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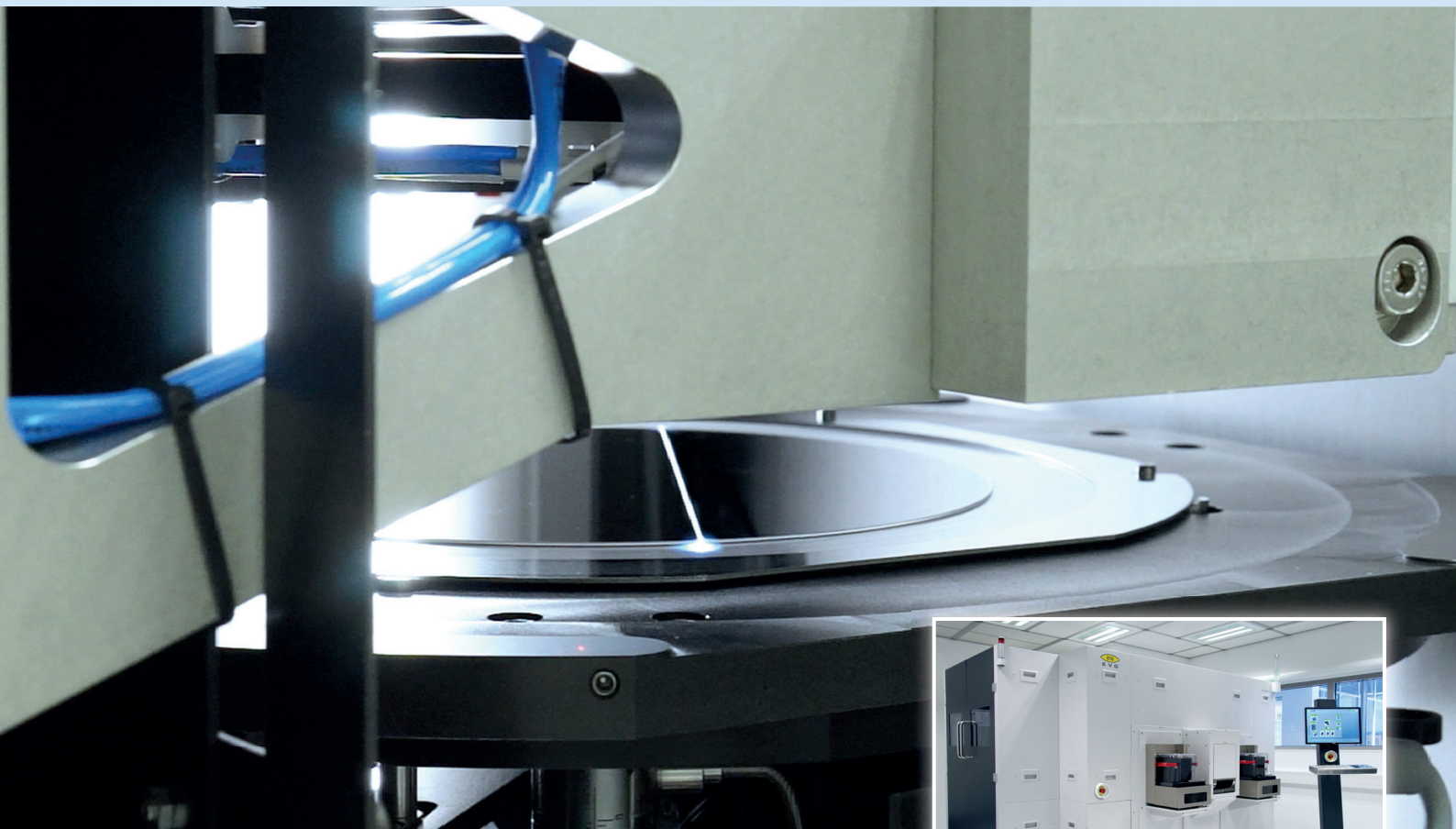




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# editor's view

By Mark Andrews, Technical Editor



## With sales approaching \$400 billion, 2017 made history

2017 began optimistically, with industry insiders hoping for 'modest growth.' But as 31st December draws closer most of those same analysts and pundits say we could top \$400 billion in sales for the first time ever—what a year indeed!

2017 began like many recent years across our industry: consumer sales in the final months of the year past were 'alright-to-good' – far better than Great Recession depths, but still, no boom. Industry analysts and researchers were hoping that positive 2016 indicators might lead to growth in the 5-7 percent range this year, and that the doldrums, retreats and failures of 2015 and 2016 would be replaced with modest progress.

### EVERYONE GOT IT WRONG

Sales across almost all regions of the global semiconductor market surged to new highs throughout 2017 as worries over the sustainability of 2016 momentum evaporated. Growth in the IoT and IIoT ecosystems made headlines. Consumers started buying again, big-time. Not only were retail sales up, but they shot up so fast that manufacturers suffered shortages—the biggest opportunity came for memory device manufacturers who saw prices doubled, or more.

Mid-year predictions of single digit growth were tossed aside. The SEMI trade organization was practically giddy by July's



SEMICON West. Device sales, ongoing fab construction in China (today at 26) and a surge in process tool sales drove indices to new highs. As the final days of 2017 tick away, forecasters say we could top (USD) \$400 billion.

2017 turned from steady growth into a torrent.

And also unlike past years such as 2015's 'merger mania' period, 2017 saw fewer major deals propose or close, save for November in which Broadcom made its unsolicited bid to acquire Qualcomm Communications for a record-setting (USD) \$103 Billion. By early December, the World Semiconductor Trade Statistics (WSTS) group and the Semiconductor Industry Association (SIA) said they believed that 2017 sales would increase by more than 20 percent to a record (USD) \$408 billion. If those sorts of revenue projections materialize by 31st December, 2017 will mark the first time that industry sales topped \$400 billion in a one year; this milestone could arrive just four years after passing the \$300 billion mark.

This year-in-review edition of Silicon Semiconductor examines major stories that made the headlines, including growth across all major indicators.

Chip sales should exceed \$400 billion; fab tool sales have already topped \$50 billion; more fabs are under construction in China at once than in any other building boom since the 1990s. What will 2018 bring? Hold onto your seats, because if 2018 is a good follow-up to 2017, we are in for a wild ride!

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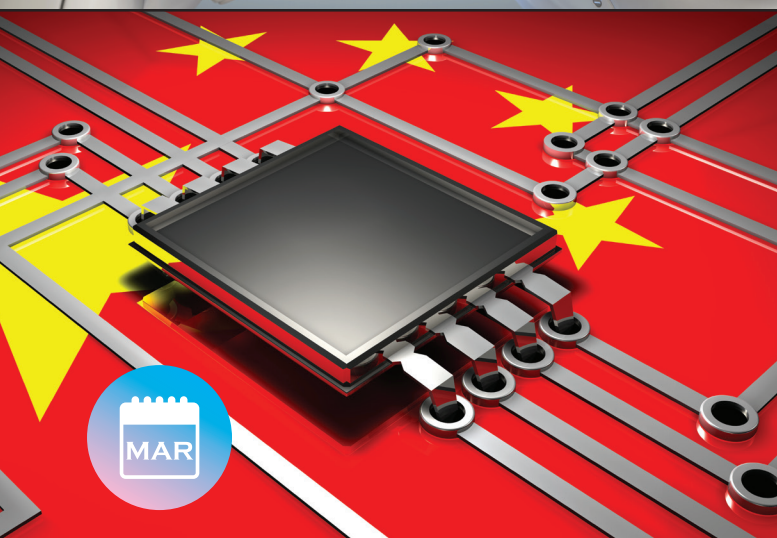
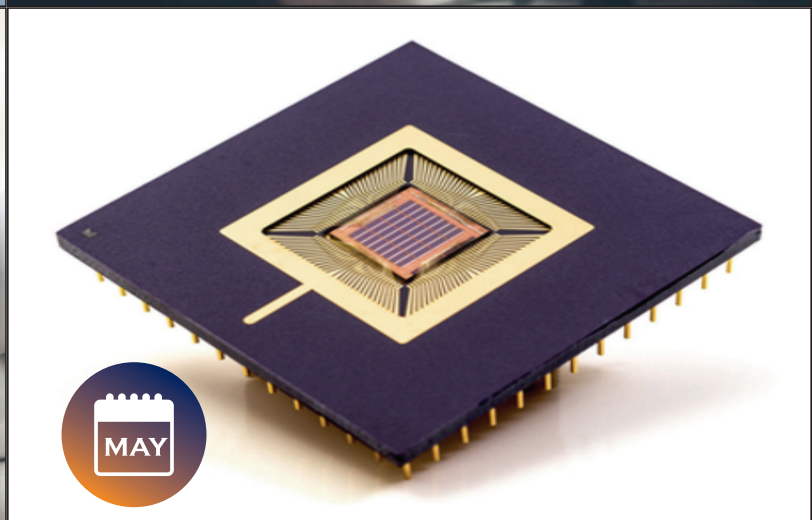
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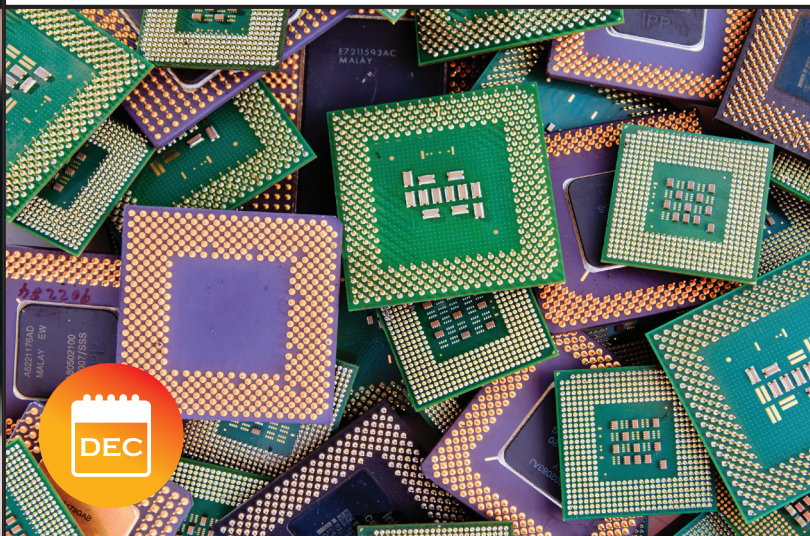
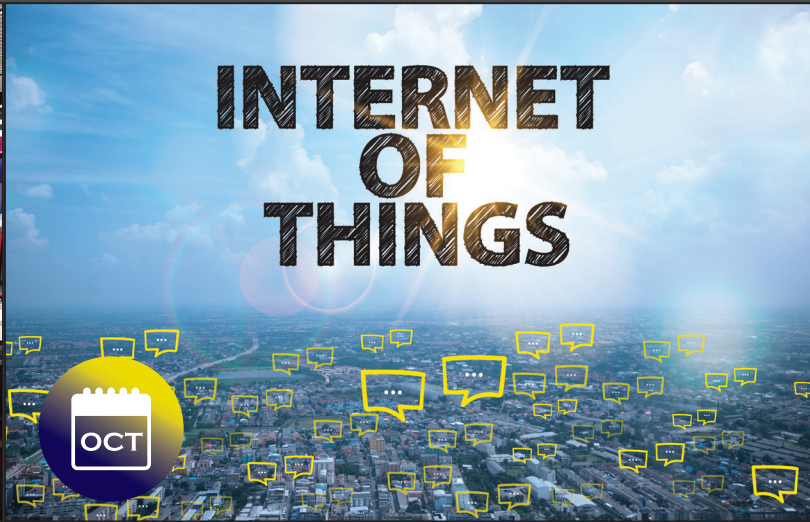


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2017 year in review











# Opportunity abounds in year characterized by record growth

2017 became the year that solid, double-digit growth returned across semiconductor manufacturing as sales surged to all-time highs and hopes remain strong for a bright 2018.

By Mark Andrews, Technical editor.



SALES across almost all segments of the global semiconductor market surged to new highs throughout 2017 as worries over the sustainability of 2016 momentum evaporated. Growth of end user/consumer device sales, ongoing new fab construction in China and a surge in process tool sales led indices to new highs as manufacturers simultaneously celebrated growth and hoped for continued health in the New Year.

While 2016 could be described as a recovery year in which signs of steady growth returned in third and fourth quarters, 2017 has focused on steady growth that turned into a torrent of upwardly mobile forecasts and revised analyses. Unlike 2015 that was characterized by 'merger mania' and sales declines, 2017 saw fewer major deals come to fruition while sales across important consumer segments such as mobile computing and smartphones saw increases. A major factor for 2017's growth spurt was a shortage of key memory components that led to higher prices for suppliers and pledges by major makers such as Samsung to increase their 2018 capacity.

Although most of 2017 was relatively quiet in terms of large-scale mergers and acquisitions, industry watchers were

surprised when Broadcom made an unsolicited bid to acquire Qualcomm Communications in November for a record-setting (USD) \$103 Billion.

The Broadcom offer was announced in the midst of Qualcomm's poor earnings reports tied to its legal battles with Apple. At the same time that Broadcom sought a marriage with Qualcomm, the mobile devices giant continued its battle for NXP Semiconductors, with both sides extending offers to allow EU regulators the time needed to further investigate implications of the deal. The European Commission twice halted their investigations in 2017.

By early December, the World Semiconductor Trade Statistics (WSTS) group that is comprised of 55 major chip companies sharing data said that 2017 sales would increase by more than 20 percent to a record (USD) \$408 billion.

If revenue gains continue through 31st December, 2017 would mark the first time that the industry's sales topped the \$400 billion mark in any one year—this milestone comes just four years after surpassing the \$300 billion mark for the first time.



The Consumer Electronics Show (CES) started trade fair season in the new year with announcements from Qualcomm that its 10nm Snapdragon 835 smartphone SoC would offer upgrades across all its subsystems that analysts called impressive, yet evolutionary. Despite that less than enthusiastic characterization, the new SoC provided support for Quick Charge 4.0 technology, a 35 percent decrease in package size with 25 percent better power efficiency compared to the existing 821. The new SoC was also the company's first ARM-based processor to support Windows 10 on a mobile device.

"This is big news, with Microsoft adding x86 emulation on ARM to Windows 10," said Kevin Krewell, principal analyst at Tirias Research. "I see this as a real threat to Intel. It may also be a step in Microsoft bringing a Windows server to ARM as well," he added. In January the 835 was expected to debut in the next generation of premium smartphones when it ships by the first half of 2017. Its predecessors, the 820/821, were used in smartphones including the Google Pixel, the LG G5 and the Galaxy S7/Edge.

#### 2016 tally: Sales up sharply

While CES saw hundreds of new devices introduced, the Semiconductor Industry Association (SIA) trade group reported that global semiconductor sales posted a year-to-year sales increase of 7.4 percent in November 2016 while the industry continued to pick up steam headed toward year's end. The November increase was the largest for the semiconductor industry since January 2015, the SIA said. That fourth quarter jump increased the likelihood that

semiconductor sales for 2016 would finish flat compared with 2015. Many market watchers—including the SIA—had predicted modest declines for semiconductor sales at the beginning of 2016 while recent sales data indicated that the industry could achieve sales of about (USD) \$335 billion, roughly unchanged from 2015.



#### John Nueffer, SIA

SIA President John Nueffer noted that as global semiconductor sales continued to pick up steam in November, the increase was at the highest rate in almost two years. Nueffer added that the strong close to 2016 left the industry well-positioned to start 2017.

## 2017 year in review

Global chip sales for November 2016 totaled \$31 billion, up from \$28.9 billion in November 2015, according to the SIA.

### **ZigBee Alliance offers language for IoT**

Also at CES, the ZigBee Alliance demonstrated 'dotdot' as a universal language for the IoT, making it possible for smart objects to work together on any network. Members of the ZigBee alliance and Thread Group will also showcase the first demonstrations of dotdot devices running over Thread's IP-based networks.

"Dotdot represents the next chapter in the ZigBee Alliance's continued commitment to create and evolve open standards for the smart networks in our homes, businesses and neighborhoods," said Tobin Richardson, ZigBee Alliance president and CEO, in a statement.



Most IoT devices don't speak the same language, even if they use the same wireless technology. The result is an Internet of Things that is often a patchwork of translations, adding complexity for developers and limiting users to single-vendor systems. According to the ZigBee Alliance, the solution lies in a common language between all IoT devices on any network, giving developers a common platform to innovate on, and users the freedom to choose products that work for them.

### **Right, yet wrong**

Gartner Inc. put their forecast hats on sideways in January, saying that it expected combined shipments of PCs, mobile handsets and tablets—major drivers of the electronics supply chain over the past few years—were projected to remain flat in 2017.

"The global devices market is stagnating," said Ranjit Atwal in January; Atwal is research director at Gartner. "Mobile phone shipments are only growing in emerging Asia/Pacific markets, and the PC market is just reaching the bottom of its decline."

Gartner projected that PC shipments would decline in 2017 for a sixth consecutive year. The firm also predicted that PC shipments would return to growth in 2018 thanks to an expected replacement cycle and the allure of premium ultra-mobile models.

### **Qualcomm gets slapped**

The US Federal Trade Commission got the attention of Qualcomm when it sought a court order against what it alleges are unfair licensing practices for its cellular baseband patents. The complaint alleges among other things that the company "precluded Apple from sourcing baseband processors from Qualcomm's competitors from 2011 to 2016."

The FTC also charged that Qualcomm maintains a "no license, no chips" policy that requires handset makers to agree with Qualcomm's licensing terms to get supplies of its baseband chips. The company also refuses to license standard-essential patents to competitors, the FTC said. In its complaint, the FTC charged, "Qualcomm is unique in requiring an OEM, as a condition of sale, to secure a separate patent license requiring royalty payments for handsets that use a competitor's components."

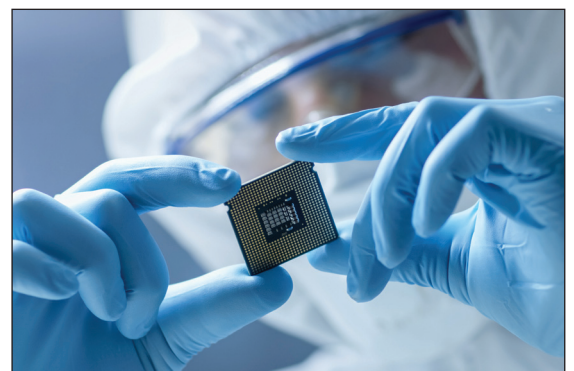
The FTC's action comes less than a month after the Korea Fair Trade Commission (KFTC) fined Qualcomm 1.03 trillion won (nearly USD \$1 billion), charging unfair patent licensing practices. The KFTC levied similar charges of failing to license standards-essential patents to competitors and forcing customers to agree to unfair terms including "making them provide [the customer's] patents for free."

Qualcomm said it will appeal both cases. It described the US complaint as a politically opportunistic move that got the facts wrong and is based on flawed legal theory. "Qualcomm has never withheld or threatened to withhold chip supply in order to obtain agreement to unfair or unreasonable licensing terms," the company said in a statement.

### **Gartner points to modest 2016 chip sales growth**

Global chip revenue increased by 1.5 percent in 2016 as a late-year surge enabled the semiconductor industry to avoid widely anticipated contraction, according to the market research firm Gartner Inc.

Total semiconductor sales for the year were (USD) \$339.7 billion in 2016, up from \$334.8 billion in 2015, according to Gartner's estimates. Combined sales for the top 25 chip vendors increased 7.9 percent compared to 2015, accounting for nearly 76 percent of the market, Gartner added.





Adrian Blanco, a senior research analyst at Gartner, said that 2016 chip sales got off to a slow start due to inventory reduction schemes, but accelerated in the second half of the year thanks to inventory replenishment and improved pricing.

The semiconductor industry's 1.5 percent growth in 2016 is notable because at the start of the year most market watchers—including Gartner—predicted that the industry would contract.

## Analysts project 7% growth in 2017

Global semiconductor revenue was projected by Gartner Inc. to grow 7 percent this year driven by chip inventory replenishment and increased average selling prices.

Gartner spokespeople said their analysts expected 2017 semiconductor sales to total \$364 billion, up from an estimated \$340 billion last year. The firm said it increased its 2017 sales projection by \$14.1 billion from its most recent forecast, \$10 billion of which comes from an increased forecast for memory sales.

"The worst is now over with a positive outlook emerging for 2017 driven by inventory replenishment and increasing average selling prices (ASPs) in select markets, particularly commodity memory and application-specific standard products," said Ganesh Ramamoorthy, research vice president at Gartner, in a statement issued 23rd January. He added that the turnaround which started in the second half of last year is expected to gain momentum and carry throughout 2017.

"Memory market supply and demand have turned positive for vendors who are pushing ASPs higher to recover margins," Ramamoorthy said.

## The IIoT comes into bloom

A new survey by researchers at ON World showed significant growth in the industrial Internet of Things (IIoT) and rising competition among low power wide area (LPWA) networks.

Nearly a third of industrial IoT networks now have more than 1,000 nodes, according to the survey that was conducted of more than 180 industrial automation professionals by ON World. That's twice the level of large scale networks it found in a 2014 survey.

ON World reported that it found 12 percent of respondents have deployed 1,000 or more wireless field devices at a single site, and 11 percent are using LPWA networks such as LoRa or Sigfox. Two out of five respondents are researching, pilot testing or developing LPWA solutions and three-quarters of those developing LPWA plans are targeting new applications that cannot be met with other technologies. Networks that support links of up to one mile make up the majority of today's deployments with rising interest in mesh nets such as 802.15.4-based

WirelessHART. But over the next five to 10 years, ON World predicts faster growth for LPWA networks including Sigfox, LoRa, Ingenu and LTE variants such as Category M1 and Narrowband-IoT.

## Apple rises (again) thanks to iPhone sales

Apple Inc. returned to growth by the end of fourth quarter 2016 following three consecutive quarters of sales declines. The company's record quarterly revenue was lifted by strong iPhone sales, paced by strong demand for the iPhone 7+. While both iPhone and Mac sales fared better than expected, sales of iPads declined versus one year ago, Apple said.

Kevin Krewell, principal analyst at Tirias Research, said a higher than normal number of "switchers" from Android to Apple during the period, which is the first quarter of Apple's fiscal 2017, may have been related to rival Samsung's disastrous Galaxy Note 7 recall in 2016.



Apple reported record quarterly revenue of \$78.4 billion, up 3 percent from the same period of 2015. The company reported a net income for the quarter of \$17.9 billion, a decline of 3 percent versus the year ago period.

## Trump and Brexit could cloud 2017, analysts say

The semiconductor industry should have a good 2017 as long as potentially volatile political issues and politicians stay neutral or positive. Growth could hit 5 percent, led by DRAMs and flash as well as 32-bit microcontrollers, analog and automotive, according to analysts at IC Insights.

That was the view from Bill McClean's annual Silicon Valley Talk. The president of market watcher IC Insights doesn't believe the big plans cooking in China or the Trump administration will substantially impact the industry in 2017, but rising populism in Europe could dampen growth.

"We think this is a milestone year," with IC sales of \$314.1 billion, cracking the \$300 billion mark for the first time, said McClean. He estimated the next milestone at \$400+ billion in 2023, a long period of 4 to 5 percent compound growth. Interestingly, the

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global revenue forecast updated near the end of 2017 points to sales reaching more than \$400 billion by year's end, beating the McClean forecast by six years.

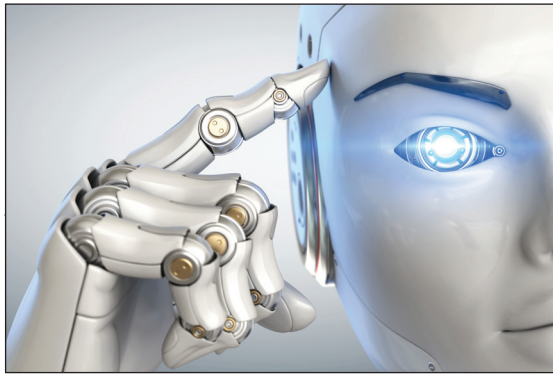


## Apple dominates smartwatch growth

The Apple Watch captured 63 percent market share in the fourth quarter of 2016 as the global smartwatch market returned to modest growth following two consecutive quarters of declines, according to researchers at Strategy Analytics.

In the same study Strategy Analytics reported that smartphone shipments increased by 9 percent while tablet shipments declined by the same percentage. Shipments of smart watches increased by 1 percent compared to the fourth quarter of 2015, reaching 8.2 million units, Strategy Analytics reported. Apple shipped some 5.2 million Apple Watch units during the quarter, the firm said.

South Korea's Samsung Electronics maintained its position as the second-place seller of smart watches globally in the fourth quarter with about 10 percent market share, Strategy Analytics said. Samsung's estimated fourth quarter watch shipments dipped to 800,000, down 38 percent compared to the fourth quarter of 2015, researchers said.



(ESD), IP core reuse, and design rule checking. Rosenbaum's research team will explore use of recurrent neural nets to model ESD characteristics of circuits so that systems pass qualification tests the first time.

"We were facing common problems. We needed behavioral models that interfaced across electro-migration and circuit domains and didn't know how to go about getting them, given that colleagues were interested in different applications," Rosenbaum said in a panel on the topic at DesignCon.

"We knew we would get no funding for one specific problem, so we decided we needed to solve them all, reaching out to other universities to work together to investigate different machine-learning techniques and algorithms that are well suited to use in electronics,"

she said.

The work got backing from the National Science Foundation as well as support from nine companies: Analog Devices, Cadence, Cisco, Hewlett-Packard Enterprise (HPE), IBM, Nvidia, Qualcomm, Samsung, and Xilinx. The center is jointly hosted at the University of Illinois Urbana-Champaign, North Carolina State University (NCSSU), and Georgia Tech.  
February 2017 (continued)

## New EDA paradigm is needed says TSMC

TSMC R&D Director Cliff Hou said at the International Solid State Circuits Conference (ISSCC) that engineers need a new class of Electronic Design Automation (EDA) tools to keep up with the complexity of designing today's semiconductors. Separate tools need to target today's four major markets using new techniques and assumptions including machine learning.

Hou observed that over the last 10 years the industry has been driven by mobile applications, building its design databases around smartphone SoCs. "Now we realize mobile is OK as a starting point but we also have to optimize circuits for automotive, high-performance systems and IoT where the considerations are very different," he said, showing four different SRAM designs TSMC uses just for a range of mobile and wearable designs.

Hou's keynote gave a laundry list of knotty challenges where TSMC is seeing some progress. For example, resistance at metal layers has doubled between the 40nm and 7nm nodes. TSMC has built up complex stacks of via pillars under wires to significantly reduce but not fully mitigate the issue. In addition, power networks must be built with greater care to avoid declines in cell utilization as transistor density increases, he said. He sketched out improvements that showed cell utilization rebounding from about 74 percent to 79 percent at 7nm.

## Intel's Arizona fab comes with \$7B tab

Intel CEO Brian Krzanich went to Washington on 8th February to stand beside President Donald Trump to announce the company's (USD) \$7 billion investment in a semiconductor fab, known as Fab 42, in Arizona. The partially completed facility has stood vacant and unequipped in Chandler, Arizona since the building's shell was completed at the end of 2013.

"The completion of Fab 42 in three to four years will directly create approximately 3,000 high-tech, high-wage Intel jobs for process engineers, equipment technicians, and facilities-support engineers and technicians who will work at the site," Intel said in a statement. Fab 42 is expected to produce devices at Intel's 7nm device node.

While some analysts believed the move was as much about making a political statement as positioning itself for future production requirements, Rob Lineback,



senior market research analyst at IC Insights, said he believes the decision is not about capacity, which Intel has aplenty. He believes Fab 42 is where EUV lithography tools will go. "Availability of EUV lithography tools and processes will help make 7nm successful, but this exposure technology represents a major change."

## Globalfoundries debuts 45nm RFSOI

Process design kits (PDKs) are now available for Globalfoundries 45nm RF SOI, a node particularly suited for making millimeter-wave chips in 24-100 GHz bands for 5G cellular. Skyworks Solutions Inc. signaled its plans to use the technology for next-generation chips.

The process provides a substrate resistivity of greater than 40 ohm-cm to enable reduced parasitic capacitance and minimize disparity in phase and voltage swing, the company said.

Designers can stack RF FETs in the process to achieve higher power and reliability. Active FETs can be tuned for very high  $F_t/F_{max}$  for millimeter wave circuits in 5G products and front-ends for car radar. The process delivers the highest  $F_{max}$  the foundry offers and is running on 300mm wafers in the former IBM fab in East Fishkill, N.Y.

Skyworks indicated it will use the process to "create RF solutions that ... further advance the deployment of highly integrated RF front-ends for evolving millimeter wave applications," said the company's CTO, Peter Gammel, in a statement it issued concerning the move. RF SOI has long been one of the success stories of the foundry business from IBM fabs Globalfoundries acquired in July 2015.

## UMC Begins 14nm device production

United Microelectronics Corporation (UMC, Taiwan) announced on 23rd February that it has initiated mass production of 14nm chips using FinFET technology. The company added that it is shipping 14nm wafers to lead customers and has achieved "industry-competitive yields" using the process.

Po-Wen, CEO of UMC, said earlier this month that the company would bring 14nm to production this quarter, ahead of the original schedule. Last April, UMC said 14nm would be in production in the second half of this year.

UMC says that its 14nm FinFET technology offers 55 percent higher speeds and twice the gate density compared to its 28nm process technology. The process also consumes about 50 percent less power than 28nm, the company indicated.

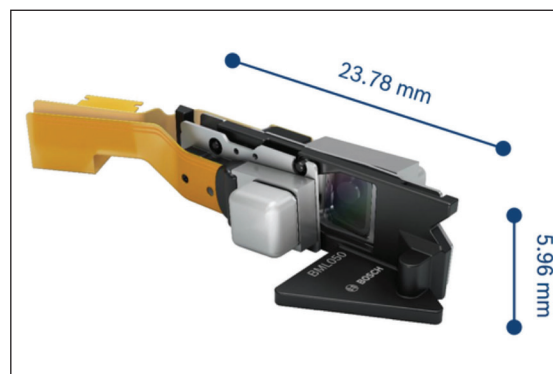
## Any surface can be a user interface

Bosch, the biggest and oldest micro-electro mechanical systems (MEMS) maker, introduced a new product at the GSM Mobile World Congress

that combines an infrared micro-scanner and laser projector. Together, the paired technologies are capable of transforming any surface into a virtual user interface.

The MEMS device, small enough for wearables and cheap enough for toys in high volumes, is also finding a plethora of applications anywhere a human-machine interface (HMI) is needed, such as on the factory floor, in industrial equipment, for robotics, medical devices, infotainment and in-car heads-up displays.

The new micro scanner BML050 extends Bosch Sensortec's portfolio into optical microsystems and moves the firm from its familiar role as a component supplier into the realm of systems supplier.



Because it is based on an integrated IR-RGB (infrared + red, green, blue) the module is just 6mm tall with resolution approaching high-definition class. Its two MEMS scanning mirrors can both project images and collect the reflected light so as to determine where a user's finger is touching the projected image. The technique also can be adapted to 3D scanning using time-of-flight calculations on light reflected from an object.

## Miles Gained, Yet Miles to Go for EUV

According to both Intel and Samsung Electronics, extreme ultraviolet (EUV) lithography is making significant progress towards volume manufacturing. But enough hurdles remain to prevent either company from making public commitments about when it will start using the technology.

Separately from the two chip leaders, the Imec research institute (Leuven, Belgium) announced techniques for creating a 5nm process technology using EUV to assist today's immersion scanners. EUV is generally expected to see adoption in about 2020 for a few critical steps that will enable manufacturers to avoid using more than four exposures with today's 193nm immersion steppers.

"It's my belief immersion will be the workhorse and EUV will be used for select layers," said Ben Tsai, chief technologist of KLA-Tencor in a keynote opening the SPIE Advanced Lithography conference. Samsung suggested it is pressing forward with plans

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announced in October (2016) to use EUV for its 7nm node, but it has yet to say how and when. Intel reiterated its guidance of the last several years that EUV is. "...highly desirable for the 7nm node, but will only be used when it is ready."



## Capital expenditures expected to grow in 2017

Total capital spending by semiconductor companies is expected to increase 6 percent this year to (USD) \$73.2 billion, with the vast majority coming from the top 11 spenders, according to a new forecast from market researchers at IC Insights.

The 11 chip companies that plan to spend \$1 billion or more will account for about 78 percent of total global capital spending this year, the forecast said. By contrast, in 2013, only eight chip companies increased their capital spending by \$1 billion or more.

The difference between the spending of the largest chip manufacturing companies and the rest of industry is wide and, according to IC Insights' President Bill McClean, getting wider. About 10 years ago, the top five capital spenders accounted for roughly 40 percent of global semiconductor capital spending; this year that number is expected to be 62 percent, he said.

China's semiconductor building plans currently dominates the capital spending landscape among chip manufacturers. The country's stated goal of pumping \$161 billion into developing a domestic semiconductor industry over the next 10 years means fab construction. According to the SEMI trade group, of the 62 new front end chip fabs scheduled to begin operations between 2017 and 2020, 26 are in China, or about 42 percent. However, the vast majority of China's projects won't be ready to start spending on equipment until 2018 at the earliest.

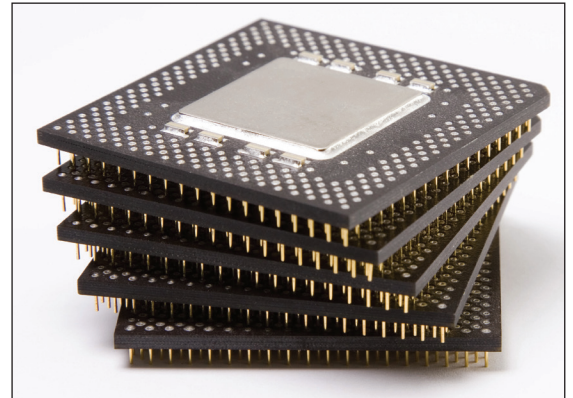
## Chip sales leap 14% in January

January chip sales tallies showed the largest year-to-year increase in more than six years as the semiconductor industry continued a run that started in the fourth quarter of last year and drove the industry to surprising growth in 2016.

According to the Semiconductor Industry Association (SIA), chip sales for January totaled about (USD) \$30.63 billion, 13.9 percent higher than in January 2016. Sales were down 1.2 percent compared to December 2016, however. The first month of each calendar year tends to have lower production and sales compared to other months due to product seasonality.

The 13.9 percent annual increase for January, based on a three-month-moving average for sales, was the largest year-to-year increase for chip sales since November 2010. John Neuffer, SIA president and

CEO, said through a statement that the industry is off to a "strong and encouraging" start in 2017. "Sales into the China market increased by more than 20 percent year-to-year, and most other regional markets posted double-digit growth," Neuffer explained. "Following the industry's highest-ever revenue in 2016, the global market is well-positioned for a strong start to 2017."



Most market watchers—including the SIA and the World Semiconductor Trade Statistics (WSTS) organization, had predicted that the semiconductor industry would contract moderately in 2016. However, based on a stronger-than-expected second half of the year, semiconductor sales finished the year at nearly \$339 billion, up about 1 percent compared to 2015.

## 1 Trillion+ semiconductors will ship in 2018

Semiconductor unit shipments are projected to top the 1 trillion mark for the first time in 2018, with the vast majority comprised of optoelectronic, sensor, actuator and discrete devices, according to market research firm IC Insights Inc.

Semiconductor shipments totaled 868.8 billion units last year and are expected to top 900 billion in 2017, according to IC Insights. In 2018, unit shipments are forecast to surpass 1 trillion after growing an average of 9 percent per year since 1978, when some 32.6 billion semiconductors shipped, according to the firm. At the time of the IC Insights report, 2017 was forecast to see modest growth compared to 2016; however, 2017 took a runaway growth tangent, and final unit shipments may exceed 1 trillion faster than expected.

## TSMC announces plans for multiple nodes

World-leading Taiwanese foundry TSMC disclosed plans for new high-, mid- and low-end processes on 16th March. The processes included an enhanced 7nm FinFET node using extreme ultraviolet lithography, a 12nm upgrade of its 16nm process and a 22nm planar technology, which the company expects will compete head-to-head with fully depleted silicon-on-insulator (FD-SOI) technologies offered by Globalfoundries. TSMC also described enhancements to its two chip-stacking techniques, advances in RF CMOS and work in transistors and materials, paving

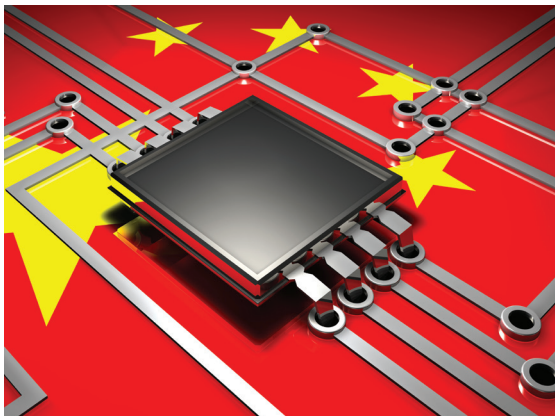


the way to a 3nm node and beyond. In addition, it previewed design capabilities using machine learning that it will offer before the end of 2017. Among its achievements, TSMC noted 76 percent yields on the 256Mbit SRAM made in its first-generation 7nm node, which will be in volume production next year. It also reported that an ARM Cortex-A72 processor in the node exceeded 4GHz using a new design flow.

The Taiwanese company, already the world's largest foundry, expects to ship 11 million 12-inch-equivalent (300mm) wafers this year, a typical 10 percent annual increase. The biggest share, two million wafers, will utilize its planar 28nm processes, a fact driving its planned 15 percent capacity expansion this year.

## China fab construction fuels equipment spending

Sales of semiconductor manufacturing equipment grew 13 percent in 2016 and are projected to grow further in each of the next two years in what would mark the first three-year period of consecutive growth for fab tools since the mid-1990s, according to the SEMI trade group.



Much of the growth in fab tool spending in 2016 and particularly, the anticipated growth in 2017 and 2018, is being driven by semiconductor fab building in China. Of the 62 front-end fabs scheduled to begin operation globally between 2017 and 2020, 26 are in China, according to tracking reports issued by SEMI last year.

The Chinese fab building escalation is driven by the PRC's stated goal of creating more homegrown semiconductor manufacturing to feed its massive internal electronics market. The Chinese government has said it will pump (USD) \$161 billion over the next decade into building a domestic chip industry.

International semiconductor powerhouses including Intel, Globalfoundries and TSMC are all building or expanding fabs in China, and a number of domestic Chinese firms are planning fabs, notably Tsinghua Unigroup Ltd., which has announced plans to spend \$54 billion on two huge memory chip fabs inside the PRC.

## Peregrine buys MIT spinoff

RF chip vendor Peregrine Semiconductor Corp. has acquired Arctic Sand Technologies, an MIT spinoff that offers low-power chips for DC-DC power conversion. Financial terms of the deal were not disclosed.

Arctic Sand (Burlington, Massachusetts) was founded in 2010 by Gary Davison, who took over as CEO of the company in 2014. Arctic Sand claims that its technology delivers power conversion efficiency enabling platforms for a variety of applications to be made thinner. In certain applications, the company claims its technology reduces the space occupied by power components by 50 percent while also reducing the height of components while reducing power loss and increasing run time.

## Intel describes its 10 and 22nm processes

Intel will start making 10nm chips in 2017 that it claims will lead the industry in transistor density using a metric it challenged rivals to adopt. Separately, it announced a 22nm low-power FinFET node to compete for foundry business with fully depleted silicon-on-insulator (FD-SOI) from rivals such as Globalfoundries.

At 10nm, Intel said it will pack 100.8 million transistors per square millimeter. It estimated 10nm foundry processes now in production from TSMC and Samsung have about half that density.

Intel's metric averages density of a small and a large logic cell. Specifically, it uses a two-input NAND cell with two active gates and a scan flip-flop cell with as many as 25 active gates.

"I think it's a comprehensive, quantitative and honest metric," said Mark Bohr, a senior fellow and director of process architecture and integration at Intel. "TSMC, and I think Samsung, used to quote (similar metrics), but my guess is they weren't looking very good with this metric anymore..." which prompted them to discontinue the practice, he said.

## Surging memory prices drive optimistic chip forecast

Semiconductor industry watcher IC Insights has more than doubled its forecast for industry growth in 2017 based upon surging average selling prices (ASPs) for DRAM and NAND flash memory.

The researchers announced in late March that they now expects integrated circuit revenue to increase by 11 percent this year due to a substantial upgrade to the forecasts for DRAM and NAND, which the analysts now expect to grow by 39 percent and 25 percent, respectively. IC Insights had previously forecast that the chip market would grow 5 percent in 2017.

Analysts and market researchers generally agree that 2017 should be a year of moderate growth for the semiconductor market after the industry

# 2017 year in review

posted a surprising 1 percent increase in 2016 sales. However, an 11 percent 2017 leap is among the most aggressive predictions to date. The World Semiconductor Trade Statistics (WSTS) organization and market research firm Gartner Inc. are both calling for around 7 percent growth this year.



## Intel Says there is life after CMOS

Intel described more than a dozen technologies to transcend the limitations of CMOS that it is developing in conjunction with universities and the Semiconductor Research Corporation industry consortium at the International Symposium on Physical Design (ISPD 2017).

"We are looking beyond CMOS logic and computation methods to discover how to do it differently," said Ian Young, a senior fellow with Intel's Technology Manufacturing Group and director of exploratory integrated circuits in components research. "We want to lower the power supply voltage well below 0.5V, but the 60mV per decade sub-threshold swing of the MOSFET limits us from doing this for CMOS logic."

The hitch is that no matter which new technology is adopted, it must be integrated with the existing CMOS process because some CMOS transistors will be needed for the clocking and I/O analog circuits. Never fear, said Young, who stated that Intel believes there are around a dozen different ideas being researched to use the same fabs while achieving significantly lower supply voltages.

## Semiconductor sales surge again

February semiconductor sales were up by 16.5 percent compared to February 2016, the largest year-to-year increase in more than six years according to the Semiconductor Industry Association (SIA) trade group. However, sales of (USD) \$30.4 billion for February declined by 0.8 percent compared with January sales of \$30.6 billion. The SIA said the month-to-month decline was less than is typical for the January to February cycle.

SIA President John Neuffer said that early 2017 chip sales have been strong, led by strength in memory products such as DRAM and NAND flash. "Year-to-year sales increased by double digits across most regional markets, with the China and Americas markets showing particularly strong growth," Neuffer said. "Global market trends are favorable for continuing sales growth in the months ahead."

The year is indeed shaping up to be a strong one for semiconductor sales, with market watchers generally forecasting moderate to strong annual growth. Last week, market research firm IC Insights Inc. more than doubled its forecast for 2017 chip sales growth to 11 percent, crediting surging average selling prices for DRAM and NAND.

## The need for speed

Google's Tensor Processing Unit (TPU) beat Intel's Xeon and Nvidia GPU in machine-learning tests by more than an order of magnitude, Google reported. A 17-page paper gives a deep dive into the TPU and benchmarks showing that it is at least 15 times faster and delivers 30 times more performance/watt than the merchant chips.

In May, Google announced the ASIC designed to accelerate inference jobs for a wide range of applications on its data center servers. Now it is providing a first in-depth look at the chip and its performance in a paper to be presented at a computer architecture conference in June.

## Machine learning impacts IC design

Semiconductor engineers are already hearing AI's footsteps as highly advanced software systems encroach on their design work. Why? Consider the vast amount of design data and variability required of chip designers, especially when developing a variety of chips with different power, temperature and performance specs. Complex IC designs might well be one of the logical areas to apply machine learning.

At least one EDA software company is making headway with home-grown machine-learning algorithms, calling it "machine learning for engineering" and applying it to variation-aware design and characterization software.



That company is Solido Design Automation, a privately-held EDA software vendor founded in 2005 in Saskatoon, Canada. Solido became the first vendor to make commercially available its machine-learning algorithms to semiconductor customers when it launched Machine Learning (ML) Labs. Solido's plan is to "collaboratively work with semiconductor companies to develop new ML-based EDA products," according to the company.

## Qualcomm v. Apple disputes widen

According to a court document filed by Qualcomm, Apple refused to pay mobile device chip royalties, pressured its contractors not to pay them, instigated regulatory investigations and throttled performance of an LTE modem chip. The charges are contained in a 134-page court document the chip vendor filed



in response to Apple's (USD) \$1 billion suit filed in January. Apple alleged Qualcomm charges exorbitant patent royalties and paid the iPhone maker not to talk to regulators.

The document provides a rare look into the sometimes combative relationship and complex web of agreements between the two mobile giants. It also sheds light on the murky area of patent royalties. In its suit, Apple claimed Qualcomm asks for five times the royalties of all other cellular patent holders combined. Qualcomm countered Apple offered "a small fraction" of the royalties that other smartphone makers pay and asked for an agreement that included more patents, including some pertaining to 5G cellular designs. In the latest court document, Qualcomm asked the Southern District Court of California for a jury trial and unspecified damages.

### **Gartner forecasts semiconductor market to grow 12% in 2017**

Predictions of 2017 semiconductor market growth are increasing as the year rolls on; favorable conditions in the commodity memory market continue to be seen as the main driver.

Market research firm Gartner Inc. said on 13th April that it expects semiconductor industry sales to grow 12.3 percent this year, reaching \$386 billion. The researchers said that favorable market conditions that gained momentum in the second half of 2016 have raised the outlook for the chip market in both 2017 and 2018. But Gartner also cautioned that the rush to add DRAM and NAND flash capacity to capitalize on the market conditions and the rise in manufacturing in China would likely result in a market correction in 2019.



Gartner said PC DRAM pricing has doubled since the middle of 2016, with a 4GB module that cost \$12.50 in the middle of last year now commanding just under \$25 today. NAND flash average selling prices (ASPs) also increased sequentially in the second half of 2016 and the first quarter of 2017.

### **EUV lithography moves toward commercial adoption**

Executives from ASML NV (The Netherlands) said on 19th April that the company expects to ship 20 to 24

extreme ultraviolet (EUV) lithography tools in 2018 as the industry continues edging closer to production deployment of the oft-delayed next-generation lithography technology.

Peter Wennink, ASML's president and CEO, told analysts following the company's first quarter financial report that the company continues to make progress toward its goals for EUV of producing 125 wafers per hour with 90 percent light-source availability. Wennink made reference to presentation at the recent SPIE Advanced Lithography Conference from Intel, Samsung and TSMC showing their latest results with EUV systems and the status of current EUV infrastructure.

"And while there is still work to be done on things like the pellicle, there appear to be no major roadblocks for EUV insertion in the timeframes indicated by our customers," Wennink said. ASML said Wednesday it has an order backlog in the pipeline of 21 NXE:3400B EUV systems—its most advanced EUV tool which started shipping this year—worth 2.3 billion euro (about USD \$2.46 billion).

### **Fab tool billings reach 16-year highpoint**

The three-month rolling average of billings among semiconductor equipment vendors based in North America hit (USD) \$2.03 billion in March, its highest total in 16 years, according to the SEMI trade organization. The three-month average of billings was up 69 percent compared to March 2016, the sixth consecutive month of year-over-year growth. The billings figure was also up 3 percent from February.

"March billings reached robust levels not seen since March 2001," said Dan Tracy, senior director of industry research and statistics at SEMI, in a statement. "The equipment industry is clearly benefiting from the latest semiconductor investment cycle."

### **Intel increases capital spending 20%**

As consensus looks to continued growth in 2016, Intel increased its 2017 revenue forecast slightly, elevated in part by a slight rise in PC prices. It also increased its annual capital equipment budget to \$12 billion, a level it expects will continue into 2018, in part to support ramping 3D NAND and 3DXP memories.

For its first quarter, the chip giant reported revenue of \$14.8 billion and net income of \$3 billion, up from 8 and 45 percent last year, respectively. A 7 percent increase in PC prices drove Intel's client group, its biggest division, to \$8 billion in quarterly revenues, a 6 percent increase. Intel's data center group, which targets high-single-digit growth, turned in a 6 percent revenue rise as unit sales fell slightly ahead of the summer release of new server CPUs. Intel's smallest units turned in its highest growth. Its flash group grew fastest at 55 percent to \$866 million, followed by the former Altera FPGA group, up 18 percent to \$425

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million. The nascent IoT group also moved forward by 11 percent to \$721 million.

All in all, the PC CPU maker reported progress in its slow transition to broaden its base. It lifted its annual revenue forecast by \$500 million to \$60 billion, which would mark a new high.

## Apple stops paying royalties, reducing Qualcomm's revenue forecast

Qualcomm is lowering its third-quarter guidance by about \$500 million, claiming that Apple said it will not pay patent royalties. The disclosure suggests that Qualcomm receives a whopping \$2 billion a year, or roughly \$8 per device, in royalties for Apple products.

Qualcomm specifically lowered its third-quarter guidance from a range of (USD) \$5.3 to \$6.1 billion to a range of \$4.8 to \$5.6 billion. Apple said that it will withhold Qualcomm royalty payments starting in the first calendar quarter until the patent dispute between the companies is resolved, Qualcomm said in a press statement.



Apple filed suit against Qualcomm in January, claiming that Qualcomm's royalties were exorbitant and the chip vendor pressured it to remain silent. In a countersuit filed earlier this month, Qualcomm said that it paid Apple to refrain from asserting patents and revealed that it gets royalty payments for iPhones and iPads through Apple's contract manufacturers including Compal, Foxconn, Pegatron, and Wistron.

MediaTek's Smartphone Market Share is Shrinking MediaTek, the second-largest smartphone chip supplier after Qualcomm, said it is losing market share after nearly four years of strong gains in the 4G mobile segment. MediaTek has slowed upgrades for its flagship Helio product line, offering only an LTE Category 6 modem, while rival Qualcomm early this year raised the bar with the world's first 10nm processor, the 835 Snapdragon, including a Category 16 modem.

"We have been losing market share for the Helio X and P series products," said MediaTek Senior Vice President David Ku on a conference call to announce the company's first-quarter results. "Based on our design wins, we expect to gain back some market

share by the second half."

MediaTek and Qualcomm are chief rivals in China, the world's largest smartphone market, with both companies seeking handset deals with companies such as Oppo, Vivo, Xiaomi and Meizu. The companies have in the past year had sales growth exceeding Samsung and Apple. Qualcomm has been gaining share in China. Moreover, Chinese chip designers such as Spreadtrum and HiSilicon are ratcheting up the competition.



## Microsoft dives deeper into HoloLens

A computer vision specialist from Microsoft gave a deep dive into the challenges and opportunities of its HoloLens in a keynote address at the Embedded Vision Summit taking place in Santa Clara, California. His talk sketched out several areas where augmented reality products such as HoloLens still need work to live up to their promises.

According to Marc Pollefeys, an algorithm expert who operates a computer vision lab at ETH Zurich and joined the HoloLens project in July as director of science, stated he believes that HoloLens, "...will be the next generation of personal computing devices with more context..." compared to today's PCs and smartphones.

Jeff Bier, host of the event and founder of the Embedded Vision Alliance, praised the headset as "one of the first AR and VR products that didn't give me a splitting headache..." But he added that the \$3,000, 1.2-pound developer version available today, "...needs to get smaller and cheaper."

## Slumping sales and lawsuits drag down Apple's China growth trajectory

Apple reported modest growth in the last three months despite continued gains by smartphone rivals in China. Looking ahead, financial analysts cited concerns about the ongoing iPhone slump in China, high memory prices and Apple's lawsuit with Qualcomm.

Apple increased second quarter revenues 5 percent from the same period last year to \$52.896 billion despite a 14 percent decline in China sales. Overall sales of iPhones—which account for almost two-thirds of Apple's revenue—were up just 1 percent, while iPads continued their decline (off 12 percent). Mac revenues were the upside note, increasing 14 percent year-over year.

## TSMC prosecutes ex-employee for leaks

Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest semiconductor device foundry, said it is prosecuting a former employee for leaking intellectual property in its second such case in the past five years. The employee, who TSMC only identified by his surname, Hsu, printed out what the



company called an “abnormal volume” of documents related to the company’s 28nm process technology. The employee also said he planned to resign from TSMC and join rival foundry Shanghai Huali Microelectronics Co. (HLMC). The case is the second major incident involving leaks of TSMC intellectual property in the past five years. In 2015, TSMC won a lawsuit against Liang Mong-song, a former senior director of R&D who later became Samsung’s System LSI division chief technology officer.

## Tablet shipments continue declining

Global shipments of tablets declined year-over-year for the 10th consecutive quarter during the first three months of this year as enthusiasm for the devices continues to wane, according to market research firm International Data Corporation.

Ryan Reith, IDC vice president and operator of the company’s tablet tracker program, noted that although device sales continue to erode, the rate at which the tablet market exploded from the launch of the original iPad in 2010 until 2013 was unlike most consumer-oriented markets. “However, it appears for many reasons consumers have become less eager to refresh these devices, or in some instances purchase them at all,” Reith said.



IDC believes the leading driver for tablet contraction continues to be increased dependency by consumers on smartphones along with minimal technology and form factor progression in tablets. With laptop prices continuing to fall across many categories, and with designers creating laptops that combine tablet-like touch screen capabilities with substantially greater storage and processing power, these factors make replacing a tablet, or choosing a tablet instead of a laptop less likely than ever before.

## DSL pioneer foresees a terabit future

At a time when carriers are pondering an expensive shift from copper cables to optical fibers, a pioneer of digital subscriber lines (DSL) is proposing a novel upgrade that someday could deliver terabit data rates. In a keynote at the G.Fast Summit in Paris on 9th May, John Cioffi unveiled ideas behind what he calls Terabit DSL (TDSL). They include carrying 50-600 GHz wireless signals through the tiny spaces between individual twisted pairs of the cables containing a hundred or more such pairs. “We are shooting for a terabit/second over 100 meters, 100 Gbits/s at 300 meters and 10 Gbits/s at 500 meters -- all those are

200 to 1,000 times better than traditional DSLs,” said Cioffi, whose research at Stanford in the 1980s led phone companies to embrace DSL for broadband.

## Consolidation continues to affect vendor ranks as merger fever subsides

The world’s largest chip vendors have growth rates in outsized proportion compared to other supply chain vendors due to the impacts of merger activity occurring in 2015-2016, concluded a new report by Gartner Inc.

Gartner said it believes that global semiconductor sales reached \$343.5 billion in 2016, an increase of 2.6 percent compared to 2015. The growth rate was higher than that estimated by other market watchers like the World Semiconductor Trade Statistics organization, which said in February that industry sales grew by 1.1 percent.

The top 25 vendors, however, grew sales by a combined 10.5 percent in 2016, according to Gartner. These companies accounted for nearly 75 percent of total market share. By contrast, other semiconductor vendors in the market saw their sales decline by 15.6 percent, Gartner reported.

According to James Hines, a research director at Gartner, the relative growth of the top 25 vendors compared to the rest of the market is skewed by the high degree of merger and acquisition activity that took place in 2015 and 2016.

“If we adjust for this M&A activity by adding the revenue of each acquired company to the revenue of the acquirer for both 2015 and 2016 where necessary, then the top 25 vendors would have experienced a 1.9 percent revenue increase, and the rest of the market would have increased by 4.6 percent,” Hines said, in a press statement.

## Imec describes new ai chips

The Imec research institute (Leuven, Belgium) reported during its annual Technology Forum that it is developing machine learning accelerators using arrays of resistive and magnetic memory cells rather than neural networks to reduce cost and power. Initial results included an MRAM array that lowered power by two orders of magnitude.

Imec is withholding details of the chips’ architecture and their performance until later in the year when it has its patents filed. The research institute started a machine learning group 18 months ago as part of its ongoing efforts to expand beyond its core work on silicon process technology.

## Record wafer shipments continue

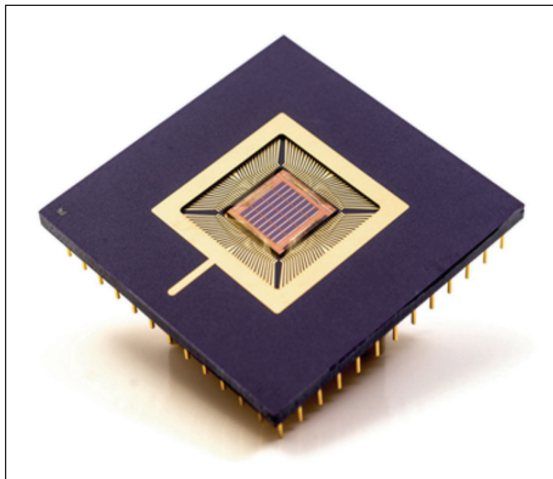
Defying typical seasonal weakness, worldwide shipments of silicon wafers increased sequentially in the first quarter of 2017, logging their highest recorded quarterly level, according to the SEMI trade group.

All silicon wafer area shipments reported totaled 2.86 billion square inches in the first quarter, up 3.4 percent compared to the fourth quarter of 2016. Shipments were also 12.6 percent higher compared to the first quarter of 2016, based on results collected and reported by SEMI's Silicon Manufacturing Group (SMG).

### **Samsung spinoff will grab foundry share**

Samsung Electronics' plan to spin-off foundry operations from its system LSI division is expected to increase the company's share of global contract chip manufacturing at the expense of Taiwan Semiconductor Manufacturing Company (TSMC) and smaller rivals.

Samsung's chip operations, consisting of memory and system LSI, will be split into three, making the foundry business an independent unit, according to the Korea Economic Daily.



The separation of Samsung's contract chip making from its branded semiconductor business would remove a conflict of interest with potential customers such as Nvidia and MediaTek, and create a new threat to dedicated foundries such as TSMC, according to analysts studying the process.

### **Imec offers 4 views of silicon's future**

The Imec research institute's semiconductor road map as discussed by senior researcher An Steegen shows a new node in the upper right hand corner – 14 . The placeholder for a 14-angstrom process; this represents a 0.7x shrink from a 2nm node in 2025, displaying optimism that this stage of semiconductor evolution will be achieved at a future point.

"We're still trying to come up with what goes into that bucket, but how we fill it in may be quite different than what we have done before," said Steegen at the annual Imec Technology Forum held in Antwerp. A 14- node suggests the atomic limits ahead. A single arsenic atom, one of the larger elements used in semiconductors, measures about 1.2.

As they approach a 14-angstrom future, engineers may start to mix on the same die FinFETs with nanowires or event tunnel FETs or spin-wave transistors. They will certainly start to experiment with more types of memories, and they may be building chips for new kinds of non-Von Neumann computers. In the near-term, Steegen sees extreme ultraviolet lithography (EUV) being adopted at 7 nm, FinFETs living on to 5- and even 3-nm nodes, and nanowire transistors emerging somewhere along the way. China Could Shape the Future of FD-SOI Globalfoundries and the municipality of Chengdu are counting on China to play a significant role in the evolution of FD-SOI technology. This public/private partnership announced on 23rd May that it plans to pump (USD) \$100 million into a project to "spur innovation in China's semiconductor industry" around FD-SOI.

The move is a significant step in efforts to ignite broader acceptance of the non-bulk CMOS technology in China. The plan rests on the fact that China today consumes more than 58 percent of semiconductors produced worldwide, and its leaders are spearheading a national drive to substantially expand indigenous semiconductor production capacities.

While China held only a 16.2 percent share of worldwide semiconductor production in 2015 according to a PricewaterhouseCoopers report, the nation is currently going through an unprecedented fab boom, backed by 120 billion yuan National IC fund (more than USD \$17 billion) and supported by 600 billion yuan (USD \$85 billion) from local government and private equity companies.

The newly unveiled \$100 million budget allocated for building the FD-SOI ecosystem in Chengdu is a part of \$10 billion investment that Globalfoundries and Chengdu's leaders announced to support fab construction.

### **Samsung plans to achieve 4nm in 2020**

Samsung Electronics released an updated foundry technology roadmap on 24th May, including details of its second-generation FD-SOI platform, several bulk silicon FinFET processes (that scale down to 5nm) and a 4nm "post FinFET" structure process set to be in 'risk production' by 2020.

Samsung, which formally broke its foundry operation into a separate business unit called Samsung Foundry earlier in May, also reiterated previously announced plans to put extreme ultraviolet (EUV) lithography into production in 2018 at the 7nm node.

"We are extremely aggressive with our roadmap, not only in planning, but in announcing what we are going to be doing in the next three to four years," said Kelvin Low, senior director of foundry marketing at Samsung. Silicon's Future to be reshaped by Big Data



The huge data sets collected by web giants such as Amazon, Google, and Facebook are fueling a renaissance of new processing chip designs. Two of the latest efforts will be described at an annual conference on computer architecture in late June.

Stanford researchers said they will describe Plasticine, a reconfigurable processor that sports nearly 100x better performance/watt than an FPGA while being easier to program. Separately, two veteran designers at Nvidia were part of a team that defined an inference processor that delivers more than twice the performance and energy efficiency of existing devices.

**MEMS Market Growth Aided by RF Filters**  
The total value of the global MEMS market is projected to grow from about \$13 billion in 2017 to more than \$25 billion in 2022, driven largely by growth in RF applications including RF MEMS filters, according to a new report by research researchers at Yole Développement (France).

The growing demand for RF MEMS filters is being fueled by further growth in 4G mobile technology and increasing complex cellular communications, according to Yole. The analysts expect sales of RF MEMS filters — the biggest business in the RF front-end — to increase at a compound annual growth rate (CAGR) of 35 percent between 2017 and 2022.

“Beyond the development of these RF MEMS devices, the RF front-end demonstrated comfortable growth, at 14 percent CAGR during the same period,” said Claire Troadec, Yole’s RF devices and technologies activity leader, in a press statement.



### Big data making waves

One might speculate that Big Data can trace its ancestral roots to the days when Sergey Brin and Larry Page (Google) helped develop an algorithm that found more relevant results on the web than the search engines of their rivals. The lesson of Google continues to ripple through all businesses seeking competitive insights from their data pools, however large or small.

Today, the Internet of Things (IoT) is opening vast new data sources, expanding big data’s promise to reshape business, technology, and the ways that technologists approach their work. Along the way, big data is inspiring new kinds of processor and systems architectures, as well as evolving algorithms and programming techniques.

At Stanford’s Data Science Initiative, researchers are working the big-data techniques in the hands of the average company.

“Machine learning is impressive but really hard to use. Even the most sophisticated companies might only have a couple of people that can apply those techniques optimally,” said Stephen Eglash, executive

director of Stanford’s program. “I can imagine the day when these tools are available in the equivalent of Microsoft Office.”



To get there, Stanford researchers are developing ‘Snorkel,’ a tool to automate the process of labeling and ingesting big data sets. “It’s far enough along that you can see that it will work,” said Eglash. “We want the domain experts to use these techniques without needing a computer science expert.”

The IEEE Big Data Initiative is taking a different approach, making large data sets freely available for research through its Dataport service. So far, they include examples as diverse as real-time feeds of New York City traffic and neuron movements in a human brain.

### Nvidia CEO touts death of Moore’s Law

Nvidia CEO Jensen Huang has become the first head of a major semiconductor company to say what academics and researchers at prominent institutes have been suggesting for some time: Moore’s Law is dead.

Moore’s Law, named after Intel cofounder Gordon Moore, reflects his 1965 observation that transistors were shrinking so fast that every year twice as many could fit onto the same surface of a semiconductor. In 1975, the pace shifted to a doubling every two years and has subsequently been modified further as more design architectures permeate an increasingly global market.

The enablers of increased speed and density at every generation, increasing the size of pipelines, shortening signal pathways and various additions to lithography tool sets, are among the techniques that are now failing to keep pace with the expected 50 percent increase in transistor density each year, Huang told a gathering of reporters and analysts at the Computex show in Taipei. The diminishing returns from Moore’s Law and Dennard scaling have seen the semiconductor industry enter a mature stage in which just a handful of chipmakers can afford the multibillion

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dollar investments required to push process technology forward. The semiconductor industry is exploring a number of pathways beyond Moore's Law. Some 'upstart' Chinese chipmakers are taking a stake in Fully Depleted Silicon-On-Insulator FD-SOI. Others see a future in going beyond planar design to three-dimensional chips.

Nvidia's bet on artificial intelligence to take the silicon industry forward is bullish, and time will tell if their approach delivers performance enhancements that will resonate across the supply chain, and ultimately with consumers looking for newer, faster and better products.

### **NAND shortage fuels price increases**

Contract pricing for NAND flash memory surged by 20 to 25 percent in the first quarter, a strong testament to the undersupply condition that persists in the market, according to DRAMexchange, a firm that tracks memory chip pricing.

NAND revenue typically falls off considerably between seasonally strong fourth quarters and the first quarter of each New Year, traditionally a slow season for end device shipments. But in the first quarter of 2017, global NAND revenue declined by just 0.4 percent, as the reduction of two-dimensional NAND capacity was severe enough to create tight demand, DRAMexchange said.

Prices of mobile storage products such as embedded multi-chip package (eMCP) devices, embedded multi-media card (eMMC) products and universal flash storage (UFS) also continue climbing, DRAMexchange said.

DRAMexchange expects the NAND shortage to persist throughout 2017, resulting in sequential sales increases for NAND suppliers.

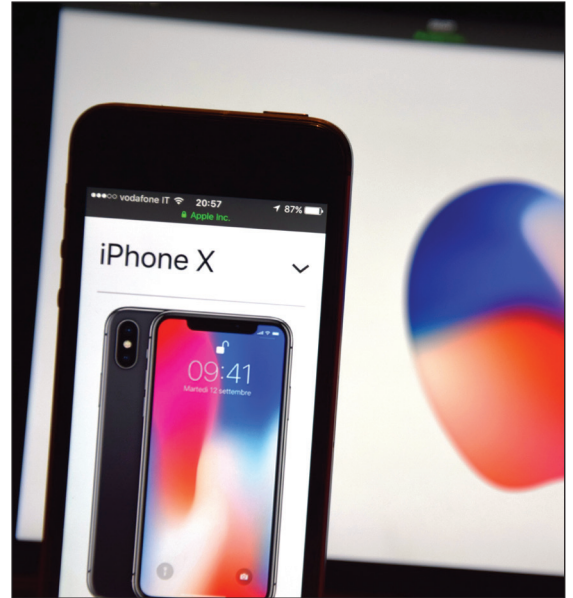
### **iPhone 10 year anniversary a time of reflection at Apple**

Memories of Steve Jobs illuminated some of the brightest moments of on-stage discussions with four engineers from the original Apple iPhone development team. The Computer History Museum organized the event as part of a tribute to the landmark handset's 10th anniversary, moderated by former New York Times tech reporter John Markoff.

The iPhone "had a very circuitous route," said Scott Forstall, the software team leader for the original iPhone.

An acquaintance of Jobs worked on tablet PCs at Microsoft, a topic that got under the Apple co-founder's skin. "Steve hated this guy ... and that was the actual origin of the iPhone," said Forstall in his first public appearance in five years, speaking about Apple route to the landmark achievement.

"One time, [Jobs] came back from seeing this guy and ... Steve came out with a set of expletives and said, 'Let's show them how it's done. Let's not use a stylus. We're born with ten styluses.'"



The team quickly decided to work on capacitive rather than resistive screens and to support multi-touch. An early demo letting fingers move a picture displayed by a large projector mounted on a conference room ceiling "wouldn't fit in a bathroom, much less a pocket or bag, but the moment we saw it, we knew that was the way to go," said Forstall, who is named on 200 Apple patents.

### **Handsets will drive the IC Market**

Sales of chips for cellular handsets will surpass sales of chips for personal computers for the first time in 2017 as the multi-year PC sales slump continues and tablet shipments also plummet, according to market research firm IC Insights Inc.

Sales of integrated circuits (ICs) for handsets are projected to grow 16 percent this year to reach \$84.4 billion, researchers said. Meanwhile, sales of ICs for PCs, including desktop and laptop computers, tablets and ultra-thin Internet-centric client devices, are forecast to grow 9 percent to reach \$80.1 billion, analysts predict.

Booming memory chip prices will boost growth in both phones and PCs, IC Insights explained. But due to their higher growth rate, handsets will become the largest application for ICs this year for the first time, they predicted.

### **Toshiba and the indelible flash lesson**

Toshiba Corporation's plan to spin-off its chip business has put the company's flagship NAND flash memory products in the spotlight. Toshiba engineers invented flash memory in the 1980s, setting off a revolution that ultimately transformed many facets



of consumer and industrial electronics. But Toshiba management, initially failing to foresee the bounty that awaited flash developers, came close to letting the big one get away.

By 1980, the need for a more economical data-storage alternative to E2PROM had become apparent to Fujio Masuoka, a factory manager at Toshiba. E2PROM incorporated two transistors per cell and had to be completely erased before being rewritten. So Masuoka assembled a team of four engineers to develop a smaller and more affordable memory chip architecture that could store a lot of data but would speed erase and write times.

Masuoka's team came up with a design that replaced the E2PROM two-transistor cell structure with a single-transistor cell and allowed data to be read and written in blocks or pages. The design eventually led to the creation of much smaller memory chips. Masuoka based his work on the premise that the cost of new memory chips would continue to drop as transistors shrank in size.

To help pitch their concept, Masuoka and his team developed a catchy name that would highlight the new memory technology's ultrafast erasing capability. Team member Shoji Ariizumi suggested "flash," as in the wink-of-an-eye trigger of a camera's flash system. The rest of the story is the stuff of technology legend. Masuoka's team presented the idea that was rejected by Toshiba executives. But convinced their idea had merit, the group presented their ideas in a paper at a 1984 IEEE IEDM meeting in San Francisco.

Intel developed its own approach independently that led to the first NOR flash chips, which drove the Toshiba team back to the drawing board. A year after Intel launched its NOR flash, the Japanese tech giant came up with a version of its NAND flash chip design that reduced the erase and write times and mandated less area per cell. Toshiba's NAND flash chips were able to offer greater storage density and lower cost per bit, while their mass data storage capability made NAND flash the memory technology of choice in devices such as solid-state drives (SSDs), memory cards, and music players.

The rest, as they say, is history.

### DRAM prices continue to climb

The average selling price (ASP) of DRAM chips is projected to increase by 5 percent from the second quarter of 2017 to the end of the third quarter as tight supply persists, according to market watcher DRAMeXchange.

While demand for DRAM chips, particularly from the smartphone market, has been rather luke warm this year, the pace of technology migration has been slow and contributed to a tightening of supply, according to Avril Wu, research director of DRAMexchange, which

tracks pricing of memory chips.

"This situation is anticipated to last (until) 2018 since suppliers will not take on significant additional production capacity in the short term," Wu said in a press statement. "Meanwhile, ASPs of various DRAM products will remain high."

Unlike previous supply and demand cycles in memory chips, DRAM chips are now being used in more and broader applications, said DRAMexchange. New DRAM applications include graphic processing, cloud computing, automotive electronics and hardware acceleration for machine learning, which have helped to stabilize ASPs for DRAM, the firm said.



### It takes a little purple to mimic the sun

Seoul Semiconductor Co. Ltd., in partnership with Toshiba Materials Co. Ltd., has created an LED that it says more closely mimics the spectrum of natural daylight.

Called SunLike, the LEDs combine Seoul Semiconductor's high-brightness purple LEDs with advanced red, green, and blue (RGB) phosphors developed at Toshiba Materials. Up to now, most attempted to create full spectrum LEDs have mimicked daylight by combining blue-emitting LEDs with yellow and red phosphors to fill out the rest of the spectrum, but that method results in peaks in the blue spectrum.

Blue peaks are undesirable because the amount of blue light the human eye can accept is limited. Over-illumination with blue light results in scatter, which distorts the texture and color of illuminated objects. Research also suggests that exposure to excess blue light can have negative health effects related to interruption of the circadian rhythms, which has led health advocates to encourage only limited exposure to blue light emitting LED and LCD screens prior to bedtimes, especially for children.

The secret to SunLike's performance is the phosphors, said Seoul Semiconductor CEO Chung Hoon Lee. "Other companies that have tried to use purple LEDs to mimic daylight still suffer from purple

peaks,” he said. “Toshiba Materials’ new phosphor is perfect, and that’s the difference.”

## **ARM’s approach to neural computing still hush-hush**

Global chip giant ARM is developing neural networking libraries for its core as the company pursues a different path to advanced chip architectures while NXP is supporting inference jobs such as image recognition in software on its i.MX8 processor. The company aims to extend its approach for natural-language processing later this year, claiming that dedicated hardware is not required in resource-constrained systems.

NXP is following in the footsteps of its merger partner, Qualcomm. However, the mobile giant expects to eventually augment its code with dedicated hardware even as ARM seeks another path that it has declined to fully discuss publicly.



## **NASA seeks a ‘tricorder’ for Mars**

NASA wants to take a geological ‘tricorder,’ to Mars according to a researcher preparing for the mission who asked attendees at last week’s Sensors Expo if they could build one based upon concepts of the device seen regularly in the original Star Trek television series and throughout the show’s 50-year history on television and in motion pictures.

Right now the space agency has four portable scientific instruments weighing about 21 pounds to do the job. They do reasonably good work, but there’s room for improvement; four different instruments is a bit much to carry. Astronauts will be laden with bulky suits, oxygen tanks and backpacks. They have limited time to accomplish a broad range of missions walking over a rocky terrain with no hospitals within 35 million miles if they fall.

“We’d like to have multiple instruments in one (device). Can we build this thing?” asked Alexander Sehlke, a research fellow in the BASALT project at NASA Ames, speaking in a keynote address at Sensors Expo.

## **FTC okay’s Broadcom deal to buy Brocade**

The US Federal Trade Commission (FTC) has approved Broadcom Ltd.’s (USD) \$5.9 billion acquisition of Brocade Communications Systems Inc. after Broadcom agreed to establish a “firewall” to prevent Brocade from accessing proprietary information about Broadcom customer Cisco Systems Inc.’s fibre channel switches.

The FTC said in a statement on 3rd July that it voted 2-0 to accept Broadcom’s proposal and allow 30 days for public comment. The FTC will decide after Aug. 2 whether to make the proposed consent order final, it said.

Broadcom announced in November it would acquire Brocade for \$5.9 billion to add Broadcom’s fibre channel switches to round out its network storage business. The deal calls for Broadcom to subsequently sell the company’s Ethernet networking business for an expected \$1-2 billion.

## **China makes significant IoT decisions**

Two of China’s Web giants tapped domestic and U.S. chip partners for embedded voice software and services competing with Amazon Alexa and Google Home. Their efforts mark a new front in the war over an emerging market for natural-language and machine-learning services targeting everything from cars to thermostats.

Alibaba announced its Tmall Genie, similar to Amazon’s Echo, using a Mediatek SoC. Rival Baidu announced two- and four-mic far-field reference designs for its DuerOS software using Mediatek and Conexant chips as well as support for Nvidia’s Shield TV streaming device. It had previously shown DuerOS running on chips from Shanghai-based RDA Microelectronics.

Alibaba and Baidu announced products in separate events on 4th July. The same day, Tencent (China’s third largest Web company,) announced a deal to supply content for TCL Corp.’s smart TVs. The move follows Tencent investments of nearly (USD) \$90 million in TCL in recent weeks, according to a Reuters report.

The news comes at a time when Amazon dominates the still small market for voice-enabled smart services. Amazon’s Echo, based on a Texas Instruments chip set, is said to have shipped 7-10 million units to date, mainly in the U.S. and the U.K.

Amazon is expected to add at least one new semiconductor partner later in 2017 to an OEM program that already includes Conexant, Microsemi and NXP. So far, Alexa is not available in China, nor does it support Chinese, leaving a wide-open door for its Web rivals there.

## **Memory prices drive record Samsung profit**

South Korean electronics powerhouse Samsung Electronics said on 7th July that it expects to report a record profit of about 14 trillion Korean won (about USD \$12.1 billion) for the second quarter as surging memory chip prices boost the company’s bottom line. Samsung said it expects its profit to increase 72 percent compared with the second quarter of 2016. The firm said sales rose to an estimated 60 trillion won (about USD \$52 billion), an increase of 18 percent compared with one year ago.

Memory chip prices have been on the rise since late last year as tight supply in DRAM and NAND flash memory have chip vendors scrambling to add



capacity. Flash memory chips are also finding uses in more applications, such as consumer electronics and solid state drives in mobile and stationary applications, leading to higher consumption.

## 5G will drive cellular BTS sales – In 2021

Despite enthusiasm over 5G, spending on cellular base stations will continue a significant decline over the next three years before returning to growth in 2021, according to a new report from the Dell'Oro Group.

The report is roughly in line with the outlook from infrastructure giant Ericsson that reported worse than expected quarterly results. Dell'Oro predicted a high single-digit percentage decline in base station sales this year followed by two years of declines in low single digits. Ericsson expressed hope that the market would be only 'somewhat flat' in 2019.

The news underscores the precarious position for wireless vendors. They are making significant investments now in 5G technologies and services while navigating the end of major 4G deployments. "The lull is impacting all regions and all vendors ... so far, Huawei has weathered the downturn better than Ericsson and Nokia," said Stefan Pongratz, a senior director and analyst at Dell'Oro. "We see some promising signs in North America, but the China market is expected to contract in 2017, and Europe will overall see a near-term decline."

For its part, Ericsson reported a \$145.3 million second-quarter loss, with both sales and gross margins below consensus forecast, according to a Reuters report that said the company will make cuts of about a billion dollars.

The rapid rise of LTE, especially in China, drove base station sales to a peak of \$33 billion in 2014. Since then, annual sales have fallen nearly \$4 billion and will fall nearly \$6 billion more before they nudge up in 2021, fueled by sales of 5G macro base stations and LTE small cells, said Pongratz.

## ASML sales surge thanks to EUV orders

Semiconductor lithography equipment vendor ASML Holdings (The Netherlands) posted better-than-expected second quarter revenue driven by sales to the booming memory chip sector. ASML also reported a significant increase in sales of next-generation extreme ultraviolet (EUV) lithography tools.

ASML reported that it sold an additional eight EUV systems in the second quarter, bringing its EUV backlog to 27 tools valued at about 2.8 billion euro (about USD \$3.26 billion). The firm also announced that it demonstrated the key productivity metric of 125 wafers per hour (125) on an EUV tool at its headquarters. ASML said it expects sales to memory companies (DRAM vendors) to grow about 50 percent this year as the memory sector enjoys one of its best

upward trajectories in history.

## Chip M&A fever cools in 2017

The blistering-hot pace of merger and acquisition activity that dominated the semiconductor industry for more than two years cooled markedly in the first half of 2017 as the absence of so-called 'mega deals' brought down the total value of transactions.

The combined value of about a dozen pending transactions announced in the first half of this year totaled just (USD) \$1.4 billion, down from \$4.6 billion in the first half of 2016 and \$72.6 billion in the first half of 2015, according to market research firm IC Insights Inc.

Despite the slow start to M&A in 2016, several large transactions announced during the second half of the year pushed the total value of deals to near \$100 billion, within striking distance of the all-time record of \$107.3 billion set in 2015, researchers said. Despite the existence of several pending or rumored deals, including the pending sale of Toshiba's memory chip business, it is unlikely that a second half M&A surge will emerge to bring the value of transactions for the year anywhere close to either 2016 or 2015, the firm said.

## Foxconn to make \$10 billion US investment

Hon Hai Precision, the parent company of Foxconn, will spend \$10 billion to build a LCD manufacturing facility in Kenosha, Wisconsin. The plant will be a 10.5-generation LCD facility for next-generation 8K displays. The deal brokered by the Trump Administration includes \$3 billion in tax breaks to create at least 3,000 Foxconn jobs in the US.

"TV was invented in America, but it does not have a single fab to produce a single 8K system—we are going to change that," said Foxconn chairman and founder in a White House event. "We are committed to build the most advanced 8K ecosystem in America – the most advanced in the world," Gou said.

The deal initially includes a 20 million square foot Foxconn campus. The company said it could ultimately create up to 13,000 Foxconn manufacturing jobs and up to 22,000 indirect jobs throughout the supply chain that would serve the plants requirements both in Wisconsin and elsewhere. The Foxconn jobs will have an average annual salary of (USD) \$53,000 plus benefits, said Wisconsin Governor Scott Walker.

## PC sales raise Intel's profits

In the midst of a bull market year for semiconductors, Intel reported strong results and lifted its financial forecast, thanks in part to better than expected sales of PC processors. Revenue hit (USD) \$14.8 billion, up 9 percent from the same period last year, while net profits jumped 111 percent to \$2.8 billion. The company now expects 2017 revenues of \$61.3 billion at 61 percent gross margins.

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Intel's PC group, which still makes up 60 percent of company sales, grew 12 percent to \$8.2 billion in the quarter. While volumes were only up in modest single digits, sales continue to shift toward gaming PCs and thin-and-light notebooks that command a premium. Semiconductor Equipment Sales Continue Rising Sales of semiconductor capital equipment continue to accelerate, driven by a booming memory chip market and the migration to more advanced technology nodes, according to the SEMI trade association.

North America based fab tool vendors posted both sequential and year-over-year increases in billings once again in June, setting a quick pace while the industry remains on track for record sales.



"Through the first half of the year, 2017 equipment billings are 50 percent above the same period last year," said Dan Tracy, senior director for industry research and statistics at the SEMI trade association. Samsung Takes Number-One Spot in 2Q Chip Sales South Korea's Samsung Electronics Company has unseated Intel Corporation as the world's leading semiconductor vendor, at least for one quarter.

Samsung reported this week that its semiconductor division posted sales for the second quarter of 17.58 trillion won, or about (USD) \$15.78 billion, which beats the \$14.8 billion in second quarter sales that Intel reported on 27th July.

Analysts have been saying since early this year that Samsung could rise to take the top spot in chip sales in 2017, surpassing Intel, which had previously led the semiconductor industry in sales every year since 1992. The booming memory chip market, which is led by Samsung, is driving growth for that company and other memory vendors at a faster pace compared to sales advances enjoyed by makers of logic chips.

It's unclear how long Samsung can retain the top spot in chip sales. The market for memory chips is notoriously cyclical. Growth in sales for DRAM and flash memory chips has begun to slow, and analysts forecast that a downturn in memory may be looming

late next year or in 2019 as new capacity comes online and new Chinese competitors enter the fray.



### Sales rise as Apple readies to debut iPhone 8

As it prepares to celebrate the 10th anniversary of its flagship iPhone products, Apple reported its third consecutive quarter of accelerating annual sales growth which was substantially driven by an all-time high in services revenue and year-over-year growth across all its product lines.

Apple will mark the 10th anniversary of the iPhone with the launch of the iPhone 8 (and later iPhone X); new phones are typically announced at key developers conferences such as the September annual gathering of Apple enthusiasts.

The company reported on 1st August that sales for the most recent quarter totaling \$45.4 billion, down 28 percent compared with the previous quarter, but up 15 percent compared with the year-ago quarter. Apple reported a net income of \$8.7 billion, up 9 percent compared with the year-ago quarter.

Apple's services revenue in its fiscal third quarter grew to \$7.27 billion, higher than sales of all Apple products other than iPhone. Overall sales, led by apps, music and web services, were up 3 percent from the previous quarter and up 22 percent compared to the third quarter of fiscal 2016.

### Capex forecasts rise as semiconductor boom continues

Market researchers at Gartner Inc. increased their capital spending forecast for the semiconductor industry to more than 10 percent based on continued aggressive spending on new wafer-level equipment for memory and leading-edge logic circuit manufacturing. Gartner said it now expects semiconductor industry capital spending to rise 10.2 percent to reach (USD) \$77.7 billion this year. The firm had previously forecast that capital spending would rise by a tepid 1.4 percent.

A shortage of NAND flash memory chips, which has led to increased prices, was more pronounced in the first quarter of the year than Gartner expected, leading to more than 20 percent growth in sales of etch and chemical vapor deposition (CVD) equipment this year with a strong capacity ramp-up for 3D NAND, according to Takashi Ogawa, a research vice president at Gartner.

Gartner's move to raise its semiconductor capital equipment forecast is right in line with other market watchers' increasing expectations for what is shaping up to be the best year for the semiconductor industry in quite some time. Several organizations, including Gartner and the World Semiconductor Trade Statistics (WSTS) organization, have increased their forecasts,



predicting sales will grow more than 10 percent in 2017. Market researchers at IC Insights Inc. revised the 2017 semiconductor forecast as well, saying it now expects chip sales to rise 16 percent this year after projecting 7 percent growth earlier in 2017. Even More Growth Optimism from the SIA

Semiconductor sales are up nearly 21 percent year-to-date, punctuated by the highest ever sales total in the second quarter, says the Semiconductor Industry Association (SIA).

Chip sales for the second quarter totaled a record (USD) \$97.9 billion, up 6 percent from the previous quarter and up 24 percent compared with the second quarter of 2016, according to the SIA. June's semiconductor sales rose to \$32.6 billion, up 2 percent from May and up 24 percent from June 2016, the SIA said.

### Rudolph expands in China, announces new litho systems

Rudolph Technologies, announced on 2 July that it has received an order for a JetStep G lithography system from a second customer in China for pilot line manufacturing of next-generation AMOLED (active-matrix organic light-emitting diode) displays.

"Customers continue to invest in Rudolph's unique lithography solution for their R&D and pilot lines because it enables them to prove-out new processes more easily and at lower cost," Rudolph's vice president of Marketing, Elvino da Silveira said. "The JetStep system is especially beneficial in pilot line environments where there is a high level of product change-over and pressure to minimize cost. A JetStep mask set is a fraction of the cost of a mask set for scanner-based photolithography tools, making it an ideal choice for new product development."



### Startup Sees a Cheaper Approach to 3D Chips

A startup emerged from stealth mode with a new low-cost approach to building 2.5-D chip stacks that targets Internet of Things (IoT) applications. zGlue has developed a substrate that can link more than

a dozen die as an alternative to designing a more expensive and time-consuming SoC or a much larger circuit board. The startup is one of many companies using novel packaging to make up for the increasing complexity and cost of CMOS scaling. To date, most chip stacks have been too expensive for anything but the most high performance devices, but many companies are working on lower cost options.

zGlue uses a trailing-edge interposer of 24 to 48 mm<sup>2</sup> with integrated passives as well as a controller supporting power management and security. Its chip-to-chip interface can be configured in software and can accommodate most packages but is optimal for WLCSPs.

### ITC investigates Apple

The US International Trade Commission said it will investigate Apple following allegations by Qualcomm that the iPhone maker is violating six of its non-standards-essential patents. The review is the latest move in an escalating legal battle between the world's largest cellular chip vendor and one of its largest customers. One Wall Street analyst said he still believes the two companies could resolve most of their disputes before the end of the year, but given the escalating war of suits and counter-lawsuits, that estimate could be optimistic.

"Our forecasted resolution timing at year-end looks to be increasingly optimistic," said Ross Seymore of Deutsche Bank in a research note. The ITC typically completes an investigation within 15 months of an announcement, in this case about November 2018, he added. Samsung Verdict Reverberates Across South Korea

A South Korean court sentenced the head of Samsung Group, Jay Y. Lee, to five years in prison. The decision is seen as a watershed for the country's techno-political climate long dominated by large conglomerates. At the same time, the court's ruling is not expected to immediately impact South Korea's fast-growing, massive electronics businesses.

The sentence was the mandatory minimum for Lee, who was convicted along with four other Samsung executives of charges including bribery of the former South Korea president, Park Geun-hye, according to a Korean newspaper report. It marks the first time a Samsung leader has been jailed, although Lee's father and grandfather both faced court actions during their tenures running the group, it said. Samsung's attorneys called the verdicts unacceptable and are expected to appeal the decisions.

### Fab tool sales show signs of slowing

Billings for North American semiconductor manufacturing equipment firms increased on a year-over-year basis for the 10th consecutive month in July, but declined on a sequential basis, according to the SEMI trade association. "We observed softening in the equipment billings in July following a strong

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surge in the first half of the year,” said Ajit Manocha, president and CEO of SEMI, in a press statement. The three-month rolling average for equipment billings in July totaled (USD) \$2.27 billion, down 1.4 percent compared with June, SEMI said. The figure was up 32.8 percent compared with July 2016 billings of \$1.71 billion.



## Lam buys modeling software leader Coventor

Semiconductor manufacturing equipment vendor Lam Research Corporation said it has acquired Coventor Inc., a provider of modeling and simulation software for chip process technology. Terms of the deal were not disclosed.

The deal brings Lam (Fremont, California) new capabilities to enable customers to address process technology challenges through software prior to fabricating a design on wafers in the fab. Coventor (Cary, North Carolina) claims that its proprietary ‘virtual fabrication’ technology enables engineers to understand process variation effects early in the development of a new chip, reducing the number of silicon learning cycles necessary to bring that chip to market.

Such capabilities become even more valuable as chip makers push scaling further and are confronted with daunting new technical hurdles. Lam said the acquisition would support its process control vision and accelerate process integration simulation.

## 5G to span ‘last mile’ to handsets

A senior Ericsson engineer, speaking at Hot Interconnects on 5th September, said that 5G cellular will start with fixed-wireless services, lead to big changes in smartphones and ultimately rack up some staggering numbers.

Verizon and AT&T have already announced plans to use 5G at 28 and 39 GHz as a last-mile access technology starting late next year. “It will be easier to plop a pole in a neighborhood than connect homes via fiber,” said Dave Allen, Ericsson.



Thanks in part to such services, Ericsson expects that more traffic will run over wireless than wired nets by 2027. The initial 5G fixed-wireless services will act as neighborhood extensions of carriers’ core LTE networks. The collaborative 4G/5G roll out is different from the past, in part because pure 5G requires a fair amount of heavy lifting.

For example, millimeter wave transmitters and receivers will need to use massive MIMO antennas with beam forming on both sides. The techniques are needed to compensate for about 40 dB signal loss leaping from traditional 3G to 5G 39 GHz radios. Semiconductor Sales Rise for 12th Month in a Row Semiconductor sales continued to boom through July, increasing for the 12th consecutive month, according to the Semiconductor Industry Association (SIA) trade group.

Global chip sales for July totaled (USD) \$33.6 billion on a three-month average basis, up 24 percent from July 2016, according to the SIA, which reports sales figures compiled by the World Semiconductor Trade Statistics (WSTS) organization. The figure also represents a 3.1 percent increase from June.

## EU regulators again halt Qualcomm-NXP deal queries

European Union regulators have for a second time halted their investigation into the proposed (USD) \$38 billion acquisition of NXP Semiconductors by Qualcomm.

The European Commission said in a posting on its website that the investigation was suspended on 17th August. The Reuters news service reported on 6th September that Qualcomm and NXP failed to supply regulators with key information about the proposed merger and that the investigation would resume after the information was received.

Qualcomm (San Diego) announced its bid last October to acquire NXP (The Netherlands). The EU launched an investigation into the proposed acquisition in June, citing concerns over the merged entity’s position in near field communications (NFC), mobile devices and vehicle-to-vehicle and vehicle-to-infrastructure technology.

## Fab tool sales set another quarterly record

Worldwide billings for semiconductor manufacturing equipment hit an all-time high in the second quarter, breaking a record that had been set in the first quarter, according to the SEMI trade association. The industry remains on track to post its best year ever, SEMI stated.

Second quarter equipment billings totaled (USD) \$14.1 billion, shattering the record of \$13.08 billion set in the first quarter by more than \$1 billion, or 8 percent, SEMI said. Second quarter equipment billings were up by 35 percent compared with the second quarter of 2016.

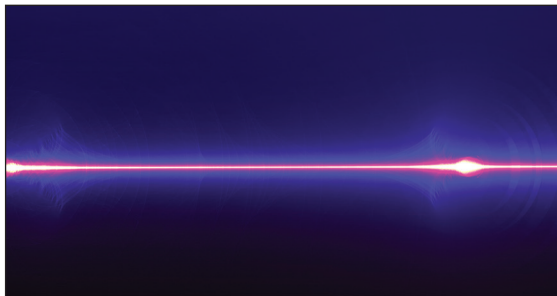


Semiconductor equipment sales are riding the wave of capacity expansions and node scaling in what is shaping up to be a huge year for semiconductor sales, particularly in the memory segment. In July, SEMI projected that tool sales would hit \$49.4 billion this year, breaking the record set in the dot com heyday of 2000.

Growth in the second quarter was strongest in South Korea, which is projected to be the No. 1 region for fab tool buying this year, SEMI said. Taiwan and China ranking second and third, respectively, in tool sales for the second quarter.

### **Samsung says EUV on schedule for 2018**

South Korea's Samsung Electronics confirmed that it expects extreme ultraviolet (EUV) lithography will be placed into initial production with its 7nm Low Power Plus (LPP) process in the second half of next year.



Samsung also announced the addition of an 11nm LPP process utilizing FinFET technology to its technology offerings, saying it would deliver up to 15 percent higher performance and up to 10 percent reduction in chip area compared to its 14nm LPP process while consuming the same amount of power. EUV, the long-heralded successor to 193nm lithography that has been delayed numerous times over the past decade, finally appears to be poised for prime time with leading edge chip makers Intel, TSMC, Samsung and Globalfoundries all targeting production deployment over the next 18 months.

### **Rudolph proclaims 'Firefly' a hit with customers**

Rudolph Technologies, Inc. announced on 12th September that its Firefly™ Inspection Systems, shipped to fulfill previously announced orders from multiple semiconductor manufacturers, are now qualified for production. The Firefly Inspection Systems provide high-resolution visual and non-visual inspection in a variety of advanced packaging processes, including fan-out wafer-level packaging, panel-level packaging and wafer-level chip-scale packaging. Rudolph expects over (USD) \$5 million in revenue in Q3 2017 from the systems. Additional Firefly System shipments are expected in Q4 2017.

### **AI reshapes fab operations**

Chipmakers are adopting artificial intelligence (AI) to boost fab operations, an effort that is starting to pay

off, according to Micron Technology. Fab managers need to juggle fluid customer demand while simultaneously implementing constantly changing process technologies in multiple manufacturing sites around the globe. All this happens as chipmakers aim to achieve yield and quality targets on a corporate level as quickly as possible, according to Buddy Nicoson, vice president of wafer fabs with Micron.

### **AMD Solutions fare well in Tesla Systems**

Tesla is examining samples of a machine-learning chip that it developed in collaboration with Advanced Micro Devices, according to a report from CNBC. AMD and Tesla both declined to comment on the story.

The chip was developed by Tesla's Autopilot group, a team of about 50 engineers under Jim Keller, a veteran microprocessor designer who led work on AMD's Zen x86 processor. The chip is expected to replace an Nvidia GPU that Tesla currently uses, which itself replaced a Mobileye chip, the CNBC report stated.

### **Samsung and Intel back Reno sub-systems**

A group of chip companies led by Samsung and Intel have invested (USD) \$11.2 million in Reno Sub-Systems, a supplier of semiconductor manufacturing process control systems.

The series C venture round was led by Samsung Venture Investment Corporation, the VC arm of South Korea's Samsung Electronics. Samsung was joined in the funding round by Hitachi High-Tech, sk Hynix and existing investors Intel Capital, Lam Research and MKS Instruments, according to the Nevada-based company. Reno Sub-Systems was founded in 2014 by a group of semiconductor industry veterans with backgrounds in the manufacturing equipment and process control space. The company offers two principal technologies: flow control for gases used in chip making and RF power generation and impedance matching of electrical loads used in the process. Both of the company's primary products offer substantial increases in performance compared to legacy solutions, the company stated.



### **TSMC aims to build first 3nm fab**

Taiwan Semiconductor Manufacturing Company (TSMC) will build the world's first 3nm fab in the Tainan Science Park in southern Taiwan, where the company does the bulk of its manufacturing. The announcement lays to rest speculation that the company might build its next chip facility in the US because of incentives offered by the administration of President Donald Trump to bring more manufacturing to America.

About a year ago, TSMC said it planned to build its next fab at the 5nm to 3nm technology node

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as early as 2022. The more recent one-paragraph announcement from TSMC on 29th September did not provide a timeframe for the opening of the 3nm fab. Monthly Chip Sales Cross \$35 Billion Milestone Monthly semiconductor sales hit (USD) \$35 billion for the first time in August, increasing on a sequential basis for the 13th consecutive month, according to the Semiconductor Industry Association (SIA).

The three-month moving average of chip sales increased by 4 percent sequentially and 24 percent year-to-year in August, as the semiconductor sales rally that began in the second half of 2016 continues to steamroller previous records, the SIA stated.

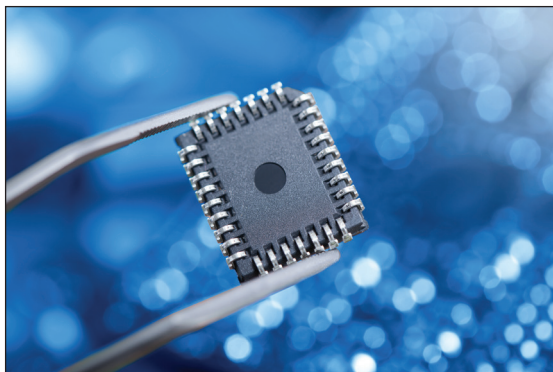
### Dialog to buy Silego for \$306 million

Dialog Semiconductor (UK) said it intends to buy privately held configurable mixed-signal IC (CMIC) vendor Silego Technology (Santa Clara, California) for up to \$306 million, to grow Dialog's sales with existing customers and also expand its customer base.

Dialog executives described Silego's technology as highly complementary to Dialog's own power management and connectivity offerings. They estimated the deal would expand Dialog's total addressable market by more than (USD) \$1.4 billion. Silego's CMICs combine analog, digital, and nonvolatile-memory functionality with software tools in a flexible, cost-effective design and prototyping platform. Silego announced in August that it shipped its 3 billionth device.

### Chip sales forecasts continue to climb

Market watchers once again increased their forecasts for 2017 semiconductor sales growth as the 'red hot' memory chip market shows no signs of cooling. Market research firm Gartner and independent industry analysts are now predicting that chip sales will top the (USD) \$400 billion mark for the first time in 2017. Gartner is forecasting that chip sales will reach \$411 billion this year, a 19.7 percent increase from last year, while other forecasts fall at or slightly over the \$400 billion milestone.



Price increases for memory chips, particularly DRAM and NAND flash, continue to set the pace. Gartner is now projecting that memory chip sales will rise 57 percent this year. In first quarter of the year, most

industry analysts said they expected modest growth in the 5-7 percent range because of momentum that began in mid-2016.

### ARM unveils new AI group

A new machine learning group at ARM will create accelerator cores, blocks for its CPU and GPU cores and software to tie everything together. Exactly what the group will deliver and when remains under wraps. Analysts suggest ARM could be as much as three years behind products from rivals such as Cadence, Ceva and Synopsys. ARM counters that these are still the early days for emerging markets where software is rapidly evolving, and that many AI-related tasks are already running on its existing cores. ARM declined to share the number of people or budget for the group, run by ARM fellow Jem Davies, best known for a decade working on ARM's media blocks. Rene Haas, president of ARM's intellectual property group, defined it simply as "a big team in hardware and software."

### Intel again lifts its 2017 forecast

Intel raised its forecast for 2017 sales and profit after delivering third quarter results that topped Wall Street's expectations. Intel said it now expects sales for the year to total between (USD) \$61.5 billion and \$62.5 billion and earnings per share to be between \$2.88 and \$2.98 for the year. The company had earlier projected sales of between \$60.8 billion and \$61.8 billion with earnings per share of between \$2.61 and \$2.71.

### IoT may require very cheap SoCs

The Internet of Things (IoT) could rise or fall on the cost of its chips—no surprise. But the latest analyst projections say that success could depend on devices costing far less than \$1 each. This 'informed speculation' was delivered by a panel of technologists at ARM TechCon in Santa Clara, California during 27th October meetings. SoCs will need new kinds of memories, connectivity and sensors to scale to dimensions that the IoT will demand, but the path to get there is still unclear, they said.

Today's SRAM and flash memories, Bluetooth interfaces and sensors consume too much power to serve volume IoT nodes in 2027, panelists said. They sketched out a few possibilities for what may replace them. Ideally, a 2027 end node SoC will consume just 10 microwatts/MHz and transmit data on a radio drawing only 1 or 2 milliwatts, said Jason Hillyard, a director of software in ARM's wireless group. His "slideware SoC" used a new architecture built of sub threshold circuits suited for its energy harvesting power source.

### Samsung chip sales hit another high

South Korea's Samsung Electronics Company nearly tripled its third-quarter profit, largely on the strength of (USD) \$17.8 billion in chip sales, a company record for any quarter. Growth in semiconductor profit offset sequential profit



declines in Samsung's mobile handset and display businesses. The company's semiconductor business accounted for \$8.9 billion of Samsung's \$12.9 billion in profit, as sales of memory chips enjoyed widespread strength across all applications, especially high-performance memory chipsets for servers. Samsung, the world's largest seller of memory chips, is all but certain to pass Intel to become the number one chip vendor globally in 2017. Samsung's \$17.8 billion in third quarter chip sales compares to about \$16.1 billion for Intel.

**Overall Semiconductor Sales Hit \$108 Billion in 3Q**  
Global semiconductor sales topped \$100 billion in third quarter 2017 for the first time, reaching (USD) \$107.9 billion, according to the Semiconductor Industry Association (SIA) trade group.

Third quarter sales were up more than 10 percent from the second quarter, which set the previous high-water mark for chip sales in a quarter by reaching \$97.9 billion, according to the SIA, which reports sales figures compiled by the World Semiconductor Trade Statistics organization. Year-to-date, semiconductor sales are tracking more than 20 percent ahead of last year's pace. The semiconductor industry is almost certain to set a sales record this year, with sales potentially topping \$400 billion for the first time, thanks largely to tremendous growth in memory revenue amid tight supply.

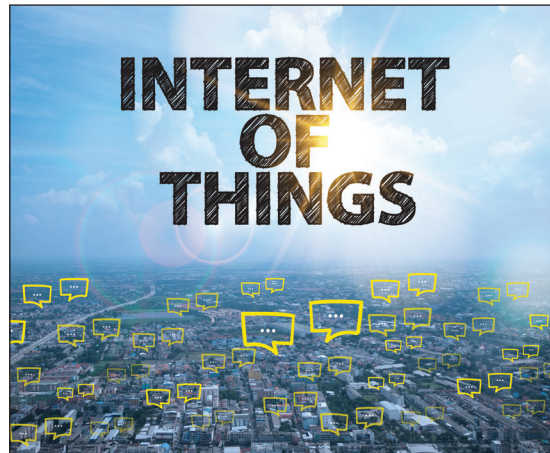
### MediaTek shifts to IoT

MediaTek, which has seen its share of the smartphone business plummet during the past two years, is turning to new products such as Internet of Things (IoT) chips to drive sales growth.

MediaTek is placing more emphasis on products that are boosting sales in the third quarter, which collectively brought in about one third of the company's revenue. These chips primarily supported applications including IoT, game consoles and ASICs. The company is selling IoT devices to new customers including Amazon, Google and Chinese internet companies that MediaTek declined to name. MediaTek did say it has also made chips, including ASICs, that go into game consoles for Sony and Microsoft. **Qualcomm Profits Drop amid Apple Disputes**  
It is not a challenge to tell that something is 'amiss' when a high-flying company like Qualcomm has no less than five top executives on an earnings call. So it was when the company reported results for the end of its fiscal 2017.

Quarterly and annual revenues of (USD) \$5.9 billion and \$22.3 billion respectively were both down 5 percent compared to 2016 results, using GAAP figures. Given the loss of licensing revenues from Apple and another unnamed customer, it was not surprising profits took a bigger dive to \$200 million for the quarter and \$2.5 billion for the year, down 89 percent and 57 percent from 2016, respectively.

The forecast is grim considering the company's storied past.



The mobile chip giant expects flat revenues for its next quarter despite a 5 percent expected rise in its chipset unit sales. Overall cellular device unit sales could rise 8 percent next year, but their average selling prices may drop given the fact that a growing share are going into more cost-sensitive systems in cars, networking and the Internet of Things.

### Apple may drop Qualcomm chips

Apple is working on designs for iPhones and iPads that use modem chips from Intel and MediaTek rather than Qualcomm, according to multiple media reports citing unnamed sources. Apple may replace Qualcomm modems in the next-generation iPhone set for release next fall, according to the reports by the Wall Street Journal, the Reuters news service and the Bloomberg news service, among others.

Qualcomm has supplied basebands chips for every generation of iPhone and iPad since the first model debuted 10 years ago. However, the relationship between Apple and Qualcomm turned adversarial early this year, and the two companies are currently awaiting trial in a (USD) \$1 billion lawsuit filed in US federal court by Apple in January over the royalties that Apple pays to Qualcomm, which Apple has called excessive. Qualcomm chip sales to Apple are projected to be worth about \$2.1 billion this year, or about 13 percent of its total revenue, according to a report by the Wall Street Journal.



### Greater DRAM supply may be coming in 2018

The DRAM supply bottleneck that resulted in slowed end-use device production and higher prices for suppliers throughout 2017 may be coming to an end. Samsung Electronics is ratcheting-up capacity to extend its lead over competitors and freeze new entrants from China out of the market, according to the market research firm, DRAMexchange.

## 2017 year in review

Researchers are predicting that the DRAM bit supply will grow by 22.5 percent in 2018, up from about 19.5 percent in 2017. The firm had predicted as recently as September that DRAM bit supply would grow by 19.6 percent next year. Samsung, which owns about 45 percent market share in DRAM, is considering a plan to allocate some capacity that had been set aside for NAND flash to DRAM at its new facility in Pyeongtaek, South Korea. Samsung may also add more DRAM capacity to its Line 17 fab in Hwaseong, South Korea, according to DRAMexchange.

### Broadcom makes \$103 billion bid for Qualcomm

Broadcom Ltd. launched an unsolicited takeover bid to acquire larger rival Qualcomm for roughly (USD) \$103 billion in what would be the largest tech acquisition ever, if accepted and approved by international regulatory bodies.

Broadcom said it would offer \$70 per share to acquire Qualcomm, the largest maker of mobile phone chips, a 28 percent premium over Qualcomm's closing stock price on 2nd November, the day before reports that Broadcom was planning a takeover offer surfaced amidst Qualcomm's fiscal year earnings report. Broadcom did not approach Qualcomm to discuss the deal prior to launching the bid, according to reports. The magnitude of the deal would be difficult to overstate, even in a period of unprecedented consolidation for the semiconductor industry. Qualcomm itself is still in the process of trying to close a deal for European chip maker NXP Semiconductors that was first announced a year ago, which is to date the largest announced semiconductor firm acquisition.

A combined Qualcomm, NXP and Broadcom could have total semiconductor sales of \$40 billion, making it the third largest chip company ahead of TSMC but below Samsung and Intel, according to the market watchers at IC Insights. Such a deal would make 2017 the largest on record in semiconductor mergers with an estimated value of \$120 billion including a reported merger proposal between Cavium and Marvell, he added. Prior to this latest announcement, 2017 had been far quieter in terms of M&A activity than 2015 and 2016.

### A better lithium battery?

Want to boost the lifetime performance of a lithium-ion battery without risking fire or explosion? Taiwan's Industrial Technology Research Institute (ITRI) is proposing a quick-fix solution: a composite paste that OEMs can apply to battery electrodes. ITRI claims, with the test data to support it, that its ChemSEI-Linker paste increases Li-ion batteries' lifetime up to 70 percent. ITRI also says ChemSEI-Linker is a green technology because it enables easier recycling of Li-ion cells at the end of their extended lifetimes.

ITRI engineered the new material after analyzing why the electrodes always seem to be the weak link that causes Li-ion batteries to fail in the field. In this case,

researchers looked at performance degradation, not the failures that result in fires or explosions that have been traced to the formation of dendrites on cell electrodes.



After surveying the literature and testing the most likely culprits in its labs, ITRI concluded that the primary cause of full-lifetime failure is the buildup of a predatory solid-electrolyte interface (SEI) layer starting with the very first recharge cycle. The buildup layer thickens over the lifetime of the battery, gradually degrading its performance until it works so poorly that it needs to be replaced.

### Samsung to Show its EUV Plans at Next ISSCC

Samsung will describe a 7nm SRAM made with extreme ultraviolet lithography (EUV) at the International Solid-State Circuits Conference in February 2018, the company announced. Other ISSCC papers will detail memories, sensors and processors spanning everything from fast DRAMs to location trackers embedded in a boot. Reinforcing its commitment earlier this year to be the first chip maker to use EUV, Samsung will describe a 0.026 $\mu$ m<sup>2</sup> SRAM bit cell in a 7nm process it plans to make available next year. The chip is the smallest SRAM described to date and uses a double-write driver to reduce minimum supply voltage.

### IBM quantum computer goes primetime

IBM's quantum computer is taking a leap into commercial availability at the Supercomputing Conference 2017 this week in Denver, Colorado. Dubbed the IBM Q, and available at the time for free on-line, the system now has time-proven capabilities, attained from the free trial period. It will still be cloud hosted with a ready-to-go 20-qubit version and a 50-qubit prototype that demonstrates how to solve NP Hard (non-deterministic polynomial-time hard) problems impossible for the fastest supercomputer today. IBM will also provide an open-source quantum information software kit (QIS-Kit).

The key to its QIS-Kit is you don't need a quantum computer to compose and debug your quantum application software, but can prove its correctness first on a conventional computer. Once debugged, the software can be assured to achieve its desired goals with NP-Hard problems. In fact, IBM claims

over 60,000 users have beta-tested and debugged their QIS-Kit on over 1.7 million quantum application programs.

### STMicro grows its low power MCU family

Chip vendor STMicroelectronics (Geneva, Switzerland) this week rolled out the successor to its STM32L4 series microcontrollers, offering significantly higher performance at ultra-low power consumption. The STM32L4+ devices, part of STMicro's STM32 family, feature an Arm Cortex-M core and can achieve performance of 150DMIPS (233 ULPMark-CP) at 120MHz, according to the company. Its new devices can serve as the central controller in range of products, including fitness bands, smart watches, medical devices, smart meters and industrial sensors, according to the company.

### Samsung likely to hold its top chip slot

Samsung Electronics is poised to unseat Intel as the world's largest semiconductor company this year based on sales. The South Korean electronics giant has benefitted throughout 2017 from strong demand for memory chips, according to market research firm IC Insights. Intel, which has held the lead since 1993, is

expected to fall to second place behind Samsung in 2017 sales rankings, with the two separated now by a (USD) \$4.6 billion gap, according to the market research firm's latest report. The jump in sales by Samsung, the world's largest memory-chip maker, is primarily attributable to soaring DRAM and NAND flash prices. Samsung first emerged in the top spot during the second quarter this year by displacing Intel. Surging memory prices are also helping SK Hynix and Micron, which are expected to make the biggest moves in IC Insights' 2017 top-10 ranking from the 2016 ranking. The memory makers are forecast to move up two spots in the top-10 ranking with SK Hynix occupying the third position and Micron moving up to number four.

### Fab tool sales decline sequentially amidst continuing IC sales boom

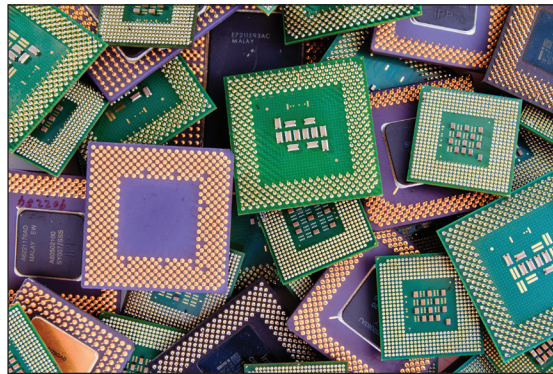
It is a curious condition, but one that semiconductor market watchers have seen before. Even as chip sales soar to record 2017 levels, the SEMI trade organization reported on 28th November that semiconductor manufacturing equipment sales declined on a sequential basis for the fourth straight month in October. Nevertheless, sales remained well ahead of last year's pace, beating the October 2016 figures by 23.7 percent.

SEMI reported that the three-month average of billings for North American semiconductor tool manufacturers slid to (USD) \$2.02 billion in October, down 1.8 percent compared with September, while the overall equipment market is on pace for a record year with sales of greater than \$50 billion expected. SEMI said in July that it expected sales to be up nearly 20 percent this year, but growth since then has

pushed the number higher. The trade group had previously predicted that the market would grow another 8 percent in 2018. Almost all other market watchers predicted (in first quarter) that sales would increase between 5 and 7 percent in 2017 with modest growth in 2018.

### Semiconductor stocks may be overvalued, analyst says

The market capitalization of publicly-traded semiconductor companies has risen dramatically over the past three years, driven largely by a frenzy of merger and acquisition activity and the performance of the chip market as a whole, according to International Business Strategies (IBS). The recent run-up in company valuations has most recently come from the unexpected growth that the industry has experienced, with most analyst firms predicting 20 percent expansion or more for the year.



The cumulative valuation of 15 selected non-memory companies studied by IBS rose from about \$520 billion in 2015 to more than \$1.07 trillion today.

Expectations of additional M&A activity and a positive assessment of the long-term prospects for the semiconductor industry among analysts and investors have also helped the cumulative valuation of the group more than double, according to IBS, which is based in Los Gatos, California.

### GaN Chip vendor secures \$15 million in new funding

High-voltage gallium nitride (GaN) semiconductor vendor Transphorm has secured (USD) \$15 million in funding from Japan's Yaskawa Electric, bringing the total it has raised so far to more than \$230 million. Transphorm (Goleta, California) was founded in 2007 and said it plans to use the funding for product development. The company announced in September that Yaskawa is using Transphorm's 650V GaN chips in its  $\Sigma$ -7 F servo motor, the first servo motor to make use of high-voltage GaN technology.

In addition to servo motors, Transphorm maintains that its high-voltage GaN technology offers performance, efficiency and reliability advantages over silicon for automotive systems, data center and industrial power supplies, renewable energy and other broad industrial applications.





## **Walmart lends its clout to the call for cheap IoT sensors**

Chris Enslin wants a sensor for his Internet of Things (IoT) applications that costs less than a dollar. Enslin knows discount retailing; as a vice president for digital enterprise solutions at Walmart he believes that if the IoT will play a large role in his company's operations the sensors will need to be 'everywhere' and will need to pay for themselves quickly. And for the right product at the right price, his company might be willing to purchase a few million of them—every year. The biggest items on his IoT shopping list are cheap sensors.

## **It's (almost) official: Chip sales will top \$400 billion in 2017**

A key semiconductor market watcher has once again revised its 2017 chip sales forecast upward after the industry posted yet another all-time record month in October. The World Semiconductor Trade Statistics (WSTS) organization said it now expects sales to increase 20.6 percent this year to reach more than \$408 billion. This would mark the first time that the industry's sales topped \$400 billion in any one year, just four years after surpassing the \$300 billion mark for the first time. "Market growth continues to be driven in part by high demand for memory products, but combined sales of all other semiconductor products were up substantially as well, showing the breadth of the market's strength this year," said John Neuffer, president and CEO of the Semiconductor Industry Association (SIA) trade group. Analysts have consistently raised chip forecasts along with predictions for sales of capital equipment in 2017 as surging memory prices have set the pace for what has been a strong market across almost all indices. Last week, researchers at IHS Markit projected sales would grow by 21 percent this year. In October, research firm Gartner forecast nearly 20 percent growth while IC Insights last month lifted its forecast to 22 percent growth for the year.

## **Startup creates a new benchmark for NB IoT**

Great ideas can sometimes be found in unexpected places, like ideas espoused by startup Riot Micro that came out of stealth mode in December to announce it can offer the market a narrow band Internet of Things (NB-IoT) device that takes cellular networking to new lows in terms of power and price. Riot Micro is sampling a modem tailored for the latest 4G IoT standards. It claims that its RM1000 chip draws milliamps to microamps of power and could sell for well below the industry's target of a \$5 module. Carriers around the world are just starting to turn on various flavors of LTE-based cellular IoT networks. They aim to leapfrog an emerging crop of emerging low-power wide-area networks such as LoRa, Sigfox, 802.11ah Wi-Fi, and others. The Riot Micro device is designed to handle both the Narrowband IoT and LTE Cat M1 (aka eMTC) standards.

## **Depth sensors potential goes deeper than iPhone X**

The FaceID system in the iPhone X has demonstrated how depth sensing can enable facial detection, recognition, and authentication. But potential applications for depth sensors extend beyond those situations and the Apple iOS platform as well. Qualcomm, for one, has taken its Spectra image signal processor (ISP) technology to the next level with a 3D depth-sensing camera module for Android developed in collaboration with Apple supplier Himax Technologies. Next year could see the emergence of a depth-sensor ecosystem, including firmware and apps, as more smartphone and wearable-device vendors incorporate third-party modules in their designs, industry insiders predict.

Qualcomm combined the Spectra imaging technology with Himax's expertise in wafer optics, sensing, drivers, and module integration to create the SLiM depth sensor for mobile, augmented-reality (AR), virtual-reality (VR), automotive, and surveillance applications. Himax CEO Jordan Wu said his company had been working with Qualcomm for more than four years to develop the 3D sensing solution.

## **Fab tool forecast to hit record \$56 billion**

Sales of semiconductor manufacturing equipment are now expected to grow by nearly 36 percent in 2017, an increase from earlier forecasts that projected 20 percent growth, according to the SEMI trade association. The group expects sales to grow by another 7.5 percent next year. SEMI said it now expects sales for fab tools to reach a record \$55.9 billion in 2017, passing the \$50 billion mark for the first time. The earlier forecast, issued in June, had predicted sales of \$49.4 billion, which itself would have been a record. This year's semiconductor equipment buying spree, fueled by capacity expansion and record chip sales, is expected to shatter the sales record set in 2000 at the height of the dot-com bubble.

## **Toshiba and Western Digital bury their hatchets**

Toshiba and Western Digital have announced a deal to settle all ongoing litigation and arbitration, extending their existing partnership and NAND flash development and manufacturing. The deal, which was expected by 15th December, extends the joint venture agreements between the firms to 2027 and beyond.

It gives WD the right to fully participate in Toshiba Memory's Fab 6 at its Yokkaichi Operations site, which will be devoted to the mass production of bit cost scalable BiCS 3D NAND.

Walter Coon, an analyst and director for technology, media and telecom at IHS Markit, said that the settlement was in the best interests of both parties. "From the WD perspective, they had to get resolution to this [to secure future supply of NAND]," Coon said. "In the long term, even if they felt like they would prevail in the courts, I think the risk was too high."

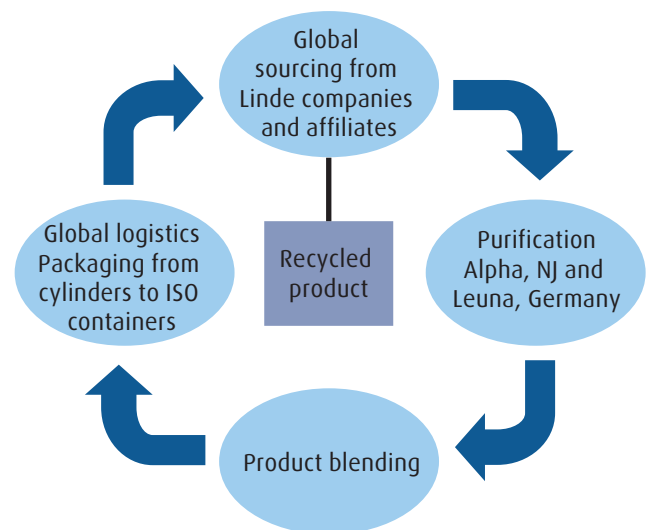


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