to market.

According to Paragraf, until now, manufacturers have struggled to harness the benefits of graphene. Paragraf claims to be the first company to deliver IP-protected graphene technology using standard, mass production scale manufacturing approaches, enabling step-change performance enhancements to today's electronic devices. Paragraf has overcome the problems of poor uniformity, reproducibility, limited size and material contamination that have stymied all current graphene manufacturing techniques. Paragraph argues that no other companies can produce commercial quality graphene at scale.

Paragraf graphene is directly compatible with existing electronic device processing and production lines, enabling readily scalable graphene electronic device production. Its modified deposition method removes the need for the transfer processes commonly applied in most large area graphene synthesis methods. It does not require catalytic formation of the graphene thus eliminating metallic contamination, which allows synthesis of large areas of the material (up to 8" diameter to date) directly onto semiconductor-compatible substrates such as silicon, silicon-carbide, sapphire and gallium-nitride.

Graphene's high transparency (only one atomic layer thick), outstanding flexibility, mechanical strength and exceptional conductivity make it particularly suitable for use in electronic device surface applications, such as touchscreens, flexible mobile devices, surface contact for SSDs and ITO replacement. Graphene has high levels of electrical and thermal conductivity, electrochemical stability, a large surface area and potential for direct combination with other crystalline materials. These qualities make it invaluable for enhancing electrical extraction efficiency in green energy applications such as solar PV cells and rechargeable batteries. Paragraf's graphene production technique enables formation of graphene directly onto semiconductor material surfaces and transparent crystalline substrates.

Serving the sensor, energy harvesting and semiconductor markets, Paragraf has developed its own Hall-Effect Sensors for measuring magnetic fields in demanding environments. Utilizing the inherently high sensitivity of 2D graphene material, the GHS Series achieves outstanding field resolution without signal conditioning, while introducing enhanced features such as a negligible planar Hall-Effect and robustness.

Existing Hall effect sensors all exhibit planar Hall effects where field components that are not perpendicular to the sensing plane produce false signals because the sensing layer is effectively 3D, with some amount of depth. These false signals, together with the non-linear response to the field strength, increase the measurement uncertainty and thus limit the application of Hall sensors.

The Hall effect sensor from Paragraf solves these problems because the active sensing component is made of atomically thin graphene, thus sensing magnetic fields along one direction. This enables the true perpendicular magnetic field value to be obtained, allowing for higher precision mapping of the local magnetic field.

Also, due to extremely low noise and high sensitivity, a resolution in the sub-100 nT region is possible, which is far beyond that achievable with a regular Hall sensor (usually in the 10's-100s μ T). Extremely high mobility of the charge carriers in the graphene enables faster sensing and a wide operational bandwidth. The sensor also has a highly linear voltage response.

Paragraf's Hall effect sensor also features a wide temperature range from +80°C (353 K) down to cryogenic temperatures of 1.5 Kelvin, with future high temperature-variants under development. This enables the sensor to be used in superconducting environments, while actually becoming more

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sensitive. Graphene Hall-Effect sensors also have an incredibly low power dissipation – of the order of picowatts with nanoamperes drive current, which means they will not heat cryogenic environments and will save energy. The devices are resistant to thermal shock and ESD.

The company is targeting multiple markets that can leverage graphene, including renewable energy, energy storage, semiconductor technologies, medical technology, computing (touchscreens, flexible displays, SSDs, ITO replacement), scientific research, healthcare, avionics, automotive, satellite & space technologies, robotics.

Currently, Paragraph produce devices end-to-end; however, as the company scales it is building strong relationships and partnerships with device developers, manufacturers and foundries. Paragraf's goal is to bring scalable graphene devices to the world as quickly as possible, which will likely be achieved through alliances.

Queen Mary University, London is collaborating with Paragraf and performing basic graphene research to study and develop a wide range of graphene devices. Paragraf "next-generation" graphene will also be assessed by the University as a potential ITO replacement for organic LEDs. Paragraf is working in partnership with Verditek, a supplier of lightweight, flexible solar panels. Depositing optically transparent, highly conductive graphene directly onto the solar cell surface facilitates current dispersal and eliminates shading. In principle, this will improve solar cell efficiency by 3%.

The standard, very high performance hall sensor, the Graphene Hall Effect Sensor (GHS) is available now. This is the first of several variants that will be launched over the next year targeting different application spaces. Paragraf is also developing graphene enhanced energy generation devices and targeting graphene enhanced and all-graphene solid-state devices, such as, for example, transistors.

- Dr. Simon Thomas, Co-founder & CEO (previously Research Associate at University of Cambridge and Scientific Engineering Manager at AIXTRON)
- Prof. Sir Colin Humphreys, Co-founder & Chief Science Officer (Professor of Materials Science at Queen Mary University of London, a Fellow of Selwyn College Cambridge and Emeritus Professor of Materials Science at Cambridge University)

Dr. Ivor Guiney, Co-founder

- Tony Pearce, COO (previously VP, Business Systems and Quality and VP, Group Operations at IQE and Managing Director at AIXTRON)
- John Tingay, CTO (previously led the development of capital equipment for the semiconductor and electronics industries for over two decades)
- Helen Adams, Chief Commercial Officer (previously spent 11 years at ARM where, as VP, she ran the sales teams in Europe and Asia)

Hugh Wolley, CFO

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Piera Systems

Piera Systems was founded in 2018 to develop particle sensors and particle counting ICs for the digital health industry. Piera has raised \$150k to date and expects to secure seed funding of \$250-500k by Jan. 2020.

The World Health Organization has identified air pollution as the cause of 7 million deaths per year with 91% of

the world's population living where air quality exceeds WHO guidelines of 10 ug/m3 (mass concentration). Particulate Matter of size PM2.5 or smaller from industrial emissions, motor vehicles, domestic combustion, smoking/ vaping etc. is the primary cause. Particles greater than 100nm (PM0.1) and under 1um (PM1.0) in diameter can penetrate the skin directly and enter the bloodstream.

The TAM for particulate sensors, air quality monitoring, and car air quality sensing is ~\$8B. Until now there has been no real-time, accurate, affordable method for measuring air quality especially < PM2.5, according to Piera.

Existing air quality detectors use a methodology called Low-Pulse Occupancy (LPO) that is inaccurate, low resolution and slow. The most accurate way to measure PM values has been the gravimetric method; however, it is bulky, expensive, and usually one specific PM level data can be obtained averaged over 24-hours. Real-time optical particle counters (OPCs or dust sensors) are based on the principle of light scattering and are low-cost. However, manufacturers rely heavily on algorithms to estimate various sized particulate concentration (usually just PM2.5 and PM10) with questionable accuracy.

Piera has developed the Piera-1, a next generation Intelligent Particle Sensor (IPS) that uses a breakthrough approach for detecting and measuring the quantity and size of particles suspended in any medium, initially air. Unlike existing air quality detectors that are inaccurate, low in resolution and slow, Piera-1 has superior accuracy, can detect smaller particles (PM0.1 and larger) and count them with real time performance. Piera-1 can be programmed to detect a wide range of particle sizes allowing for a single sensor to be used in a range of applications.

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Piera-1 is an optoelectrical sensor also based on laser scattering. Piera-1 utilizes the PCIC (Particle Counting Integrated Circuit) mixed-signal ASIC, a derivation of an ASIC originally developed for photon-counting live X-ray image data processing (3 granted US patents). The PCIC can identify different sized particles and their concentration by directly counting pulses of different levels of photon energy, featuring superior accuracy, resolution and true real-time data acquisition compared to existing sensors based on the LPO technique.

The PCIC is capable of sampling and processing a much smaller signal from the photodiode at least 1000X faster (in a given time frame) than existing sensors. Compared to the LPO time measurement that relies only on pulse width information, the PCIC can deliver at least 100% more accurate and reliable particulate count data with more than 2X faster overall speed. The PCIC significantly increases accuracy and resolution and can detect particles from PM0.1-10. It has 5 unique 'bins' to report particulate count in real-time. Future versions will support up to 9 bins.

The resulting data can be used to identify the Particulate Matter and calculate its mass concentration. The signature of the data can be analyzed using Machine Learning/AI and algorithms to classify the components.

The first product developed with Piera-1 is a vape/smoke detector, Canāree, that can identify and discriminate cigarette and vape smoke, it's mass concentration and dissipation. When deployed in public spaces or homes, Canāree could reduce the impact of vaping and smoking affecting people's health.

The company offers the PCIC Particle Counting IC, Piera-1 Intelligent Particle Sensor and Canāree Vape/Smoke Detector. Piera-1 and PCIC samples are available now. Canāree MVP is April 2020. Piera has an exclusive agreement with Luxen Technologies, a chip company in Korea for technology used in PCIC and Piera-1. The PCIC is manufactured on a mixed-signal 180nm standard process at GlobalFoundries.

- Aaron Soh, Founder & CEO (7+ years of experience of CMOS X-ray image sensor IC design at Luxen Technologies)
- Vin Ratford, COO (previously SVP, Worldwide Marketing and Business Development at Xilinx, among many other semiconductor executive roles)
- Jim Pekarsky, CFO (20+ years as CFO, including Virage Logic, MoSys, AccelChip and SiliconBlue)
- Kannan "Kenny" Premanand, VP, Operations and Manufacturing (previously Sr. Operations Program Manager for Kindle Products at Amazon Lab126)
- Howard Pakosh, Sales Director (30+ years semiconductor sales experience)
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SCINTIL Photonics

Scintil Photonics, a Leti spinoff founded in November 2018, is developing high speed photonic circuits that are fully integrated (multi-wavelength lasers, modulator, and photodetector) on silicon. In September 2019, the company raised €4 million (\$4.4M) in first-round funding led by Supernova Invest, Innovacom and Bpifrance and joined by Credit Agricole Alpes Développement and endowment Fund Foreis. With the funding, the team and development partnerships, including those with CEA-Leti in France and the University of Toronto in Canada, will be strengthened.

SCINTIL's technology draws upon 15+ years of research in InP/Si lasers, silicon photonics, and 3D packaging

carried out at CEA-Leti. Prior to its establishment, the startup project, incubated at CEA-Leti, received initial funding as a winner of i-Lab 2018, a French government-sponsored innovation competition hosted by Bpifrance.

Silicon Photonics is prevalent in optical interconnects in Data centers; however, the lack of integrated lasers on Silicon prevents the solutions from scaling to higher bit rates with Wavelength Division Multiplexing (WDM). Indium Phosphide (InP) has been the material of choice for semiconductor lasers and WDM interconnect but the assembly of discrete components results in high cost and package size.

SCINTIL combines the best of Silicon (Si) and Indium Phosphide (InP) materials using wafer-scale bonding of InP on Si and relies on commercial silicon foundry processes to build fully integrated photonic circuits (comprising multi-wavelength lasers, waveguides, wavelength filters, and photodetectors). SCINTIL plans to produce devices that can generate, modulate, route, filter and detect light. This includes the integration of heterogeneous III-V on silicon lasers, modulators, photodetectors, fibre couplers, waveguides and mux/demux. The company argues that it's solution will reduce the footprint by 5X, reduce power consumption by 3X and scaling to capacities through WDM 400G, 800G, and 1600G.

SCINTIL's BackSide-on-BOX technology enables seamless and extensive integration of active and passive optical components by combining Si and InP/ III-V materials. Unprocessed InP/III-V dies are bonded on the back of processed Silicon-On-Insulators (SOI) wafers. The process is CMOS-compatible and relies on a standard silicon-photonics process. The optical component library includes lasers (WDM laser arrays & tunable lasers), modulators, SOA, waveguides, wavelength filters, surface fiber couplers, and photodetectors.

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The process enables high-coupling efficiency of lasers in the waveguide without alignment of lasers needed. Optical amplification and high-speed modulators with low insertion loss are on-chip. Germanium (Ge) can be incorporated into the silicon photonics layer for efficient photodetectors and Silicon Nitride (SiNx) provides improved passive devices. The process provides for wafer-level laser integration & test, flip-chip assembly, and no need for a hermetic package.

Scintil's devices are targeted at shortreach datacenter communications as well as optical communications and detection systems like LiDAR. The company is developing 800 Gbps transceiver photonic circuit prototypes in commercial semiconductor foundries. The first pre-series runs are expected by the end of 2021.

- Pascal Langlois, Founder, Chairman & Deputy CEO (previously CEO of Tronics Microsystems, Chief Sales and Marketing officer at ST-Ericsson and SVP marketing and sales at NXP)
- Sylvie Menezo, Founder, Ph.D., CEO & CTO (previously Business Development, Head of Lab, Research Engineer at Leti and Head of R&D Optical Lab at Sercel)
- Yannick Paillard, Chief Commercial Officer (previously Director of Marketing & Business Development, Strategic Partners at Dolphin Integration)
- Jean Marc Gilet, Director, Industrial Operations (previously Director, Industrial Operations at Tronics Microsystems)

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People

AMD has appointed methodology architect **Alex Starr** to AMD Corporate Fellow. Starr, an AMD veteran of nearly 15 years, is a leader in verification methodologies for CPU and GPU processors and complex SoCs. Currently, only 7 engineers at AMD hold the title of Corporate Fellow.

Cornami has appointed Dr. Walden Rhines as president and CEO. Co-founder and chairman Gordon Campbell has moved from the CEO position to executive chairman. Dr. Rhines is CEO Emeritus at Mentor, a Siemens Business. During his tenure as CEO and chairman of Mentor, the company's revenue nearly quadrupled, enterprise value increased by 10X and the company grew to the #1 market share position in 4 of the 10 largest product segments in the EDA industry. Prior to joining Mentor, he was EVP of TI Semiconductor Group, sharing responsibility for TI's Components Sector.

Rhines has been actively involved with the government in seeking silicon solutions that could deliver the performance required to process Fully Homomorphic Encryption (FHE), an encryption scheme that enables analytical functions to be run directly on encrypted data, yielding encrypted results, all while keeping the underlying critical information secure. Cornami had already partnered with a large enterprise company in fintech and demonstrated that it can deliver the performance required to make this commercially viable.

First Solar's COO, Philip Tymen deJong, has decided to retire effective April 2021. He will transition the majority of his responsibilities to Michael Koralewski, Chief Manufacturing Operations Officer; Kuntal Kumar Verma, Chief Manufacturing Engineering Officer; and Patrick **Buehler**, Chief Quality and Reliability Officer. **Markus Gloeckler** has been appointed Co-CTO alongside **Raffi Garabedian**, First Solar's CTO since 2012. **Jason Dymbort** will join the executive leadership team as General Counsel and Secretary after serving in this capacity on an interim basis since March 2020.

GLOBALFOUNDRIES has appointed **David Reeder** as CFO. Reeder previously served as CFO and as CEO of Lexmark, a \$4 billion publicly-traded company listed on the New York Stock Exchange and as CEO of Tower Hill Insurance Group.

Himax has appointed Jessica Pan (Ming-Feng Pan) as CFO and Eric Li (Tzung-I Li) as Chief IR/PR Officer and Spokesperson. Both will report directly to CEO Jordan Wu. Pan and Li succeed Jackie Chang who has resigned. Pan joined Himax in 2006 and currently serves as Associate VP of Finance & Accounting. Joining Himax in 2012, Li has worked in sales, marketing and R&D. Currently an Associate VP covering the Intelligent Sensing AI product line, Eric has previously worked in video processing ASIC service and TV/monitor ASSP products before he was put in charge of the fab construction and operation of Himax's WLO advanced optics operation.

Intel has made changes to its technology organization and executive team. The Technology, Systems Architecture and Client Group (TSCG) will be separated into the following teams, whose leaders will report directly to the CEO. Technology Development will be led by **Dr. Ann Kelleher**. **Dr. Mike Mayberry**, who has been leading Technology Development, will consult and assist in the transition until his planned retirement at the end of the year. Manufacturing and Operations will be led by **Keyvan Esfarjani**. He most recently led manufacturing for

Intel's Non-Volatile Memory Solutions Group (NSG).

Design Engineering will be led in the interim by Josh Walden. Most recently, he has been leading the Intel Product Assurance and Security Group (IPAS), which will continue to report to him. Architecture, Software and Graphics will continue to be led by **Raja Koduri**. Supply Chain will continue to be led by **Dr. Randhir Thakur**. As a result of these changes, **Murthy Renduchintala** will leave Intel on Aug. 3, 2020.

Kandou, a supplier of high-speed, energy-efficient, chip link solutions, has named **Jeff Winzeler** as CFO. Winzeler previously was CFO of Everspin. Prior experience includes serving as CFO for Avnera, Rackwise, Solar Power and International DisplayWorks.

Kioxia has appointed Michael Splinter as an independent director. Splinter served as President and CEO of Applied Materials from 2003 to 2012 and as chairman of the board since 2009 until he retired in June 2015. Prior to joining Applied Materials, he served as an executive at Intel. Splinter currently serves as an external director of TSMC and as chairman of NASDAQ.

Lion Semiconductor, a company developing switched-capacitor power ICs, has named Chae Lee to its board of directors. Lee is currently CEO and President of Insyte Systems. He was previously SVP of NXP leading their Secure Interfaces and Power Solutions Business and was SVP of Maxim leading their Mobility Business.

MagnaChip has appointed Kyo-Hwa (Liz) Chung to its board of directors. Ms. Chung currently serves as the Head of Corporate, External and Legal Affairs for Microsoft Korea. Ms. Chung's appointment fills a vacancy on MagnaChip's Board created as a result of the Board increasing the number of directors on the Board to seven from six.

Marvell has appointed **Marachel Knight**, SVP of Engineering and Operations of AT&T, to its board of directors. **Oleg Khaykin**, who has served as a director since May 2016, and **Donna Morris**, who joined the Marvell Board in 2018 and has recently taken on a new executive role as Chief People Officer for Walmart, did not stand for reelection.

NVIDIA has named John Dabiri. Ph.D., the Centennial Professor of aeronautics and mechanical engineering at the California Institute of Technology, where he previously served as dean of Students and chair of the Faculty Board, to its board of directors. Dabiri recently returned to Caltech after four years at Stanford, where he was a professor of civil and environmental engineering and of mechanical engineering. He heads the Dabiri Lab, which conducts research at the intersections of fluid mechanics. energy and environment, and biology. His appointment expands NVIDIA's board to 12 members.

Qualcomm has appointed **Jean-Pascal Tricoire**, CEO, Schneider Electric SE, to the Board.

Rambus has appointed **Greg Lang** to its Board of Directors. Lang led PMC-Sierra as president and CEO. Previously, he served as president and CEO at IDT, following his role as VP and GM of the Platform Networking Group at Intel.

Silicon Motion has appointed Young Rae (YR) Kim as VP of Korea Sales & Operations. Kim is a 30-year memory industry veteran and had previously served at Samsung, SK Hynix and Marvell in sales and marketing, as well as engineering leadership roles relating to SSD controllers and NAND flash. **SkyWater** has appointed **Steve Manko** as CFO. **Steve Wold**, former CFO, has been appointed as the company's first Chief Administrative Officer. Manko has been consulting with Sky-Water since early 2019 working with the company's finance and accounting team on a number of initiatives and projects. Manko was a Managing Director at Riveron Consulting where he led the Financial Advisory Services practice in Minneapolis. Prior to Riveron, he was at Ernst & Young and specialized in the Banking & Capital Markets industries.

Soitec announced the resignation of **Sébastien Rouge**, its CFO, for personal reasons. **Léa Alzingre**, up to now in charge of Corporate Finance at Soitec, has been appointed Senior Director and acting CFO.

Vishay has appointed Joel Smejkal to the newly created role as EVP Corporate Business Development. Smejkal continues to report to Dr. Gerald Paul, President and CEO. Smejkal has been with Vishay since 1990. Jeff Webster is assuming Smejkal's previous responsibilities as EVP Business Head Passive Components and is reporting directly to the CEO. Webster was formerly SVP Corporate Quality. Webster has been with Vishay since January 2000. Andreas Randebrock has been appointed EVP Global Human Resources reporting directly to the CEO. Werner Gebhardt has retired from that position after 44 years of service. Randebrock had been SVP Employee Development and has been with Vishay since May 2015.

X-FAB has appointed **Jörg Doblaski** as CTO. He fills the role of former CTO **Dr. Jens Kosch**, who is becoming an X-FAB Fellow and will serve as an adviser to the company's CEO Rudi De Winter. Doblaski joined X-FAB in 2004 and since then has held various positions in engineering and

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management. Prior to becoming CTO, he was Director of Design Support.

Xilinx has appointed Hasmukh Ranjan as Chief Information Officer. Hasmukh previously served as CIO and Corporate VP of IT at Synopsys. ■

Funding

Aryballe, a pioneer in digital olfaction, has raised €7 million in a new global funding round from investors across Europe, North America, and Asia, including new investors Samsung Ventures and Seb Alliance (Groupe SEB's corporate venture arm) as well as existing investors INNOVACOM, CEMAG INVEST, Asahi Kasei, and HCVC. The company has raised €17 million to date. Aryballe combines biochemical sensors, advanced optics, and machine learning in a single objective solution to collect, display and analyze odor data so companies can make better decisions.

CMC Microsystems, a technology research support organization in Canada, has received funding through the Canada Foundation for Innovation (CFI) and its Major Science Initiatives (MSI) fund. The funding totals \$18.3M over three years from April 2020 to March 2023. These funds will enable CMC's flagship program: Canada's National Design Network (CNDN), which is hosted by Queen's University and managed by CMC.

Through the facility, CMC supports research in a variety of advanced micro-nanotechnologies including those related to biomedical diagnostics, IoT, products with embedded AI and 5G. In 2018-19 the network was used to enable the launch of 20 startups, provide 10,000 researchers in Canada access to design tools, testing equipment and prototyping services, and train 800 graduate students and post-doctoral fellows who were hired by industry in Canada.

e-peas has raised euro 8 million led by Partech and Airbus Ventures, with KBC Focus Fund, W.IN.G, Noshaq Ventures, LeanSquare, Nivelinvest and Vives also contributing. Over the last 3 years, e-peas has been broadening the scope of its Ambient Energy Manager (AEM) product line. This now covers solar, thermal, vibration and RF methods for extracting energy from IoT devices' surroundings. The imminent introduction of ultra-low power processing and sensing solutions will bolster the e-peas portfolio further.

Innovium, a provider of switching silicon for Cloud and Edge data centers, has secured \$170 Million in additional equity funding from Premji Invest, DFJ Growth, funds and accounts managed by BlackRock, and multiple strategic investors, along with existing investors including Greylock, Capricorn, WRVI, Qualcomm Ventures, Redline, S-Cubed Capital and DAG. Innovium becomes the first network silicon company to achieve unicorn status (>\$1B valuation).

Innovium's TERALYNX family delivers software compatible products ranging from 1Tbps to 25.6Tbps with unmatched telemetry, low latency, programmability, and large buffers, and a feature rich architecture that scales to 51.2Tbps+. The company is ramping TERALYNX 5 shipments for ToR, Edge & 5G customer designs, is continuing the volume production ramp of TERALYNX 7, and has introduced TERALYNX 8, a 25.6Tbps switch with 112G SerDes.

Innovium has seen strong adoption at leading OEM, Cloud and ODM customers for its TERALYNX family, which resulted in over 20% market share for 50G SerDes switch silicon in its first year of shipments. The company has wins, deployments and trials at the majority of the top 25 cloud customers worldwide. Revenue grew > 5x in 1H'20 vs 1H'19.

Liquid Wire has closed a \$10 million Series A financing round to expand its stretchable electronics technologies into the medical wearables market. The financing was led by Deerfield Management Company. Liquid Wire was founded in 2016 in Portland, Oregon, and has established itself as a leader in the emerging field of liquid metal circuitry. The Company produces conformal and pliable electronic circuits using a patented class of non-toxic printable liquid metals printed on plastic and textile substrates.

ONiO has received \notin 7M (74M NOK) in funding from the EU Horizon 2020, the biggest EU Research and Innovation programme ever with nearly \notin 80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract.

Spin Memory, a developer of MRAM technologies, announced an extension of its Series B funding round, having received additional investment from all major investors. The funding includes recent investors Arm, Applied Ventures and Abies Ventures (Abies) as well as founding investor Allied Minds. Spin's MRAM IP features high-retention, high-endurance, high-density and high-speed. It is bolstered by over 250 patents, a commercial agreement with Applied Materials and a licensing agreement with Arm.

SynSense (formerly aiCTX), a Zurich-based neuromorphic computing company, has closed Series A fundraising and will expand its footprint to China. Led by CTC Capital, the latest round included co-investment from several strategic partners including M Ventures, Ecovacs, and Yunding, and several financial investors, including CAS-Star and Archer Investment. Jade

River Capital provides the financial advisory. Following the investment round, SynSense has built R&D teams in Shanghai and Chengdu.

The UK Government has announced the first wave of funding through UK Research and Innovation's flagship Strength in Places Fund in which a major £43.74M project with South Wales' compound semiconductor cluster has been approved and will be supported by £25.44M funding from Strength in Places. The project "CSconnected" is based around integrating research excellence with the unique regional supply chains in advanced Semiconductor Manufacturing. The project partners include Cardiff University (lead partner), Cardiff Capital Region City Deal, Compound Semiconductor Applications Catapult, Compound Semiconductor Centre, IQE, MicroLink Devices, Newport Wafer Fab, Rockley Photonics, Swansea University, SPTS Technologies and Welsh Government.

Mergers & Acquisitions

ams has closed the **OSRAM** acquisition. Following the closing, ams holds 69% of all shares in OSRAM and additional purchases equivalent to a transaction value of around EUR 2.7 billion.

Analog Devices and Maxim have entered into a definitive agreement under which ADI will acquire Maxim in an all stock transaction that values the combined enterprise at over \$68 billion. Maxim stockholders will receive 0.630 of a share of ADI common stock for each share of Maxim common stock. Upon closing, ADI stockholders will own approx. 69% of the combined company, while Maxim stockholders will own approx. 31%. Two Maxim directors will join ADI's Board, including Maxim President and CEO, Tunc Doluca. The combination strengthens ADI's analog semiconductor leadership with expected revenue of \$8.2 billion and free cash flow of \$2.7 billion on a pro forma basis. The transaction is expected to be accretive to adjusted EPS in 18 months subsequent to closing with \$275 million of cost synergies by the end of year two.

Analog Devices has acquired the HDMI business of INVECAS, a Santa Clara-based company specializing in embedded software and system level solutions. This addition will provide ADI with complete audio and video solutions to meet the needs of enterprise and consumer markets. Terms were not disclosed.

The INVECAS HDMI technology group has a long history in the space, stemming from **Silicon Image**, a semiconductor company founded in 1995, where the HDMI technology was first created. Through this acquisition, ADI will also increase the company's role in the standards body representing HDMI. In addition, ADI will incorporate certification and compliance capabilities.

ASML has agreed to acquire **Berliner Glas**, a manufacturer of ceramic and optical modules, which are important to support the future roadmap for EUV and DUV products. Terms were not disclosed.

AZUR SPACE, a provider of III-V epitaxy for solar cells, has acquired the high power electronics and RF business of **ALLOS Semiconductors**. AZUR SPACE will use the acquired technology to expand its III-V epi business into the GaN-on-Si high power electronics and RF epiwafers.

AZUR SPACE is a provider of high efficiency multijunction space solar cells based on III-V epitaxy with a capacity of 500,000 wafers/year and with multiple MOCVD reactors running 24/7. Beyond the supply of GaN-on-Si epiwafers, AZUR SPACE's is also engaged in the field of GaAs for the HPE market.

Since its formation, ALLOS had developed its GaN-on-Si epiwafer technology for both high power electronics and micro LED applications. ALLOS will continue its optoelectronics business with the focus on the emerging micro LED display market. ALLOS sees its 200 and 300 mm epiwafer technology as being crucial in meeting the uniformity, crystal quality and manufacturability requirements of micro LED display applications.

Entegris has acquired **Global Measurement Technologies** (GMTI), an analytical instrument provider for critical processes in semiconductor production, and its manufacturing partner **Clean Room Plastics** for approx. \$36 million in cash. Located in Chandler, Arizona, GMTI is now part of the Advanced Materials Handling (AMH) Division of Entegris.

GMTI is a market leader in the design and production of high precision analytical instruments for Chemical Mechanical Planarization (CMP) slurries and formulated cleaning chemistries used in the semiconductor manufacturing process. The acquisition enhances Entegris' position as a supplier for yield enhancement solutions.

Galaxy Semiconductor has signed a definitive agreement to acquire substantially all of the assets of the Quantix Business from Mentor Graphics, a Siemens-owned business. Galaxy is acquiring several software solutions from Mentor including a suite of software used by over 100 microelectronic device designers and manufacturers to improve quality, reliability, and yield of their devices. Terms were not disclosed.

M&A

(Continued from page 9)

Originally founded in 1998, Galaxy Semiconductor Solutions was the #1 provider of test data analytics tools to the semiconductor industry as measured by number of customers. The launch of the new company in conjunction with the acquisition of several products designed by its predecessor, establishes Galaxy Semiconductor as the premier independent provider of test data analytics solutions for the semiconductor industry.

LeddarTech, a provider of ADAS and AD technology, has acquired sensor fusion and perception software company VayaVision. LeddarTech supports Tier 1-2 automotive system integrators with an open automotive and mobility sensing platform, including its Li-DAR-based LeddarEngine. There is an industry consensus that level 3 to 5 autonomous driving applications require multiple sensors and sensor combinations of LiDAR, radar, and cameras.

VayaVision, founded in 2016 by Dr Nehmadi Youval and Ronny Cohen and based in Israel, is a deep-tech company and a pioneer in the field of sensor fusion and perception. The integration of VayaVision enables LeddarTech to accelerate time-to-market while significantly reducing customer development costs and risks with a sensor fusion and perception stack that scales from a single sensor to multiple sensor combinations and is hardware and operating system agnostic. The first perception software stack product based on LeddarTech's Leddar Pixell LiDAR sensor will be available for lead customer demonstration and sampling in Q4'20 with production by 1H'21.

Siemens has signed an agreement to acquire Avatar Integrated Systems, a developer of place and route software for IC design. Terms were not disclosed. Avatar helps engineers optimize power, performance, and area (PPA) for complex chips with fewer resources. Siemens plans to add Avatar's technology to the Xcelerator portfolio as part of Mentor's IC suite of software, capitalizing on the growing segment of place and route. Avatar will be integrated with existing products from Mentor, a Siemens Business, including the Calibre platform, Tessent software, and Catapult HLS software.

At 7nm and below, detailed routing must be considered during placement. Avatar pioneered a detailed-route-centric architecture that has been built bottom-up on a unified in-memory data model, designed to enable all engines to access full design data and attributes at any time. This empowers each engine (placement, routing, timing, optimization, clock tree synthesis, etc.) to dynamically invoke other engines incrementally.

Avatar's products are built on technologies acquired from ATopTech in 2017. The product line includes Aprisa, a netlist-to-GDS full-function block-level physical implementation tool, and Apogee, a complete top-level prototyping, floor-planning and chip assembly tool.

ST has signed two M&A agreements related to the acquisitions of Ultra-Wide Band specialist BeSpoon and the cellular IoT connectivity assets of Riot Micro. Terms were not disclosed. BeSpoon, based in Le Bourget du Lac, France, is a fabless semiconductor company founded in 2010 specializing in UWB communications technology. ST will acquire BeSpoon from its majority shareholder, TRUMPF, and from its founders. In parallel with the transaction, ST and TRUMPF will enter into a strategic partnership for UWB tracking technology. Riot Micro, based in Vancouver, Canada, designs cellular IoT solutions by applying proven design techniques from Bluetooth Low Energy (BLE) and Wi-Fi to LTE Cat-M and NB-IoT to optimize system cost and power.

Synaptics has signed a definitive agreement to acquire certain assets and manufacturing rights associated with the wireless IoT business of Broadcom for approx. \$250 million in cash. Synaptics will acquire certain rights to Broadcom's existing Wi-Fi, Bluetooth and GPS/GNSS products and business in the IoT market as well as future roadmap devices designed in advanced process nodes. Synaptics expects the transaction to add approx. \$65 million in current annualized sales and provide significant revenue growth potential. The transaction is expected to be immediately accretive to non-GAAP earnings.

Synaptics has signed a definitive agreement to acquire **DisplayLink**, a leader in high-performance video compression technology, for \$305 million in cash. Synaptics expects the transaction to add approx. \$94 million in annualized sales and be immediately accretive to non-GAAP earnings.

DisplayLink's software compression technology enables universal docking and casting of high bandwidth video from any device to any display using any transport medium such as USB, Ethernet or Wi-Fi. For the Enterprise IT market, the solution supports multi-OS environments including Windows, MacOS, ChromeOS and Ubuntu Linux.

The DisplayLink acquisition, in addition to the acquisition of Broadcom's wireless IoT connectivity portfolio, further accelerates Synaptics' longterm IoT diversification strategy. The combined roadmap is capable of delivering solutions that drive up to four 4K displays, adds support for emerging 8K/10K displays and the upcoming USB4 standard, and enables high-performance, dynamic wireless video docking and casting. ■

Business

Alchip has become a leading advanced technology ASIC provider with the number of expected tape-outs jumping to nine by the end of 2020. Alchip has completed 3 tape-outs in May alone. Alchip's 7nm ASIC capabilities focus on full reticle size devices that features billions of gates for ultra-large-scale design. These advanced ICs primarily target AI, high-performance computing, network and storage applications. Alchip is also working on a 6nm project, with several more in the pipeline.

Altair Semiconductor is changing its name to "Sony Semiconductor Israel," four years after being acquired by them. The company's cellular IoT product line will maintain "Altair" branding.

Analog Devices narrowed and raised its financial guidance for the third quarter of fiscal 2020. ADI currently anticipates revenue of approx. \$1.45 billion, +/- \$30 million. This compares to previous guidance of \$1.32 billion, +/- \$70 million, provided on May 20, 2020. The guidance increase is driven by better than expected demand across ADI's end markets with particular strength in Communications and Industrial. This upside in demand has resulted in less cancellations and higher than anticipated backlog conversion.

Arm has announced proposed strategic organizational changes to strengthen its focus on growth and profitability. The company is proposing to transfer its two IoT Services Group (ISG) businesses, IoT Platform and Treasure Data, to new entities that would be owned and operated by **SoftBank** and its affiliates. Upon completion of the proposed transfer, Arm will deepen its focus on its core semiconductor IP business and expects to continue collaborating with the new ISG businesses. To-date, Arm partners have shipped more than 165 billion Armbased chips, and an average of more than 22 billion per year over the past three years as demand for computing accelerates with the proliferation of IoT, 5G and AI.

ASE, the leading provider of semiconductor manufacturing services in assembly and test, reported revenues of NT\$107,549 million (~US \$3.66B) for 2Q20, up 19% Y/Y and up 11% sequentially. Net revenue contribution from packaging operations, testing operations, EMS operations and others, each represented approx. 50%, 12%, 37% and 1%, respectively, of total net revenues for the quarter. The total number of employees was 95,448 as of June 30, 2020.

The five largest customers together accounted for approx. 50% of total net revenues in Q2'20. Two customers each accounted for more than 10%. The top 10 customers contributed 61% of total net revenues. IDMs accounted for 29%.

Himax pre-announced preliminary unaudited key financial results for the three months ended June 30th, 2020. The second quarter revenues, gross margin and EPS all exceeded the guidance issued on May 7th, 2020. Revenues were \$187 million, an increase of 1.3% sequentially versus the guidance of a slight decrease of within 5% sequentially.

Intel is accelerating its transition to 10nm products this year with increasing volumes and strong demand for an expanding line up. This includes a growing portfolio of 10nm-based Intel Core processors with "Tiger Lake" launching soon and the first 10nm-based server CPU "Ice Lake," which remains planned for the end of this year. In 2H'21, Intel expects to deliver a new line of client CPU's ("Alder Lake"), which will include its first 10nm-based desktop CPU, and a new 10nm-based server CPU ("Sapphire Rapids").

The company's 7nm-based CPU product timing is shifting approx. 6 months relative to prior expectations. The primary driver is the yield of Intel's 7nm process, which based on recent data, is now trending approx. 12 months behind the company's internal target.

Intel Q2 Rev Mix	<u>\$B</u>	<u>Gth</u>
Client Computing	9.5	7%
Data Center	7.1	43%
NVM Solutions	1.7	76%
IoT	0.67	-32%
Programmable (FPGA)	0.501	2%
Mobileye	0.146	-27%
Total	19.728	20%

Kioxia expected to complete its acquisition of **LITE-ON Technology's Solid State Drive (SSD) business**, Solid State Storage Technology Corporation and its affiliated companies on July 1, 2020.

Navitas has delivered its 5 millionth GaN power IC based on its GaN-Fast technology to **OPPO**. Navitas GaN power ICs are also embedded power chargers from Aukey, Anker, RavPower, Xiaomi, Huawei, Lenovo, and others.

Presto Engineering, an ASIC design and outsourced operations provider to semiconductor and IoT device manufacturers, has opened its new Caen Hub in France. The facility will provide IC test, qualification, and test production services primarily for communications, automotive, IoT, and industrial applications.

Seoul Semi, the world's second-largest global LED manufacturer, announced KRW 268 billion (~US \$220M) of consolidated revenue for Q2 and operating profit of KRW 14 billion. Seoul also provided sales guidance of KRW 300 billion for Q3. The rebound comes from wider adoption of Seoul's WICOP technology for various applications such as TVs, monitors and

Business

(Continued from page 11)

notebook PCs which require slim LED designs.

SK hynix announced revenue for Q2'20 ending June 30, 2020 was 8.607 trillion won (~US \$7.21 billion) while the operating profit amounted to 1.947 trillion won, and the net income 1.264 trillion won. Both the Company's revenue and operating income increased by 20% and 143% QoQ respectively.

For DRAM, although weak demand of mobile customers continued, SK hynix managed to expand sales of both server and graphics products as demand and price remained stable. Consequently, both DRAM bit shipment and ASP increased by 2% and 15% QoQ respectively. SK hynix's SSD business accounted for nearly 50% of its NAND Flash business for the first time. As a result, the NAND Flash bit shipment and ASP increased by 5% and 8% QoQ respectively.

Skyworks has reached a milestone with the shipment of over 150 million bulk acoustic wave (BAW) filter-enabled modules for 5G mobile solutions. According to Strategy Analytics, 5G smartphones are expected to take up a much larger portion of global shipments this year, growing more than 10X to an estimated 15% of all smartphone shipments, up from just 1% in 2019.

Soitec announced **EpiGaN's** name change to SOITEC BELGIUM N.V. With EpiGaN's acquisition in May 2019, Soitec confirmed its ambition to further extend its portfolio beyond silicon. Soitec's GaN business unit acquired a year ago consolidates the company's portfolio of engineered substrates for RF and power markets.

Ultra Clean has expanded into Malaysia and will be opening a manufacturing facility in the Batu Kawan Industrial Park, Pulau Pinang. Leasehold improvements should begin in Q4 and the new facility will likely employ more than 650 personnel over the next five years, including roles in manufacturing, engineering, R&D and quality management. Ultra Clean is a developer and supplier of critical subsystems, ultra-high purity cleaning and analytical services primarily for the semiconductor industry. ■

Market Research

Worldwide sales of semiconductors were \$35 billion in May 2020, up 5.8% from the May 2019 total of \$33 billion and 1.5% more than the April 2020 total of \$34.4 billion, reports the SIA. A newly released WSTS industry forecast projects annual global sales will increase 3.3% in 2020 and 6.2% in 2021. SIA represents 95% of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms.

North America-based manufacturers of semiconductor equipment posted \$2.32 billion in billings worldwide in June 2020, according to **SEMI**. The billings figure is 1.1% lower than the final May 2020 level of \$2.34 billion, and 14.4% higher than the June 2019 billings level of \$2.03 billion.

The global semiconductor packaging materials market will track chip industry growth to expand from \$17.6 billion in revenue in 2019 to \$20.8 billion in 2024, a 3.4% CAGR, reports SEMI and TechSearch International.

Worldwide silicon wafer area shipments rose 8% to 3,152 million square inches in Q2'20 compared to the 2,920 million square inches shipped in Q1 and surpassed Q2'19 shipments by 6%, according to the **SEMI Silicon Manufacturers Group**.

Silicon Area Shipment Trends Semiconductor Applications Only Millions of Square Inches

1Q′19	3,051
2Q'19	2,983
3Q'19	2,932
4Q'19	2,844
1Q'20	2,920
2Q′20	3,152

Global sales of semiconductor manufacturing equipment by OEMs are projected to increase 6% to \$63.2 billion in 2020 compared to \$59.6 billion in 2019 before logging record high revenue of \$70 billion in 2021, reports **SEMI**.

The wafer fab equipment segment, which includes wafer processing, fab facilities, and mask/reticle equipment, is expected to rise 5% in 2020 followed by 13% growth in 2021 driven by a memory spending recovery and investments in leading-edge and China. Foundry and logic spending, accounting for about half of total wafer fab equipment sales, will see single-digit increases in 2020 and 2021. Both DRAM and NAND spending in 2020 will surpass 2019 levels and are projected to grow over 20%, respectively, in 2021.

The assembly and packaging equipment segment is forecast to grow 10% to \$3.2 billion in 2020 and 8% to \$3.4 billion in 2021 driven by advanced packaging capacity buildup. The semiconductor test equipment market is expected to increase 13%, reaching \$5.7 billion in 2020, and continue the growth momentum in 2021 on the back of 5G demand.

Robust spending in China in the foundry and memory sectors is expected to vault the region to the top in total semiconductor equipment spending in 2020 and 2021. Taiwan equipment spending, after seeing 68% growth in 2019, is forecast to contract this year but bounce back with 10% growth in 2021, with the region maintaining the

SEMI[®] Mid-Year Total Equipment Forecast by Region



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IC market in 2020 with sales of \$56 billion, an increase of 27%, the strongest projected percentage growth rate among all 33 IC product categories this year. Like DRAM, the record-high year for NAND sales was 2018 when the market topped \$59.4 billion. The NAND flash market is expected to represent 15.2% of the total IC market this year. Together with DRAM, the two memory categories are forecast to account for nearly one-third of all IC sales this year.

The forecast for computer CPU MPUs shows a 2.2% increase in sales to about \$41.7 billion. Cellphone application processor sales are expected to decline 3% in 2020 to \$20.9 billion, which still would make this segment the fifth-largest IC product category. ■

Emerging Trends

AUDI, Ericsson, Qualcomm, SWARCO Traffic Systems and the University of Kaiserslautern have completed the world's first-announced C-V2X trial. Initiated in December 2016, the trial utilized a test bed and field tests based on 3rd Generation Partnership Project (3GPP) C-V2X direct and network-based complementary technologies

2020 Forecast of Largest IC Products Sales and Unit Shipments

Sales	\$, Millions	20F/19 % Chg
DRAM	\$64,555	3.2%
NAND Flash	\$56,007	27.2%
Computer CPU	\$41,681	2.2%
Computer and Periph—Spcl Purp Logic	\$28,787	6.0%
Cellphone Application MPUs	\$20,904	-3.0%
Unit Shipments	Millions	20F/19 % Chg
Power Management Analog	65,105	-3.2%
Wireless Comm—App Specific Analog	22,901	-2.0%
Industrial—App Specific Analog	21,602	-4.9%
DRAM	18,560	7.5%
General Purpose Logic	16,681	-4.9%

Source: IC Insights

second spot in equipment investments. Korea is expected to rank third in semiconductor equipment investments in 2020, outstripping its 2019 levels. Korea equipment spending is projected to grow 30% in 2021 powered by the memory investment recovery. Most other regions tracked will also see growth in 2020 or 2021.

EDA industry revenue increased 3.5% in Q1'20 to \$2,698 million, compared to \$2,606.4 million in Q1'19, reports the **Electronic System Design (ESD)** Alliance. The companies tracked employed 45,938 in Q1'20, a 5.6% increase over the Q1'19 head-count of 43,500 and up 1.1% compared to Q4'19.

CAE generated revenue of \$854.9 million in Q1'20, a 1.7% increase compared to Q1'19. IC Physical Design and Verification revenue reached \$507.9 million, an 8.9% decrease compared to Q1'19. PCB and MCM revenue grew 12% to \$250.9 million. SIP revenue totaled \$985.6 million in Q1'20, a 12.5% increase compared to Q1'19. Services revenue totaled \$98.7 million, an 8.6% decrease.

The Americas, the largest reporting region by revenue, purchased \$1,118.1 million of EDA products and services in Q1'20, a 0.5% increase compared to Q1'19. Revenue in EMEA increased 13.4% to \$392.3 million. Revenue in Japan increased 9.8% to \$268.6 million. APAC revenue increased 1.8% to \$918.9 million.

DRAM will account for 17.5% of the total \$368.3 billion IC market in

2020, according to IC Insights. The DRAM market achieved its highest-ever sales volume in 2018 when it reached \$99.4 billion. That year, DRAM sales accounted for 23.6% of the total IC market. With expected sales growth of 3.2% this year, the DRAM market is forecast to reach nearly \$64.6 billion, 15% greater than the NAND flash market.

NAND flash is forecast to be the second-largest

Emerging Trends

(Continued from page 13)

for connected vehicles and Intelligent Transportation Systems (ITS).

The tests were designed to provide further evidence of the complementary nature of short-range direct and cellular wide-range communication with C-V2X and received results demonstrating the reliability and performance of the vehicle-to-everything (V2X) technology. The organizations formed the Connected Vehicle-to-Everything (V2X) of Tomorrow (ConVeX) consortium in December 2016, and since have successfully completed and analyzed end-to-end implementation and performance testing in realistic driving conditions.

During the project, ConVeX, which is co-funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI), tested and demonstrated several use cases for C-V2X, including Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) direct communication operating in the 5.9GHz ITS frequencies, as well as Vehicle-to-Network (V2N) wide area communication. For these tests, Audi vehicles and SWARCO's intelligent road infrastructure were equipped with C-V2X technology based on the Qualcomm 9150 C-V2X Platform. ■

Products

Ampere announced further roadmap details of its Ampere Altra server processor family. In March, the company announced Ampere Altra, a cloud native processor featuring 80 cores. Ampere has now unveiled preliminary details of the expansion of the cloud-native processor family by adding Ampere Altra Max, which has 128 cores. Compatible with the 80core Ampere Altra and also supporting 2-socket platforms, Ampere Altra Max will be sampling in Q4. Ampere has also recently completed the tape-out of a 5nm test chip for internal validation. Several customers have begun to offer platforms featuring Ampere Altra.

Efinix has introduced the Trion Titanium FPGA family, which is fabricated on a 16nm process node and feature Efinix's QuantumTM compute fabric. Inspired by the Quantum fabric underlying Efinix's first-generation Trion FPGAs, the Quantum compute fabric adds additional compute and routing capability into its enhanced eXchangeable logic and routing (XLR) cells. The Titanium family comprises FPGAs ranging from 25K to 500K logic elements. The FPGAs have a range of hardened IP such as PCIe Gen4, DDR4, 10 Gbps Ethernet, and 2.5 Gbps MIPI controllers.

GLOBALFOUNDRIES' most advanced FinFET solution, 12LP+, has completed technology qualification and is ready for production at GF's Fab 8 in Malta, New York. Several 12LP+ tape-outs are scheduled for 2H'20. 12LP+ builds upon GF's established 14nm/12LP platform, of which GF has shipped more than one million wafers. GF's 12LP is being used by companies including **Enflame**, **Tenstorrent**, and others for AI accelerator applications.

12LP+ features a 20% SoC-level logic performance boost over 12LP, and a 10% improvement in logic area scaling. 12LP+ introduces new features including an updated standard cell library, an interposer for 2.5D packaging, and a low-power 0.5V Vmin SRAM bitcell.

Graphcore has introduced its second generation IPU platform with greater processing power, more memory and built-in scalability for handling extremely large Machine Intelligence workloads. The IPU-Machine M2000 is a plug-and-play Machine Intelligence compute blade that has been designed for easy deployment and supports systems that can grow to massive scale. The slim 1U blade delivers one Peta-Flop of Machine Intelligence compute and includes integrated networking technology, optimized for AI scale-out.

Each IPU-Machine M2000 is powered by four of Graphcore's new 7nm Colossus Mk2 GC200 IPU processors, which deliver an 8X step up in performance compared to first-generation Graphcore IPUs. The design of the IPU-Machine M2000 allows customers to build datacenter-scale systems of up to 64,000 IPUs, in IPU-PODTM configuration, that deliver 16 ExaFlops of Machine Intelligence compute.

Each IPU chip contains more than 59.4 billion transistors on a single 823mm² die. The GC200 integrates 1,472 separate IPU-Cores and is capable of executing 8,832 separate parallel computing threads. Each IPU processor core gets a performance boost from a set of novel floating-point technologies developed by Graphcore, called AI-Float.

The new Mk2 GC200 has 900MB ultra-high-speed SRAM spread across the IPU, with In-Processor Memory sitting right next to each processor core in an IPU-Tile[™] for the lowest energy access per bit. 900MB is a 3x step up in density when compared to the Mk1 IPU. IPU-Machine M2000 and IPU-POD64 systems are available to pre-order with full production volume shipments starting in Q4'20.

GSI Technology announced the publication of the whitepaper "In-Memory Acceleration For Big Data" by **The Linley Group**. The whitepaper provides an overview of GSI's Gemini Associative Processing Unit (APU), advantages over other processors, and examples of its performance.

Gemini APU's includes millions of processors that can load data directly from the on-chip memory. This design intersperses more than two million small processing units among 48 million

	<u>Gemini APU</u>	<u>Xeon 8280</u>	<u>Nvidia A100</u>	Graphcore		
Compute Cores	2 millionx1-bit	28x2x512-bits	104x4,096-bits	1,216x64-bits		
Compute Speed	400MHz	2.7GHz	1.4GHz	1.6GHz		
Peak Compute*	25 TOPS	10 TOPS	75 TOPS	16 TOPS		
On-Chip Memory	12MB L1	38.5MB L3	40MB L2	300MB L1		
Mem Bandwidth	26 TB/s	1 TB/s	7 TB/s	16 TB/s		
Power	60W TDP	205W TDP	400W TDP	150W TDP		
*Trillions of 8-bit ADD operations per second (TOPS). (Source: vendors)						

memory cells, dividing this memory into enough subunits to feed each processor, thereby allowing for much higher data flow. As a result, Gemini outperforms standard processors by 100x or more on big-data workloads while reducing power by 70%.

Intel has revealed new details about Thunderbolt[™] 4, the next generation of its universal cable connectivity solution, delivering increased minimum performance requirements, expanded capabilities and USB4 specification compliance. Thunderbolt 4 always delivers 40 Gbps speeds and data, video and power over a single connection. It is the most comprehensive Thunderbolt specification yet with compliance across the broadest set of industry-standard specifications, including USB4, DisplayPort and PCI Express (PCIe).

For the first time, Thunderbolt 4 will offer docks with up to four Thunderbolt ports and universal cables up to 2 meters in length. Intel's upcoming mobile PC processors, code-named "Tiger Lake," will be the first to integrate Thunderbolt 4. Intel also announced the Thunderbolt 4 controller 8000 series, compatible with the hundreds of millions of Thunderbolt 3 PCs and accessories already available.

Marvell announced a custom ASIC offering that addresses the requirements of next generation 5G carriers, cloud data centers, enterprise and automotive applications. Marvell's custom ASIC solution enables a mul-

titude of customization options and a differentiated approach with best-inclass standard product IP including Arm-based processors, embedded memories, high-speed SerDes, networking, security and a wide range of storage controller and accelerators in 5nm and beyond. With its legacy as part of IBM, GlobalFoundries and AveraSemi, the Marvell ASIC team brings decades of expertise with the custom ASIC model across 14 leading-process nodes and has produced over 2,000 custom ASICs.

Palma Ceia SemiDesign's new transceiver for the 802.11ax Wi-Fi standard, PCS11ax28, is now available for customer sampling. The 802.11ax standard, also known as Wi-Fi 6, offers greater maximum data rates than earlier standards, as well as higher network capacity to support greater numbers of IoT devices. Wi-Fi 6 is backward-compatible with the previous version of the Wi-Fi standard, 802.11ac. The new Wi-Fi 6 chip is currently available in 1x1 MIMO configuration. Availability of 2X2 and 4X4 configurations is expected to begin in Q3'20. The chip

How Thunderbolt 4 is different than other solutions

Based on minimum solution requirements so people know what they are getting

		Thunderbolt™ 4	Thunderbolt™ 3	USB4	USB3/DP
Unrivaled	One universal computer port	•	•		
Simplicity	Universal 40Gb/s cables up to 2 meters in length	•			
	Accessories with four Thunderbolt ports	•			
Maximum	Minimum PC speed requirements	40Gb/s	40Gb/s	20Gb/s	10Gb/s
Performance	mance Minimum PC video requirements		One 4K display	One display (No Minimum)	One display (No Minimum)
	Minimum PC data requirements	PCIe 32 Gb/s USB 3.2 - 10Gb/s	PCIe 16 Gb/s USB 3.2 - 10Gb/s	USB 3.2 - 10Gb/s	USB 3.2 - 5Gb/s
Required PC charging on at least one computer por		•			
	Required PC wake from sleep when computer is connected to a Thunderbolt dock	•			
	Minimum PC port power for accessories	15W	15W	7.5W	4.5W
	Thunderbolt Networking	•	•		
Reliable Mandatory certification for all shipping computers, accessories and cables		•	•		
	Cable testing and cable quality audits for Thunderbolt cable manufacturers	•	•		
	Required Intel VT-d based DMA protection	•			
	USB4 Specification	Compliant	Compatible	Compliant	Compatible

thunderbolt.

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¹For thin and light notebooks that require less than 100W to charge

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Products

(Continued from page 15)

is fabricated on a high-performance 28nm HPC process.

Qualcomm has unveiled the new Qualcomm Snapdragon Wear 4100 platforms, Snapdragon Wear 4100+ and Snapdragon Wear 4100, designed for next-gen connected smartwatches. The Snapdragon Wear 4100+ platform is based on a hybrid approach and includes a super-fast SoC, a smarter Always On (AON) co-processor, and substantial improvements in platform power based on 12nm process technology.

imoo and Mobvoi, the first of many customers, are announcing smartwatches based on the Snapdragon Wear 4100 platform and will be shipping their products later this year. imoo is the leading brand for kid smartwatches. Mobvoi is an AI company and is announcing its next gen Tic Watch Pro smartwatches based on the Snapdragon Wear 4100 platform. The Suunto 7 smartwatch is based on Snapdragon Wear 3100 and Wear OS by Google. Suunto is looking forward to learning more about the new Snapdragon Wear 4100 platforms and expanding its collaboration with Qualcomm.

Tenstorrent has achieved first-pass silicon success for its Grayskull AI processor SoC using **Synopsys'** DesignWare PCIe 4.0 Controller and PHY, ARC HS48 Processor, and LPD-DR4 Controller IP. Due to the success of the Grayskull SoC, Tenstorrent intends to engage with Synopsys on their next-gen AI processor SoCs.

Unispectral, developer of the ColorIR[™] filter, introduced a new Evaluation Kit for its tunable NIR filter and camera. Unispectral's miniature tunable filter turns low cost IR cameras into 700-950nm spectral cameras. The core product consists of a tunable MEMS filter assembled on a

camera module. A RaspberryPi is used to capture parameters and interface by USB/WiFi to a PC or Mobile device. An SDK is included to develop additional applications.

xMEMS has introduced Montara, a monolithic true MEMS speaker, delivering high fidelity, full-bandwidth sound and low total harmonic distortion (THD) for sealed in-ear personal audio devices, including true wireless stereo (TWS) earbuds. Montara is also the first IP-57 rated microspeaker, enabling water and dust-resistant earbuds, and first SMT-ready MEMS speaker. Montara eclipses early hybrid-MEMS speakers by implementing the entire speaker (actuator and diaphragm/membrane) in silicon. Samples now, MP in early 2021. ■

Licensing & Partnerships

II-VI has signed an agreement with GE to license technology to manufacture silicon carbide (SiC) devices and modules for power electronics. II-VI intends to remain focused on executing its plan to scale capacity of 150mm SiC materials by 5-10x while scaling volume production of a differentiated 200mm materials technology to meet anticipated growing demand over the next five years. GE and its industrial businesses, led by Aviation, continue to aggressively develop next-gen silicon carbide for new applications. The business offers electrical power products with power levels from kilowatts to megawatts for harsh environments in aerospace, industrial, and military applications.

HiSilicon and **Nowi** showcased the 2nd generation of their Energy Autonomous NB-IoT platform. The device acts as a sensor hub that can transmit via NB-IoT while operating indefinitely through its energy harvesting capabilities. It is based on HiSilicon's Hi2115 NB-IoT solution and Nowi's NH2 energy harvesting PMIC. It supports 3 trans-

missions per day indoors or 6 outdoors operate with PV cells.

Imec and GLOBALFOUNDRIES announced a hardware demonstration of a new AI chip. Based on imec's Analog in Memory Computing (AiMC) architecture utilizing GF's 22FDX solution, the new chip is optimized to perform deep neural network calculations on in-memory computing hardware in the analog domain. The chip achieves record-high energy efficiency up to 2,900 TOPS/W for inference-on-the-edge for low-power devices. GF will include AiMC as a feature able to be implemented on the 22FDX platform. 22FDX with the new AiMC feature is in development at GF's 300mm production line at Fab 1 in Dresden, Germany.

Infineon's Silicon Valley Innovation Center (SVIC) has entered a new agreement with Blumio to co-develop a wearable, non-invasive blood pressure sensor based on Infineon's XENSIV radar chipset by 2021. The new sensor has the potential to disrupt the \$45 billion market for wearable cardiovascular monitoring devices by enabling continuous and precise measurement without a cuff. Upon successful completion, a kit combining Infineon's radar chipset and development board with Blumio's software and algorithms would be released to consumer and medical wearable device makers to integrate into their blood pressure monitoring devices.

JLQ Technology (www.jlq.com) has adopted Synopsys' DesignWare IP portfolio to reduce risk and speed timeto-market for next-gen mobile chipsets. JLQ chose Synopsys' silicon-proven DesignWare IP, including USB, MIPI, DDR, and more. The long-standing collaboration between the two companies has resulted in first-pass silicon success and volume production for JLQ's prior SoCs.

Jianguang Asset Management, Leadcore Technology, Qualcomm and Wise Road Capital formed the JLQ joint venture in 2017 to develop chipsets for mass-tier smartphones designed and sold into China. JLQ now develops mobile chips and solutions, as well as SoCs for intelligent IoT products including smart cameras, smart players and industrial robots.

Mixel, a provider of mixed-signal IP, and **Perceive**, an edge inference solutions company, announced that Mixel's MIPI IP solution has been integrated into Perceive's Ergo[™] edge inference processor, which is currently being sampled and will be in mass production in the near future. Ergo achieved first-time silicon success on GLOBAL-FOUNDRIES 22FDX platform.

Ergo delivers more than 4 sustained GPU-equivalent floating-point TOPS at over 55 TOPS/W, with the ability to run multiple heterogeneous, large neural networks in a consumer device friendly 7x7mm package without need for any external RAM. Mixel provided Perceive with three different MIPI IP solutions; a four-lane MIPI D-PHYSM CSI-2SM TX IP and both a two-lane and four-lane MIPI D-PHY CSI-2 RX IP. The CSI-2 Peripheral Controller Core is developed by Rambus, who acquired Northwest Logic and is an active participant in Mixel's MIPI Central Ecosystem.

Nordic Semi and Qorvo are expanding their partnership to include dual UWB and Bluetooth LE connectivity solutions, complementing the companies' low power cellular IoT portfolios, following Qorvo's acquisition of UWB pioneer **Decawave**. Nordic and Qorvo have collaborated for years on Nordic's nRF9160 SiP with integrated LTE-M/ NB-IoT modem and GPS. Nordic's nRF9160 leverages Qorvo's RF Front End (RFFE), advanced packaging, and MicroShield technology. Nordic and Decawave collaborated previously, and Nordic's nRF52832 SoC is integrated in Decawave's DWM1001C UWB and Bluetooth LE module. Future UWB/Bluetooth LE products jointly designed by Nordic and Qorvo will combine Qorvo's UWB transceiver with Nordic's nRF52833 SoC, a 105°C qualified Bluetooth 5.2 SoC supporting Bluetooth LE, Direction Finding and Bluetooth mesh.

POET Technologies, developer of the POET Optical Interposer and Photonic ICs for the data center and telecom markets, has signed a LOI to establish a joint venture with Xiamen Sanan Integrated Circuit Co., Ltd. (Sanan **IC)** to manufacture high-performance optical engines based on POET's CMOS compatible Optical Interposer platform technology. The proposed JV will be formed with contributions of \$50 million based on a combined commitment of cash and IP from Sanan IC and IP and know-how from POET. The JV is expected to manufacture 100G, 200G and 400G optical engines with customized lasers and photodiodes from Sanan IC combined with optical interposer platform technology from POET.

Soitec announced a business agreement with **Qualcomm** on the supply of piezoelectric-on-insulator (POI) engineered substrates for 4G and 5G RF filters. After multiple years of collaboration with Qualcomm, Soitec has concluded an agreement to bring POI wafer production to high volume manufacturing to be used for Qualcomm's RF filters going into smartphone RF front end modules.

Velodyne Lidar announced a long-term global licensing agreement with Hesai Photonics Technology encompassing 360° surround-view lidar sensors. As a result, Velodyne and Hesai have agreed to dismiss current legal proceedings in the U.S., Germany and China that exist between the two companies. The relationship with Hesai is the third major licensing agreement for Velodyne's fundamental lidar technology. Velodyne's founder, David Hall, invented real-time surround view lidar systems in 2005 as part of Velodyne Acoustics.

Design Wins

Atmosic announced that TraceSafe, a provider of contact tracing solutions, has selected Atmosic's M2 solution for the TraceSafe AllSafe Wristband. The wristbands provide a complete device-to-cloud solution for contact tracing, social distancing and location tracking that can quickly notify someone if they have come into close contact with someone who has been diagnosed with COVID-19.

TraceSafe selected the Atmosic's M2 because of its support for long-range connectivity of up to 100 meters and its ultra-low power consumption, which provides more than twice the battery lifespan of competitive solutions. This long-range support makes AllSafe Wristbands suitable for a wide variety of contact tracing systems, whether the devices are configured to connect to a person's smartphone or a gateway – for example, a factory implementation that sends signals from workers' wristbands to a gateway.

Atmosic's portfolio also includes its M3 solutions, which further extend battery life and can eliminate the need for batteries by integrating Energy Harvesting technology. The AllSafe Wristband will be distributed to all fans attending events hosted by the Toronto Wolfpack Rugby League Football Club, the "Toronto Wolfpack," at Lamport Stadium, as well as at other Canadian Rugby Stadiums during the coming season.

Ford and Mobileye, an Intel company,

are collaborating on driver-assistance systems across Ford's global product lineup. Mobileye will provide its EyeQ family of devices, together with

Design Wins

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vision-processing software to support Level 1 and Level 2 driver-assistance systems in Ford vehicles globally. Ford will include Mobileye's logo in the SYNC driver-assist displays.

Level 1 systems are defined by the Society of Automotive Engineers as automating a single part of the driving experience, such as steering or acceleration / deceleration, while Level 2 systems provide both steering and acceleration / braking support. Both require drivers to supervise performance of the vehicle.

Used to help identify what the windshield camera in a vehicle can see – including lane markings, traffic signs, pedestrians and other vehicles – Mobileye's technology will support features such as Lane-Keeping System, Auto High-Beam headlamps, Pre-Collision Assist with Automatic Emergency Braking and Intelligent Adaptive Cruise Control, as well as Active Drive Assist hands-free driving coming to the all-new Mustang Mach-E and all-new F-150.

Ford is also evaluating the use of Roadbook in its vehicles. Roadbook uses anonymized, crowd-sourced data from vehicle cameras to build a high-definition map that can be accessed by vehicles and leveraged by driver-assist technology, including hands-free driving features like available Active Drive Assist.

Company Financials - July Releases

		Next Qtr		Cu	Irrent Qtr			Last Qt	r	Yr-a	igo Qtr		Sales		
Company	Symbol	Outlook	Sales	Net	Margin	GM	Sales	Net	GM	Sales	Net	GM	Growth	Qtr	Ending
Aehr Test Sys	AEHR	n/a	4	-2.9	-76%	-3%	6	0.2	49%	7	0.1	46%	-47%	4Q20	31-May
AMD	AMD	\$2.45-2.65B	1932	157.0	8%	44%	1786	162.0	46%	1531	35.0	41%	26%	2Q20	27-Jun
Amkor	AMKR	\$1.2-1.3B	1173	55.4	5%	16%	1153	63.9	16%	895	-9.5	14%	31%	2Q20	30-Jun
AMS	AMS	\$530-570M	460	5.9	1%	37%	501	-16.4	44%	407	24.7	35%	13%	2Q20	30-Jun
ASM Intl. (euro	os) ASM	€00-320M	342	74.1	22%	48%	325	74.1	52%	363	121.6	59%	-6%	2Q20	30-Jun
ASML (euros)	ASML	€.6-3.8B	3326	751.0	23%	48%	2441	390.6	45%	2568	476.0	43%	30%	2Q20	28-Jun
Be Semi (euros) BESIY	Dwn 10-25%	124	39.8	32%	62%	91	13.9	57%	93	18.9	56%	34%	1Q20	30-Jun
Brooks Auto	BRKS	\$229-241M	220	13.7	6%	42%	220	9.2	41%	204	7.3	41%	8%	3Q20	30-Jun
Cadence	CDNS	\$630-650M	638	131.3	21%	88%	618	124.0	88%	580	107.2	89%	10%	2Q20	27-Jun
Cohu	COHU	\$134-146M	144	-4.7	-3%	42%	139	-17.3	40%	150	-19.3	42%	-4%	2Q20	27-Jun
CyberOptics	CYBE	\$19.5-20.5M	16	1.6	5%	46%	16	0.8	45%	15	0.5	43%	7%	2Q20	30-Jun
DSP Group	DSPG	Down	28	-1.1	-4%	50%	28	-2.5	51%	29	-0.5	50%	-2%	2Q20	30-Jun
Entegris	ENTG	\$450-475M	448	68.0	15%	46%	412	61.0	45%	379	124.0	44%	18%	2Q20	27-Jun
FormFactor	FORM	\$170-182M	158	20.5	13%	42%	161	15.9	42%	138	6.9	40%	14%	2Q20	27-Jun
GSI Tech	GSIT	\$6-7.2M	7	-6.1	-92%	45%	9	-3.8	52%	13	-0.1	63%	-49%	1Q21	30-Jun
Intel	INTC	\$18.2B	19728	5105.0	26%	53%	19828	5661.0	61%	16505	4179.0	60%	20%	2Q20	27-Jun
Knowles	KN	\$185-200M	152	-19.5	-13%	31%	163	-9.1	34%	205	5.9	37%	-26%	2Q20	30-Jun
Kulicke & Soffa	a KLIC	\$155-175M	151	11.2	7%	46%	151	11.9	46%	127	1.3	46%	18%	3Q20	27-Jun
Lam Research	LRCX	\$2.9-3.3B	2792	696.7	25%	46%	2504	574.8	47%	2361	541.8	46%	18%	4Q20	28-Jun
Lattice	LSCC	\$96-104M	101	10.6	11%	60%	97	8.2	59%	102	8.6	59%	-2%	2Q20	27-Jun
Littlefuse	LFUS	Up 12-15%	307	-9.0	-3%	32%	346	24.6	36%	398	43.8	36%	-23%	2Q20	27-Jun
MACOM	MTSI	\$144-148M	137	-25.0	-18%	52%	126	-10.2	50%	108	-324.7	31%	27%	3Q20	3-Jul
Magnachip	MX	\$118-124M	119	29.2	25%	27%	121	-23.7	n/a	141	-9.5	22%	-16%	2Q20	30-Jun
Maxim	MXIM	n/a	545	207.3	38%	66%	562	161.2	65%	556	367.6	64%	-2%	4Q20	27-Jun
Maxlinear	MXL	\$72-76M	65	-21.8	-33%	50%	62	-15.5	50%	83	-2.2	53%	-21%	2Q20	30-Jun
Melexis (euros)	MEX.BE	Up 10%	100	9.7	10%	39%	138	20.7	41%	120	15.6	41%	-16%	2Q20	30-Jun
Mono Power	MPWR	\$200-210M	186	30.2	16%	55%	166	35.8	55%	151	20.7	55%	23%	2Q20	30-Jun
NXP	NXPI	\$1.9-2.1B	1817	-214.0	-12%	47%	2021	-21.0	49%	2217	41.0	52%	-18%	2020	28-Jun
O2Micro	OIIM	\$17.6-19M	17	0.5	3%	51%	16	-1.5	52%	14	-3.1	50%	21%	2020	30-Jun
Parade Tech	4966.TWO	\$135-149M	122	28.2	23%	44%	98	20.7	45%	91	17.6	42%	34%	2020	30-Jun
Power Int	POWI	\$110-120M	107	13.2	12%	50%	110	15.9	52%	103	10.8	50%	4%	2020	30-Jun
Oorvo	ORVO	\$925-955M	788	96.9	12%	41%	788	50.4	43%	776	39.5	38%	2%	1021	27-Jun
Oualcomm	OCOM	\$7.3-8.1B	4893	845.0	17%	57%	5216	468.0	56%	9635	2149.0	78%	-49%	3020	28-Jun
Sequans	SONS	Up 10%	12	-19.0	-156%	48%	9	-15.3	51%	8	-9.2	36%	54%	2020	30-Jun
Silicon Labs	SLAB	\$208-218M	208	-1.8	-1%	61%	215	2.2	60%	207	-16.0	61%	0%	2020	4-Jul
Silicon Motion	SIMO	\$114-120M	137	28.2	21%	50%	133	25.9	48%	99	26.5	47%	38%	2020	30-Jun
Skyworks	SWKS	\$830-850M	737	129.7	18%	45%	766	181.1	49%	767	144 1	41%	-4%	3020	26-Jun
STMicro	STM	Up 17 4%	2087	90.0	4%	35%	2231	192.0	38%	2173	160.0	38%	-4%	2020	27-Jun
TI	TXN	\$3 26-3 54B	3239	1380.0	43%	64%	3329	1174.0	63%	3668	1305.0	64%	-12%	2020	30-Jun
Teradyne	TFR	\$745-805M	839	188.9	23%	56%	704	176.2	58%	564	97.4	57%	49%	2020	28-lun
Towerlazz	TSFM	\$320M +5%	310	19.1	6%	19%	300	17.0	18%	306	20.9	17%	1%	2020	30-lun
TSMC	TSM	\$11 2-11 5R	10385	3644.0	35%	53%	10382	4001	52%	8055	2350	43%	29%	2020	30-lun
Ultra Clean	UCTT	\$320-360M	345	21 3	6%	21%	321	9.4	20%	265	-0.2	18%	30%	2020	26-lup
UMC	UMC	Flat	1498	311.0	21%	23%	1427	-84.0	19%	1216	57.0	16%	23%	2020	30-lun
Xilinx	XINX	\$730-780M	727	93.8	13%	69%	756	162.3	71%	850	241 5	67%	-14%	1021	27-lun
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✓ Scintil – Photonic ICs based on Wafer-Scale Bonding of InP on Si

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