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Every week CB DIGEST scours many of newspapers, magazines, and websites, searching for the most intriguing tech stories and the most thoughtful things – left, right, and in-between. The CT DIGEST also reports on what the smartest people are saying about the world.

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Makers of iPhone apps questioned in U.S. antitrust probe of Apple, report says. The U.S. Justice Department has reached out to app developers as part of its investigation into Apple, one of the four big tech companies being probed for alleged anti-competitive behavior, according to a report from Reuters, citing one of the developers and another person familiar with the investigation. As part of the ongoing investigation, Suren Ramasubbu, The chief executive of developer Mobicip, said he was interviewed in November by a U.S. investigator who asked about the company's interactions with Apple. The app, which has nearly a million users worldwide, allows parents to control what their children see on their iPhones. Ramasubbu said the Mobicip app was temporarily removed from the iPhone app store last year for a failure to meet requirements imposed by Apple.

U.S. Head of SoftBank's Vision Fund Is Leaving
Michael Ronen, the U.S. chief of SoftBank's $100 billion Vision Fund, is leaving the investment firm less than three years after joining from Goldman Sachs, the Financial Times reported. The decision comes as SoftBank endures increased criticism of its investments, particularly its support of the struggling coworking business WeWork.

As the head of U.S. investments, Ronen struck deals with the multi-billion-dollar freight startup Flexport, car-sharing service Getaround and autonomous delivery company Nuro, among others. The Financial Times reports Deep Nishar and Colin Fan, former LinkedIn and Deutsche Bank executives, respectively, may take over Ronen's duties.

News of Ronen's exits follows reports the Japanese outfit is struggling to raise its second fund in the aftermath of the implosion of WeWork and a number of other big bets that have been troubled. Yesterday (Feb 3, 2020), Business Insider reported SoftBank's chief people officer Michelle Horn had departed after only one year.

Mitsubishi Electric develops technology for controlling in-building robots
Mitsubishi Electric announced that it has developed a technology for controlling in-building mobile robots used for cleaning, security, delivery and guidance, as well as next-generation electric wheelchairs. The company said in a release that it is using building dynamic maps to achieve "cooperative interaction" between the robots and building facilities, such as elevators and access control systems.

LinkedIn CEO Jeff Weiner is stepping down. Jeff Weiner, the CEO of LinkedIn, is stepping down from his position effective June 1. The company made the announcement Wednesday. Head of product Ryan Roslansky will take over as CEO. "Ryan will report directly to Satya (Nadella) and serve as a member of his senior leadership team," the company added. Weiner, who has been the CEO since 2008, would become the platform's executive chairman. Microsoft bought the LinkedIn in March 2016 for $26.2 billion to grow the professional networking site and integrate it with Microsoft's enterprise software.

Amazon Is Fourth U.S. Company Worth $1T
Amazon on Tuesday (Feb 4, 2020) became the fourth U.S. company to grab a $1 trillion market valuation. After a few days of flirting with the line, Amazon closed up 2.3% at 2,049.67, giving it a market capitalization of about $1.01 trillion. Amazon was briefly worth $1 trillion in 2018 before falling back under the level.

With the climb, Amazon joins Apple, Google parent Alphabet and Microsoft as U.S. companies worth the eye popping amount. Oil giant Petrochina was worth more than $1 trillion in 2007 before falling back below, and Saudi Aramco, another oil company, is worth more than $1.5 trillion.

Macy's to shutter 125 stores in massive retooling
The department store is also closing its Cincinnati headquarters, moving macys.com out of San Francisco, and cutting some 2,000 jobs.

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Sequoia Expands Seed Investing Team as Rivals Loom
Sequoia Capital, already one of the most influential venture capital firms in the world, is putting more boots on the ground to make sure it doesn't miss out on the next big early-stage startups.

In an unusually large expansion of its investing team, Sequoia has hired four new partners—Bogomil Balkansky, Konstantine Buhler, Shaun Maguire and Josephine Chen—to bolster its ability to bet on seed-stage startups, where some of the most lucrative venture investments occur. Sequoia is already widely envied for its prowess in that category through its blockbuster bets on WhatsApp, Google and others. Its success, though, has attracted growing competition from investors seeking to horn in on such deals.

IPhone Maker Tells Staff to Delay Returning to Work at Shenzhen Facility
Foxconn, the Taiwanese company that is Apple's most important contract manufacturer, has told staff at its facility near Hong Kong to delay returning to work after the Chinese Lunar New Year as a preventive measure to halt the spread of the coronavirus. According to Bloomberg, an internal memo by the company told employees not to return to Shenzhen, a city in Southern China that is a major export center, even after Feb. 10, when the government has said people can resume working after an already extended break. It isn't clear if the policy extends to all Foxconn facilities, including cities in other parts of China where the company assembles iPhones and other devices for Apple. Still, it further clouds the outlook for how much damage the outbreak could have on Apple's output.

FBI Has 1,000 Open Cases on China-U.S. Tech Theft
FBI Director Christopher Wray told a conference that the agency has about 1,000 open investigations into theft of U.S. technology by Chinese actors, Reuters reported. Speaking at a conference hosted by the Center for Strategic and International Studies, Wray said the theft spans "every industry sector" and is "diverse and multilayered," Reuters reported.

Chinese IP theft has long been overlooked by the U.S., but it has become a major sticking point in trade negotiations between Washington and Beijing. For instance, one in five North American-based companies surveyed by CNBC last year said Chinese firms stole technology from them over the past decade. Wray's comments might help Washington make the case for why it must remain tough on China despite the two countries striking a Phase One deal to de-escalate trade tensions.

SoftBank Facing Pressure From Activist Investor
Elliott Management, a prominent activist investor, has built a 3% stake in SoftBank in recent months, adding to the potential threats aimed at the Japanese conglomerate. The Wall Street Journal described Elliott's involvement as "cooperative," with the fund meeting with SoftBank executives and encouraging the firm to improve corporate governance and buy back shares. Things could, of course, turn more combative.

The investment comes when SoftBank is vulnerable. It is believed to be having trouble raising outside money for its second tech investment fund because of high-profile blow-ups like WeWork, one of the biggest investments in its portfolio. The value of SoftBank's investment in Sprint is also under threat amid a legal challenge to Sprint's proposed merger with T-Mobile.

The Journal notes the gap between the value of SoftBank's holdings—which also include Alibaba and its Japanese telecom business—and its market capitalization, which sat at $89 billion at the beginning of the day. SoftBank shares shot up 7% after the Journal's story.

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Japan Display receives $935 million from Ichigo Asset Management
In August 2017, Japan Display announced a last-resort strategic focus on OLED displays as the Japanese display maker failed to shift to OLED displays in time. Since then JDI was busy trying to raise the funds needed to construct a large-scale OLED fab, raising $430 million from Oasis Management group and one of its customers (likely to be Apple).

Koch Industries acquires Infor in deal pegged at nearly $13B
Infor announced today that Koch Industries has bought the company in a deal sources peg at close to $13 billion. Infor, which makes large-scale cloud ERP software, has been around since 2002 and counts Koch as both a customer and an investor, so the deal makes sense on that level. Koch was lead investor last year in a $1.5 billion investment, wherein the company indicated that it was a step before going public.

It's not clear if that is still the goal, as sources suggested that staying private might provide the company with more capital flexibility in the future. Daniel Newman, founder and principal analyst at Futurum Research, says staying private longer could benefit Infor in the long run.

Payments giant Worldline to buy rival Ingenico in $8.6 billion deal as fintech competition heats up. Two European giants in the payments space are set to combine to create the industry's fourth-largest player. France's Worldline said it would buy domestic rival Ingenico in a deal that values the startup at 7.8 billion euros ($8.6 billion), Worldline said in a statement Monday. Older payments players have been under pressure to consolidate as they face competition from a wave of new fintech rivals.

Accenture to Acquire Mudano to enhance its analytics and data transformation services to financial services firms in the UK. Accenture announced today it has reached an agreement to acquire Mudano, a strategic data consultancy to U.K. financial services firms, further enhancing its analytics, data and artificial intelligence (AI) transformation capabilities. Terms of the transaction were not disclosed. Mudano's team of industry-focused data professionals will join Accenture Applied Intelligence, which employs more than 20,000 professionals worldwide who help clients scale AI, including 6,000 data scientists, data engineers and AI professionals. Founded in 2014 and headquartered in London, with a presence in Edinburgh, Scotland, Mudano uses advanced analytics, applied data science and modern data technologies to help the U.K.'s largest banks, insurers and wealth management firms transform key areas, such as customer behavior analytics, financial crime-prevention and intelligent data management.

OpenLegacy bags $20M strategic investment from SBI Holdings. OpenLegacy, a Reston, Virgina-based tech startup and a provider of microservice-based APIs for legacy and core systems, has received a $20 million strategic investment from SBI Holdings. The investment will help to accelerate its own digital transformation activities. The Japanese investor wants to leverage OpenLegacy's technology for the MoneyTap app and says it will recommend OpenLegacy for the digital transformation of regional banks.

Cresta launches out of stealth with $21M in funding from Andreessen Horowitz, others to provide AI for the human side of your contact center. Cresta, an AI startup that was spun out of the Stanford Artificial Intelligence lab, announced it has closed $21 million in funding to enable office workers to be experts on day one. Backers for the funding include Greylock Partners, Andreessen Horowitz, Andy Bechtolsheim, Mark Leslie and Vivi Nevo. In conjunction with the funding, Cresta also announced that its transformative software for contact centers, a $310 billion market, is now available to the public. Fortune 500 companies using Cresta are already seeing their agents become more effective and more efficient, and ramp up in significantly less time. Founded in 2017 by Zayd Enam, Tim Shi, and Sebastian Thrun, the Palo Alto, California-based Cresta is a developer of an artificial intelligence platform designed to help scale and improve the quality of customer services.

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JumpStory, Netflix of images, raises $1M to use AI to find authentic images and videos for users. Jumpstory, the Netflix of images and the creator of revolutionary AI-based digital content platform, today announced the rollout of its AI-powered image search and success prediction tools after securing $1 million investment. The platform, which features a Netflix-style subscription model, uses AI to find authentic images and videos based on written marketing content and predicts how images will perform, saving marketers time To date, the Aarhus-based startup JumpStory has raised $1m after two rounds of funding. The startup provides a Netflix-style subscription makes stock image sourcing fast, effortless and affordable.

Industry Ventures closes its debut hybrid fund with $125M to buyout funds within the technology space. Industry Ventures, an investment firm pioneering venture capital solutions, announced today the final closing of its debut hybrid fund of funds for technology buyouts, Industry Ventures Tech Buyout, L.P. ("the Fund"), with total commitments of $125 million. The hybrid fund will focused on direct investments and to buyout funds within the technology space. Founded in 2000, Industry Ventures is a leading venture capital platform with $3.6 billion under management. Industry Ventures invests across all stages of the venture capital lifecycle through complementary fund strategies. The firm is headquartered in San Francisco, with offices in Washington, DC and London.

Nasdaq acquires fintech startup OneReport to accelerate delivery of ESG reporting and workflow solution to corporate clients. Nasdaq, a global technology company serving the capital markets and other industries, announced today the acquisition of OneReport, a fintech startup and provider of corporate responsibility and environmental, social, and governance (ESG) data management and reporting services. The financial terms of the deal were not disclosed. The acquisition will help NASDAQ to accelerate the delivery of its recently-announced ESG reporting and workflow solution, to be named Nasdaq OneReport. The platform is now available to companies as part of the suite of solutions offered by Nasdaq's Corporate Services business. Founded in 2003, OneReport is a provider of corporate responsibility (CR) information management and reporting services.

Porsche Ventures and NeueCapital Partners invest in German software startup Nitrobox. Nitrobox, a German software startup and a provider of a payment, billing and accounting digital platform, has closed a a financing round in the single-digit million euro range led by Porsche Ventures and Silicon Valley-based "NeueCapital Partners" fund. The company intends to use the proceeds from the financing round to further expand its market position in Germany and to prepare for its entry to the US market. Founded in 2012, Nitrobox creates, automates and optimizes financial processes for Fortune 500 multinationals. The startup has developed a cloud platform which can be used for automatic monetization and billing of digital business models.

Leidos acquires L3Harris Technologies' Security Detection and Automation businesses for $1 billion in cash. Leidos, a Reston, Virginia-based Fortune 500 information technology, engineering, and science solutions and services provider, today announced that it has entered into a definitive agreement to acquire L3Harris Technologies' Security Detection and Automation businesses, for $1 billion in cash. The Boards of Directors of both companies unanimously approved the transaction. In 2018 alone, Leidos reported annual revenues of approximately $10.19 billion. L3Harris' Security Detection and Automation businesses provide airport and critical infrastructure screening products, automated tray return systems and other industrial automation products.

Copenhagen-based SaaS startup Dixa raises $36M to end bad customer service. Dixa, the SaaS startup that offers a customer service platform delivering more personal and data-driven customer experiences, has closed $36 million in Series B funding. Leading the round is Notion Capital, with participation from existing investors Project A Ventures and SEED Capital. Dixa was founded in Copenhagen in 2015 by four friends and is on a mission to empower brands to create great experiences for their customers and agents by giving them the ability to communicate in an easy and conversational way. Dubbed the "customer friendship" platform, Dixa empowers customer service teams to engage with customers, much like the way friends do.

Orthofix acquires FITBONE Limb Lengthening System for $18 million in cash. Orthofix Medical Inc., a global medical device company focused on musculoskeletal healing products, today announced an asset purchase agreement with

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Wittenstein SE, a privately-held German-based company, to acquire assets associated with the FITBONE® intramedullary lengthening system for limb lengthening of the femur and tibia bones. Additionally, the transaction brings other potential applications of the technology, which are in preliminary development, including the FITSPINE® system for early onset scoliosis. Terms of the agreement include $18 million in cash closing consideration and a manufacturing supply contract with Wittenstein SE.

Hyundai leads seed investment round in Israeli tech startup Kardome to develop voice-control technology for machines
Modern voice user interfaces (VUI) are expected to recognize natural language in acoustically challenging environments. Interfering signals, such as TVs, simultaneous speakers, and environmental noise, negatively affect the performance. Therefore, the state of the art VUIs utilizes multi-microphone pre-processing modules to obtain a spatial focus towards the direction of desired speech.

Enter Kardome, an Israeli startup that is developing technology gives the machine better "ears" through algorithms that manage to isolate the user's voice, even in a noisy environment with multiple speakers and background noises that are active at the same time. Kardome was originally founded in 2018 to develop a multi-user speech to text algorithm that hones in on a person's individual voice, as opposed to also picking up wind noise or background music.

Today (Feb 5, 2020), Kardome announced it has completed a seed funding round, led by Hyundai Motor Company, with the participation of NextGear Ventures and ATOORO Fund. The total amount of funding was not disclosed. In conjunction with the funding, Kardome also announced that Koby Simana, Investment Manager at Hyundai CRADLE TLV, will join to its board of directors.

Founded just a year ago by serial entrepreneurs Dani Cherkassky and Alon Slapak, with the goal of meeting the growing demand for reliable voice control technology from automakers and electronics manufacturers. Kardome's technology gives the machine better "ears" through algorithms that manage to isolate the user's voice, even in a noisy environment with multiple speakers and background noises that are active at the same time.

Kardome's technology combines dedicated software with the use of microphones that exist in various products. Kardome software enables the implementation of a new generation of voice user interface, operating reliably even in noisy and multi-speaker environments, such as vehicles, public buildings, restaurants and even at home.

Commenting on the funding, Kardome's CEO, Dani Cherkassky, said: "Hyundai's investment, one of the world's leading automakers, directly in Kardome – made after a thorough comparative technical examination, expresses confidence in the technology we have developed and also indicates the need and yearning of all the world's leading technology makers for a zero touch interface that works reliably in a natural and noisy environment. The investment will help us increase the company's manpower and accelerate the development of the new generation of voice interfaces, as well as expand the company's global presence."

Amazon's AWS to invest $236 million in Brazil to strengthen cloud infrastructure. Amazon Web Services (AWS), the cloud computing unit of Amazon announced today that it will invest $236.18 million (1 billion reais) in the Brazilian state of Sao Paulo over the next two years, the state government said on Wednesday, to strengthen its infrastructure in South America. The announcement comes as the company also strives to expand its in online retailing in the increasingly competitive Brazilian market, where well-established local players pose a challenge to international rivals. "With this major investment by AWS, Amazon's cloud computing business, we will create more jobs, technology and also opportunities for startups," governor João Doria said in the statement.

Cloud storage startup NGD Systems nabs $20M in Series C funding to bring intelligence to storage using AI and machine learning. NGD Systems, an Irvine, California-based cloud storage startup, has raised $20 million in series C funding to support and accelerate the production and deployment of the world's first NVMe Computational Storage

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Drive that continues to enable artificial intelligence and machine learning within the device where the data resides. The round, which brings total funding raised to date to $45 million, was led by MIG Capital, with participation from Western Digital Capital Global, Ltd, the strategic investment fund of Western Digital Corp., and existing investors, including Orange Digital Ventures, Partech, BGV and Plug-N-Play. Founded in June, 2013, NGD Systems is focused on the design and manufacture of a new generation of Intelligent SSD Solutions.

Lumos Diagnostics raises $15M Series A funding to help healthcare professionals more accurately diagnose and manage diseases. Lumos Diagnostics, an healthtech startup that helps develop and manufacture custom rapid Point-of-Care diagnostic solutions, has secured $15 million in Series A funding to support the international commercial expansion of the FebriDx rapid point-of-care (POC) test, the FebriDx U.S. FDA pivotal clinical trial, and additional development and manufacturing resources for the company's expanding full-service POC business. The round was led by Planet Innovation, an Australia-based healthtech innovation and commercialization company. Lumos Diagnostics is a spinout from Planet Innovation, which was merged with RPS Diagnostics in May 2019 to create a diverse healthcare company that combines the FebriDx test and commercial experience with a novel and proprietary digital reader platform.

Rad Power Bikes Closes $25 Million in Funding to Grow Direct to Consumer Electric Bike Business. Rad Power Bikes, a Seattle-based ebike brand, closed $25 million in funding led by Vulcan Capital and Durable Capital Partners LP. The funding will support new brick and mortar retail locations around the world, along with expansion of the company's mobile service and white glove delivery offerings. Founded in 2007, the company has 200 employees spread across offices in Seattle, Wash., Vancouver, British Columbia, and Utrecht, the Netherlands. Rad Power Bikes is the largest electric bike brand in North America, with more than 100,000 owners across 30 countries and a full lineup of ebikes packed with power, comfort, and utility for both personal and commercial use.

Fleet management startup Maven Machines nabs $7M Series A funding to accelerate growth. Maven Machines, a provider of mobile-cloud technology for transportation safety, operations, and compliance, has closed $7 million in Series A funding to expand product development and accelerate growth. The round was led by Allos Ventures, with additional participation from Hearst Ventures, Riverfront Ventures, Great Oaks Venture Capital and existing private investors. Founded in 2014 by Avishai Geller, the Pittsburgh, PA-based Maven Machines is the only provider of fleet management software for commercial transportation that combines telematics with workflow, dispatch and route optimization capabilities. The startup blends a combination of IoT sensors, artificial intelligence, software, and wireless communications to provide a 100% real-time platform for both drivers and managers.

Sequoia leads $340 million funding Cloud security startup Netskope. Santa Clara, California-based Netskope announced it has closed $340 million in financing round led by Sequoia Capital. The financing, which includes participation from existing investors, brings the 8-year old startup to a valuation of nearly $3 billion. Founded in 2012 by Sanjay Beri, Netskope is a cloud access security broker (CASB). Using patented technology, Netskope's cloud-scale security platform provides context-aware governance of all cloud usage in the enterprise in real time, whether accessed from the corporate network, remote, or from a mobile device.

FinTech startup Ocrolus partners with Kiva to launch a new lending program to offer zero-interest loans. Ocrolus, a venture-backed FinTech startup that uses Artificial Intelligence and crowdsourcing to automate financial review processes, today announced a new lending program through a partnership with Kiva, a non-profit organization that enables anyone to make zero-interest loans to specific entrepreneurs in over 85 countries. Ocrolus believes that access to capital can change businesses and change lives. In 2019, through its partners and customers, Ocrolus created a faster application and approval process for over 1.4 million business loans. In fact, over $56.8 billion in loans was funded using data from the Ocrolus platform in 2019. Founded in 2014 by John Guerci, Sam Bobley, and Victoria Meakin, Ocrolus is a fintech infrastructure company that transforms documents into actionable data with over 99% accuracy.

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Boston-based tech startup SaaSWorks bags $5M in funding to provide no-app solution for scaling SaaS companies. SaaSWorks, a Boston-based tech startup that provides a revenue operations and customer success solution for scaling subscription businesses, today announced it has received a $5 million investment led by Conversion Venture Capital along with prominent SaaS CEOs, CFOs and executives. SaaSWorks was founded by Jim O'Neill and Vipul Shah in 2019 with a mission to provide customer success and revenue operations (RevOps) solutions for scaling subscription businesses.

Luxembourg-based tech talent recruitment platform startup nexten.io raises $660K seed funding to accelerate growth. nexten.io, a Luxembourg-based tech recruitment platform startup, has closed a total of $660,000 (EUR 600,000) in a new round of seed funding, with EUR 400,000 invested by Expon Capital, and matched by EUR 200,000 from our original investors. Expon Capital supports the development of startups that use digital technologies to make a meaningful impact. Through their Digital Tech Fund, which is dedicated to technology startups in Luxembourg, they have invested €400,000 into nexten.io, which was matched by an additional €200,000 from its original investors. Used by over 150 local companies to hire highly skilled profiles from software engineers to IT security experts, nexten.io matches developers and companies in direct contact to make the recruitment process more efficient.

Casper, a once high-flying unicorn startup, got a massive valuation haircut after Wall Street debut. Casper is a sleep startup that launches a comfortable mattress sold directly to consumers, eliminating commission driven, inflated prices. Casper makes its Wall Street debut with its shares surging nearly 30% following the company's initial public offering Thursday morning, opening at $14.50, which means the retailer startup is now valued at about $575 million based on where shares opened Thursday. However, as a private company, Casper was valued at $1.1 billion, giving it so-called unicorn startup status. Responding to the lower valuation, CEO Philip Krim, told CNBC in an interview, saying: "Valuations are just moments in time. This is obviously a huge milestone for us. … It doesn't distract us from building the business we want to build."

Coherent reports a positive Q4 2019 and sees an increase in OLED system orders
Photonics-based solutions provider Coherent reported its financial results for Q4 2019 - with revenues of $320.8 million, and a net profit of $5.8 million. The company says that these are encouraging results, and full-year outlook is improving. Coherent's display orders were up significantly for LineBeam systems and service. These systems orders are all destined to China, and the increase in service orders "reflects higher demand for OLED-equipped smartphones in Q4 2019". Orders for OLED cutting using short pulse and CO_2 lasers were also up.

By Sean Kinney

Qualcomm CEO Steve Mollenkopf, discussing Q1 2020 earnings on a Feb. 5 conference call, touted the company's near- and long-term view of 5G adoption in not just handsets but also in IoT, automotive, always-connected PCs and cloud-based artificial intelligence.

"Our business reached a key inflection point exiting fiscal Q1," Mollenkopf said, "demonstrating the positive financial impact of our 5G strategy to grow our addressable dollar per device with higher performing core chipsets and new RF front-end content. Virtually all of our 5G Snapdragon design wins are using our RF front-end solutions for 5G sub-6 [GHz] and/or millimeter wave."

The executive added that more than 45 device OEMs have launched or announced 5G devices and the company tallies some 275 5G devices announced or in development across price tiers. In China, for instance, Mollenkopf said there are 5G devices priced as low as $285. "At this point, 5G can address approximately 40% of domestic China smartphone sales."

In addition to updating its 5G portfolio with the flagship Snapdragon 865 mobile platform and the Snapdragon 765 and 765G, both of which feature integrated 5G modems with the latter also including a graphics processing boost for gaming, Qualcomm recently announced new LTE platforms tailored for the Indian market.

"Our product offerings will help make 5G more accessible to consumers," Mollenkopf said. The new LTE products "enable our partners to offer sophisticated solutions that meet global 4G demand, particularly in emerging economies across multiple tiers and price segments."

Mollenkopf called out Korea as a "leading indicator for the pace of 5G adoption." The three carriers in that country reported a combined 4.7 million 5G subscribers and are forecasting growth throughout 2020. "Of note," he said, "the expected 5G subscriber growth is not just isolated to the sub-6 frequency bands. Carriers are planning millimeter wave service in 2020."

On the millimeter wave front, Mollenkopf mentioned Verizon's deployment of high-band frequencies in 31 markets and said that, "Looking forward, we continue to expect millimeter wave to be deployed in all regions." He said approximately 345 operators in more than 120 countries are investing in 5G, including 45 commercial launches in 20 countries.

The automotive business has a "design win pipeline" valued at more than $7 billion, up from $5.5 billion a year ago; this includes solutions are telemetry, in-vehicle connectivity and infotainment, not the newly announced Snapdragon Ride autonomous vehicle platform. Debuted at CES, Snapdragon Ride features an ADAS Application Processor that support Level1/2 "active safety." The Autonomous Driving Accelerator chip uses AI to support more advanced "self-driving" functionality.

"We have now become a trusted advisor to many of the world's leading automakers," Mollenkopf said, noting that Snapdragon Ride expands Qualcomm's total addressable automotive market. He expects Snapdragon Ride-equipped vehicles on the road in 2023.

Right now the focus of 5G deployments is on providing enhanced mobile broadband to consumers. Further enhancements in the works for 3GPP Releases 16 and 17 will open up new opportunities around low-latency, reliability and massive support for the internet of things.

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"Our 5G roadmap extends beyond Release 17, placing us on the cusp of a multi-decade mobile transformation as 5G increasingly becomes the foundation for the digital transformation of industries beyond smartphones," Mollenkopf said.

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By Kelly Hill

Testing of 5G at sub-6 GHz frequencies concludes that mid-band LTE is "the weakest link"

Even with low-band 5G New Radio deployments that would presumably provide more, and more robust, coverage than millimeter-waved-based 5G, carriers' 5G coverage maps are still "optimistic," according to new drive test data from Signals Research Group. And that fancy 5G signal indicator on a new smartphone? It's not particularly accurate in indicating that the phone is actually connected to a 5G network.

In a new report, SRG details the results of drive-testing 5G New Radio in FDD and sub-6 GHz frequencies, exploring 5G deployments by AT&T and T-Mobile US in Indianapolis, Indiana and San Diego, California. The testing included smartphones from each carrier as well as the use of a Rohde & Schwarz scanner to determine the extent of 5G coverage, whether the smartphone connected to the network or not.

SRG's report highlights some of the limitations of NonStandalone 5G.

"Although low-band 5G NR signals may propagate for miles and miles, they still need LTE for an anchor with NSA," the report noted, going on to add that "Since a smartphone can't support two low-band frequencies, it means it must use a mid-band LTE frequency for the anchor carrier with 5G NR. Put simply, an operator's low-band 5G NR coverage is only as good as the propagation of a mid-band LTE frequency."

"Moving to a Standalone (SA) architecture is one way to address the issue," SRG pointed out.

5G NSA also plays into the discrepancy between when a 5G signal indicator is displayed and when the device is actually connected to 5G. As SRG said in its report, there are "stark differences between the smartphone having an actual 5G NR connection and what the phone displays. … The 5G icon is a poor indicator of a 5G connection."

"The LTE cell that provides the anchor for 5G NR (NSA) is used to trigger the phone's display of the 5G icon while the LTE cell's signal strength [and not the 5G NR cell]helps the phone determine how many bars to display," SRG explained. "The challenge is that the LTE cell and the 5G NR cell are not necessarily co-located, so it is very possible to be within range of the LTE anchor cell but outside the range of the 5G NR cell." The company went on to add that while its understanding is that "an AT&T 5G NR smartphone should only display a 5G icon when the LTE and 5G NR cells are collocated," it's also possible to have a 5G NR connection while the phone is displaying LTE or 5GE.

SRG said that on a T-Mobile device, the 5G icon is "almost always on, even if the scanner indicates all 5G NR signals are too low to support a connection." An AT&T smartphone did a better job of accurately indicating a 5G connection, SRG said, but added that even so, the 5G icon popped up while testing License-Assisted Access in downtown Indianapolis where there wasn't any 5G NR available.

The vagaries of the 5G icon could impact customers' perception of the value of 5G and 5G smartphones.

"It is a bit frustrating to see both smartphones showing a sustained 5G icon with full bars while parked when neither phone is connected to 5G NR and the top 5G NR cell barely registers on the scanner (-135 dBm). Since we used loaner phones and we were using test SIMs to supported unlimited data, we don't have any skin in the game," SRG said.

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"However, we surmise that consumers could respond quite differently to misleading information about 5G NR availability after shelling out close to $1,500 for a new smartphone."

In terms of coverage, SRG used the Rohde & Schwarz scanner to map out potential 5G NR coverage areas in both cities.

"Although coverage is quite good and 5G NR is available in some very unlikely places, the maps overstate where the 5G NR signal is strong enough to support a good data connection," the company said, concluding that "5G coverage maps are optimistic."

In all, SRG covered a drive test route of more than 350 kilometers in each of the two cities, using a Rohde & Schwarz TSME6 scanner as well as Accuver Americas' XCAL-M solution to log chipset data from the smartphones and capture log data; SRG used Spirent Communications' Umetrix Data tool to generate sustained high-bandwidth HTTP data transfers.

5G NR coverage was generally better in Indianapolis, which has less complicated terrain that San Diego. SRG found that overall, based on the scanner data (not smartphone performance), T-Mobile's 5G NR coverage was better than AT&T's 5G NR coverage in both markets, although the difference was "very modest" in San Diego. However, 5G NR performance in the low band doesn't necessarily beat out good old LTE. When testing on Coronado Island, for instance, LTE throughput on AT&T's network achieved almost 450 Mbps, which was more than twice the observed speeds on T-Mobile US' 5G network in the same place.

By Kate Clark

Rising Late Stage

How the size of funding rounds have grown over the past decade compared to the previous decade

Last year, Papaya Global, a financial services business based in New York City and Tel Aviv, pitched investors on its hopes of raising $15 million to expand the business, according to a person familiar with the situation. But after talks with venture capital firm Insight Partners, Papaya ended up raising a $45 million Series A round from a group that also included Bessemer Venture Partners, New Era Ventures and Dynamic Loop Capital.

It's the new normal in VC. So much money is sloshing around the system that not only are companies often raising far more than they expected, they're getting unsolicited offers of funding—when they're not even looking to raise money.

That overall picture may not surprise anyone in the VC investment community. It's partly a result of the rise of megafunds, like SoftBank's $100 billion Vision Fund. An analysis of funding rounds over the past 20 years shows starkly how things have changed. In particular, it reveals how excess capital has inflated late-stage funding rounds: The median Series E deal leaped 119% in size in the past decade compared to that of the previous decade, while series D rounds rose 107%, the data shows.

Early-stage funding rounds have risen at a more leisurely pace—Series A rounds rose, at the median, 25% over the same period.

Confining the analysis to the biggest tech firms magnifies the impact of this free-floating capital on late-stage deal-making, according to investment bank Code Advisors. By analyzing PitchBook data on 289 companies valued above $1 billion, Code determined that "unicorn" series E rounds rose 658% compared with such rounds in the previous decade.

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The data is another reminder—if we needed any—of why tech companies are waiting longer to go public than in the past. While a generation of decade-old companies, such as Uber and Pinterest, went public last year, plenty remain private. And that poses problems for liquidity-seeking investors.

"I have 25 companies that are private and valued at over $100 million in the market," said Ian Sigalow, co-founder of the multistage VC fund Greycroft. "The reality is that 100% of those companies would have been public already if this was 1999."

Overall, U.S. startups raised $136.5 billion from VC investors last year, making 2019 the second consecutive year total investment surpassed $130 billion.

One result is that companies can be pickier about which investors they allow into rounds—as Papaya Global showed with its $45 million fundraising last year. "We were lucky enough to be at a stage where we could choose our investors from an amazing list of VCs," said a spokesperson for the company in a blog post.

More Money, Fewer Exits
U.S. venture funds, for their part, attracted $46.3 billion in 2019. Although this was down from 2018's decade high of $58 billion, last year's total represents the second-highest amount since at least 2009.

With increasing levels of dry powder available, certain VCs are seeking to invest in startups before they begin fundraising. These unsolicited offers can expedite the process and allow investors to bypass competition.

"Any good deal is going to get preempted," said Vas Natarajan, a partner at Accel, which invests in seed, early-stage and growth ventures. "You don't want to wait around for a company to be [fundraising]."

Last year, for example, Tiger Global Management partner John Curtius approached Lattice, an employee performance management startup, shortly after it raised a $15 million Series B, Lattice CEO Jack Altman told me at the time. The company wasn't fundraising, but Tiger Global's $25 million offer at a post-money valuation of $215 million was enticing. The deal more than doubled Lattice's most recent valuation in exchange for an 11% stake.

Lattice's fundraising process isn't out of the ordinary and reflects the ultracompetitive state of VC these days.

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By Robert Hof

Alphabet Inc. today for the first time revealed numbers for two of its fastest-growing units, showing Google Cloud and G Suite revenue collectively jumped 53%, to $2.61 billion, and YouTube revenue rose 31%, to $4.72 billion.

But the newly revealed numbers came in a somewhat disappointing fourth-quarter earnings report. The Google LLC parent said it earned a profit of $10.67 billion, or $15.35 a share, in its fourth quarter. That's up from last year's $8.9 billion or $12.77 a share, thanks to carrying a 0% effective tax rate in the fourth quarter. Revenue rose 17%, or 19% in constant currency, to $46.08 billion.

Analysts surveyed by FactSet had expected a $12.57-a-share profit on revenue of $46.93 billion, meaning the search and advertising giant beat forecasts on profit but missed on revenue.

Alphabet shares fell close to 5% in after-hours trading following the results. In regular trading they had risen 3.5%, to $1,482.60 a share, staying above a $1 trillion market capitalization. Shares were up about 7% on the year after recovering from a third-quarter earnings disappointment last October.

The results were the first since Google Chief Executive Sundar Pichai (pictured) in early December took over the top spot at Alphabet overall from co-founder Larry Page. That elevation was widely seen as a positive by investors on the assumption that Pichai might be more parsimonious with Alphabet's perennially money-losing "other bets" such as its healthcare unit Verily and its self-driving car unit Waymo, as well as more forthcoming on financials. "This change in the guard offers the most optionality for multiple expansion for the stock we have seen in years," Pivotal Research Group analyst Michael Levine wrote in a recent note to clients.

In prepared remarks, Pichai cited the benefits of continued investment in "deep computer science," including artificial intelligence, ambient computing and the cloud. "I'm really pleased with our continued progress in Search and in building two of our newer growth areas — YouTube, already at $15 billion in annual ad revenue, and Cloud, which is now on a $10 billion revenue run rate," he said.

Rising cloud
Cloud computing remains a tiny portion of overall revenue, though it's becoming enough of a contributor to compel Alphabet to reveal more of its size. It's now separate from Alphabet's "other revenues," which include Google Play apps, smartphones and smart speakers. They rose 10%, to $5.26 billion.

"We are really pleased with the momentum of Google Cloud," Pichai said on a conference call with analysts. He said the company more than doubled deals of more than $50 million. "Definitely we are increasingly doing much larger deals," he said.

Taken together, cloud and other revenues totaled $7.88 billion, far below analysts' $8.65 billion consensus. That means hardware revenues probably accounted for much of the revenue shortfall, but the lower level of low-margin hardware also might have boosted the bottom line.

In particular, Pichai called out Google Cloud Platform, the company's infrastructure piece. "GCP's growth rate was meaningfully higher than Google Cloud's overall," he said, and it accelerated last year over 2018.

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"Likely the cloud numbers looked 'good enough' for 2019 to be broken out, and certainly show good traction," said Holger Mueller, an analyst with Constellation Research Inc. "But the cloud unit needs to grow faster than YouTube to show its relevance for Google overall. And then Google Cloud needs to catch up with fellow stalwarts AWS and Azure. Cloud is an economies-of-scale business that Google needs to scale up."

Google's cloud growth is faster than Amazon Web Services Inc.'s 34% growth reported last week, totaling nearly $10 billion for its fourth quarter. However, Google's growth still doesn't match that of No. 2 Microsoft Corp. Last week it reported better-than-expected earnings for its fiscal second quarter, with revenue from its Azure cloud infrastructure services up 62%, down from 76% the year before but ahead of some forecasts. The company got a big boost with the award in the quarter of the U.S. Department of Defense's controversial Joint Enterprise Defense Infrastructure contract, which could be worth up to $10 billion over the next decade.

"It was good to see Google break out its cloud revenue, but even more transparency would help," said Patrick Moorhead, principal analyst at Moor Insights & Strategy. "For instance, how much of that cloud revenue is G Suite versus infrastructure as a service and platform as a service? It does confirm that AWS is a giant which, based on its annualized number, is at $40 billion, four times larger than GCP."

That said, Pichai took pains to note that Google Cloud Platform, the infrastructure side, is growing faster that G Suite, implying that Google's growth rate at least comes close to Azure's, if not beating it.

Despite Google Cloud Platform continuing to trail leader Amazon Web Services Inc. and hard-charging Microsoft by a wide margin, some analysts like its prospects under Chief Executive Thomas Kurian. "We have been constructive about GCP under Thomas Kurian, think this will have turned out to be a critical foundation year, and the narrative continues to improve in 2020 and beyond," wrote Pivotal's Levine.

Likewise, Global Equities Research analyst Trip Chowdhry noted the expansion of Google Cloud's partner ecosystem to include established systems integrators such as Infosys, Accenture and Deloitte, a key to capturing more large enterprise customers. He also called out traction for Anthos, Google's hybrid-cloud service that allows applications to run in any cloud or in on-premises data centers.

Indeed, Chief Financial Officer Ruth Porat said the unit had a backlog of $11.4 billion in 2019, almost all of which relates to Google Cloud. In particular, she mentioned "strong uptake" of Anthos in the quarter. Google has pledged to triple the number of salespeople on staff in the next three years.

Capital spending for the quarter totaled $6.05 billion, down from $6.73 billion in the third quarter and $7.08 billion a year ago. Much of that spending goes toward data centers for Google's own operations and for its cloud services.

Alphabet's "other bets" segment reported a $2.03 billion operating loss on revenue of only $172 million. A year ago, it reported a $1.33 billion operating loss on revenue of $154 million.

For all that, advertising remains the big driver for Alphabet's business. In particular, ad revenues from search ads and YouTube together rose 18%, to $31.9 billion. "YouTube is growing strongly according to this report, and revenues are above where eMarketer had thought they were," said eMarketer Principal Analyst Nicole Perrin.

Still, the ad business remains under something of a cloud because of ongoing investigations by various federal and state agencies looking into antitrust issues involving ads, bias in search, and the way Google manages its Android mobile operating software. Reuters today reported that Justice Department officials will meet Tuesday state attorneys general staff to discuss their probes. Amazon, Apple Inc. and Facebook Inc. all face their own investigations as well.

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Sourced by Massachusetts Institute of Technology

We've heard it for years: 5G is coming.

And yet, while high-speed 5G internet has indeed slowly been rolling out in a smattering of countries across the globe, many barriers remain that have prevented widespread adoption.

One issue is that we can't get faster internet speeds without more efficient ways of delivering wireless signals. The general trend has been to simply add antennas to either the transmitter (i.e., Wi-Fi access points and cell towers) or the receiver (such as a phone or laptop). But that's grown difficult to do as companies increasingly produce smaller and smaller devices, including a new wave of "internet of things" systems.

Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) looked at the problem recently and wondered if people have had things completely backwards this whole time. Rather than focusing on the transmitters and receivers, what if we could amplify the signal by adding antennas to an external surface in the environment itself?

That's the idea behind the CSAIL team's new system RFocus, a software-controlled "smart surface" that uses more than 3,000 antennas to maximize the strength of the signal at the receiver. Tests showed that RFocus could improve the average signal strength by a factor of almost 10. Practically speaking, the platform is also very cost-effective, with each antenna costing only a few cents. The antennas are inexpensive because they don't process the signal at all; they merely control how it is reflected. Lead author Venkat Arun says that the project represents what is, to the team's knowledge, the largest number of antennas ever used for a single communication link.

While the system could serve as another form of WiFi range extender, the researchers say its most valuable use could be in the network-connected homes and factories of the future.

The RFocus platform has more than 3,000 tiny, inexpensive antennas that are used to amplify nearby wireless signals.

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For example, imagine a warehouse with hundreds of sensors for monitoring machines and inventory. MIT Professor Hari Balakrishnan says that systems for that type of scale would normally be prohibitively expensive and/or power-intensive, but could be possible with a low-power interconnected system that uses an approach like RFocus.

"The core goal here was to explore whether we can use elements in the environment and arrange them to direct the signal in a way that we can actually control," says Balakrishnan, senior author on a new paper about RFocus that will be presented next month at the USENIX Symposium on Networked Systems Design and Implementation (NSDI) in Santa Clara, California. "If you want to have wireless devices that transmit at the lowest possible power, but give you a good signal, this seems to be one extremely promising way to do it."

RFocus is a two-dimensional surface composed of thousands of antennas that can each either let the signal through or reflect it. The state of the elements is set by a software controller that the team developed with the goal of maximizing the signal strength at a receiver.

"The biggest challenge was determining how to configure the antennas to maximize signal strength without using any additional sensors, since the signals we measure are very weak," says Ph.D. student Venkat Arun, lead author of the new paper alongside Balakrishnan. "We ended up with a technique that is surprisingly robust."

The researchers aren't the first to explore the possibility of improving internet speeds using the external environment. A team at Princeton University led by Professor Kyle Jamieson proposed a similar scheme for the specific situation of people using computers on either side of a wall. Balakrishnan says that the goal with RFocus was to develop an even more low-cost approach that could be used in a wider range of scenarios.

"Smart surfaces give us literally thousands of antennas to play around with," says Jamieson, who was not involved in the RFocus project. "The best way of controlling all these antennas, and navigating the massive search space that results when you imagine all the possible antenna configurations, are just two really challenging open problems."

More information: RFocus: Practical Beamforming for Small Devices: arXiv:1905.05130 [cs.NI] arxiv.org/abs/1905.05130

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Optical Communcations Could Quickly Outpace 5G

By Neil Savage

Replacing radio waves with laser light could boost the speed and reach of communications far beyond that promised by 5G. It could allow autonomous cars to talk to each other, let drones send high-resolution photos to the ground, and move large volumes of data around smart factories and smart homes. At least that's the vision of SLD Laser, a Santa Barbara, Calif., company that demonstrated its latest version of laser LiFi at the recent Consumer Electronics Show in Las Vegas.

"There's loads of data that are being accumulated and are being moved around," says Paul Rudy, chief marketing officer at SLD. "You need to transmit data and you need to do it at [long] range with as fast a data rate as possible."

The idea of LiFi is to use optical communications—the backbone of data transmission on the Internet and telecommunications networks—in situations that normally rely on radio frequency transmissions, such as WiFi. One idea is to place LiFi routers on ceilings and use the light from LEDs to beam data around a room at rates of 100 gigabits per second, much faster than WiFi can achieve. The concept hasn't really penetrated the market, although an Edinburgh-based startup, Pure LiFi, and CEA-Leti, a research institute in Grenoble, France, have demonstrated systems.

Rudy hopes focusing on applications that are data heavy and require stable connections over a broad range of distances—autonomous vehicles and drones head this list—will help break the logjam. Those require data rates of many gigabits per second over ranges of perhaps hundreds of meters. Lasers can achieve that at lower power and with less difficulty than RF equipment, Rudy says. As for cars, "You already have headlights in the vehicle," he says. "Being able to broadcast data from those existing illumination sources can save lots of energy and also save the overall system cost."

At CES, the company demonstrated data rates of 20 Gb/s with its laser LiFi. The 5G wireless communication that is currently being rolled out should make possible rates of at least 1 Gb/s and could eventually reach 10 Gb/s.

Basing LiFi on lasers rather than LEDs boosts the performance because lasers can be modulated much faster and the optical power can be greater, increasing the range. To get high optical power without causing eye damage, SLD uses blue-emitting lasers to excite a phosphor, producing white light. That cuts the power down to eye-safe levels while still maintaining the advantages of lasers over LEDs.

It makes sense that SLD is innovating in this area. It was founded in 2013 by Shuji Nakamura, who won the 2014 Nobel Prize in physics for his role in inventing efficient blue LEDs and helping to kick off use of LEDs for general illumination. The company has hired as an advisor Harald Haas, a professor of mobile communications at the University of Edinburgh, who coined the term LiFi and has been promoting research into the technology. He's also a co-founder and chief scientific officer at Pure LiFi.

Rudy says laser LiFi could be ready for mobile applications such as autonomous vehicles within about three years. Systems for transmitting bits across fixed, data-heavy environments (including smart factories and smart homes) might begin showing up in about four years, he says.

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By Kevin Dowd

It's Super Bowl Sunday, which means that in a few hours, some 100 million Americans will gather with friends and family to inhale ridiculous amounts of chips and guacamole. They'll lose a few dollars in gambling pools they don't completely understand, watch Jennifer Lopez perform, knock back a cold one or two, and absorb a ceaseless stream of the most creative advertising Madison Avenue has to offer.

A football game, I think, will also occur.

Much of the world will be watching when the Kansas City Chiefs meet the San Francisco 49ers in Miami. In Silicon Valley, where ties abound between the hometown 49ers and the venture capital and private equity industries, viewers might be watching a little more closely.

The private market will be more present than ever at America's biggest unofficial holiday, and that's one of nine things you need to know from the past week:

1. Gold mining

The money in pro sports has exploded in recent decades. Top athletes now earn tens of millions of dollars a year in salary and endorsements, and an increasing number of them are turning to venture capital and private equity as a way to make that money grow. Considering their proximity to the heart of the VC industry, it's probably little surprise that the 49ers boast several examples.

The last time the 49ers won the Super Bowl, in 1995, they were quarterbacked by Steve Young. Today, Young is a co-founder and president of HGGC, a Palo Alto-based private equity firm that has deployed nearly $6 billion since its launch in 2007.

The four previous times the 49ers were NFL champions, their quarterback was Joe Montana. Today, Montana—who spent the final two years of his career with the Chiefs, the 49ers' opponent—is a general partner at Liquid 2 Ventures, a seed-stage firm that primarily targets tech startups.

This is Montana's second foray into firm-building. Along with former 49ers teammates Harris Barton and Ronnie Lott, he was previously a partner at HRJ Capital, a failed fund-of-funds that was sold amid legal woes in 2009. HRJ had evolved from Champion Ventures, another fund-of-funds formed by Barton and Lott in 1999 that reportedly invested in vehicles from VC stalwarts like Sequoia, Benchmark and Kleiner Perkins.

It seems both football and startups run in the Montana family. Joe's son Nick was a former college football quarterback who is now CEO and co-founder of Balto, a fantasy sports upstart backed by Y Combinator.

Montana and Young both used to throw passes to Brent Jones, a former 49ers tight end. After Jones' career ended, he and another former teammate, Tommy Vardell, formed Northgate Capital, which makes fund-of-funds investments in addition to directly backing startups. Jones and Vardell sold a majority stake in the firm in 2010, and they eventually moved into lesser roles in 2016 after a bit of a confusing saga.

At least one current 49er is already playing the startup game: Cornerback Richard Sherman, who earlier this month became an investor and adviser at Decibel, a new firm led by former NEA partner Jon Sakoda. The 49ers franchise has made a few early-stage investments of its own, reportedly staking companies like baby-food startup Little Spoon and Arianna Huffington's Thrive Global. It also invested in Sapphire Ventures' $115 million sports tech fund. Team

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owner Jed York was briefly a financial analyst at Guggenheim Partners before joining the family business of pro football.

Kansas City might never be confused for an investment hot spot. But the Chiefs do have at least one notable private-market tie of their own: Owner Clark Hunt is the grandson of famed oil magnate H.L. Hunt and the son of Lamar Hunt, who founded the Chiefs; Lamar Hunt also founded Hunt Capital Group, which played a key role in the creation of Trinity Hunt Partners, a Dallas-based private equity firm that raised $350 million for its latest fund.

If you're watching the big game later today, focus on the pigskin and the nachos. But no matter where you go in today's world, an undercurrent of private-market intrigue is just waiting to be found.

2. Unicorn union-busting
Fifteen Instacart employees who pack groceries at the Mariano's chain in a Chicago suburb voted Saturday on whether they would become the first of the food-delivery company's workers to unionize. Instacart, as you might imagine, had an opinion: The company sent in new managers to the location to distribute anti-union literature and lobby workers to vote against unionizing, according to a Vice report from early this week. The rise of the gig economy continues to be a wellspring of labor tensions.

3. Bankruptcy baggage
Forever 21 joined the retail bankruptcy parade when it filed for Chapter 11 protection last September. Now, the company is reportedly seeking approval for an auction that could save it from liquidation. Authentic Brands Group and Simon Property Group have emerged as two potential buyers. Bar Louie, a restaurant chain backed by Sun Capital Partners, filed for Chapter 11 protection itself this week, according to reports. And shortly thereafter, Helios and Matheson Analytics—the company behind MoviePass—filed for Chapter 7 bankruptcy ahead of an expected shutdown, proving once and for all that unlimited movie tickets for $9.99 a month is indeed too good to be true.

4. Old media, new media
Warren Buffett is getting out of the newspaper game: This week, his Berkshire Hathaway agreed to sell a portfolio of more than 30 daily newspapers to Lee Enterprises for $140 million, a major addition to Lee's existing news empire. On the digital side of things, casino operator Penn National Gaming agreed to buy a 36% stake in the highly polarizing Barstool Sports and its budding sports media empire, resulting in a profitable partial exit for The Chernin Group.

5. Valentine's preparations
Investors were busy this week backing startups that could be helpful in crafting a special day with that special someone. The Bouqs, a flower-delivery startup, announced $30 million in strategic funding to help expand its operations into Japan, reaching a valuation of $116.2 million, according to PitchBook. And when it's time for a nightcap, you can turn to Haus, a direct-to-consumer aperitif startup (what a phrase) that raised a reported $4.5 million in seed funding. The company's goal, according to TechCrunch, is to be a "Glossier for alcohol."

6. Public pops
VC-backed oncology startup Black Diamond Therapeutics went public on Thursday with an offer price of $19. By the end of its first day of trading, that figure had skyrocketed to $39.48, giving the company a market cap of around $1.3 billion. On Friday, primary care startup One Medical saw its stock close up 58% on its first day of post-IPO trading, reaching a market cap of more than $2.7 billion. Mattress seller Casper will be dreaming of a similar reception for its own public debut next week.

7. Public drops
Apollo Global Management reported its Q4 2019 earnings on Thursday, with net income jumping more than $300 million on a year-over-year basis. But that wasn't enough to keep the firm's stock price from falling nearly 9%. Shares of Blackstone also slumped after the company's earnings report. But fellow publicly traded firm KKR was able to

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buck the trend, reporting strong income and plans for future Russell index inclusion that helped its stock rise around 5%.

8. Nine-figure fundings
SoftBank dipped into its second Vision Fund this week for a new unicorn funding, according to Reuters, supplying most of a $250 million round for drug delivery startup Alto Pharmacy at a valuation of more than $1 billion. Insurance startup Policygenius also pulled in major backing this week in the form of a $100 million round led by KKR, while Moda Operandi, which runs a platform for discovering and buying new clothes and other apparel, raised a $100 million funding of its own.

9. In and out
If you want to make a few bucks by letting strangers into your home—or at least the shed in your backyard—you might be interested in Neighbor, the operator of a peer-to-peer storage platform that raised a $10 million round led by Andreessen Horowitz. But VCs pumped more money this week into the idea of keeping people out, as Verkada, which makes building security software, collected $80 million in funding at a $1.6 billion valuation.

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Leading-edge technologies, including NVMe, storage class memory, and intent-based storage management, promise *to change the way IT organizations store, manage and use data.*

By John Edwards

For decades, storage technology progress was measured primarily in terms of capacity and speed. No longer. In recent times, those steadfast benchmarks have been augmented, and even superseded, by sophisticated new technologies and methodologies that make storage smarter, more flexible and easier to manage.

Next year promises to bring even greater disruption to the formerly staid storage market, as IT leaders seek more efficient ways of coping with the data tsunami generated by AI, IoT devices and numerous other sources. Here's a look at the five storage technologies that will create the greatest disruption in 2020, as enterprise adoption gains ground.

Software-defined storage
Attracted by the lures of automation, flexibility, increased storage capacity and improved staff efficiency, a growing number of enterprises are considering a transition to software-defined storage (SDS).

SDS separates storage resources from their underlying hardware. Unlike conventional network-attached storage (NAS) or storage area network (SAN) systems, SDS is designed to operate on any industry-standard x86 system. SDS adopters benefit from smarter interactions between workloads and storage, agile storage consumption and real-time scalability.

"SDS technologies virtualize the available storage resources while also providing a simplified storage management interface that represents different storage pools as a unified storage resource," explains Cindy LaChapelle, principal consultant at tech research and consulting firm ISG.

SDS offers abstraction, mobility, virtualization, and storage resource management and optimization. The technology also requires managers to shift their view of hardware as the most important enterprise storage element to that of a less critical supporting player. In 2020, managers will deploy SDS for various reasons.

"Often, the goal is to improve operating expense (OpEx) by requiring less administrative effort," LaChapelle says. Solid-state drive (SSD) technologies are changing the way organizations use and manage their storage needs, making them prime candidates for a transition to SDS. "These technologies provide organizations with greater control and configurability to enable the right level of performance and capacity while also optimizing utilization and controlling cost."

Selecting the least disruptive approach to SDS requires a clear and thorough understanding of application requirements for capacity and performance. Potential adopters also need to honestly assess their organizations' ability to manage an SDS environment. Depending on the level of in-house expertise, an SDS appliance featuring prepackaged software and hardware often provides the best adoption course.

NVMe/NVMe-oF
Early flash storage devices were connected via SATA or SAS, legacy interfaces that were developed decades ago for hard disk drives (HDD). NVMe (Non-Volatile Memory express), running on top of the Peripheral Component Interconnect express (PCIe) layer, is a far more powerful communications protocol, targeted specifically at high-speed flash storage systems.

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Supporting low-latency commands and parallel queues, NVMe is designed to exploit the performance of high-end SSDs.

"It not only offers significantly higher performance and lower latencies for existing applications than legacy protocols, but also enables new capabilities for real-time data processing in the data center, cloud and edge environments," says Yan Huang, an assistant professor of business technologies at Carnegie Mellon University's Tepper School of Business. "These capabilities can help businesses stand out from their competition in the big data environment." NVMe is particularly valuable for data-driven businesses, especially those that require real-time data analytics or are built upon emerging technologies.

The NVMe protocol is not limited to connecting flash drives; it also can serve as a networking protocol. The arrival of NVMe-oF (NVMe over Fabrics) now allows organizations to create a very high-performance storage network with latencies that rival direct attached storage (DAS). As a result, flash devices can be shared, when needed, among servers. (Read more: What you need to know about NVMe over Fabrics)

Together, NVMe and NVMe-oF represent a leap forward in terms of performance and low latency relative to predecessors, such as SATA and SAS.

"This enables new solutions, applications and use cases that were previously unattainable or cost prohibitive," says Richard Elling, principal architect at storage manufacturer Viking Enterprise Solutions.

A lack of robustness and maturity have so far limited NVMe/NVMe-oF adoption. "With enhancements, such as the newly announced NVMe over TCP, we see the adoption of new applications and use cases accelerating dramatically," Elling notes. "Although experiencing only modest growth in this early adoption period, we now see NVMe and NVMe-oF hitting their stride and accelerating their deployment in 2020."

Computational storage
An approach that allows for some processing to be performed at the storage layer, rather than in main memory by the host CPU, computational storage is attracting the interest of a growing number of IT leaders.

Emerging AI and IoT applications require ever greater amounts of high-performance storage, as well as additional compute resources, yet moving data to the host processor is both costly and inherently inefficient. "Due to high-performance SSDs, the trend of moving compute closer to the storage has been going on for several years," says Paul von-Stamwitz, senior storage architect at technology incubator Fujitsu Solutions Labs. Observers believe that 2020 will be the year that the method finally enters the IT mainstream.

Computational storage can be used in several different ways, "from using small edge devices to filter data before sending it to the cloud to storage arrays providing data sorting for databases to rack-level systems transforming large datasets for big data applications," von-Stamwitz explains.

NVMe and containers are computational storage's primary enablers. "Therefore, if they have not already done so, IT managers should plan to transition to NVMe- and container-based infrastructures," von-Stamwitz advises. "In addition, managers can identify applications that could benefit most from the improved efficiencies of computational storage and engage with the appropriate vendors," he suggests.

Storage-class memory
Widespread adoption of storage class memory (SCM) has been predicted for several years, and 2020 may be the year it finally happens. While Intel Optane, Toshiba XL-Flash and Samsung Z-SSD memory modules have all been available for some time, their impact hasn't exactly been earth shattering so far.

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"The big difference now is that Intel has gotten their Optane DCPMM persistent memory module version working," says Andy Watson, CTO of enterprise storage software developer Weka.io. "That's a game-changer."

The Intel device blends the characteristics of fast, yet volatile, DRAM with slower, but persistent, NAND storage. This two-punch combo aims to boost users' ability to work with large datasets, providing both the speed of DRAM and the capacity and persistence of NAND.

SCM is not merely faster than NAND-based flash alternatives—it's in the range of 1,000-times faster. "Microsecond latency, not millisecond," Watson says. "It's going to take some time to wrap our collective heads around what this will mean for our applications and our infrastructure," he adds. SCM's initial big play will be extending memory, Watson predicts, noting that third-party software already allows in-memory applications to use Optane to achieve footprints of up to 768TB.

The fact that data centers planning to adopt SCM will be restricted to deployment on servers using the latest-generation Intel CPUs (Cascade Lake) threatens to mute the technology's immediate impact. "But the ROI may turn out to be so irresistible that it could drive a wave of data center upgrades to embrace the unfolding opportunities associated with this major sea change," Watson says.

Intent-based storage management
Building on SDS and other recent storage innovations, intent-based storage management is expected to improve the planning, design and implementation of storage architectures in 2020 and beyond, particularly for organizations coping with mission-critical environments.

"Intent-based approaches … can deliver the same benefits we've seen in networking, like rapid scaling, operational agility and adoption of emerging technology, years earlier—for both existing and new applications," says Hal Woods, CTO of enterprise storage software developer Datera. He adds that the approach can also compress deployment time and administrative effort by orders of magnitude, compared to conventional storage administration, while being far less error prone.

With intent-based storage management, a developer who specifies a desired outcome (such as, "I need fast storage") isn't consumed with administrative overhead and can thereby provision containers, microservices or conventional applications more rapidly.

"Infrastructure operators can then manage to the needs of the application and the developer, including performance, availability, efficiency and data placement, and allow the intelligence in the software to optimize the data environment to meet application needs," Woods says. Additionally, with intent-based storage management, a developer can simply adjust storage policies, rather than spend days manually tuning each array.

A continuous and autonomous cycle of deployment, consumption, telemetry, analytics and SDS technology make intent-based storage possible. "The SDS system can then employ AI/ML techniques to continuously ensure the customer-specified intent is being met, and even allow the intent to be non-disruptively adjusted as the AI/ML engine provides feedback on improving the customers environment," Woods says.

The downside to intent-based storage management, as with any disruptive technology, is the hurdle of deployment versus promised value. "Intent-based storage is not a one-size-fits-all technology," Woods notes. "It delivers the greatest value in disaggregated, at-scale, mission critical environments where delivering developer velocity and operational agility will have the largest business impact." For smaller, less critical environments, approaches such as direct-attached storage or a hyperconverged infrastructure are often sufficient, he says.

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By Steve Crowe

Mobile Industrial Robots CEO Thomas Visti (left) and Universal Robots President Jürgen von Hollen

Mobile Industrial Robots (MiR) and Universal Robots (UR), along with their US-based parent company Teradyne, are investing $36 million into the construction of a "cobot hub" in Odense, Denmark. Both MiR and UR are based in Odense, which the companies call the "cobot capital of the world."

MiR and UR are leaders in autonomous mobile robots (AMRs) and cobot arms, respectively. The two companies will remain separate entities, but a new 50,000-square-meter site will become the joint headquarters for the companies. The companies said this will create "significant synergies" to strengthen each company's footprint in their respective markets.

MiR and UR also opened a cobot hub in Barcelona in November 2019 to promote collaborative automation in Southern Europe. A 1,500-square-meter facility in Barcelona's 22@ district includes offices for each company, as well as a joint showroom where the latest technology and applications for AMRs and cobot arms.

"Teradyne continues to invest aggressively in the development of new products, solutions, and sales channels and this new facility is a key part of our growth strategy," said Mark Jagiela, President and CEO of Teradyne. "We have found something very special in Denmark. The Danes' combination of innovative industrial design, combined with a practical business sense, have created a perfect combination for this emerging industry. The ability to make robots work in collaboration with humans in a user-friendly manner is something we have not encountered to this degree anywhere else in the world and we're very excited to expand our capabilities in Odense."

Strength of Danish robotics cluster
"Denmark has a significant lead in the global market for cobots. Investing ambitiously in building the world's largest cobot hub right here in Odense makes a lot of sense," said Thomas Visti, CEO of MiR. "Offering a strong, professional environment with superb facilities enables us to attract talent from all over the world."

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MiR said it hired 100 employees within the past year, with UR adding 280 staff members during the past two years. Today, the two companies have 160 and 450 employees, respectively, based in Denmark. UR employs almost 700 employees worldwide while MiR's staff counts a total of around 220 globally.

MiR and UR are the two most notable Danish robotics companies, but the Danish robotics cluster as a whole is quite strong. The Robot Report has watched the cluster closely. Danish robotics companies' total revenue rose 18 percent in 2018, reaching $995 million with exports increasing 26 percent.

UR grew to $234 million in revenue by 2018, with nearly 40,000 cobots sold at the end of 2019. In 2018, MiR represented 9.2% of industrial automation revenue for Teradyne. For the first three quarters of 2019, it represented 14.3% of industrial revenue.

"This is a market expected to grow to a total value of almost $12 billion in 2030, according to ABI Research. Demand for Danish cobots already means that we are growing out of our current offices in Odense, both at UR and MiR," said Jürgen von Hollen, President of Universal Robots. "Odense has a strong ecosystem of talent and we are pleased to have the opportunity to invest long-term in the unique robotics environment that we have been building here over the last 10 years."

Teradyne's growing automation business
Automatic test equipment for electronics still accounts for 75% of the $2.1 billion revenue Teradyne made in 2018. But that is a mature market that is unlikely to yield significant growth in the long-term future. As a result, Teradyne in the last five years has acquired four key industrial robotics startups:

- Acquired UR for $285 million in 2015
- Acquired MiR in 2018 for $272 million
- Acquired Energid in 2018 for an undisclosed fee
- Acquired AutoGuide Mobile Robots for $58 million in 2019

Automation is still a peripheral part of Teradyne's business as far as gross revenue goes. But the company said it has invested more than $500 million into MiR and UR. In 2015, industrial automation represented 2% of all revenue, but industrial automation represented 12% of revenue in 2018. Teradyne hopes its automation unit will be posting revenues exceeding $1 billion in 2021.

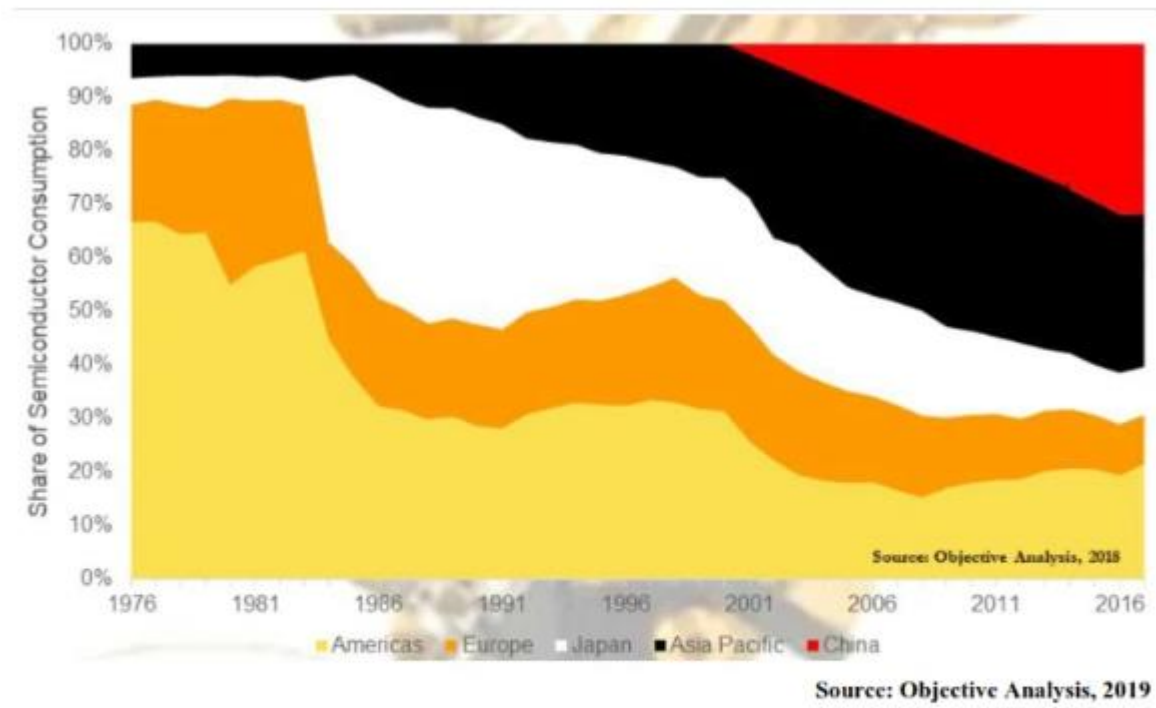*An illustration of the new cobot hub. The final design has not been finalized.*

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By Gary Hilson

The 2020 outlook for the memory market looks flat, with transitions doubtful and impact expected from Brexit, trade wars, and the coronavirus.

Will DRAM and flash prices boom again? Will emerging memories finally emerge? Will China's ambitions begin to pay off? What else is in store for memory technologies in 2020?

The business environment for memory last year was shaped a great deal by low prices for both DRAM and NAND. Jim Handy, principal analyst with Objective Analysis, is expecting the market to be somewhat flat for 2020, with DRAM having endured a significant price collapse that has put a great deal of pressure on margins. Prices may even fall further, he said. "We're projecting for NAND flash to go up 5% next year. But we're projecting for DRAM to go down 25%. So, it's a mixed-up kind of a year. But, when all is said and done, we think 2020 will end with an ongoing oversupply in the memory market."

Cheap prices for incumbent memories mean there's not a lot of reason to take a chance on new ones when DRAM and flash are getting the job done at a good price. "They still have a long, tough, hard battle to slog through to get to their place in the front," said Handy. And with both DRAM and NAND having plenty of runway left based on manufacturers' road maps, neither is going to run out of speed anytime soon.

Source: Objective Analysis, 2019

An Objective Analysis report released last fall extrapolated what China's monthly semiconductor sales might be if broken out as its own region from Asia-Pacific, but the coronavirus could upset the country's memory ambitions in the shorter term. (Source: Objective Analysis)

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Michael Yang, director at IHS Markit, doesn't see 2020 as the year emerging memories break out either. "There are still hurdles for all these memories." They are challenged with scaling and bringing costs to a reasonable price point where they can get into more applications, he said, while for the most part, progress on both the DRAM and flash fronts are proceeding per the road maps. Flash, with most suppliers, is gearing up for 128-layer, which is expected, but the ramps for either DRAM or Flash aren't particularly steep. "The transition to new technology is not as aggressive historically speaking, especially on the DRAM front. Anything new will be very minimally ramped."

In the middle of emerging memories and the dependable incumbents lays 3D Xpoint technology, primarily in the form of Intel Optane SSDs and DIMMs, as Micron isn't pushing as hard on the once jointly developed technology. Yang said Intel has been busy getting the word out about the Optane value proposition, "but I think most people are still waiting." A critical hurdle for Optane is building the ecosystem, he said, not just having customer-ready samples for evaluation, including hardware, software, firmware, and support from the chipset and processors, as well as from the intended applications. "Unfortunately, it is an ecosystem play."

Yang said Optane is more potentially viable than other emerging memories, and that it is probably ahead in terms of volume, but it still must solve the cost dilemma. "Pricing is a big consideration. You make decisions on what you pay for the performance that you get," he said. "DRAM prices have come down to very reasonable levels — the price advantage simply got washed away."

Gregory Wong, principal analyst with Forward Insights, looks at 2019 as an enabling year for Optane, with this year being the first that it's shipping in meaningful volume, but he also acknowledges pricing is a factor as DRAM prices have plummeted. "We haven't seen the same for 3D XPoint pricing in terms of cratering." One variable to consider is that Micron is now shipping a 3D Xpoint SSD, he said, so it's a wait and see game for a technology that had higher expectations than the traction it has gotten thus far.

While low DRAM prices may curtail Intel Optane DIMM adoption, low 3D NAND prices may impact the SSD adoption. "You'd have to have a really compelling use case to go with that expensive premium when you know NAND is cheap," said Wong. "And if NAND is really cheap, you might as well just over-provision. There's a comfort zone there."

As for other emerging memories, he doesn't see much happening this year on the ReRAM front as a high-density memory — but more so as a low-power option in embedded applications. Wong sees MRAM having more opportunities in 2020 as a stand-alone, although it has its own inherent challenges. "It doesn't quite fit in the memory hierarchy." Today, its performance is lower than DRAM while being more expensive. "You're basically looking for niches that will accept the high costs because MRAM is potentially a persistent type of memory."

Projected 5G uptake blended with 4G is expected to drive demand on solid-state storage and memory for both telecom equipment and data centers.

Not everyone is as optimistic about MRAM. Gill Lee, managing director of memory technology in the semiconductor products group at Applied Materials, said despite the buzz about MRAM potential, there isn't a huge breakthrough ahead for the technology this year. "MRAM is still mainly pursued as the embedded flash replacement in the

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micro controller." He also sees low DRAM and NAND prices inhibiting 3D Xpoint uptake with Intel as the primary driver through its Optane offerings.

Low pricing due to oversupply also tends to mean less capex investment for manufacturing, but Lee said Samsung Electronics's announcement late last year — that it would make a further $8 billion investment in its memory plant in Xian, China — is a promising one. Further adding to his optimism is that 5G deployments are expected to drive more traffic to the data center. "Data centers are basically the major consumers for memory chips." (Handy, however, is a little more cautious, because although he sees 5G as a major story this year, part of it is how quickly consumers rush out to buy new handsets.)
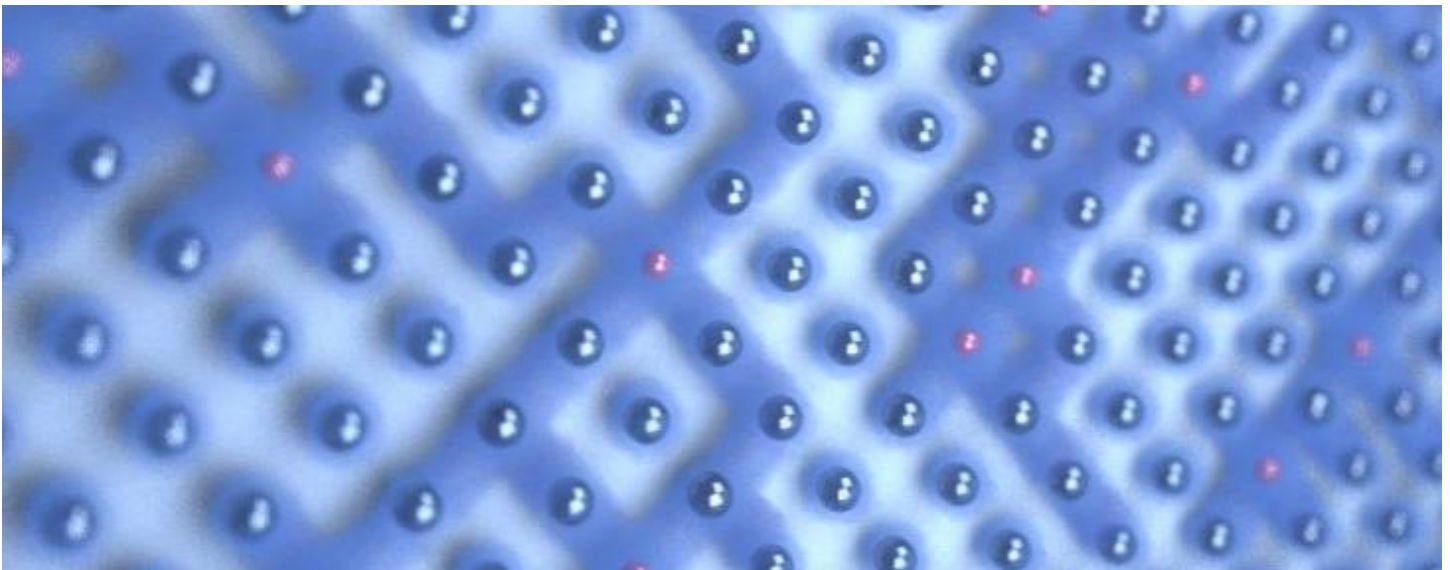
However, Lee doesn't see any major advances ahead from a technology perspective in terms of scaling DRAM and NAND. "Cost effective scaling is the biggest challenge." The speed of any transition will be closely tied to pricing, he said. "If pricing pressure continues, it will be very challenging to move the node migration. Once node migration happens, the big cost will be scaling, but it still requires capital investment."

Handy said that need for capital investment could lead to some consolidation in the DRAM space given that the cost of putting up a new fab is growing faster and eating into revenue. "And if we do have outside entrants joining into the market, then that ends up putting more pressure on the existing suppliers to consolidate."

Those new entrants are likely to come from China. Beyond pricing pressures and technology advances, the global economic climate and trade relations will also be key influencers for the memory market over the next year, including China's role as it looks to build its own capabilities and be less dependent on outside suppliers. IHS's Yang said regardless of any tariffs, we can expect to see China continue to get stronger as its memory ambitions have been fueled by tensions. "They see this as an absolute must; China is definitely on its way to becoming a stronger player in every market," he said. "Maybe not in 2020, but definitely I think 2021 and beyond."

However, at the time of these interviews, the coronavirus was not yet a factor, and it's already having a short-term economic impact as supply chains are poised for disruption. Brexit and continuing tensions between the U.S. and China will no doubt also continue to be wild cards this year.

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By Univestity of British Columbia

This is an artist's impression of the dissolving of the electronic 'traffic jam.' The red atoms are different in their quantum nature and allow transport of electrons in their surroundings.

Most modern electronic devices rely on tiny, finely-tuned electrical currents to process and store information. These currents dictate how fast our computers run, how regularly our pacemakers tick and how securely our money is stored in the bank.
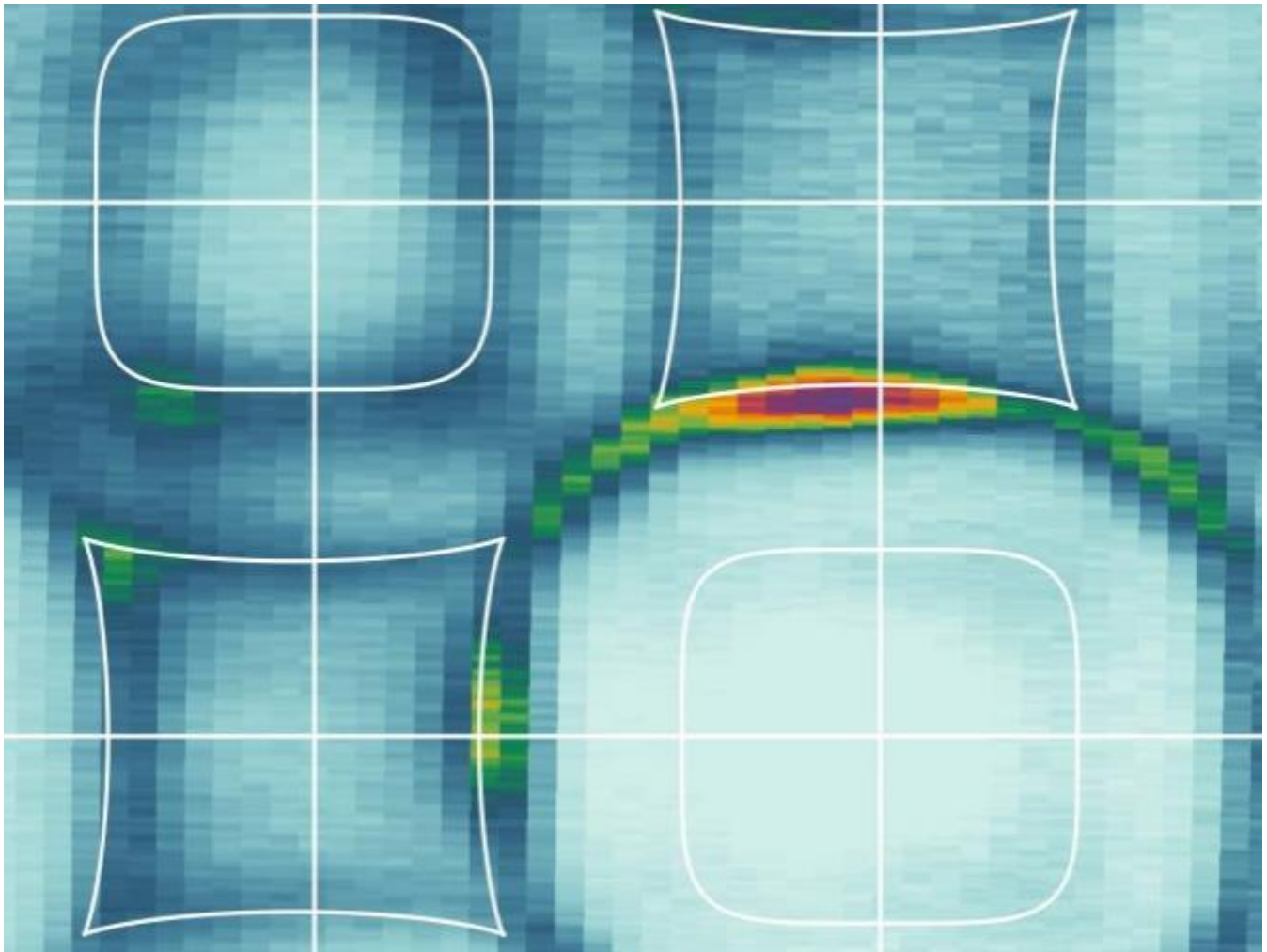
In a study published in Nature Physics on January 27, 2020, researchers at the University of British Columbia have demonstrated an entirely new way to precisely control such electrical currents by leveraging the interaction between an electron's spin (which is the quantum magnetic field it inherently carries) and its orbital rotation around the nucleus.

"We have found a new way to switch the electrical conduction in materials from on to off," said lead author Berend Zwartsenberg, a Ph.D. student at UBC's Stewart Blusson Quantum Matter Institute (SBQMI). "Not only does this exciting result extend our understanding of how electrical conduction works, it will help us further explore known properties such as conductivity, magnetism, and superconductivity, and discover new ones that could be important for quantum computing, data storage, and energy applications."

Flipping the switch on metal-insulator transitions
Broadly, all materials can be categorized as metals or insulators, depending on the ability of electrons to move through the material and conduct electricity.

However, not all insulators are created equally. In simple materials, the difference between metallic and insulating behavior stems from the number of electrons present: an odd number for metals, and an even number for insulators. In more complex materials, like so-called Mott insulators, the electrons interact with each other in different ways, with a delicate balance determining their electrical conduction.

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Measurement of a material where modification of the spin-orbit coupling has been used to make it electronically conductive. The dark colors represent electrons that are free to move through the material, and are an indicator of the conductive behavior.

In a Mott insulator, electrostatic repulsion prevents the electrons from getting too close to one another, which creates a traffic jam and limits the free flow of electrons. Until now, there were two known ways to free up the traffic jam: by reducing the strength of the repulsive interaction between electrons, or by changing the number of electrons.

The SBQMI team explored a third possibility: was there a way to alter the very quantum nature of the material to enable a metal-insulator transition to occur?

Using a technique called angle-resolved photoemission spectroscopy, the team examined the Mott insulator Sr_2IrO_4, monitoring the number of electrons, their electrostatic repulsion, and finally the interaction between the electron spin and its orbital rotation.

"We found that coupling the spin to the orbital angular momentum slows the electrons down to such an extent that they become sensitive to one another's presence, solidifying the traffic jam." said Zwartsenberg. "Reducing spin-orbit coupling in turn eases the traffic jam and we were able to demonstrate a transition from an insulator to a metal for the first time using this strategy."

"This is a really exciting result at the fundamental physics level, and expands the potential of modern electronics," said co-author Andrea Damascelli, principal investigator and scientific director of SBQMI. "If we can develop a

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microscopic understanding of these phases of quantum matter and their emergent electronic phenomena, we can exploit them by engineering quantum materials atom-by-atom for new electronic, magnetic and sensing applications."

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By James Blackman

How does a mobile operator, in the business of airtime subscriptions, go beyond selling straight connectivity? Because this must be the goal, and the measure of ambition. There is no future in SIM cards, as we have argued – especially as technological innovation higher up the stack presents an opportunity for society to jump forward.

The operator community knows this, of course, even as their primary focus is taken with threading the world with wireless 5G networks. The same conundrum has vexed it for a decade, at least, as its members have sought ways to lodge themselves in the service stack, sprung by cellular and other technologies.

Their strategies, as they should, reflect their own supplementary specialisms, both horizontal (technological) and vertical (industrial). Let us consider the case of one: French telecoms group Orange, whose digital-change strategy is well articulated by its enterprise division, Orange Business Service (OBS).

'This company will be very different in 2025', Orange said last month, as it unveiled a 2025 master-plan that placed data services for enterprises at the heart of its strategy in the 5G era. The company's focus is shifting with 5G, it said, to drive new sales out of industrial transformation.

Enterprise IoT Insights caught up with Werner Reuss (pictured), in charge of Industry 4.0 at OBS, towards the back-end of 2019. In delayed playback of the conversation, he points to the rejig at OBS in the middle of last year, which saw the creation of a new Smart Mobility Services entity to forge tighter links between mobile workspaces and IoT activities.

Its strategy with IoT, he explains, used to be anchored in two business units, which separated the old discipline of connectivity ("everything that is traditional in the space") and the newer one of IoT systems integration ("selecting hardware and software components"), layering in new-fangled data services on top.

The new Smart Mobility Services division within OBS – awkwardly acronymized as SMS; headed up by Valérie Cussac, who used to manage the division's "traditional" sales in France – brings these entities together, and seeks to leverage its horizontal expertise in vertical markets where it has success, and where the IoT narrative is clearest.

Orange's beyond-connectivity expertise has been bolstered in recent years with acquisitions of data specialists, targeted squarely at enterprise and industrial sectors. Via OBS, it acquired a controlling stake in France-based Business & Decision in late 2017, valued at around €62.5 million at the time. Its background is in business intelligence in IoT, cloud computing, and cyber-security, notes Reuss.

Six months later, OBS bought cloud infrastructure and services company Basefarm outright for €350 million, in the summer of 2018. Basefarm, in Norway, owns Unbelievable Machine Company, as well, an analytics outfit based in Germany. "It does data lakes and deep learning things, and works with Microsoft and AWS; they have some big projects together."

But Orange's chief specialism outside of airtime, arguably, is cyber-security, which is being wrapped into its new enterprise IoT consultancy practices. "OBS has 2,100 security specialists in Europe. We're one of the biggest players. We want to make it a €1 billion business over the next couple of years," says Reuss.

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The question Orange has grappled with, as it has expanded its services portfolio, is how to take it to market. "The assets we have are so rich, and so relevant to verticals. And we need to extend our go-to-market strategy, and think how to address the customer."

Hence the structural rejig at OBS, and the formation of the Smart Mobility Services division, orchestrating mobility and data as bass and tenor voices in its play of industrial transformation. The sales operation is split three ways, targeting Industry 4.0, smart cities, and connected products, alternatively.

Reuss heads international operations for the first of these, covering industrial IoT for process optimization and machine automation, mostly in discrete manufacturing. The second is the prototype for the others, as Orange's focus on smart cities, covering everything from smart meters and utilities to urban data platforms and government services, is longer-established.

The last, loosely defined, has grown out of legacy SIM sales to car makers, for connected vehicles. It has been expanded to cover smart devices in retail and the home, as well, but it remains more focused, says Reuss, on loading traffic onto the mobile network, and less on the services component.

"Process optimization in the factory is very different from the connected cars, or connected products," says Reuss. He is even more explicit, in fact. "Let's make the distinction," he says. "Connected products are for the time being focused on the SIM card and the whole connectivity story. Smart cities and Industry 4.0 are more about services."

What about private LTE and 5G – just because it is such an emotive topic, and because we have to ask? Presumably when OBS goes to cities and factories, it is selling some form of dedicated connectivity, as well? "We will do that. But it's not the major focus," replies Reuss.

He adds: "It's all about use cases and business cases – where we support customers to make use cases into business cases. For the Industry 4.0 space, you have to be able to articulate a very good business case, or else you just get stuck in proof-of-concept, or in pilot. It is the thing many vendors are suffering in that space."

But just that comment, before, about yes-but-no private networking; is Orange seeing much demand for dedicated cellular from industry, and is it offering private LTE as a solution, like other tier-one operators in Europe?

"It depends where we are. If you want to have that [dedicated networking], then you need to have spectrum. We have discussions in France. But we also provide some big industrial customers [with private networks] already, as 4G private networks."

And is that like a slice, or an equivalent LTE-based segmentation, of the public network? "Yes. We're using our own spectrum there. It's not a slice, because that's a 5G term. But we are building the infrastructure, making sure there's no interference. It's a private network – a PMR (professional mobile radio) private network. That's what we're doing currently."

But here's the thing, and the reason Reuss is reticent about private networking as a driver for digital change, and as a headline act in the OBS portfolio. Connectivity is wrapped up as an enabling function in a broader offer, he says, which matches the solution, including connectivity, to the problem – rather than retrofitting the problem to an airtime sale.

He explains: "We're talking about a solution. The connectivity is a means [to an end]. But we start with the solution. We have isolated a set of them – and actually a rather small set – and we are offering them where we see demand. And these use cases are mature; the business cases exist, which means they are more likely to end up as real projects and implementations.

"We are looking to put as many components as we can into the offer, to make it holistic. Because all of these components we're talking about are crucial for Industry 4.0 – I mean, the security discussion is pretty much everywhere, and we have consulting and integration capabilities we're factoring in as well. We want to be as complete a partner as we can be."

This is telling; Orange is subjugating its legacy airitime tendencies in OBS to capture new business – and even just to be in the reckoning. It is not self-cannibalization, because its old cellular business has either no place at all in the conversation, or else is introduced later in the piece, as the solution is scoped out.

Reuss quotes unnamed analyses of enterprise spending on Industry 4.0 projects that says the estimated share for straight connectivity providers hovers somewhere between "three-and-a-bit per cent and seven and-a-bit per cent".

It is not much, he reasons. "You end up with five per cent, as an average, which is about what we have found – €5 out of every €100 goes on connectivity. So we're looking to get a bigger share."

Which explains it, and clarifies the sense of the OBS strategy in the industrial IoT space to draw on its new cloud, data, and security expertise, plug in bits and pieces of cellular, and partner everywhere else. But what about those industrial IoT use cases, crossing over into smart cities as well, that it is pushing hardest?

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By Sean Kinney

WiGig, unlicensed 5G, microwave backhaul, fixed wireless among current and future uses of 60 GHz

Two companies are seeking a waive of U.S. Federal Communication Commission rules governing use of the 60 GHz band. In response, a group of heavy-hitters in the tech world, all with their own interests in accessing the unlicensed frequency, are asking the regulatory body to carefully consider "reasonable coexistence among all technologies reliant on 60 GHz spectrum."

Based on FCC filings, Leica Geosystems AG wants a waiver from the FCC in order to integrate a radar device that operates in the 60 GHz to 64 GHz range onto an unmanned aerial vehicle to visually inspect the exterior of structures. Vayyar Imaging Ltd. wants a similar waiver to for "interactive motion-sensing applications" in the 57 GHz to 64 GHz range for things like "touchless control, medical/safety alerts, vital sign monitoring and environmental management." The waiver requests were submitted by the companies in September and November respectively.

In response to this waiver request, tech companies Facebook, Google, Infineon, Intel, Qualcomm and Socionext America, in a Feb. 3 letter to the FCC, point out that "These recurring requests for special relief outside of the current FCC rules confirm the need for the FCC to improve its regulatory framework governing unlicensed use of the 60 GHz band."

The operative guidelines here are in Section 15.255 of FCC code and cover the RF range from 57 GHz to 64 GHz. So what interest do the companies calling for a review of unlicensed activity in 60 GHz have in that band?

Facebook has been operating its Terragraph project, which uses 60 GHz for fixed wireless in dense, urban areas, for several years with partners, including Cambium, Common, MicroTik, Nokia, Qualcomm, Radwin and Siklu. This has yielded commercial deployments in Alameda, California, for instance, where Common Networks deployed a localized network.

Driving alignment around 60 GHz is a priority of the Telecom Infra Project, which Facebook founded to create cohesion around the development of low cost hardware that can facilitate rapid scaling for operators. That working group is focused on four major issues: providing an economic template to help operators determine potential new revenues or cost savings; create test and simulation tools for 60 GHz equipment; model and plan network deployments to minimize equipment costs; and develop a set of best practices.

Google's interest is based on its Soli miniature radar which enables motion control of devices; the technology is present in Google's Pixel 4 smartphone and Infineon provides the 60 GHz radar chip.

Socionext America makes system-on-chip products for automotive, consumer and industrial devices; it was formed through the integration of the integrated circuit organizations of Fujitsu and Panasonic, according to the company website. The company also makes 60 GHz radar sensing products.

Although adoption has been slow, 60 GHz has long been used for the Wi-Gig flavor of Wi-Fi based on the IEEE 802.11ad standard and is set to evolve to the 802.11ay standard which contemplates the addition of 4X4 MIMO to provide a bandwidth increase. Use cases include wireless docking or creating an in-home Wi-Fi hot spot for things like untethering a VR headset from a high-performance computer.

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Intel and Qualcomm both make silicon that supports Wi-Gig. Qualcomm has also been working through the 3GPP to develop Rel. 16 specifications related to both non-standalone and standalone operation of 5G NR transmissions in the unlicensed 5 GHz and 6 GHz bands; that's referred to as NR-U. The logical next step in that process would be NR-U for 60 GHz, although that's not necessarily something that will be realized in the near-term.

Another use of the 60 GHz band that could prove important as 5G networks scale and are densified through the addition of small cells–wireless backhaul. Fiber is obviously the backhaul mechanism of choice as network capacity skyrockets but fiber isn't everywhere and putting it everywhere would be cost prohibitive. As such, 60 GHz is used for wireless small cell backhaul.

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By Darrell Etherington

Drone startup Wingcopter, working with partners Merck and the Frankfurt University of Applied Science, has completed a first flight of a new drone delivery trial designed to show the benefits of using drones instead of trucks or other road faring vehicles for moving small cargo between two physically separate office facilities. This first flight covered around 25 km (roughly 15.5 miles), taking a sample of pigments from one Merck lab in Gernsheim to its headquarters in Darmstadt in Germany.

This trial is significant in more ways than one: The area it covered spanned a fairly dense metropolitan area, flying over power lines, trains, roadways and more. It also did all of this without continuous line-of-sight, something that's been required of most drone delivery trials in a commercial setting to date. The partners involved are hoping this means it can stand as a blueprint to other similar pilot projects and trials being run all over the world.

Next up, the project will continue to fly additional deliveries and then summarize their findings in a report to be delivered in March. Already, using drones instead of trucks seems to provide advantages in terms of time (saving between an hour and even a full day in some cases) and emissions, and it can cut down on the amount of empty return trips made by large, heavy gas-guzzling vehicles as well.

Wingcopter CEO Tom Plümmer points out in a press release detailing the news that his company has "repeatedly demonstrate" the advantages of drone delivery across a number of use cases, including for use in getting life-saving medical supplies to remote areas. Trials in the U.S. include Alphabet's Wing, which partnered with FedEx, and UPS, which is working with Matternet, but this commercial trial shows a potentially more fruitful avenue for deploying services in the near-term that don't require buy-in from the average consumer.

Wingcopter's Overview
Wingcopter's core innovation is its unique tilt-rotor mechanism. It ensures a smooth and robust transition between hovering like a multicopter and efficient forward flying like an airplane. Engineered by Wingcopter's dedicated team in Germany, they have patented it in all major markets across the world.
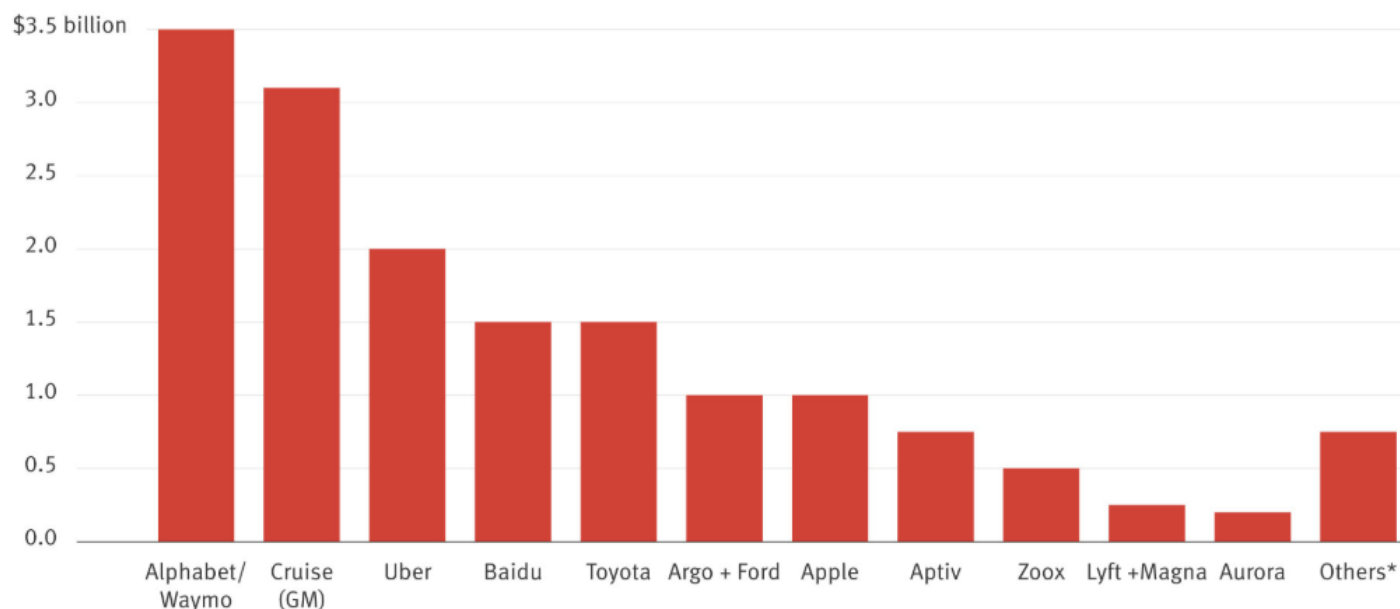
The current version, the WINGCOPTER 178, is designed to carry up to 6 kilograms of additional payload, covers great distances of up to 120 kilometers and sets the benchmark for commercial VTOL drones, with a world-speed-record of 240 km/h. The WINGCOPTER can be flown autonomously or in position control mode.

Delivering medical commodities to remote health facilities as well as parcels and food to private customers via WINGCOPTER – Wingcopter's creates technologies to save and improve lives, as their vision is to create a better tomorrow for everyone by building the future of aviation.

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By Amir Efrati

Who Spent What on Fully Self-Driving Car R&D
Disclosed and estimated minimum total spend through 2019

*Combined minimum spending by companies including Yandex, Mobileye, Daimler and Bosch, Audi, Voyage, Optimus Ride, May Mobility, Oxbotica, Wayve AI, WeRide, AutoX, Pony AI, Didi Chuxing, BMW, Zenuity, FiveAI, Nissan, Drive.ai (defunct)

Sources: Financial filings and estimates from people who have worked at 10 of the top 11 spenders in this chart

A group of 30 companies has spent at least $16 billion on developing fully self-driving cars over the past few years—and so far they have little, if any, revenue to show for it. But billions more will likely be needed before the technology is ready for primetime.

Just three companies spent half of that money—Alphabet's Waymo, GM's Cruise and Uber, according to our calculations. Four other companies, including Apple, Baidu, Ford and Toyota, spent most of the rest. Only a few of those—most prominently Alphabet, Toyota and Apple—have the kind of immensely deep pockets that guarantee they can stay the course for the long run. And Apple has already pulled back on its investment.

For most companies on the list—including a group of 20 smaller spenders such as startups and established carmakers—cost cutting, partnering and consolidation is the order of the day. Uber is looking to cut spending in its autonomous vehicle group by around 15% this year, while Baidu, the perceived leader in China, cut some staff in the U.S. and relocated other U.S.-based employees to China as it retrenched overall, said two people who have worked there.

But cost cutting won't be enough. Technology to assure a completely safe autonomous vehicle for the road, and reliable way to measure its safety, is far from ready. A research breakthrough is needed to get software to a point where it can handle complex driving scenarios the way humans do.

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One additional complicating factor is that as more cars with advanced features like automatic emergency braking and collision warnings gain market share, the bar will get even higher for fully self-driving cars to prove they're safer than humans driving their own safety-conscious vehicle.

To put together the table, we tallied the likely minimum amount the best-known developers have spent so far. We based our calculations on financial and other disclosures as well as estimates from people who have worked at 10 of the top 11 spenders on the list.

The spending figures include the cost of certain acquisitions, such as GM buying Cruise for about $1 billion after performance-based payouts. Automotive supplier Aptiv paid $340 million in cash for robotaxi developer startup nuTonomy, although that number could rise with payouts tied to performance taken into account.

One thing that's becoming clearer: The amount a company has spent on research and development doesn't necessarily correlate with how far along it has come in terms of software or hardware quality or the scale of its tests. Just ask Uber, which has spent $2 billion so far and yet is doing only limited road tests of self-driving car prototypes in a small part of Pittsburgh.

Cost Breakdown
The top cost for all programs is salaries for engineers—and in Waymo's case, exorbitant bonus cash payouts to some early employees. Other major costs include prototype road test operations, vehicle collection of map data, and salaries for operations workers such as safety drivers to monitor vehicles. Then there's internal software and hardware infrastructure for teaching the software how to recognize certain objects around the car and training neural networks for a variety of related tasks, as well as running the software through a vehicle-simulation program.

Software infrastructure also enables regular code changes to prototype vehicles—and each change can cost thousands of dollars at programs such as Cruise, according to a person with knowledge of the issue. At the major self-driving car programs, software infrastructure groups typically are the biggest software team by engineer headcount.

Then there's the cost of producing prototype vehicles, which can be $250,000 to $500,000 apiece depending on how much it takes to add automated-driving software, special computers and sensors to them. Some programs such as Voyage have less than 10 prototype vehicles, Cruise has around 200, and Waymo has roughly 600.

Nearly 20 of the smaller robotaxi programs are grouped together in the "other" bar in the chart. They include startups that have raised relatively little venture capital and have been more thrifty than the big programs in how they develop and test prototypes, such as Voyage. Also in that category are carmakers who have taken a slower or more cautious approach to developing such vehicles, including Daimler, and those that outsource software for their prototypes to developers such as Intel's Mobileye, including BMW. The group also includes China-based startups such as Didi Chuxing and Pony.ai, whose spending levels are harder to measure than those of public companies and other players based in the U.S. and Europe.

The chart excludes developers of fully automated trucks, such as Kodiak Robotics, Embark, and Ike. It also excludes companies developing street vehicles for transporting physical goods as opposed to people, such as SoftBank-backed Nuro.

One player we also left out is Tesla, which offers a semi-automated freeway-driving software called Autopilot that CEO Elon Musk hopes will eventually also handle city streets. Even if Autopilot progresses nicely—as Musk, after previously expressing frustration, now says is happening in internal testing—the vehicle owners will still be responsible for the safety of the vehicle. That's why Tesla doesn't belong in the same category as developers of fully self-driving cars.

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The five-and-a-half-year Autopilot program is a lean operation—it was staffed by about 200 engineers in total a year ago. It has likely cost Tesla a minimum of $600 million, two former employees estimate. That figure is conservative, given that the company in recent years also designed its own microchip and on-board computer to power Autopilot. Tesla also has been trying to develop some of its own sensors to boost the system. The technology has probably made up that cost by helping to boost vehicle sales and adding to the company's brand cachet.

State of the Art
Atop our spender list is Waymo, which has been working on self-driving vehicles for about a decade. Most practitioners believe Waymo has the most advanced prototype. But while Waymo insiders believe their tech is worth tens of billions of dollars or as much as $100 billion as of last year, the company doesn't appear to have persuaded an outside investor to agree on such a valuation, and Waymo isn't close to being a functional business.

Waymo recently said it was serving more than 1,500 riders per month in suburban Phoenix in its retrofitted Chrysler Pacifica minivans, and by now most of those passengers are probably paying fares in the vicinity of what an Uber ride would cost. That implies that, at best, Waymo is generating tens of thousands of dollars a month. That's equivalent to how much it pays a senior engineer on staff—and it has more than 600 engineers in total. Most of the vehicles operate with a Waymo worker sitting behind the wheel, ready to take over should the need arise. That's an expensive operation.

The most advanced type of Waymo tech is a "driverless" ride with no human driver behind the wheel. The company runs several of those per day, only for local residents in a subsection of the Phoenix suburbs, said a person who has worked at Waymo. (See a map of the area here.)

But the driverless rides are just as expensive to operate as the rides with backup drivers, if not more. A dedicated "remote assist dispatcher" monitors every driverless ride, regardless of whether there is a passenger inside. From Waymo's office, the dispatcher watches the vehicle, which carries at least half a dozen cameras that give a 360-degree view of its surroundings and interior. The dispatcher also watches a screen showing how the vehicle is interpreting sensor data about its surroundings and what it plans to do next.

Dispatchers can help a vehicle out of a jam, such as when it doesn't know how to proceed safely and comes to a stop. They can push a button to stop the van they're monitoring if they feel it hasn't detected something important on its own. Or they can suggest to the vehicle a path to take around an obstacle by drawing an "augmented trajectory" on their computer screen.

Waymo also sends a "chase van" that follows each driverless vehicle, said a person who has knowledge of the arrangement. Two Waymo representatives sit inside the chase van, one of whom can walk over to the vehicle if it gets stuck and drive it if necessary.

A Waymo driver in a chase van had to do exactly that recently, when a crossing guard on the street in a school zone caused a driverless car to get stuck in the middle of the road because it wasn't sure what to do. Other vehicles had to drive around it, said a person who saw the encounter.

The vast majority of Waymo's automated rides have a human backup driver. The company has made progress in improving the ride quality, according to customers. But its leaders have acknowledged internally that even when it solves the issues of automated driving in suburban Phoenix, that would not create a good business opportunity in and of itself. To do that, its managers have said, Waymo would need to manage automated rides in a denser urban area like San Francisco or Los Angeles.

Manufacturing Mountain

GM and Ford are ones to watch because in the coming years they plan to manufacture special vehicles with no steering wheels, powered by software developed by their Cruise and Argo units, respectively. That's likely going to be a multibillion-dollar effort for both carmakers.

Both Ford and Cruise have taken steps to bring in outside investors to reduce costs. Cruise, which appears to have the biggest headcount—1,700 employees—raised several billion dollars from investors including SoftBank, Honda and T. Rowe Price. Cruise also has improved software quality over time, though it's far from achieving what it considers human-level driving and its program costs around $1 billion per year. Cruise's next goal is to begin generating revenue from a public robotaxi service in San Francisco, which may then unlock some or all of $1.35 billion of additional capital promised by SoftBank. Later, Cruise will likely purchase from its parent company the special vehicles with no steering wheels.

Ford, meanwhile, has struck a deal with Volkswagen under which the two companies will share the costs of funding Argo. If the deal closes this year, as expected, each will own 40% of Argo.

The most ambitious startup on the list, Zoox (No. 9 on the list), is also trying to climb the multibillion-dollar manufacturing mountain, attempting to develop a "bidirectional" vehicle—meaning it can drive in both directions and doesn't have a front or back—that is also electric and drives autonomously. Now with around 1,000 employees, according to LinkedIn, the company will need much more capital than the $1 billion or so it has raised, according to Pitchbook.

Apple and Aptiv
How much Apple is spending on its self-driving car effort is harder to figure out. At one point, Apple had about 1,400 employees working on "Project Titan" to develop a new vehicle, sensors and automated driving software from scratch, said a longtime member of the group. The program, which began at least five years ago, has taken many twists and turns. The company ramped down some hardware and vehicle development in favor of more software development, and the team—and its costs—shrunk considerably. The person who worked on the team estimated it still has at least 600 members, some of whom joined last year from defunct robotaxi startup Drive.ai.

In a demonstration late last year outside the Bay Area, Apple successfully showed senior executives its vehicles could handle a several-mile loop without problems, according to a person with direct knowledge of the demo. The person declined to say where it was, but a likely location is Surprise, Arizona—a suburb of Phoenix—where Project Titan had planned to set up a facility to test prototypes by the middle of 2018, as The Information previously reported.

A less talked about but still prominent spender is Aptiv (No. 8 on the list), the auto parts supplier formerly called Delphi. It develops autonomous vehicle tech in addition to its main business of selling traditional automotive systems. Aptiv spent at least $380 million in cash on two acquisitions of self-driving car developers, including nuTonomy in 2017. The personnel involved have continued their research and done pilot tests in Singapore and Boston, in addition to setting up a research facility in China last year.

Aptiv also operates a fleet in Las Vegas that comprised at least 75 prototype vehicles as of a year ago, powered in part by Mobileye technology. Lyft incorporates these vehicles, with an Aptiv human backup driver, for its ride-hailing service there. Conservatively, we estimate that in recent years Aptiv spent a total of at least $350 million on R&D, salaries for up to 700 employees, and operations staff, particularly in Las Vegas. The company has an annual R&D budget of about $1 billion, so fully driverless tech development is a relatively small piece of that.

Chase Cars
Not to be overshadowed by Uber, ride-hailing rival Lyft in 2017 began to develop its own self-driving car software and later partnered with car parts supplier Magna International, which appeared to contribute $45 million per year to the effort, according to a Lyft financial filing. Magna recently pulled out of the partnership to save on costs. Lyft

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has been focused on automating a route between its Palo Alto office park and the train station downtown, a couple of miles away.

As of last fall, Lyft was sending its own chase cars to drive behind some of the prototypes it was testing. It's unclear exactly why it was doing so, but other programs in the past have used the practice to lessen the chance that the prototypes cause problems by, for instance, suddenly coming to a stop.

Regardless of Uber's and Lyft's own tech development, their core ride-hailing businesses appear to have an advantage no matter who wins the robotaxi race. Robotaxis cannot, and aren't expected to, handle every route riders request because some streets are much harder to navigate than others, especially if there's construction or bad weather. Developers of the vehicles are likely to try to work with bigger ride-hailing networks, where humans drive most cars, so that their prototypes can accept only the subset of ride requests they can handle confidently.

One carmaker that is about to jump up the spending leaderboard is Hyundai. The South Korean automaker has largely sat out the robotaxi race. Last fall, though, it said it would provide $2 billion in cash and engineering services and resources to a joint venture it will soon set up with Aptiv to develop and commercialize self-driving cars. Aptiv will contribute 700 employees and its intellectual property to the venture.

A recent newcomer to robotaxis, Yandex, which runs the leading ride-hailing app in Russia, has more than 200 engineers for self-driving car development. The company showed off a driverless ride demonstration in Las Vegas that impressed some attendees at the Consumer Electronics Show in January. We estimate that it has spent at least $75 million on such efforts in the three years it has worked on them.

Toyota's $1.5 billion figure comes with an asterisk. The company's president said in 2015 that Toyota would spend $1 billion in the next five years to develop self-driving car technology, so we're assuming it has made good on that pledge. The company also said in 2018 that it would spend $2.8 billion on a joint venture with auto suppliers to develop self-driving vehicle tech.

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By Maria Deutscher

Carrier Corp., a maker of air conditioners and building management products with $18 billion in annual revenue, has selected Amazon Web Services Inc. as its preferred cloud provider.

AWS shared details of the agreement this morning. The cloud giant didn't divulge any financial terms, but did say Carrier intends to move up to 70% of its 4,000 servers and 996 applications to AWS. The migration is part of a broader digital transformation project by the manufacturer to incorporate artificial intelligence capabilities into its hardware.

Charlotte, North Carolina-based Carrier is best known for its air conditioning units, but also sells a variety of other products including industrial refrigerators, building control systems and CO_2 detectors among others. The company will use AWS to collect data from those systems, as well as analyze the data using the cloud platform's AI services to improve the user experience.

Automated building management seems to be one of the use cases Carrier will pursue. As an example of a product it could build using AWS services, the company outlined a hypothetical facility control system that tweaks temperature, humidity and ventilation in different parts of an office building based on occupancy.

Carrier will also develop new software services to help customers "monitor, optimize, report on and forecast the performance and utilization of their IoT devices." Those services might be similar to Smart Service, a cloud-based analytics tool the company launched in 2017 that gives building operators access to sensor data from Carrier systems.

Carrier will build out a data processing environment in AWS to power the planned features. As part of the effort, it will implement a data lake on S3 as well as adopt the cloud giant's IoT Core platform for connecting devices to the cloud, IoT Analytics tool and IoT Events, which makes it possible to monitor devices for malfunctions.

Lastly, Carrier will collect data from internal operations to identify opportunities to improve efficiency in areas such as manufacturing.

"AWS is the hyperscale platform on which we expect to turn connected product and ecosystem data into opportunities for segment growth, new market channels, and improved customer experiences," Carrier Chief Digital Officer Bobby George said in a statement.

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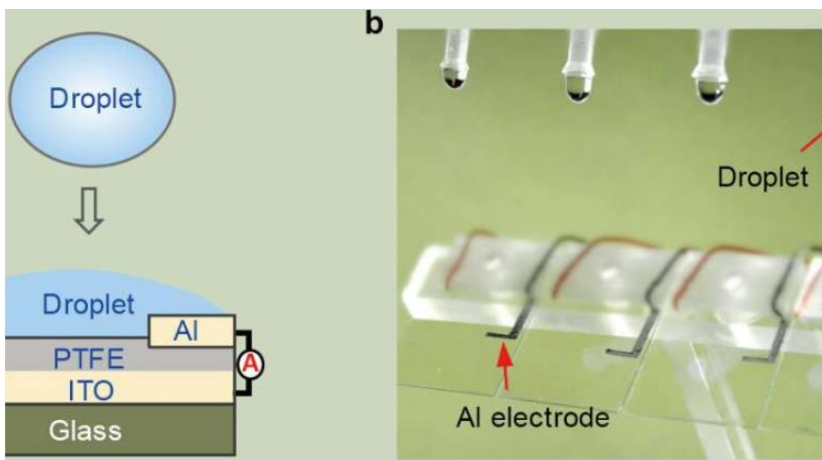*By City University of Hong Kong*

Fig a is the schematic diagram of droplet-based electricity generator (DEG). Fig b is the optical image showing four parallel DEG devices fabricated on the glass substrate.

A research team led by scientists from the City University of Hong Kong (CityU) has recently developed a droplet-based electricity generator (DEG) with a field-effect transistor (FET)-like structure that allows for high energy conversion efficiency and instantaneous power density thousands of times that of its counterparts without FET technology. This would help to advance scientific research of water energy generation and tackle the energy crisis.
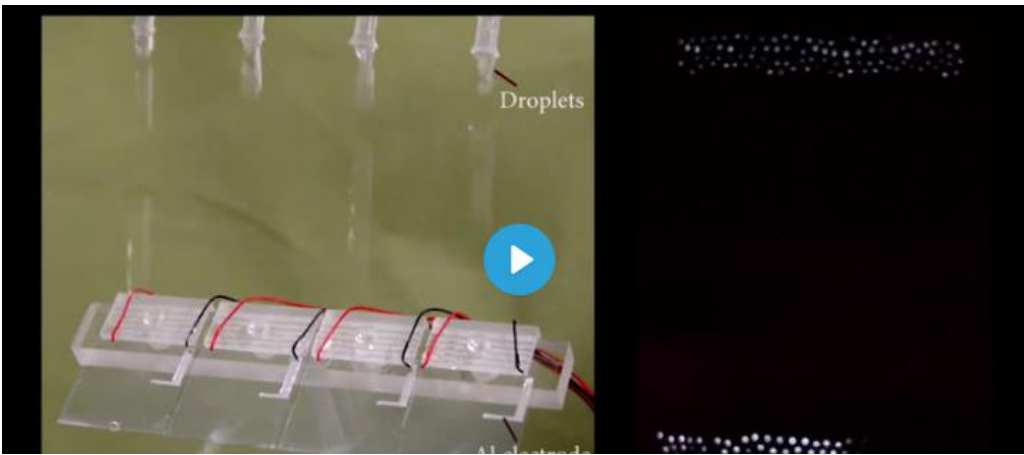
The research was led together by Professor Wang Zuankai from CityU's Department of Mechanical Engineering, Professor Zeng Xiao Cheng from University of Nebraska-Lincoln, and Professor Wang Zhong Lin, founding director and chief scientist from Beijing Institute of Nanoenergy and Nanosystems of Chinese Academy of Sciences. Their findings were published in Nature in a study titled "A droplet-based electricity generator with high instantaneous power density."

Efficiency of electrical energy conversion greatly improved
About 70% of the Earth's surface is covered by water. Yet low-frequency kinetic energy contained in waves, tides, and even raindrops are not efficiently converted into electrical energy due to limitations in current technology. For example, a conventional droplet energy generator based on the triboelectric effect can generate electricity induced by contact electrification and electrostatic induction when a droplet hits a surface. However, the amount of charges generated on the surface is limited by the interfacial effect, and as a result, the energy conversion efficiency is quite low.

In order to improve the conversion efficiency, the research team has spent two years developing the DEG. Its instantaneous power density can reach up to 50.1 W/m2, thousands times higher than other similar devices without the use of FET-like design. And the energy conversion efficiency is markedly higher.

Professor Wang from CityU pointed out that there are two crucial factors for the invention. First, the team found that the continuous droplets impinging on PTFE, an electret material with a quasi-permanent electric charge, provides a new route for the accumulation and storage of high-density surface charges. They found that when water droplets continuously hit the surface of PTFE, the surface charges generated will accumulate and gradually reach a saturation. This new discovery helped to overcome the bottleneck of low charge density encountered in previous work.

With the new droplet-based electricity generator, a drop of water released from a height of 15 cm can generate a voltage of over 140V, lighting up 100 small LED bulbs. Credit: City University of Hong Kong / Nature

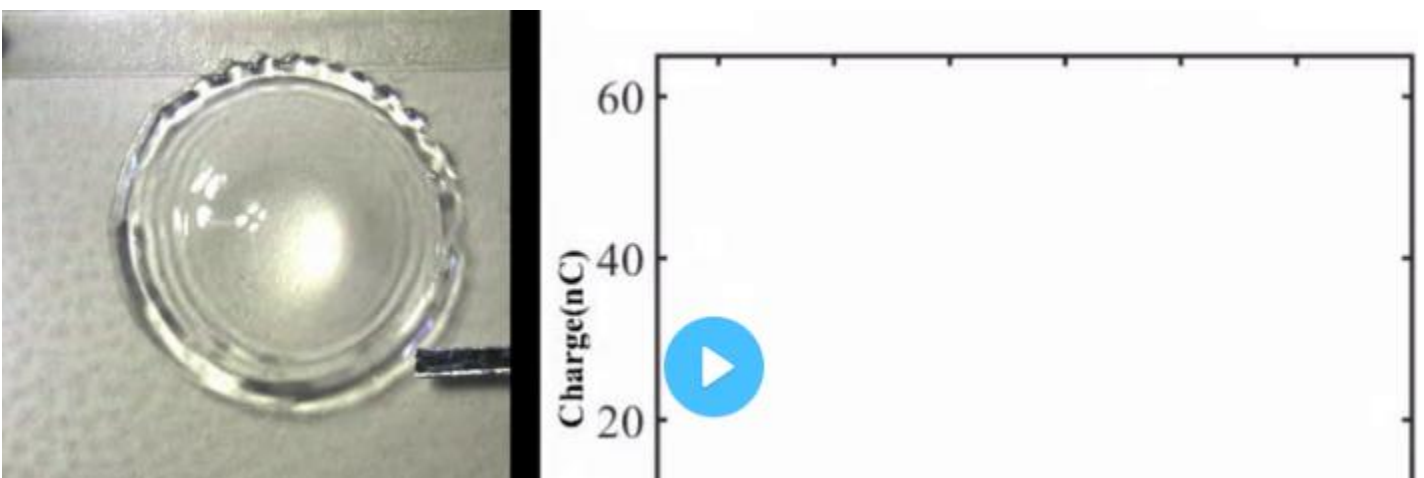Unique field-effect transistor-like structure

Another key feature of their design is a unique set of structures similar to a FET, the basic building block of modern electronic devices. The device consists of an aluminum electrode and an indium tin oxide (ITO) electrode with a film of PTFE deposited on it. The PTFE/ITO electrode is responsible for the charge generation, storage and induction. When a falling water droplet hits and spreads on the PTFE/ITO surface, it naturally "bridges" the aluminum electrode and the PTFE/ITO electrode, translating the original system into a closed-loop electric circuit.

With this special design, a high density of surface charges can be accumulated on the PTFE through continuous droplet impinging. Meanwhile, when the spreading water connects the two electrodes, all the stored charges on the PTFE can be fully released for the generation of electric current. As a result, both the instantaneous power density and energy conversion efficiency are much higher.

"Our research shows that a drop of 100 microliters of water released from a height of 15 cm can generate a voltage of over 140V. And the power generated can light up 100 small LED light bulbs," said Professor Wang.

He added that the increase in instantaneous power density does not result from additional energy, but from the conversion of kinetic energy of water itself. "The kinetic energy entailed in falling water is due to gravity and can be regarded as free and renewable. It should be better utilized."

Their research also shows that the reduction in relative humidity does not affect the efficiency of power generation. Also, both rainwater and seawater can be used to generate electricity.

Facilitates the sustainability of the world

Professor Wang hoped that the outcome of this research would help to harvest water energy to respond to the global problem of renewable energy shortage. "Generating power from raindrops instead of oil and nuclear energy can facilitate the sustainable development of the world," he added.

He believed that in the long run, the new design could be applied and installed on different surfaces, where liquid in contact with solid, to fully utilize the low-frequency kinetic energy in water. This can range from the hull surface of ferry, coastline, to the surface of umbrellas or even inside water bottles.

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When it comes to determining how safe it is to drive in any given country, you can read all the statistics you want, but the best way to get some ground truth is to rent a car and see for yourself. For example, take the country of Rwanda. It's the second most dangerous country in Africa to drive, and a place where a sophisticated series of hand gestures are used to warn oncoming drivers about traffic police. Everybody just learns to skirt the system, and driving safely just becomes an impediment to getting somewhere quicker. Should you actually be stopped by the police, 20,000 Rwandan francs (about $20) will do the trick, so the purpose of having traffic police is just to extort a form of road tax. There are many countries in the world where people are comfortable taking risks while driving, and one of them is the great Kingdom of Saudi Arabia.

The second leading cause of death in Saudi Arabia is getting killed in an auto accident. Most of the people we spoke with in Riyadh speculated that the problem results from the large number of drivers who hail from other countries where driving isn't exactly that safe. The end result is a melting pot of drivers on the road, each with their own set of road rules. Regardless of the reason why people are comfortable taking more risks when driving, spend some time in the Kingdom and you'll quickly realize two things – Saudi people are incredibly friendly, and road safety is a problem that needs to be dealt with. One Saudi Arabian startup – Hazen.ai – is looking to improve road safety around the globe using artificial intelligence.

About Hazen.ai

Founded in 2018 and based out of Makkah, Saudi Arabia, Hazen.ai has taken in an undisclosed amount of funding (rumor has it their seed round made seven figures) from Saudi Aramco's venture capital arm, Wa'ed Ventures, to develop computer vision solutions for traffic – "smart cameras for a smarter city." We sat down to speak with co-founder and CEO of H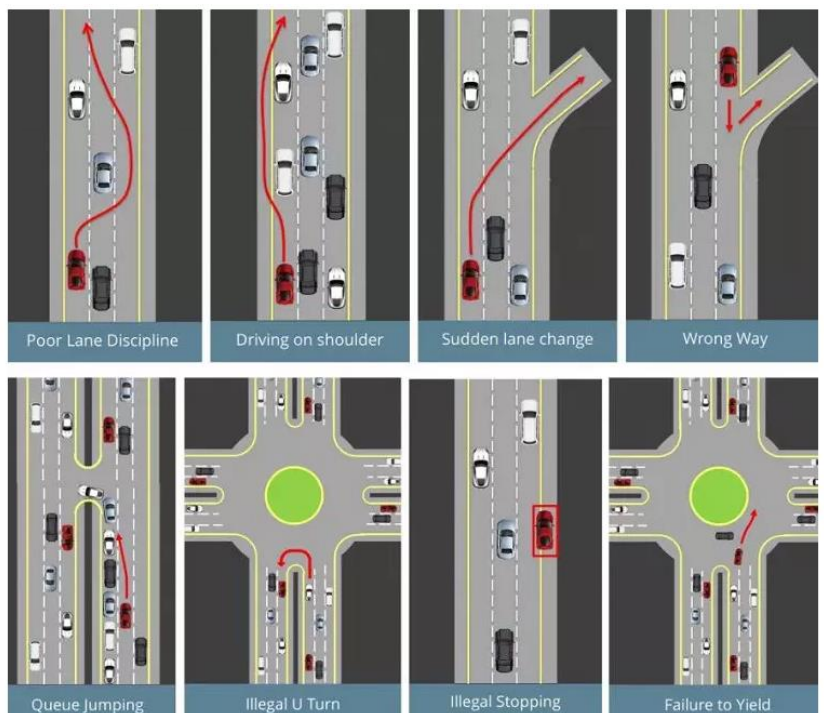azen.ai, Sohaib Khan, who worked as a professor of computer vision for fifteen years before deciding to embark on an entrepreneurial quest to save lives.

Today, traffic enforcement is conducted using expensive equipment like LiDAR and radar devices which capture speeding or red-light infractions. Tomorrow, it just might be computer vision algorithms. Turns out that Saudi Arabia, and the region as a whole, is the perfect place to build such a solution for any number of reasons.

Why Saudi Arabia?
Tech news is inundated with stories of startups trying to make cars drive themselves, or cars equipped with cameras that assess other people's driving capabilities, or even cameras facing inwards which detect driver fatigue or a lack of concentration. What seems to be lacking is a technology solution that can detect moving violations from a stationary position. Here are some examples of moving violations that you might want to detect with such a solution.

A menu of moving violations – Credit: Hazen.ai

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The environment in the region is so rich with traffic pattern variations that traffic management companies from all over the world come to Saudi Arabia to set up shop. A rich variety of edge cases for training algorithms means that if algorithms work well here, they'll work well anywhere. Improving traffic safety is a problem that governments are more than willing to spend the money needed to fix, and there aren't a whole lot of organized groups that would oppose the deployment of safety mechanisms. It's the perfect place to build a solution and then sell it across the globe, something that Hazen.ai is actively doing.

The Hazen.ai Platform
We've talked a lot before about training data that's being used to train computer vision algorithms for autonomous vehicles. What you may not be aware of is that most of this data is based on Western markets where things operate a whole lot differently. Hazen.ai seeded their computer vision algorithms using Western data sets, then started using customer data from various geographies to fine-tune their models (what's called model adaptation). Figuring out what entails a "moving violation" will differ based on what country the camera is placed, or even what physical location it occupies. The core technology behind the Hazen.ai solution is the ability to classify vehicles in any environment or lighting configuration, then determine the vehicles' trajectory.

Tracking vehicle trajectory – Credit: Hazen.ai

Once trained, these algorithms are then placed "at the edge" where a credit card-sized GPU chipset from NVIDIA resides in a small box that plugs into any IP-enabled camera that is conducting surveillance, like CCTV cameras, for example. The camera's feed is then redirected into the box where moving violations can be assessed in milliseconds. Once a violation has been identified, a request is made to an automatic license plate reader (ALPR) to identify the vehicle. That identification image along with video evidence of the infraction is then assembled as a "violation package" that's configured based on the legal requirements of the country their client resides in. It's just what traffic enforcement officers need to issue a citation and curb moving violations without having to deploy more bobbies on the beat.

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Detecting an illegal left turn – Credit: Hazen.ai

The Way Forward

Mr. Khan spoke proudly of the prestigious product innovation award his startup managed to land at Gulf Traffic 2018 in Dubai. At that time, they were the only company present dabbling in computer vision for traffic safety. When they attended that same event in December 2019, that all changed, with numerous companies beginning to tackle this problem. Hazen.ai has a good head start, having landed their first commercial client from a developed market, along with plenty of potential clients they're doing pilot projects with. In one example, Hazen.ai was given 24 hours of traffic data to classify infractions on. When all was said and done, they discovered that drivers had actually figured out ways to cheat the existing traffic cameras – the equivalent of a head fake for all you basketball players out there. They're also doing classification work in other countries like Pakistan where you're liable to see bikes, motorcycles, tuk-tuks, buses, people, and just about everything else on the road.

There are plenty of other use cases that Hazen.ai might address such as traffic management or parking, but moving violations are where their bread and butter is at right now. Insurance companies are likely to find this technology interesting, as are governments, but Mr. Khan thinks the way forward is to target bigger traffic management companies that are just starting to explore this space. As a small startup, Hazen.ai can deploy their solution much quicker by partnering with companies that already have cameras or ALPR devices deployed on street corners. More importantly, their core technology – vehicle classification algorithms – can be used for autonomous driving when the time comes. If you're a company that already mastered autonomous driving for Western markets, you just might need some data from places where things are a bit more heterogeneous. Anyone who is able to amass such a big data set will be sitting pretty when that time comes.

Conclusion

Pundits are always quick to call for the death of oil in the face of electric cars, not realizing just how far away that point is for the rest of the world, which doesn't reside in developed markets like 'Murica. The same can be said for self-driving vehicles. Until we reach a point in time where all the world's nations can afford to upgrade to green transportation methods, there will be traffic safety issues to address because understandably, all cultures choose to drive differently depending on their norms. It's difficult to change driving behavior without using a carrot or a stick. In countries where auto insurance isn't so popular, the carrot won't work. This means that solutions like the one being built by Hazen.ai can save lots of lives while we wait for the world to catch up to autonomy, and perhaps make some investors a whole lot of money in the process.

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By Pryamvada Mathur

Operators of car-sharing fleets had a rough 2019. To summarize: ReachNow halted its Seattle operations in July, with LimePod reportedly following suit in September. And by the year's end, Car2go had pulled out of five cities across North America.
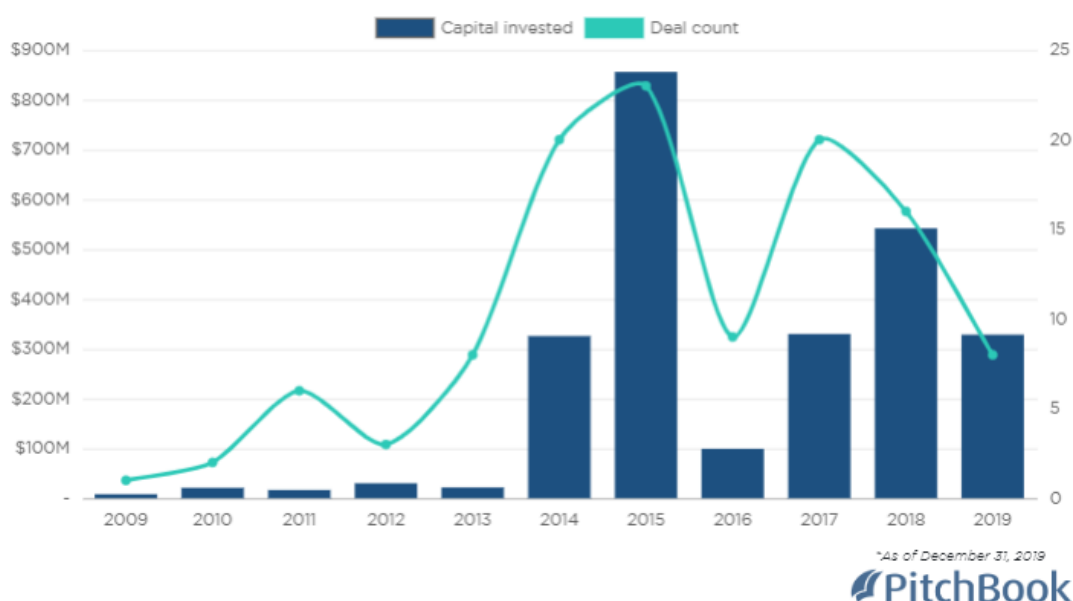
The challenges are numerous: Traditional car-sharing companies must sustain a capital-intensive business of owning a fleet of vehicles, while also competing with ridesharing giants and effectively catering to an ever-evolving transportation market.

Alternatively, peer-to-peer car-sharing providers allow car owners to rent their vehicles to other people, generating extra income through what would otherwise be an idle asset. The P2P model successfully circumvents the higher costs of vehicle ownership—such as maintenance, parking and depreciation—that are typically incurred by the traditional car-sharing model, according to PitchBook mobility analyst Asad Hussain. This helps improve margins and enables operators to scale in line with demand.

A couple of startups in the space, including SoftBank-backed Getaround, and Turo, pulled in VC mega-deals at unicorn valuations in 2019.

But P2P car sharing has also had its share of challenges. Getaround announced in early January that it will shed a number of jobs in an effort to reduce costs, with The Information reporting that around 150 people —roughly one-quarter of its staff—will be let go. Meanwhile, customers seeking to make extra cash from renting their cars have reportedly faced insurance and regulatory hurdles.

Still, investors funneled nearly $330 million in VC financing into car-sharing companies last year. The data for 2019 doesn't include the latest round for Getaround, as the deal is yet to be closed.

Turo, which offers P2P car-sharing services in more than 6,000 cities, on Wednesday said it has added $30 million from Manhattan Venture Partners and Allen & Co. to its ongoing Series E round. In July the San Francisco-based company raised $250 million from InterActive Corp, valuing Turo at $1.2 billion, according to PitchBook data.

However, Turo's expansion plans are limited. CMO Andrew Mok said the company's margins make sense only if it focuses on customers seeking to rent a car for at least a day trip.

"The hourly car-sharing business is generally being eaten up by the rideshare players, as it's a lot more convenient,"Mok said.

Achieving larger scale is another challenge for fleet-owned car-sharing businesses, as expansion means that they sustain capital expenses related to the purchase of new cars. Mok added that Turo leverages existing car owners who live in the cities where it operates, and it can expand to more locations without incurring significant incremental costs.

Mok said Turo is making a brand-awareness push over the next 12 months. As part of the latest investment, the company has added several celebrity shareholders, including NFL star Larry Fitzgerald, NBA player Victor Oladipo and rapper 2 Chainz.

"Bringing these folks on board will really help spread the word and make the brand more of a household name," Mok said.

CHAMBIZ

Buying a new robot is a considerable investment for any business owner. Collaborative robots have been widely marketed as a cheaper alternative to industrial robots, but what's the catch?

By Nigel Smith

Upfront costs

Let's kick things off with the collaborative robot, or 'cobot' as they are commonly called. The term cobot has been coined to represent an unguarded, easy to integrate collection of robots that typically carry out repetitive or unsafe tasks while the human workforce performs higher-value manual tasks up or downstream. In terms of upfront costs, most cobots are cheaper than traditional, industrial robots.

These low costs have provided smaller businesses with accessibility to robots, which in itself is something to be celebrated. However, that doesn't mean all small businesses need to opt for a cobot to board the automation train.

The alternative is industrial robots. Think SCARA, 6-axis or cartesian models. These are heavy duty robots with high payloads that can tackle dangerous, repetitive and heavy applications. These robots are commonly used for parts assembly, pick and place and palletizing in many different industries — and they have been for decades.

Generally, industrial robots cost more upfront but can provide entirely different levels of performance. Plus, there's much more to consider than the first financial transaction. Firstly, pricing structures are changing, meaning industrial robots are now a becoming more viable option for small businesses.

TM Robotics' is a good example of this. The company's new pricing structure puts the company's range of Toshiba Machine SCARA robots as the performance leader of the low-cost end of the market. The company's latest SCARA model for instance, the THE400, can provide manufacturers 40 per cent faster speed compared with competing models in this price range.

Using this model, the company can ensure small businesses and those that are new to automation, aren't priced out of the robot market.

Cost of ownership

Whether we're discussing cobots or industrial robots, a challenge for small to medium sized manufacturers is determining the actual cost of ownership when investing in automation. These are the additional costs of maintenance, energy consumption and additional equipment requirements that enable the safe usage of the robot.

For example, a risk assessment may determine a cobot needs extra fencing, or force limiters, if it is to be used safely alongside humans. This is a very common occurrence for misinformed cobot purchasers. Manufacturers would be forgiven to believe that cobots are automatically safe to use alongside humans, but this isn't always the case.

The risk assessment, and the heavy fees for additional safety equipment, can leave manufacturers thinking, 'why didn't we just buy an industrial robot for all this money we've spent?'

Cost of energy consumption also needs to be evaluated against the production output. As many cobots are relatively new inventions, many boast low energy consumption. But, you wouldn't celebrate a cobot only using 800 watts of energy, if it only outputs one unit during that time. Similarly, you can forgive an industrial robot for using 3000 watts of energy in the same time period, if it outputs a large number of units.

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Thankfully, many industrial robots now have energy saving options. Toshiba Machine's latest line of cost effective and low-energy SCARA Robots, the THL Series, is ideal for price-conscious end-users, and system integrators looking to incorporate automation.

Programming
According to TM Robotics' Global Robotics Report, 79 per cent of robot distributors stated that simple programming was one of the most important things customers were looking for when purchasing a robot.

By nature, cobots are designed for ease-of-use alongside human employees. In fact, one of the most marketed features of these machines is ease of programming.

Easy robot programming is not only an attractive feature for new users, but provides established users with reduced programming time. Growing demand for easily programmable robots is particularly evident in the rapid increase in sales of collaborative models.

Cobots are known for their ease of use, some having intelligent hand-guided teaching ability, where the operator simply teaches a cobot a new program, by moving the robot manually.

On the other hand, industrial robots have developed an unfair reputation of being labor intensive, in relation to programming. That's not to say some aren't, but when you test the usability of Toshiba Machines latest robots and programming software, it's clear to see this isn't always the case.

We're witnessing a shift in behavior from robot manufacturers in favor of easy to program industrial robots. This is particularly advantageous for small to medium-businesses that are perhaps new to automation, but don't have the expertise in house for complex programming.

There's an argument for both industrial robots and cobots, but the decision on which to select depends on the application. While industrial robots are shifting some long-standing misconceptions on programmability and costs, the collaborative robot is also being held to higher standards in relation to return on investment and productivity.

There's space on the market for both industrial robots and cobots. The question is, which one is worth your investment?

About TM Robotics
TM Robotics has installed thousands of robots in factories throughout the world, including North and South America, India, Russia, Europe, the Middle East, Africa and Australia. Many of the top manufacturing companies depend on TM Robotics' product offerings for their reliability, performance, and overall value.

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The Petah Tikva-based quality assurance firm, already the world's largest of its kind, hopes to grow fivefold in 5 years with help of AI tools and aggressive M&A strateg

By Shoshanna Solomon

Norm Merritt, the CEO of software testing firm Qualitest, in Tel Aviv; Feb. 2, 2020 (Shoshanna Solomon/Times of Israel)

Israel's Qualitest Ltd., the world's largest independent software testing company by revenue, hopes to grow sales fivefold within five years, riding the wave of increased digitalization of industries and businesses worldwide.

"Our goal is to be five times our size in the next five years through organic and inorganic growth," said Norm Merritt, CEO of the Petah Tikva-based firm. Qualitest has some 3,700 employees, of whom 1,500 work locally, with others in the UK, the US, India and Europe.

Merritt, who joined the firm as CEO in September 2018 and is based in the United States, spoke with The Times of Israel in Tel Aviv this week.

Founded in Israel in 1997 by Ayal Zylberman and Eli Margolin, Qualitest provides automated and manual software testing services for companies including tech giants Google, Microsoft, and Intel Corp.

The Qualitest team in Petah Tikva, February 2020

In July, private equity firm Bridgepoint Advisers Ltd. acquired a controlling stake in Qualitest for $420 million from Marlin Equity Partners.

The funds from the investment will allow Qualitest to grow market share through global acquisitions, strengthen its product development and recruit more workers, the company said.

Qualitest designs and develops solutions offering a wide range of advanced testing and quality assurance capabilities for blue-chip companies in the fields of technology, telecom, entertainment, AI, cyber, healthcare, finance, security, media, and retail, using up to date tools such as artificial intelligence.

"Every company, every industry is recognizing that they have to change the way they do business. They have to change their whole approach, their whole value proposition, using technology," Merritt said, in the lobby of a Tel Aviv hotel overlooking the city with a view to the sea. "You walk into any McDonald's and …there's now kiosks and it's a very different business and it's driven by technology."

As a result, with firms "using technology in unprecedented ways," they need an independent body to verify that the software they are buying or developing for the app, product or website used by their customers works well.

"The demand for our services at Qualitest is increasing at an unprecedented rate," Merritt said. "We help make sure that before they launch new code and a new technology, that it not only works properly and functions as a design, but that it's reliable, it's usable, it actually fulfills the business purpose for which it was created."

The market in which Qualitest operates is expected to grow 13% year on year, and is valued at $38 billion globally, he said.

"It's a big market. Its's growing very quickly," he said. But Qualitest is "growing at almost twice the rate of the market," he said.

The company's products, which include artificial intelligence tools developed in Israel, pinpoint what sections of thousands of lines of code need to be looked at for flaws and vulnerabilities.

An AI edge
In December, Qualitest said it acquired Israel-based artificial intelligence and machine learning company AlgoTrace for an undisclosed amount. The acquisition will allow Qualitest to "radically expand the number of AI-powered testing solutions available to clients, as well as develop its capabilities in assisting companies test and launch new AI-powered solutions with greater confidence and speed," the firm said at the time.

The AI tools acquired give Qualitest its competitive edge and "the capacity or the capability to determine what we should be testing," Merritt said, because the complexity of systems that use software is growing constantly.

Take "Tesla as an example," he said. "They have 100 million lines of code in a single car." Human beings no longer have the ability to know where they should be spending their time checking for flaws, he said, and that is why machine learning is necessary.

AI tools, however smart, will not replace engineers, he said. They "will replace some jobs," he said, but more importantly, "they will extend the capability of our engineers to allow them to be more effective and be more pointed, and more precise in their solution."

Merritt added that the day when software will write itself and correct itself is "way off."

"You can't teach the computers to be human. You can teach them to do things that humans can't do," he said. "But there is still an intuitive kind of understanding and what's interesting is, like any tool, if you don't have an expert using it, the tool is useless. And I think that's the key. You have to have an expert using the tool and that's why Qualitest is using AI as an enhancement to our engineers' capability."

One third of the firm's revenues stem from the Israeli market, one third from the US, and the rest from the UK. "The US market is growing the quickest," by some 40% year on year, Merritt said. Sales in Israel grew 15% last year.

"Israel as a percentage of revenue will decrease over time," he said. "But only because the company's growing so dramatically elsewhere. But it's still growing in Israel."

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Qualitest is the largest company globally operating in this field, he said, with competitors being either much smaller or boutique testing firms, "many of whom are open and ready for acquisition. And that is something that we are definitely looking at."

Bridgepoint "wouldn't have acquired us if they didn't want us to double, triple" revenue through acquisitions, he added.

Qualitest is currently looking at a number of possible acquisitions, Merritt said, one of which is in Israel, though he declined to elaborate.

The main challenges ahead, Merritt said, said are finding the right talent — "all companies are struggling" — and execution, "the ability to take advantage of the growth in the market."

At expo in Lucknow, India, Israel Aerospace Industries inks agreement with India's Hindustan Aeronautics and Dynamic Technologies

By Shoshanna Solomon

Officials at Israel Aerospace Industries (IAI) and India's Hindustan Aeronautics Limited (HAL) sign an MOU for the use and production of drones at the DefExpo 2020 exhibition, in Lucknow, India;, February 5, 2020

Israel Aerospace Industries (IAI), the nation's largest aerospace and defense company, said Wednesday (Feb 5, 2020)that it signed a strategic partnership agreement with India's Hindustan Aeronautics Limited (HAL) and Dynamatic Technologies Limited (DTL) to share drone technologies and promote the production of Indian unmanned aerial vehicles (UAVs).

The memorandum of understanding signed between the parties at the DefExpo 2020 exhibition, in Lucknow, India, "will allow the implementation of optimal solutions for the needs of the local customer based on their specific technologies and needs," IAI said in a statement.
HAL is a state-owned aerospace and defense firm headquartered in Bangalore, while DTL is a firm that focuses on precision engineering for the automotive, aerospace and hydraulic pumps industries.

IAI has been developing and selling drones for nearly 50 years, and is the exclusive UAV supplier for all of India's military arms, the statement said. The Israeli firm provides services to over 50 customers worldwide and has logged over 1.8 million operational flight hours.

The collaboration with the Indian firms will focus on sharing technologies for upgrading UAV capabilities, and offer the Indian customers advanced systems that include integrated local technologies, the statement said.

IAI has also set up, together with a local partner, a maintenance, repair and overhaul business that will focus on UAVs "to provide the customers with high-availability responses and quick maintenance," the statement said.

IAI's Overview
Israel Aerospace Industries (IAI) develops and produces systems for the defense and commercial markets.

IAI produces satellites and space systems; defense systems, missiles, and loitering weapons; special mission and early warning aircraft; unmanned aerial systems (UAS); radar and electronic intelligence equipment; and robotic machines.

The company has also developed the TaxiBot, a semi-robotic, pilot-controlled towing tractor. The engineless vehicle, steered by the pilot, is designed to tow aircraft close to the take-off point.

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In 2019, IoT and its role in industrial and commercial applications often stole the industry's top headlines, especially in terms of security and wearables. Will the same hold true in 2020?

By Mitch Maiman

In 2019, the buzz around technology was all about the Internet of Things applied to industrial and commercial applications—with security and wearables being some of the significant technologies to deploy it. So, while we launch into a new decade, let's look at those key technologies in 2019 and how they fared, and then take a look ahead at 2020.

These top technologies in 2019 will continue to have a major impact in 2020:

Security
Security was a hot topic in 2019, while the buzz around the term "blockchain" faded. Blockchain, an approach to software coding used largely in Fintech to make systems less hackable, has become mainstream. The hottest area of concern regarding security seems to be in the industrial, commercial, and financial sectors—as it should be. Security is also important in the consumer arena, but, absent high-profile cases involving consumer IoT devices, there's a concern that the focus on security may relax in this segment.

It should be anticipated that security will remain a major concern in 2020 and that the non-consumer segment will be the one driving demand for increased protection, particularly as it relates to edge based devices.

Indusotrial IoT
Dramatic growth was anticipated in Industrial IoT, aided by cloud-based solutions. In turn, such systems would help minimize time and expense for development of complex solutions involving data aggregation, analytics, and the driving of action-based responses.

Rather than a tidal wave of action in 2019, there was a steady growth in the deployment of innovative use of IoT in industrial and commercial applications. Areas like farming, piping, and power have seen innovative new developments. Expect this trend to continue in the coming year. The development and deployment of limited scope, targeted AI (artificial intelligence) based on data acquisition, analytics, and control will be a hot topic for more advances in 2020 and beyond.

Wearables
Last year at this time, it was anticipated that the wearable category would continue to evolve but no earth-shattering breakthroughs would emerge in the coming year. This view has largely been validated in 2020. There's incremental improvement in wearable devices, particularly as it relates to health monitoring, but the shakeout in the industry is in progress. Commoditization is underway and the market, while growing modestly, often focuses on the replacement and upgrading of existing products in the hands of consumers (Fig. 1).

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In 2020, and beyond, the potential around wearables is to engage a new category of consumers. Specifically, as biometric sensing improves on wearable devices, expect to see a stronger push into health monitoring of those with chronic conditions or the elderly. The ultimate goal in all cases is to allow for wellness at the lowest cost location of caregiving—the home. Wearable technology is already more than "smart watches." Expect, in the future, to see increased monitoring in various places on the body and the growth of systems that actively monitor and deliver medications to those with chronic conditions.

2020 Trendsetters
Looking ahead to 2020, these four technologies will make the most impact in the coming year and thereafter:

5G Services
While it will still take several years before 5G becomes ubiquitous, cellular carriers are making a greater push around 5G and investing heavily in 5G infrastructure. 5G will be important in 2020 and more so in the upcoming years.

AI and AR
AI and AR (augmented reality) are already rolling out, and it will continue throughout 2020. A "tipping point" isn't anticipated, but expect a steady increase in the types of intelligent things that will come out of data mining (i.e., data sciences) based on information from IoT and other devices as well as public and private web and social media data. The medical segment will be increasingly hot in this area.

Electric Vehicles (EVs)
There are already options for purchase of commercially available EVs. However, expect this trend to rapidly accelerate as more manufacturers release an increasing number of vehicles and vehicle types with all-electric power. However, the "800-lb. gorilla in the room" has to do with availability of high-speed charging stations and the distribution of high-power charging demand on the electric grid.

Robotics
Much development is underway in this domain. However, the robots that you'll see in 2020 and the near future are likely to be very application-specific *(Fig. 2)*. Among the work in progress are applications involving routine, repeat operations in a narrow environment. Examples include warehouse and retail (cleaning, picking, stocking, etc.) and operations.
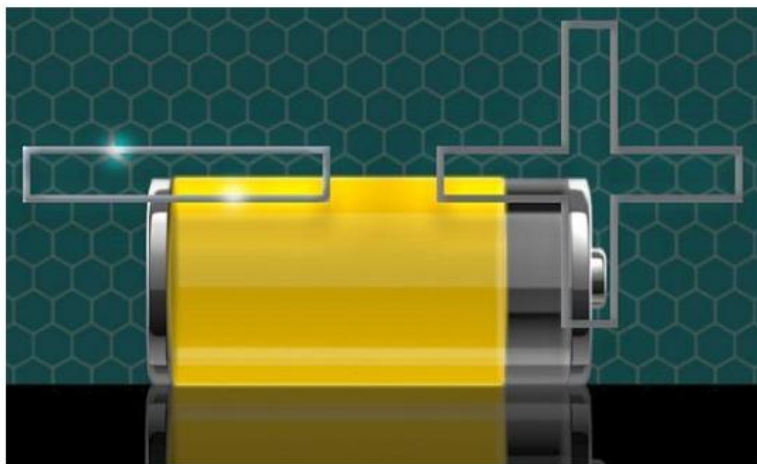

2. Developments in robotics are underway that target applications involving routine, repeat operations in a narrow environment.

The roll out of these new technologies into consumer, commercial, health, and industrial markets will greatly impact how we design products in 2020. It will also lay the groundwork for devices still to come in the next decade that will be used by consumers and industry alike.

By Rich Pell

Researchers at MIT say they have developed a lithium metal anode that could improve the longevity and energy density of future batteries.

The research is based on the goal of using pure lithium metal as one of a battery's two electrodes. The design is part of a concept for developing safe all-solid-state batteries by avoiding the liquid or polymer gel usually used as the electrolyte material - which allows lithium ions to travel back and forth during the charging and discharging cycles of the battery - between a battery's two electrodes.

While much work has been done pursuing solid-state batteries with lithium metal electrodes and solid electrolytes, say the researchers, such efforts have faced a number of issues. For example, when the battery is charged up, atoms accumulate inside the lithium metal, causing it to expand; the metal then shrinks again during discharge, as the battery is used. These repeated changes in the metal's dimensions make it difficult for the solids to maintain constant contact, and tend to cause the solid electrolyte to fracture or detach.

Another problem is that none of the proposed solid electrolytes are truly chemically stable when in contact with the highly reactive lithium metal, and tend to degrade over time. Most attempts to solve these issues, say the researchers, have focused on designing solid electrolyte materials that are absolutely stable against lithium metal, which turns out to be difficult.

The researchers therefore focused instead on a design approach that uses two additional classes of solids - "mixed ionic-electronic conductors" (MIECs) and "electron and Li-ion insulators" (ELIs) - that are absolutely chemically stable in contact with lithium metal. The result was a three-dimensional nanoarchitecture in the form of a honeycomb-like array of hexagonal MIEC tubes, partially infused with the solid lithium metal to form one electrode of the battery, but with extra space left inside each tube.

When the lithium expands in the charging process, it flows into the empty space in the interior of the tubes, moving like a liquid even though it retains its solid crystalline structure. This flow, say the researchers, is entirely confined inside the honeycomb structure and relieves the pressure from the expansion caused by charging, but without changing the electrode's outer dimensions or the boundary between the electrode and electrolyte. The other material, the ELI, serves as a crucial mechanical binder between the MIEC walls and the solid electrolyte layer. "We designed this structure that gives us three-dimensional electrodes, like a honeycomb," says Ju Li, the Battelle Energy Alliance Professor of Nuclear Science and Engineering and professor of materials science and engineering. The void spaces in each tube of the structure allow the lithium to "creep backward" into the tubes, says Li, "and that way, it doesn't build up stress to crack the solid electrolyte."

The expanding and contracting lithium inside these tubes moves in and out, similar to the way a car engine's pistons move inside their cylinders, says Li. Because these structures are built at nanoscale dimensions, the result is like "an engine with 10 billion pistons, with lithium metal as the working fluid."

Because the walls of these honeycomb-like structures are made of chemically stable MIEC, the lithium never loses electrical contact with the material, says Li. Thus, the whole solid battery can remain mechanically and chemically stable as it goes through its cycles of use.

While many other groups are working on what they call solid batteries, says Li, most of those systems actually work better with some liquid electrolyte mixed with the solid electrolyte material. "But in our case," he says, "it's truly all solid. There is no liquid or gel in it of any kind."

The researchers say they have proved the concept experimentally, putting a test device through 100 cycles of charging and discharging without producing any fracturing of the solids. The new system, say the researchers, could lead to safe anodes that weigh only a quarter as much as their conventional counterparts in lithium-ion batteries, for the same amount of storage capacity.

If this new anode design was combined with new concepts for lightweight versions of the cathode, such as one already proposed previously by Li, this work could lead to substantial reductions in the overall weight of lithium-ion batteries, say the researchers. For example, the researchers hope it could lead to cellphones that could be charged just once every three days, without making the phones any heavier or bulkier.

For more, see "[Gradient Li-rich oxide cathode particles immunized against oxygen release by a molten salt treatment.](#)"

By James Blackman

By 2025, 5G connections should cover 40 per cent of Europe's workforce, 70 per cent of its industrial sites, and 80 per cent of its main logistics routes. This was the message from DigitalEurope, the trade association for the European tech industry, at the launch of a new Industry 4.0 policy document.

Speaking at its flagship digital policy event, Masters of Digital 2020, in Brussels, Cecilia Bonefeld-Dahl, director general at DigitalEurope, said the European Union (EU) member states must raise their investment in digital technologies above 10 per cent of budget.

Current EU proposals allocate closer to three per cent of budget, as it stands. EU leaders are scheduled to meet on February 20 to negotiate over the bloc's trillion-euro budget, complicated by the UK's exit from the union. The European Commission has drafted an industrial strategy, to be finalised in March, to make "Europe fit for the digital age".

Bonefeld-Dahl commented: "Europe needs to build on its strengths in… health, manufacturing, green tech, energy, and transportation. Digitalisation has huge potential to make our industry greener and more competitive, and to provide good, well-paid jobs."

"We urge member states to put their money where their mouth is on the EU budget. When leaders gather in Brussels on 20 February they need to set an ambitious goal for digital investment, right now it is only three per cent of the budget – anything below 10 per cent would hinder the implementation of the ['Europe fit for the digital age'] vision."

In a speech at the Masters of Digital 2020 event, at the Royal Museum of Fine Arts in Brussels, she set EU targets for industrial 5G deployments, as above, including 70 per cent of industrial sites and 80 per cent of logistics routes.

On the subject of 5G, specifically, the new policy document states that an industrialised version of it — roping massive machine-type (mMTC) ultra-reliable low-latency (URLLC) communications in the forthcoming standalone versions (to be standardized in 3GPP Releases 16 and 17) — must be prioritized across Europe.

It calls for a "favourable regulatory environment for industry connectivity", which is being shaped already by moves in the UK and Germany, notably, to liberalize spectrum holdings for industrial access to affordable high-capacity LTE and 5G networks.

The EU should "prioritise long-term societal benefits deriving from spectrum auctions over immediate state revenues, notably by setting low reserve prices, providing certainty regarding licence duration, and encouraging broader rollout and coverage," it states.

The new policy document defines five areas that require urgent attention from political leaders for the EU to make the most of the economic opportunities afforded by new Industry 4.0 technologies, including 5G, keeping climate change and workforce automation as key challenges.

These include an EU framework for the digital transformation of industry, with a digital spending set at 10 per cent of budget, at least — of which half should be focused on deployment, it states. Funding the EU's current 2021-2027 Digital Europe programme should be raised from €9.2 billion to €25 billion, it adds, essentially to cope with short-term workforce training and displacement from the impact of industrial analytics and automation.

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Other recommendations include: 'open markets and fair global competition', with the EU taking a lead on data governance and cybersecurity; 'upscaling and upskilling the workforce', with detail of new 'digital innovation hubs' and new curricular initiatives; and alignment with the EU's Green Deal, which sets a target for the continent to be carbon neutral by 2050.

The document states: "For a European digital transformation of industry, the European Commission would need to shift its digital policy focus towards driving the digitalisation of industry... The digitalisation of our industry is a precondition to reach the Green Deal... We need a consolidated European Industrial Strategy under a common plan.

"Research, investment, and innovation must go hand in hand... We need common metrics on how digital will enable decarbonisation and reduce energy consumption. We also need to accelerate the development of artificial intelligence technologies. This requires a targeted and ambitious Multiannual Financial Framework (MFF).

"It is vital we safeguard the proposed funding for the Digital Europe programme, and if possible, increase it... Funding authorities should prioritise EU spending on digitally transforming programmes and initiatives. This includes money earmarked for other areas like transport, agriculture, and regional development."

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By Priya Anand & Jessica Toonkel

Twithc hasn't turned into the advertising powerhouse Amazon might have expected when it bought the live-streaming gaming service in 2014. But Amazon may have found a new way to generate more revenue from Twitch—by selling its live-streaming technology to other companies.

Amazon has considered launching a service based on Twitch's technology that outside companies could use, say people familiar with the effort. Amazon Web Services—Amazon's cloud computing division, which oversees Twitch—would sell the service, two of the people said. It would not bear Twitch's brand name.

If Amazon moves ahead with the offering, it would be the latest example of the company selling technology it uses internally to customers. The launch of AWS was an early example: Amazon began selling access to the servers that powered its e-commerce business to smaller firms. AWS is now the leading cloud computing provider. Similarly, Amazon's e-commerce division sells its warehousing and shipping capabilities to merchants who offer their goods on Amazon.com.

Twitch over the last decade has developed a streaming technology that is highly regarded within the tech industry for offering smoother and faster interactive features than are available elsewhere. That quality reflects the purpose of Twitch's service: Its users can simultaneously watch streams of people, most often playing video games, and chat with them. Other streaming services, like Netflix, tend to essentially broadcast programming to viewers only.

Twitch has managed to minimize the frequency of delays that would undermine such a service, said a person familiar with the effort. And it has figured out how to deliver the capabilities at a relatively reasonable cost, the person said.

Darren Feher, CEO of Vizbee, which builds streaming tech for media companies, says that live streaming of gameplay can produce viral moments "when all of a sudden you have hundreds of thousands of people attached to stream" and the infrastructure has to figure out how to handle it. Twitch "is sophisticated with that problem in a way that differentiates them," he said.

That makes the technology an ideal foundation for a new service that could be of value to AWS customers, which include Netflix and newer streaming entrant Disney. It's not clear whether Amazon has decided to offer the service, however. A Twitch spokeswoman referred questions to AWS, which declined to comment.

Selling Twitch's technology would help Amazon generate more revenue from the unprofitable live-streaming platform it purchased for nearly $1 billion five years ago. Twitch has struggled to meet ambitious goals for growth in ad revenu.

Twitch brought in about $230 million in ad revenue in 2018, according to two people familiar with the matter, and as of the middle of last year it was on track to deliver about $300 million in ad revenue for the full year, according to another person. That was short of an internal goal for the year of between $500 million and $600 million, that person and another familiar with the matter said. In contrast, Google revealed this week that YouTube generated $15 billion in ad revenue in 2019.

Meanwhile, Twitch's user base has declined between late 2018 and late 2019, despite efforts by its management to diversify the kind of programming it offers.

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The acquisition of Twitch was part of Amazon's efforts to expand its reach beyond retail and cloud computing to everything from artificial intelligence, with its Alexa virtual assistant, to media and entertainment, with its Prime video service. Just as Amazon sought to make a mark in Hollywood with the launch of Prime, the company hopes to become a force in video gaming. Twitch is the crown jewel of that strategy.

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By James Farrell

Autonomous vehicle delivery company Nuro Inc. *(*Chambiz DF 8 Dec 18)* has become the first company to be given an exemption from the federal government to operate its cars.

The U.S. Department of Transportation and the National Highway Traffic Safety Administration Thursday granted the Mountain View-based startup permission to test its second-generation vehicle, the R2. That car is designed to carry packages, not people, and can take loads of up to 400 pounds while maxing out at 25 mph.

The major difference from other self-driving vehicles is the fact it's not designed to have any humans as passengers or drivers. Nuro calls it a "zero-occupant vehicle" rather that a driverless car. The cars can be powered by remote if need be, though.

"Today's decision shows that 'exemption' can mean more safety," co-founder Dave Ferguson wrote in a blog post. "It allows us to replace the mirrors relied on by human drivers with cameras and other sensors. We can round the edges of the vehicle body to take up less road space, and make it safer for those around us."

The R2 has been designed with safety in mind, and instead of having a windshield at the front there is a panel that can absorb energy if it should ever bump into a person. The entire car has specifications relating to speed and weight and sensor technology that the company says makes it a "socially responsible neighborhood vehicle."

Nuro was founded in 2016 by Ferguson and Jiajun Zhu, two engineers who had previously worked for Google LLC parent Alphabet Inc.'s self-driving car initiative. Almost exactly a year ago, the company announced that it had picked up a $940 million investment from SoftBank Group Corp.'s Vision Fund. That money went into expanding Nuro's fleet of cars.

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"We were convinced that such a class of vehicle had the potential to be safer than passenger vehicles: more nimble, narrower, and better able to prioritize the well-being of other road users," Ferguson wrote. "And by building such a vehicle we could also lower vehicle cost, improve the customer experience, and accelerate autonomous technology deployment by solving problems jointly through both hardware and software development."

The delivery vehicle will hit the streets first in Houston, but other cities are in the pipeline, according to Nuro. The fact that the R2 has been given the green light by the government to go ahead with testing is very likely a sign that other companies will receive the thumbs-up soon to operate their own vehicles.

CHAMBIZ

By Alan Boyle

Voxa CEO Chris Own stands in the middle of a living room that's been converted into a workshop for building and testing electron microscopes. (GeekWire Photo / Alan Boyle)

Running a startup out of your garage may sound like a tech cliche, but for Voxa CEO Chris Own, it's routine.

What's not routine are the breadbox-sized electron microscopes that are sitting in Own's garage, and in the living room that's been converted into a workshop. This weekend, one of those microscopes is scheduled to be launched to the International Space Station.

Voxa's Mochii microscope is among the science payloads that are due to go into orbit inside Northrop Grumman's Cygnus cargo capsule as early as Sunday, as part of an uncrewed resupply mission launching from the Mid-Atlantic Regional Spaceport at NASA's Wallops Flight Facility on the Virginia coast.

"The payload itself is an experiment," Own told GeekWire at the family home in Shoreline. "It's the first time an electron microscope — any instrument of this type of complexity in such a small, convenient form factor — has ever been flown."

Electron microscopes fire beams of accelerated electrons to map the structure of a sample on the scale of nanometers, or analyze the elemental composition of that sample on a spot-by-spot basis. They're standard, albeit expensive, instruments that can be found in labs around the world.

But not in space.

Today, samples from space have to be flown down to Earth in order to be analyzed using electron microscopes. Such was the case, for example, when engineers were trying to figure out what went wrong when water built up in Italian astronaut Luca Parmitano's spacesuit, nearly drowning him during a spacewalk in 2013. Microscopic analysis of samples from the suit determined that tiny bits of aluminum silicate had built up in an internal fan pump separator.

Having an electron microscope aboard the station — and having it hooked up for remote access so that earthbound experts could review the data — would streamline such sleuthing. It could also open up new frontiers in space science and engineering, such as monitoring the space station's air quality, analyzing biological samples, doing on-the-spot quality control for advanced materials or protein crystals made on the space station, and making use of resources on the moon and Mars.

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"I'm expecting that there will be new applications that we haven't even thought of, similar to how we never thought this would ever be an effective product in space," Own said.

The Volkswagen of electron microscopes

Own didn't start out wanting to send gizmos into space. He had a more down-to-earth goal in mind: creating a small, inexpensive electron microscope for the masses. "This is sort of the Volkswagen device for the everyman," Own said.

To trace the genesis of Voxa, you have to go back more than a decade, to the days when Own worked as an engineer and instrument designer at companies that produced high-performance electron microscope systems. Those high-end systems typically sold for $1 million or more.

"It was really cool to be working on the bleeding edge of the field and pushing the limits of technology there," Own recalled. "But at the same time, we were selling maybe two or three of them a year. … It remained a technology that was locked in the lab. So I thought, what if we took some of this and gave it to everyone?"

That's what led Own to create Voxa in 2012. The first product was a line of cheaper and faster transmission electron microscopes that Voxa made for the Allen Institute of Brain Science. "We initially started there and said, 'OK, what if we made like 5,000 of these, and put them all into a server room and scanned brains all day," Own said. "So we kind of did that."

As time went on, the Voxa team was able to trim down and miniaturize components even more, to the point that everything could fit inside the proverbial breadbox. Much of the work was done at Own's home, which also serves as Voxa's corporate headquarters. Hardware fabrication was done in partnership with suppliers, some of whom serve other customers in the Seattle area's aerospace market.

Voxa's scanning electron microscope, or SEM, was given a tasty name: Mochii.

"Mochii is a delicious Japanese dessert, and is also cute, small and sweet, which represents perfectly the vision for our tiny little SEM," Own said. "It's the opposite of the big products in the electron microscopy industry, with names like Titan, Sigma, and Quanta, that need specialized facilities and cost millions of dollars."

Making the space connection

The space connection entered the picture in 2015, when Own attended a conference on microscopy and got in touch with NASA scientists

"After a lot of discussions with NASA, we realized that there are tremendous benefits to having this capability — like a reading capability, or an elemental analysis capability — in low Earth orbit," Own said.

Voxa won contracts totaling about $461,000 from NASA to support further development of the Mochii microscope for use in space. Last June, the device was tested during an underwater research mission conducted by NASA. That cleared the way for a flightworthy Mochii to take its place aboard the Cygnus cargo craft due for departure this weekend.

"We were actually going to go with SpaceX, but we were early, which is really neat," Own said.

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Another thing that's neat about Mochii is the remote-operation feature, which will make it possible for researchers to steer the space microscope from earthly labs over a secure online connection.

Multiple researchers can look at the same picture simultaneously, and add pointers and annotations that are shared with the rest of the group in real time.
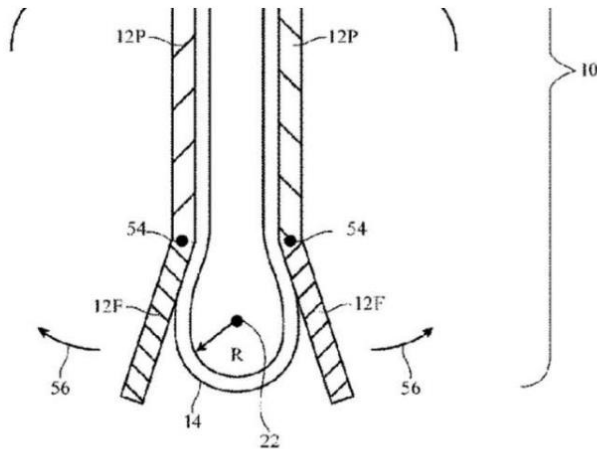

To minimize the time that busy astronauts have to spend maintaining the machine, Mochii is designed to make replacing worn-out components as easy as replacing the ink cartridge on a printer.

Voxa is planning to sell Mochii microscope systems to earthly users for around $65,000 each. And if the space-bound instrument passes its orbital tests, that could open up a whole new market for Own's home-grown company.

"Potential customers who want to take advantage of Mochii for microgravity science and engineering on ISS should contact Voxa," Own said in an email.

In short, Voxa is aiming to turn space-based electron microscopy into a cloud computing service, where the server just happens to be high above the clouds.

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By Nancy Cohen

Credit: United States Patent 10,551,880

AA patent application from Apple is all about a foldable device with a clever hinge design and it has tech watchers beating the drums for what Apple could bring to the table in folding phones with, if any, a difference.

Nonetheless, patent talk over a foldable device with Apple's name attached is not new. As the BBC said, "it marks the latest in a series of patent filings by Apple over the past five years related to foldable devices."

Rob Thubron similarly reminded his TechSpot readers that Apple has been working on a foldable phone for years—"and we've seen several patent applications hinting at what the final design might look like."

This one, though, has an attractive nuance in that there are no creases. "No creases here," said TechSpot on Wednesday. "The hinge has been an issue for several foldable devices," Thubron said, and the issue being handsets that show screen creases when unfolded.

Gizbot likewise mentioned the hinge factor: "The hinge plays a crucial role in foldable smartphones...The new design is a radical improvement in comparison to the fragile folding smartphone displays we've seen so far."

According to this patent's discussion, movable flaps extend to cover the gap when unfolded. Then flaps retract when the phone is folded.

MacRumors had let the world know about this on Tuesday: "Apple this week has been granted a patent for a foldable device with a unique hinge mechanism that utilizes movable flaps to help prevent the display from being creased or damaged when folded."

What about Motorola's foldable Razr? Joe Rossignol in MacRumors said early reviews indicated creaking sounds when the device was opened or closed.

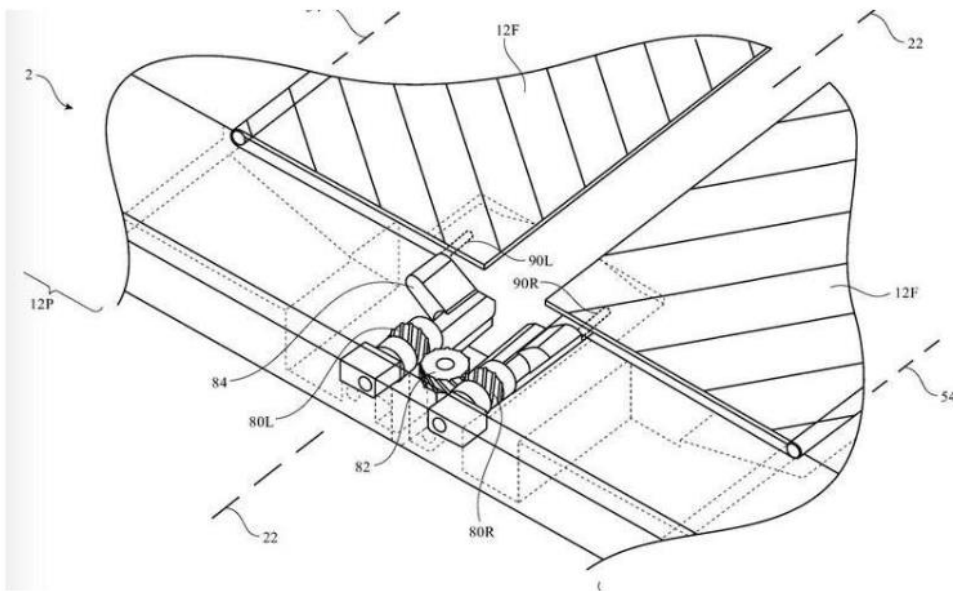A bit of recent history on the creak factor:

A video of a in-store Razr demo unit creaking when the device was folded or unfolded and with similar videos by other early adopters of the device were posted. But interesting reader comments in Notebookcheck included a few comments in defense.

"One thing I notice with a number of those people complaining, is that in their video where they demonstrate the issue, they're all pressing on the screen while folding it shut...When you're folding or unfolding the phone, try handling it by the edges or the back." Another said, "you should not 'press down' on the screen when opening or closing.")

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The title of the patent application is "Electronic devices with flexible displays and hinges," dated Feb. 4. It was first filed back in 2016.

Some of the wording in the abstract: "An electronic device may have a flexible display that overlaps an axis. The display may be supported by a housing. The housing may have first and second portions that rotate relative to each other about the axis... A hinge mechanism may be used to ensure adequate separation between the first and second portions when the housing is bent. Movable flaps may be retracted when the housing is bent to create room for a bent portion of the display."

With vendor activity around plans for a future of foldables, this Apple patent concept drew genuine enthusiasm from a number of tech watchers.

Gordon Kelly in Forbes wrote in terms of "a remarkable new hinge mechanism which allows the middle of the display to bow outwards before folding over. This creates a much softer bend inside the hinge to maintain structural integrity while stopping the crease from forming and opening the door for Apple to use less flexible glass panels."

Kelly added that this softer bend should result "in less pressure being applied at the point of the curve, a crucial improvement given how (infamously) fragile folding smartphone displays have been so far."

AppleInsider's Malcolm Owen also offered a patent-talk translation of what Apple had in mind about the bend design:

"Apple's solution is that it needs to bend the display in a certain way, specifically by allowing the middle section to bow outward slightly before making the curve around. By doing so, this can allow the main sections and edges of the display away from the curved area to meet up as close as they can, while allowing the bending section to do so at an enlarged radius, minimizing stress."

Interestingly, while nearly all reports on this foldable had the standard "this-is-only-a-patent-may-never-be-actual-thing" advice, the Forbes article suggested this patent idea was at least plausible as a product in the future.

Kelly: "When will this folding iPhone arrive? Certainly not this year, but 2021 will bring a third generation of folding Android phones and I'd expect Apple not to want to be much further behind than that, even if it is famed for entering new markets fashionably late."
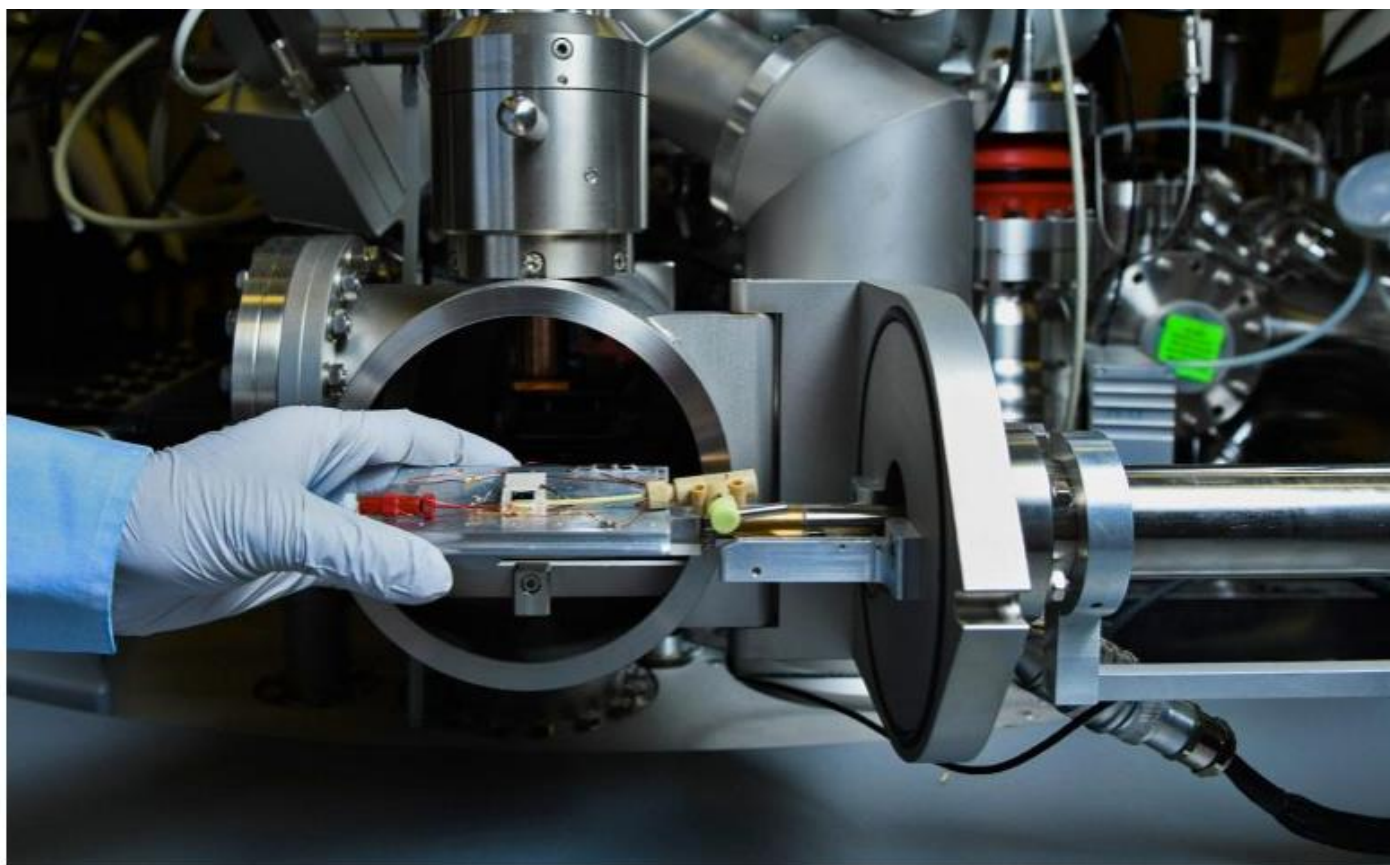
Kelly is not alone in the "fashionably late" observation. The BBC quoted an analyst. "Apple has a long history of assessing technology and only jumping into the market when it feels a particular technology is mature enough or that it can use it in a way that makes a meaningful difference to its products," said analyst Ben Wood.

Meanwhile, a few reader comments on MacRumors indicated the very idea of a foldable phone was not top of mind for every smartphone consumer. "Can't wait for this stupid foldable trend to go away!!!" Another reader voiced a preference instead for self-folding clothes. Another said that beyond "morbid curiosity, no one actually wants this product."

Still, the patent concept is impressing those who do find a folding phone design not only attractive but helpful. One reader comment said, "if you can fold my standard iPhone to half the size in my pocket—that would be rather nice, or perhaps if you make my standard iPhone twice the size and I can use it almost like an iPad mini that would also be pretty cool."

More information: Electronic devices with flexible displays and hinges, United States Patent 10,551,880.

CHAMBIZ

By DOE/Pacific Northwest National Laboratory

Scientists load a specially designed lithium-ion battery into a secondary ion mass spectrometer that allows them to see the formation of the solid-electrolyte interphase at the molecular level while the battery operates. Credit: Andrea Starr/PNNL

Scientists Learn More about the First Hours of a Lithium-ion Battery's Life

The first hours of a lithium-ion battery's life largely determine just how well it will perform. In those moments, a set of molecules self-assembles into a structure inside the battery that will affect the battery for years to come.

"The findings could potentially help others tailor the chemistry of the electrolyte and electrodes to make better batteries." — Zihua Zhu

This component, known as the solid-electrolyte interphase or SEI, has the crucial job of blocking some particles while allowing others to pass, like a tavern bouncer rejecting undesirables while allowing in the glitterati. The structure has been an enigma for scientists who have studied it for decades. Researchers have tapped multiple techniques to learn more but never — until now — had they witnessed its creation at a molecular level.

Knowing more about the SEI is a crucial step on the road to creating more energetic, longer-lasting and safer lithium-ion batteries.

The work, published on January 27, 2020, in Nature Nanotechnology, was performed by an international team of scientists led by researchers at the U.S. Department of Energy's Pacific Northwest National Laboratory and the U.S. Army Research Laboratory. Corresponding authors include Zihua Zhu, Chongmin Wang and Zhijie Xu of PNNL and Kang Xu of the U.S. Army Research Laboratory.

Why lithium-ion batteries work at all: the SEI
The solid-electrolyte interphase is a very thin film of material that doesn't exist when a battery is first built. Only when the battery is charged for the very first time do molecules aggregate and electrochemically react to form the structure, which acts as a gateway allowing lithium ions to pass back and forth between the anode and cathode. Crucially, the SEI forces electrons to take a detour, which keeps the battery operating and makes energy storage possible.

It's because of the SEI that we have lithium-ion batteries at all to power our cell phones, laptops, and electric vehicles.

But scientists need to know more about this gateway structure. What factors separate the glitterati from the riffraff in a lithium-ion battery? What chemicals need to be included in the electrolyte, and in what concentrations, for the molecules to form themselves into the most useful SEI structures so they don't continually sop up molecules from the electrolyte, hurting battery performance?

Scientists work with a variety of ingredients, predicting how they will combine to create the best structure. But without more knowledge about how the solid-electrolyte interphase is created, scientists are like chefs juggling ingredients, working with cookbooks that are only partially written.

Exploring lithium-ion batteries with new technology
To help scientists better understand the SEI more, the team used PNNL's patented technology to analyze the structure as it was created. Scientists used an energetic ion beam to tunnel into a just-forming SEI in an operating battery, sending some of the material airborne and capturing it for analysis while relying on surface tension to help contain the liquid electrolyte. Then the team analyzed the SEI components using a mass spectrometer.
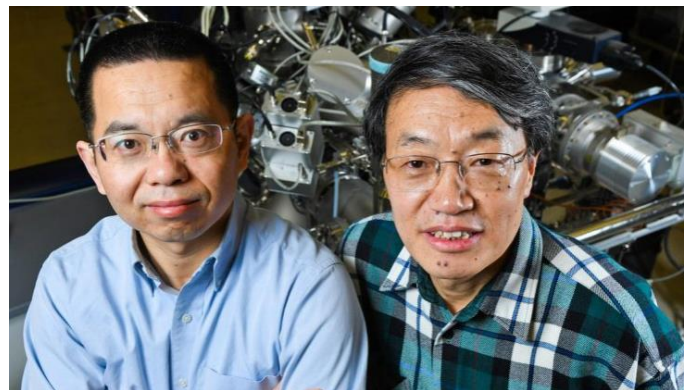
The patented approach, known as in situ liquid secondary ion mass spectrometry or liquid SIMS, allowed the team to get an unprecedented look at the SEI as it formed and sidestep problems presented by a working lithium-ion battery. The technology was created by a team led by Zhu, building on previous SIMS work by PNNL colleague Xiao-Ying Yu.

"Our technology gives us a solid scientific understanding of the molecular activity in this complex structure," said Zhu. "The findings could potentially help others tailor the chemistry of the electrolyte and electrodes to make better batteries."

U.S. Army and PNNL researchers collaborate
The PNNL team connected with Kang Xu, a research fellow with the U.S. Army Research Laboratory and an expert on electrolyte and the SEI, and together they tackled the question.

The scientists confirmed what researchers have suspected — that the SEI is composed of two layers. But the team went much further, specifying the precise chemical make-up of each layer and determining the chemical steps that occur in a battery to bring about the structure.
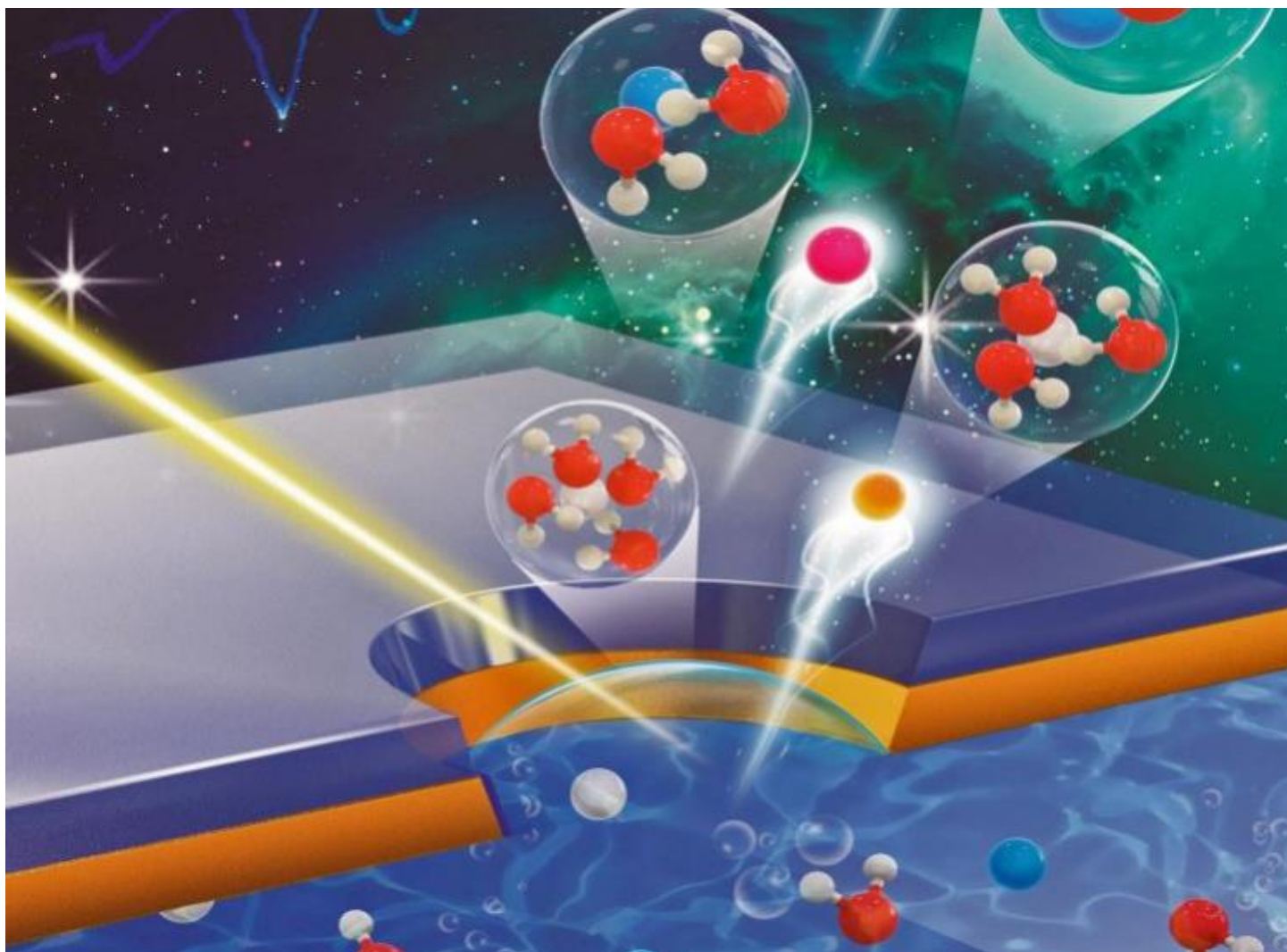

Zihua Zhu and Chongmin Wang are part of the team that learned crucial new information about the creation of a key component of lithium-ion batteries. Credit: Andrea Starr/PNNL

CHAMBIZ

The team found that one layer of the structure, next to the anode, is thin but dense; this is the layer that repels electrons but allows lithium ions to pass through. The outer layer, right next to the electrolyte, is thicker and mediates interactions between the liquid and the rest of the SEI. The inner layer is a bit harder and the outer later is more liquidy, a little bit like the difference between undercooked and overcooked oatmeal.

The role of lithium fluoride
One result of the study is a better understanding of the role of lithium fluoride in the electrolyte used in lithium-ion batteries. Several researchers, including Kang Xu, have shown that batteries with SEIs richer in lithium fluoride perform better. The team showed how lithium fluoride becomes part of the inner layer of the SEI, and the findings offer clues about how to incorporate more fluorine into the structure.

"With this technique, you learn not only what molecules are present but also how they're structured," Wang says. "That's the beauty of this technology."

An illustration of the liquid SIMS technology which scientists used to learn more about lithium-ion batteries. Scientists use an energetic ion beam (yellow) to tunnel through the anode (orange), which is attached below a thin silicon nitride membrane. When the beam hits the electrode-electrolyte interface where the solid-electrolyte interphase (SEI) forms, its molecules become airborne and available for analysis by a mass spectrometer. The aperture is so narrow that surface tension prevents the electrolyte from spreading out. Credit: Illustration courtesy of Journal of Physical Chemistry Letters, Jan. 1, 2019. Copyright 2019 American Chemical Society.

CHAMBIZ

In addition to Xu, Wang and Zhu, PNNL authors include Yufan Zhou, Mao Su, Xiafei Yu, Yanyan Zhang, Jun-Gang Wang, Xiaodi Ren, Ruiguo Cao, Wu Xu, Donald R. Baer, and Yingge Du.

CHAMBIZ

The Zigbee standard used by Philips Hue bulbs and other popular smart-home gadgets is vulnerable to an old—but potent—form of cyberattack.

By Rob Pegoraro

If your smart light bulbs blink twice, they may be trying to tell you they're under duress.

A vulnerability reported Wednesday by security firm Check Point could allow that to happen—along with hacks of other smart-home gadgets that employ the same widely used underlying Zigbee wireless protocol.

That's "could" instead of "will" because Signify, the company behind the Philips-branded line of Hue smart bulbs, already patched that flaw in the firmware of the bridge base stations required by many of those connected lights. And since the Hue mobile apps come preset to install updates automatically, that patch should already be on every Hue bridge.

Does that make this a feel-good security story? No. The vulnerability documented by Tel Aviv-based Check Point Software Technologies relies on a common attack technique, and too many internet-of-things gadgets don't come with automatic software updates. Check Point isn't singling out any other devices as being vulnerable, but the list of Zigbee-certified hardware is long indeed.

A video posted by Check Point shows how it can work. As eerie music plays, the Hue bulb in a house starts changing colors and going on and off on its own—a sign that the attacker has exploited the flaw in an unpatched bridge to seize control. The attacker uses the infected bridge to take over a Windows 7 laptop plugged into it.

"I'm inside your home network and I can do whatever I want," sums up Yaniv Balmas, head of cyber research at Check Point.

The attacker does not need to be inside a home or office or even on the same wireless network as the target; instead, connecting a special antenna into a laptop from as much as 330 feet away can allow breaking into the Zigbee radio-frequency communications between the bridge and Hue bulbs.

"Zigbee is a complex protocol," says Balmas. "The problem, as always, is with the implementation."

In this case, Check Point found that a buffer-overflow attack sufficed to get hostile code running on a Hue bridge. This is a common technique in which the attacker sends an unexpected amount of data to a program expecting input of a particular size.

(Some newer Hue smart-bulb kits don't require a bridge; this bug does not appear to affect them.)

OLD PROBLEM, NEW TARGETS
The same basic buffer-over low tactic allowed the Heartbleed vulnerability that left holes in the security of a large fraction of the web sites online almost six years ago. No, developers haven't learned to close that hole. As Balmas puts it, "buffer overflows are everywhere."

" THEY SHOULD BE MORE CLEAR WITH THEIR CUSTOMERS ABOUT EXACTLY WHAT WAS FOUND."

YANIV BALMAS, CHECK POINT

The last part of the attack shown in the Check Point video, the remote compromise of the laptop, relies on another old bug, the EternalBlue vulnerability behind the WannaCry ransomware outbreak of 2017. The laptop in the clip ran Windows 7 because Windows 10 defeats that attack—as should a Win 7 machine that's been kept current with Microsoft's security patches, something too many users fail to do. Check Point credited Signify for responding promptly and professionally to its report, resulting in a firmware update being pushed out to Hue bridge users on January 23.

The release notes for that patch, however, betray a common failing of the software industry by providing no useful information about their contents. They read, in full: "We regularly update your Hue Bridge to improve the performance and reliability of the system."

Signify—spun off from Philips in 2016 to focus on lighting technology—did not respond to an email inquiry sent to its publicist Monday night about the vague release notes.

But it has far too much company in that habit of not documenting security patches, in effect inviting uses to put off installing what appear to be noncritical updates. When Twitter patched a vulnerability in its Android app that it considered severe enough to warrant an email to users, the release notes for that December 20 bug fix read: "We made improvements and squashed bugs so Twitter is even better for you."

Check Point's Balmas agrees: "They should be more clear with their customers about exactly what was found."

But at least Signify responded correctly to Check Point's report and had already instituted an automatic-updates policy. (To see if your Hue bridge has been patched, open the Hue app and tap Settings and then "Software update.")

That company also documents a vulnerability-disclosure policy, a key step many gadget vendors fail to take that can leave security researchers unclear on how to communicate their findings to the right people.

Many other IoT vendors probably aren't exercising as much care.

"We can't possibly research each and every device," warns Balmas. "If you'll ask me if other devices suffer from the same or similar vulnerability, my answer will probably be yes."

CHAMBIZ

By Christoph Hammerschmidt

The automotive industry plans to increase its investment in the construction of smart factories by more than 60% over the next three years. This puts it ahead of other industries. A current study by the Capgemini Research Institute states that the construction of smart factories can increase productivity by more than $160 billion.

The study examines where automobile manufacturers (OEMs) and suppliers stand today when it comes to the topic of smart factories and compares the results with studies from the years 2017/18. It shows that both the predicted investment levels and productivity increases associated with smart factories are considerable.

"Smart" factories are characterized by the fact that they use digital technologies to achieve improvements in productivity, quality, flexibility and service. Three key technologies make the intelligent factory possible: connectivity, e.g. the use of industrial IoT to collect data; intelligent automation, e.g. advanced robotics, industrial image processing, distributed control or drones; and predictive analytics based on AI These digital technologies also enable IT-OT convergence to support digital continuity from design to operation (digital twin).

According to the study, only a small proportion of automotive companies are currently able to fully exploit the advantages of the smart factory. The study classifies 72% of the companies in the automotive value chain as "beginners", while only 10% are "pioneers" and thus equipped to exploit the full potential of intelligent factories. There is a certain gap between the OEMs and suppliers: Among OEMs, 18 % are among the pioneers, among suppliers only 8 %.

The most important results of the study at a glance:
In the last two years, 30% of the factories have been converted into smart ones. This pace exceeded the expectations of 2017/18, because two years ago the managers surveyed still assumed a 24% share.

The automotive industry has set itself ambitious targets for the next five years and plans to convert 44% of its factories into smart plants. This puts it in a leading position worldwide compared with other industries. In the discrete manufacturing sector (excluding the automotive industry), for example, the share of intelligent factories is to be increased by 42% by 2025, followed by the process industry with 41%, the energy and utilities sector with 40% and the consumer goods industry with 37%.

The investment plans of automotive companies are also reflected in the proportion of total sales that they plan to invest in smart factories each year: This is expected to rise from around 2.2% over the last three years to 3.5% by 2023 - an increase of 62%. Automotive companies will focus their investments on a combination of "greenfield" and "brownfield" facilities: 44% are planning a hybrid approach, 31% are considering building brownfield factories (estimated cost for one of the ten largest OEMs: $4 to $7.4 million per facility), and 25% want to invest in a greenfield factory (cost of $1 to $1.3 billion per factory - this sounds more expensive at first, but allows for an efficiency-oriented setup right from the start). The term greenfield stands for the installation of digital technology in a completely new environment, brownfield means the gradual replacement of conventional technology and equipment with digital.

The study extrapolated the productivity growth through intelligent factories until 2023: Even in a conservative scenario, it was $104 billion. Companies like Mercedes-Benz Cars are already exploiting the potential: By using Advanced Data Analytics to create self-learning and self-optimizing production systems, the automaker was able to achieve a fourfold reduction in the reject rate for some key components.

"Since smart factories are a crucial part of Industry 4.0, OEMs and suppliers must also focus on smart operations, "commented Henrik Ljungström, Head of the Automotive Sector at Capgemini in Germany. "This includes making asset management, supply chain and service management 'smart' in order to fully exploit the potential of the various technologies.

However, there is still a long way to go before the automotive industry can fully exploit the potential of intelligent factories: For example, the goal of increasing productivity by 35% has so far only been achieved in 15% of cases.
For the study, 100 managers of major automotive manufacturers and suppliers from eleven countries with sales of more than 1 billion US dollars were surveyed, 98 of whom already operate intelligent factories.
The study (in German language) can be found at www.capgemini.com/de .

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