CB DIGEST FOR TECHNOLOGY

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Alibaba operates 10 data centers in China and 11 more internationally
In response to the ongoing COVID-19 pandemic, which has heightened demand for cloud computing services and technology, Chinese company Alibaba revealed that it will invest 200 billion yuan ($28.26 billion) in its cloud computing division over the next three years. Specifically, the company said that the funds will go towards infrastructure and technologies related to operating systems, servers, chips and networks.

In a statement, Jeff Zhang, president of Alibaba Cloud Intelligence, spoke in more detail about the motivation behind the investment: "The COVID-19 pandemic has posed additional stress on the overall economy across sectors, but it also steers us to put more focus on the digital economy."

While Alibaba is the biggest cloud computing provider by market share in China, it has not get matched U.S. rivals Amazon and Microsoft, who continue to dominate on a global scale. In a 2018 interview with CNBC, Daniel Zhang, CEO of Alibaba and chairman, suggested that Alibaba's future might be one in which cloud is its main business, even though at the time it only accounted for for 7% of the company's current total revenue. At the moment, Alibaba operates 10 data centers in China and an additional 11 more internationally.

The deepened focus on cloud computing might be the result of COVID-19's destructive impact on the retail businesses that make up a significant percentage of Alibaba's overall revenue, like Tmall and Taobao, forcing the company to look elsewhere for growth.

Cloud computing technology has been a hot topic amid the pandemic from company investments like these to the launch of the COVID-19 High Performance Computing Consortium by the U.S. federal government in an effort to support researchers around the world battling the virus by leveraging U.S. supercomputers. Members of the consortium include IBM and Amazon Web Services and more recently, GPU maker NVIDIA.

Netflix to Tap Bond Market for Another $1 Billion
Fresh off its pandemic-driven strong first quarter, Netflix is looking to borrow another $1 billion in the bond markets. The fundraising appears designed to take advantage of debt investor appetite for Netflix bonds, rather than the video streaming company's need for cash. Netflix taps the bond market every year to raise money to cover the cash shortfall of what it spends versus what it brings in from subscribers. The first quarter was the first time in years that Netflix didn't burn cash, thanks to a pandemic-triggered halt to film and TV production, although the company still expects to burn cash for the year as a whole.

Debt investors long have had a strong appetite for Netflix bonds, just as equity investors like Netflix stock. In the past couple of years questions have been raised among investors about Netflix's continuing cash burn, a concern that deepened as subscriber growth slowed. But the surge in subscriber growth in the first quarter has likely vanquished those concerns. Netflix warned, however, that the strong growth would slow once the quarantines end. Raising money at that point, though, could entail higher costs. How much Netflix pays for this new round of debt will be closely watched. Netflix finished the March quarter with debt of $14 billion, offset by $5 billion in cash. The new debt, along with the slower rate of cash burn, should give Netflix enough cash to last for a little while.

Look for Congress to approve a new tranche of funding for the small business loan program as early as Tuesday.
The new agreement will reportedly include an additional $310B for small businesses, as well as $75B for hospitals and $25B to expand testing. The $350B Paycheck Protection Program, part of last month's emergency stimulus package, was depleted in less than 2 weeks.

Amazon could reopen its 6 warehouses in France this week. The e-commerce giant shut sites after a French court ordered it to temporarily stop shipping non-essential goods due to concerns over worker protection. A court appeal is due Tuesday.

COVID-19 drives PC market supply down, demand up

The COVID-19 pandemic pushed PC market shipments down, despite higher demand for remote work devices. A The PC market experienced disruption due to the coronavirus outbreak in the first quarter of 2020, with shipments down despite the demand from the jump in remote work. Both Gartner and the International Data Corporation (IDC) reported a steep decline in worldwide first-quarter PC shipments; Gartner said shipments were down 12.3% year over year, while IDC reported the reduction at 9.8%. The decrease was attributed to supply chain and manufacturing disruptions caused by the COVID-19 pandemic, which shuttered Chinese factories earlier this year. The reports follow a year in which the global PC market grew for the first time in seven years.

Industry observers noted that the decline in shipments comes amid higher demand for the devices, as quarantines have forced a shift to remote work. Exact figures for the bump in demand are not yet available, but analysts reported seeing an increased need for laptops to enable employees to work from home.

Jeff Bezos Returns to Daily Oversight of Amazon

The New York Times is reporting that Amazon founder and CEO Jeff Bezos has retaken day-to-day management of Amazon after years of working only on long-term and big-picture projects. The newspaper said Bezos previously spent most of his time away from Amazon's headquarters in Seattle traveling the world. He also spent one day each week working at his space exploration company.

Since the outbreak, Bezos has hunkered down at his West Texas ranch and held daily calls with executives to make decisions on nitty-gritty issues such as what to show on Amazon's website, what items should be prioritized at its warehouses and also how the company should respond to criticism in the press, the Times said.

Bezos' return to form highlights how CEOs are responding differently to the coronavirus, an extraordinary situation that is reshaping the way companies operate. It might assure some Amazon shareholders that the company is in capable hands during the pandemic.

Apple AI Research Chief Goes Back to Academia

Ruslan "Russ" Salakhutdinov, a Carnegie Mellon University professor who joined Apple in 2016 as its first-ever director of AI research, left the company a few months ago, according to a person with direct knowledge of his departure. An Apple spokesperson declined to comment and Salakhutdinov didn't respond to a written request for comment. Salakhutdinov was one of Apple's first big hires from academia. His background in deep learning, a form of AI used for things like recognizing spoken words and the meaning of speech, was expected to help Apple fix long-standing issues with its Siri digital assistant.

Apple hasn't said much about Salakhutdinov's role over the years. In 2017, Business Insider reported that Salakhutdinov was leading an Apple team working on self-driving cars. John Giannandrea, a former Google executive who joined Apple in 2018 as senior vice president of Machine Learning and AI Strategy, is now leading development of Siri.

Salakhutdinov, who continued to teach part-time at Carnegie Mellon University while working at Apple, was expected to help Apple draw more AI talent from universities. At least two of his former Ph.D. students from the University of Toronto, Nitish Srivastava and Charlie Tang, joined him at Apple and are still at the company, according to their LinkedIn Profiles.

Salakhutdinov, who tweeted on Feb. 1 that he'd been named a full-time professor at Carnegie Mellon, has removed all mention of Apple from his updated LinkedIn profile.

AT&T CEO to Step Down

AT&T CEO Randall Stephenson is stepping down in July, the company announced today (April 24, 2020), to be succeeded by COO John Stankey. Stephenson will stay on as executive chair until January, the company said. The announcement came a little earlier than was anticipated–many people had expected Stephenson to stay on as CEO through 2020. However, he is staying on as exec chair.

Stephenson, who oversaw AT&T's acquisitions of satellite company DirecTV and Time Warner (now WarnerMedia), was a longtime advocate for the idea that owning content and distribution was critical for the next generation. His thesis has yet to prove out, though, and the pressure now will be on Stankey to justify the strategy.

Snap to Raise $750 Million With Debt Offering
Snap said Thursday it would raise $750 million in a convertible note offering, beefing up its cash reserves with what is likely to be inexpensive debt.

The move comes a day after Snap reported better than expected earnings for the first quarter, sending its stock price up roughly 30%. The company said it would use the money to cover expenses, "general corporate purposes," and to potentially make acquisitions.

The offering comes just eight months after Snap raised $1.26 billion in another convertible note offering. Raising money by issuing convertible notes, a form of debt that can be repaid as equity or cash, has become increasingly popular among tech firms thanks to the relatively low interest rates and flexibility they provide. In a memo to employees first obtained by Axios, Snap CEO Evan Spiegel said "investor demand for these types of convertible notes remains strong in the current environment." With repayment due by 2025, it also signals management's faith that the stock price will continue to rise over time.

While Snap has made strides to reduce its cash burn, the company is still not profitable. It ended the last quarter with about $2 billion in cash and securities.

Confluent raises $250M at $4.5B valuation
Confluent, a San Francisco, California-based that offers a streaming platform based on Apache Kafka, announced today it has closed a massive $250 million Series E funding to enable every organization to harness the full power of event streaming. The round, which brings the company's valuation to $4.5 billion, was led by Coatue Management. New investors Altimeter Capital and Franklin Templeton, with participation from existing investors Index Ventures and Sequoia Capital. To date, Confluent has raised a total of $456 million in funding.

Founded in 2014 by Jay Kreps, Jun Rao, and Neha Narkhede, Confluent offers a streaming platform based on Apache Kafka that enables companies to easily access data as real-time streams. Apache Kafka, an open source technology created by the founders of Confluent, acts as a real-time, fault-tolerant, highly scalable streaming platform. It is widely adopted for use cases ranging from collecting user activity data, logs, application metrics, stock ticker data, and device instrumentation.

Its key strength is its ability to make high volume data available as a real-time stream for consumption in systems with very different requirements—from batch systems like Hadoop to real-time systems that require low-latency access, to stream processing engines that transform the data streams as it arrives. This infrastructure lets you build around a single central nervous system transmitting messages to all the different systems and applications within your company.

Guru lands $30M for knowledge software
Guru, a Philadelphia-based collaborative knowledge management software provider, has raised $30 million in a Series C funding round led by Accel. The company has been doubling annual revenue, but this year saw its fastest growth in adoption after launching a free version of its product.

Moshi raises $12M for kids' sleep
London-based Moshi has just raised a $12 million Series B round to help it achieve its mission of helping kids relax and sleep with its audio sleep and mindfulness app. The startup was born out of Mind Candy, a company created by Michael Acton Smith, one of the co-founders of popular meditation app Calm.
Unlearn closes on $12M for clinical trials

San Francisco-based Unlearn, developer of a machine-learning platform that generates control patient data for clinical studies, has secured a $12 million Series A financing. The startup's aim is to reduce the number of patients required to run a trial while maintaining rigorous standards.

Hone scores $2.75M for remote training
San Francisco-based startup Hone has raised $2.75 million in fresh seed funding to build out its online training platform, which combines research-backed, live classes led by expert executive coaches, with data to reinforce and measure programs' impact at scale. Its CEO and co-founder, Tom Griffiths, previously co-founded popular fantasy sports platform FanDuel.

ForgeRock secures $93.5M for digital IDs
ForgeRock, developer of an AI-driven platform for identity management, has raised $93.5 million in a Series E round led by Riverwood Capital. The company, which is headquartered in San Francisco and has offices in Norway, is the latest in a string of digital ID companies to secure big funding rounds in recent weeks.

Aledade secures $64M for primary care
Bethesda, Maryland-based Aledade, operator and service provider for a national network of primary care providers, announced it has closed a $64 million Series C funding round led by OMERS Growth Equity. The round brings total funding for the 6-year-old company to around $195 million.

Alan raises $54M for online insurance
Alan, a Paris-based digital health insurance provider, has closed a $54 million Series C round led by Singapore's Temasek. The funding brings the company's total amount raised to $136 million.

Frame AI lands $6.3M to understand customers
New York-based startup Frame AI raised $6.3 million in Series A funding to help companies engage more efficiently with their customers using artificial intelligence and machine learning. G20 Ventures and Greycroft led the round, which brings the company's total raise to just over $10 million since its founding in 2016.

Noah secures $150M to tap home equity
San Francisco-based Noah (formerly known as Patch Homes), is out to help homeowners tap into their equity without accumulating more debt. And it's just secured $150 million to help it reach that goal.

Bodhala raises $10M to disrupt legal billing
New York City-based Bodhala, a data-intelligence and legal technology platform, has raised $10 million in a financing round led by Edison Partners. The company, founded by two Harvard Law School grads, aims to disrupt how law firms charge for outside services.

Augmented reality swimming goggles maker Form raises $8.5M
Vancouver, B.C.-based startup Form raised $8.5 million ($12 million CAD) for its augmented reality swimming goggles. Founded in 2016 by tech vet and former competitive swimmer Dan Eisenhardt, Form's $199 goggles provide real-time visual feedback such as metrics on split times, distance, stroke rate, pace, and calories. There's a heart rate monitoring feature powered by Polar. The company launched in August and shipped more than 10,000 goggles in its first four months of operation.

Paige AI secures additional $5M Series B funding from Goldman Sachs to transform the diagnosis and treatment of cancer
Paige announced it has received additional $5 million funding from Goldman Sachs Merchant Banking Division, which will be added to the recently announced Series B financing round. This brings Paige's Series B funding round to over $50 million and the company's total raised capital to over $75 million.

Paige will use this new capital to further develop the company's diagnostic and test products for the biopharma industry, while strengthening its leadership position in clinical AI for pathologists and development of the Paige platform for remote viewing and routine clinical practice. Additionally, Paige has added David Castelblanco, Managing Director at Goldman Sachs, to its Board of Directors. David brings with him a wealth of experience as an investor and board member working with leading cancer treatment centers internationally.

Opera Event closes $5M Series A for its esports-focused influencer platform
Opera Event, an influencer software service, announced that it closed a $5 million Series A. The Oakland-based startup raised the capital from new lead investor Antera, with prior investors Atlas Ventures, Everblue, and Konvoy Ventures coming along. According to Crunchbase data, Opera Event had raised at least $1.2 million before this new round.

Opera Event is starting with a focus on influencers in the esports market, a business that founder Brandon Byrne knows well. Byrne previously worked for former esports organization Curse and served as the CFO of Team Liquid; Team Liquid is an active esports organization with players in a number of games, including League of Legends and Starcraft 2.
The startup wants to help esports teams monetize, a likely welcome effort given the industry's historical issues with revenue generation, and reward micro-influencer fans. How it intends to do that is its core software service, one that Byrne expects will in time work for other verticals and influencer sets.

Affinivax raises $120M for vaccines
Boston-based Affinivax, a startup with a lead pneumococcal vaccine currently in clinical trials, announced it has closed on a $120 million Series B round led by Viking Global Investors.

Peak secures $12M for AI software
U.K.-based Peak, a developer of software aimed at enabling mass adoption of AI systems across industries, raised $12 million in an extended Series A investment led by MMC Ventures and Praetura Ventures.

Movandi Finds $27M In Series C
Irvine-based hardware maker Movandi *(* Chambiz DF 22 Dec 2018)*, a developer of millimeter wave, wireless technology used for 5G networks, has raised $27M in a Series C funding on last Thursday (Apr 16, 2020), according to the company. The funding was led by WRVI Capital, and also included Cota Capital and DNX Ventures. According to Movandi, it will use the new funding to further develop its 5G millimeter wave technology and expand rollout of 5G networks and devices. The company said the new funding will enable the company to ramp and expand their active router/repeater platform, RF front-end, and ORAN radio units. It also said it plans to grow its teams in Irvine, California and Australia to continue developing its integrated circuits and other technology.

Charlotte unicorn AvidExchange secures $128M
Fintech unicorn AvidXchange, a provider of accounts payable and payment automation tools for mid-sized businesses, has raised an additional $128 million in funding. The financing is an extension of a $260 million Series F round the Charlotte-based company raised in January.

Bestow closes on $50M for life insurance
Dallas-based Bestow, a provider of term life insurance offered through an online platform, has closed on $50 million in a Series B funding round led by Valar Ventures. The financing comes after the company posted 800 percent year-over-year policy growth in Q1 of 2020.

Clever Care raises $20M for health plans
Clever Care Health Plan, an insurance provider that describes itself as incorporating both Eastern and Western medicine into its coverage, has raised $20 million in a Series A round led by Norwest Venture Partners. The company

plans to use the new financing to set up a California Medicare Advantage health plan and hire staff for its two offices in Southern California.

Kalanick's CloudKitchens, Ideal Bet for Pandemic, Hits Snags

By Amir Efrati

This should be Travis Kalanick's moment.

The Uber co-founder not only sold out of Uber ahead of the pandemic that has cratered that company's ride-hailing business, but switched his money and energy to a real estate startup that leases space to restaurants for meal preparation. The firm, CloudKitchens, is well positioned to benefit from the pandemic lockdowns. Its tenants serve the fast-growing online food-delivery market, which has gotten a big boost from stay-at-home orders that prevent people from going out to eat.

But CloudKitchens is struggling to overcome early challenges, limiting how much it can take advantage of the crisis, at least in the U.S. Certain properties it has bought have turned out to be in worse shape than anticipated, making some of them unusable and sharply raising the costs of renovating others, say people with knowledge of the problems. Meanwhile, some key managers have quit, including one of Kalanick's longtime former colleagues at Uber, Matt Atkin, who for the last two years was responsible for launching CloudKitchens' business in new markets. While CloudKitchens has bought at least 70 U.S. properties, only about 10 appear to be operational.

Kalanick's firm also has lost some high-profile restaurant clients, such as Sweetgreen, the salad chain, which recently pulled out of a CloudKitchens facility in Los Angeles after operating there for a year or so. Sweetgreen, which did not have a comment, continues to work with rival firm Zuul in New York City. Eric Greenspan, a well-known Los Angeles chef and restaurant owner who launched new food brands out of a CloudKitchens facility, also cut ties with Kalanick's firm. Greenspan, who was the only restaurant tenant featured on CloudKitchens' website giving a testimonial, referred questions to his recent Instagram post citing Covid-19–related health concerns for kitchen workers at CloudKitchens as one reason for his departure.

Some current and former CloudKitchens tenants in the U.S. say the high fees CloudKitchens charges shrink the potential returns to a level too low for independent restaurants.

"It's like the Amazon marketplace. There will only be so many sellers that can succeed," says Matt Newberg, who runs food industry publisher Hngry.tv.

The progress of Kalanick's company, which a year ago raised money from Saudi Arabia's government at a $5 billion valuation, has enormous implications for the restaurant and online food-delivery industries. Kalanick's bet is that CloudKitchens-owned facilities can produce food so cheaply that people would no longer visit restaurants. Others in the "dark kitchen" sector—including Alphabet-backed Kitchen United and Andreessen Horowitz–backed Virtual Kitchen Co—are making similar bets, though without as much direct investment in property as Kalanick has made.

Real estate companies are jumping into the fray as well. In February, developer Simon Property Group announced a joint venture with a hotel and restaurant operator to open up "commissary kitchens" at distressed malls and hotels that would also serve delivery customers, and the group added that it would also lease four dark kitchens from Kalanick's company.

Betting on dark kitchens is sure to grow in appeal in these pandemic-dominated times. Indeed, some restaurants using CloudKitchen facilities are seeing booming business. Starbird, a Silicon Valley–based chain of fried chicken restaurants, says delivery orders from its CloudKitchens facility in San Francisco have doubled in recent weeks.

But the pandemic lockdowns have also hurt some of CloudKitchens' tenants. In the company's home market of Los Angeles, for example, numerous restaurant tenants in two of its four properties have suspended operations. They mainly served office workers or students in nearby areas who are now quarantined at home. There is no indication CloudKitchens is giving any of the restaurants a break on rent, according to one restaurant tenant.

Even as Kalanick has grappled with early challenges, he has attempted to broaden CloudKitchens' business, in part by developing its own food that kitchens in its facilities could potentially prepare and sell. One example is Skinny Bitch Pizza, which the company has licensed to Salted, a venture capital–backed startup run by Los Angeles–based entrepreneur Jeff Appelbaum. In exchange, CloudKitchens gets a small cut of all revenue he generates from selling the pizza. Appelbaum did not respond to a written request for comment. But his case represents a possible path for Kalanick to create tenants that might succeed better in his properties than more traditional restaurants.

Kalanick also has shown interest in starting his own delivery network. Two years ago, soon after he acquired control of CloudKitchens, Kalanick hired a network of delivery drivers, said a partner involved in the move. The effort was short-lived as CloudKitchens couldn't run the network economically, this person said. But some in the industry expect he will try again. (For more details on CloudKitchens' history and key employees, see this article here.)

Through a spokeswoman, Kalanick did not have a comment for this article.

Pandemic Effects

Some of Kalanick's rivals in the dark kitchen sector are also struggling. In New York, where CloudKitchens tried but failed to launch a facility, other dark kitchen companies have suspended operations due to the pandemic. In parts of Europe and the Middle East, some of them have temporarily shuttered their kitchens due to government lockdowns, preemptive closures to prevent infections, or because workers don't want to risk using mass transit to get to work, operators of some kitchens say.

In contrast, most of CloudKitchens' properties globally appear to be operating normally through the crisis, except for temporary closures of some kitchens in China earlier this year related to government-ordered Covid-19 lockdowns. CloudKitchens generally appears to have let its tenants decide whether to pause operations or stay the course. It has acquired around 10 startups collectively running dozens of facilities in China, Singapore, the U.K. and South Korea, pushing up its employee head count to at least 750. It has also had staff prepare for acquisitions of property or existing startups in other regions, such as the Middle East and Latin America.

Kalanick's 2018 acquisition of London startup FoodStars has been a bright spot. Occupancy rates at the half-dozen facilities CloudKitchens acquired from FoodStars in the London metro area have hovered close to 100% because of pent-up demand in the market, according to a person with knowledge of the business. FoodStars has taken a more flexible approach to leases than CloudKitchens generally does, allowing month-to-month commitments rather than longer-term deals, said a person with knowledge of the business.

"They're doing something right. We need to learn from them," Kalanick has told colleagues regarding FoodStars, this person said.

In the U.S., though, a series of stumbles in acquiring real estate at relatively cheap prices has slowed CloudKitchens' plans to launch new facilities. CloudKitchens co-founder Diego Berdakin has overseen these efforts. Hopes for New York stalled after CloudKitchens bought properties there that it later had to abandon because they were deemed unsuitable for use as kitchens, in part because of insufficient ventilation. The company has looked at selling those locations, the people said.

Elsewhere, some properties ended up costing far more to renovate than anticipated. After it acquired a distressed property in downtown San Francisco, CloudKitchens found widespread asbestos and lead below the flooring and

concrete foundation, and had to rip up and redo much of that space. This added considerable time and millions of dollars in project costs, said two people with knowledge of the matter.

Containing Costs

Kalanick also ran into obstacles trying to cut down on the amount of remodeling the firm had to do. CloudKitchens attempted to produce modular kitchens by modifying shipping containers for insertion into CloudKitchens properties. The company in December 2018 signed a $25 million contract with publicly traded Brooklyn-based SG Blocks to buy and refashion containers in Texas. SG supplied containers for a relatively new CloudKitchens location in Los Angeles near the University of Southern California.

But the initial cost of developing the containers wildly overran CloudKitchens' expectations, said people with knowledge of the issue. Last year it aborted the contract. Representatives of SG Blocks did not respond to written requests for comment.

In parallel, CloudKitchens has been building a team of several dozen engineers in the San Francisco Bay Area, led by two former Tesla managers, to separately develop and manufacture modular kitchens at scale by creating elements such as wall panels or stick frames. It's a risky and pricey effort that, if successful, could help the company lower costs in the long term.

Early on, Kalanick planned to add unique design elements to the common areas of CloudKitchens' facilities, but that also proved too costly. Last year, CloudKitchens shifted course, outsourcing all contractor work locally and deciding to forego aesthetic flare in its locations. Two senior managers at the company, design chief Denise Cherry and construction chief Jimmy Knauf, departed to join electric carmaker Rivian, according to people close to CloudKitchens. More than a dozen other facility designers left with Cherry, these people said. Cherry and Knauf didn't respond to written requests for comment.

Tenant Churn

Once CloudKitchens gets a facility up and running, each with at least two dozen small kitchens, some restaurants find the costs are too high. Tenants pay a monthly rental fee of around $5,000 to $6,000 a month, including shared maintenance expenses, in places like Los Angeles and San Francisco. Many tenants also pay a small percentage of the food order as a processing fee to CloudKitchens, and some share a percentage of their revenue with the company. Tenants also have to fork over 20% to 30% of each order's value as a commission to delivery apps like DoorDash, whose drivers pick up the food for delivery.

As a result, some tenants have switched to or kept working with rival operators that take a different approach. While CloudKitchens simply rents the kitchen facilities and leaves much of the rest to restaurants, others do things differently. For instance, Virtual Kitchen Co, started by two former Uber managers and backed by Andreessen Horowitz, buys meals from restaurants at wholesale prices and gets them ready for delivery. The startup has leased numerous spots across the San Francisco Bay Area.

"CloudKitchens wants me to use the kitchen, and it ends up being a huge risk for me, a capital investment and a labor investment, and I've got to still do my own marketing," said Anjan Mitra, owner of Dosa, an Indian restaurant in San Francisco. The Virtual Kitchen Co approach means "I make money no matter what," he said.

One big defector from CloudKitchens is Kitopi, whose name stands for "Kitchen Operation Innovation." The VC-backed startup acts as a kind of restaurant franchisee, preparing food on behalf of traditional restaurant chains such as U.S.-based Nathan's Famous hot dog chain and U.K.-based Pizza Express inside more than 40 dark kitchens. Kitopi recently pulled out of numerous CloudKitchens facilities, said the two people close to CloudKitchens. CEO Mohamad Ballout did not have a comment.

Kitopi is based in the United Arab Emirates but operates in New York, London and the Middle East. Many of Kitopi's kitchens suspended operations amid Covid-19 quarantines and curfews but have slowly come back online, with added safety measures, according to a press release.

Tenant churn could complicate a key part of Kalanick's business model, which is to refinance the loans it takes out for real estate purchases on better terms after filling at least 90% of the kitchens in each property. It aims to recoup its up-front investment from rent within five or six years, depending on the location.

Success Stories

To be sure, there are plenty of success stories inside CloudKitchens. Well-known Los Angeles brand Fat Sal's Deli has done well, as have some bigger brands such as Chick-fil-A, according to the people close to CloudKitchens and some tenants.

CloudKitchens tenant Starbird, which recently saw a 100% surge in orders from its San Francisco kitchen, was started less than six years ago by longtime restaurant-industry consultant Aaron Noveshen. Starbird operates several dine-in locations outside San Francisco, in Silicon Valley and at San Francisco International Airport. While the lockdowns have forced it to switch to takeout and delivery orders only, it has been able to retain all of its 72 employees amid the outbreak, Noveshen said. Unlike many restaurants, Starbird garnered only a fourth of its total sales from dine-in eaters before the Covid-19 outbreak, making it better prepared for the current environment.

Noveshen said that opening a CloudKitchens spot costs about $100,000, a tenth of what a dine-in restaurant costs to open. Profit margins are lower in a dark kitchen, however. Starbird has lost money for the few months it has spent inside CloudKitchens. But Noveshen says "it's a very compelling model" for brands that are able to generate a high volume of sales and that have online marketing prowess.

Having stand-alone restaurants, he said, is also part of the formula for success because they raise consumer awareness in the region, which creates demand in areas served only by the dark kitchens.

THE TAKEAWAY

Travis Kalanick's dark kitchens startup CloudKitchens has stumbled in its efforts to expand in the U.S. It has acquired some properties that cost much more than expected to renovate while other properties had to be abandoned. Some key executives have left. That has limited CloudKitchens' ability to take advantage of the shift to online food delivery caused by the pandemic.

Korean telcos aim to launch mmWave 5G network in 2020: Report

By Juan Pedro Tomas

Korea's main telecom operators expect to commercialize an ultrafast mmWave 5G network this year, The Korea Herald reported, citing industry sources.

According to the report, the mmWave 5G service will be initially available for the business-to-business segment. Operators have not yet finalized investment plans for the business-to-consumer sector, as the cost of building additional infrastructure still represents a major issue, according to the report.

Due to the high level of capital expenditures needed, the launch of the mmWave 5G network for personal smart devices is likely to start next year or in 2022, the report said.

"We are currently planning on bringing a 28 GHz-band 5G network for B2B areas this year. But in terms of B2C, the company is still reviewing various options," an SK Telecom official was quoted as saying.

Local operators are planning to introduce the new 5G technology while expanding the existing 5G infrastructure in the 3.5 GHz spectrum band.

Korean vendor Samsung Electronics announced that it has tested a high-frequency 5G network station, confirming that its current infrastructure allows smart devices to download data at 8.5 Gbps speed.

"Stations for the mmWave 5G network will be installed in areas that handle high loads of data traffic," adding that the initial focus will be on the B2B sector, most likely in smart factories," an industry source said.

In June 2018, South Korea completed a tender process through which it awarded spectrum in both the 3.5 GHz and 28 GHz bands. The government made available a total of 280 megahertz in the 3.5 GHz spectrum band and 2,400 megahertz in the 28 GHz band. The spectrum was divided into 28 blocks and 24 blocks.

Participant operators SK Telecom, KT, and LG Uplus had a 10-block cap per spectrum band. The telcos paid a total of 3.6183 trillion won ($3.3 billion) for the spectrum, 340 billion won higher than the starting price of 3.3 trillion won.

The 3.5 GHz band licenses cover a ten-year period and the 28 GHz band licenses a five-year term.

South Korea claimed to be the first country in the world to launch full 5G commercial services on April 3, 2019. As of the end of January, the three operators had deployed approximately 92,000 5G base station across the country.

Last month, South Korea's Ministry of Science and ICT said that the country's three major telecom carriers, SK Telecom, KT and LG Uplus, have agreed to invest KRW 4 trillion ($3.4 billion) in their 5G networks during the first half of this year.

Operators will heavily invest to install additional 5G equipment with the aim of expanding the coverage of current 5G networks across the country.

The initial new investment had been initially set at KRW 2.7 trillion, but has been expanded to KRW 4 trillion. The additional investment will be used to deploy 5G infrastructure in subways, railroads, department stores and universities, according to the report.

An IPO? In this economy?

Sourced by TechCrunch

Late last week a Chinese company called Kingsoft Cloud filed to go public in the United States. The cloud infrastructure business intends to list on the Nasdaq under the symbol "KC," with J.P. Morgan, UBS and Credit Suisse helping out with running the deal.

Kingsoft Cloud has a $100 million placeholder figure in its F-1 filing, giving us an idea of its expectations for the size of the public offering. According to Crunchbase data, Kingsoft Cloud raised nearly $1 billion while private.

There are a few questions to answer:

1. Does Kingsoft compete with Alibaba's cloud projects that the Chinese tech giant just promised to spend $28 billion building out?
2. Is it an economically viable business?
3. What are we supposed to think about an IPO in this economy?

What does Kingsoft Cloud do?
Kingsoft Cloud is a China-focused cloud infra provider that has a little over 5% market share in the country, according to its own math. In its F-1 filing, the company says that it also sells "well-architected industry-specific solutions across public cloud" and "enterprise cloud and AIoT cloud services." You can dig into those terms as much as you want, but what really matters is that, in the infrastructure as a service (IaaS) and platform as a service (PaaS) markets (spaces where Microsoft's Azure and Amazon's AWS compete), Kingsoft Cloud has a piece of the Chinese market.

It's a space that is anticipated to grow quickly as China's economy and digital footprint expands. For example, Alibaba's cloud revenue grew 62% in the last year. Kingsoft Cloud agrees, saying that "China's cloud market is at an early stage with tremendous growth potentials as indicated by the lower market penetration as compared to that in the United States." That argument could be attractive to investors; if you think that China's cloud penetration will eventually match that of the United States's own, then putting capital into one of its players might make sense.

But what about Alibaba? How can Kingsoft Cloud take on the huge company with its brand, cash and incumbency? Well, Kingsoft has a positive spin on its status as not one of China's biggest tech empires:

> Being an independently operated company, focusing on cloud services since our inception, we are able to fully mobilize our resources into the innovation of our business models and provide high-quality services to businesses and organizations of all kind. With our full dedication to cloud business, we are able to avoid potential conflicts of interest with our customers and enhance our neutral position, which in turn gains additional trust from more and more customers.

Maybe!

Kingsoft Cloud is largely owned by Kingsoft Group — a Beijing-based public software company — and Xiaomi, a Chinese hardware company. Kingsoft Group owns 53.8% of the company before the IPO, while Xiaomi owns a smaller 15.8%. Other investors in the business include Yuri Milner, FutureX Capital, Forebright Capital and Shunwei Capital per Crunchbase.

Let's see if its business is any good.

Financial results
Is it a good business? Not so far.

Kingsoft Cloud generated $568.3 million in 2019 revenue, including $496.8 million in "public cloud services," the vast majority of its top line. Its full revenue result grew by 78.4% in 2019, similar to its 79.5% growth it registered in 2018 when that year was compared to its 2017 result.

That growth has come at a rising cost, with Kingsoft Cloud posting growing losses during its life. In 2019 the firm posted its largest ever operating loss of $164.3 million, up 47.8% from its 2018 operating loss.

The firm's operating costs came to $165.4 million in 2019, effectively the same figure as its operating loss. How is that possible? It turns out that Kingsoft Cloud effectively sells its services at cost; the firm generated a mere $1.1 million in gross profit in 2019, or 0.2% of its revenues. That means it has gross margins of 0.2% for the whole year. That's catastrophically bad but somehow still an improvement.

In 2017 and 2018, the company posted -9.6% and -9.0% gross margins, meaning that it sold its services for less money than it cost to deliver them. Seeing it go gross margin positive in 2019, then, is a material improvement. The company generated gross margin of 4.6% in Q4 2019, the most recent financial period it detailed. So, we can see the firm growing nicely, and improving its gross margins, even if it's still a mess of a business.

After a billion dollars in capital, Kingsoft Cloud has only managed to reach gross margin neutrality! What a world.

Kingsoft Cloud's net losses fluctuate depending on a few factors, including forex gains and losses, making its operating losses more useful for our understanding. Is this a business that can afford to keep operating? Kingsoft Cloud had $290.6 million in cash at the end of 2019 and only burned $63.1 million in cash during 2019. The answer is yes, for a while yet.

But its private investors are turning to public markets now instead of putting more of their own capital into the business. It's not exactly a vote of confidence, as they are pushing it live into the public markets when the IPO window is expected to be closed. A sure-shot, profitable, slam-dunk this company is not, making its IPO timing all the more interesting.

Why now? I don't know.

We'll keep tabs on the offering, especially its expected F-1/A filing that should include Q1 2020 data. If the company can keep the growth pumping while showing more gross margin improvement, its IPO could go over well. But I did not expect to see a gross margin break even Chinese cloud company try to go public in the United States in Q2.

As nothing here makes sense, it's hard to have real expectations. More when we have it.

Verizon's BlueJeans acquisition is about more than the work-from-home trend

By Ron Miller

It would be easy to assume that Verizon's purchase last week of video-conferencing tool BlueJeans was an opportunistic move to capitalize on the sudden shift to remote work, but the ball began rolling last June and has implications far beyond current work-from-home requirements.

The video-chat darling of the moment is Zoom, but BlueJeans is considered by many to be the enterprise tool of choice. The problem, it seems, is that it had grown as far as it could on its own and went looking for a larger partner to help it reach the next level.

BlueJeans started working with Verizon (which owns this publication) as an authorized reseller before the talks turned toward a deeper relationship that culminated in the acquisition. Assuming the deal passes regulatory scrutiny, Verizon will use its emerging 5G technology to produce much more advanced video-conferencing scenarios.

We spoke to the principals involved in this deal and several industry experts to get a sense of where this could lead. As with any large company buying a startup, outcomes are uncertain; sometimes the acquired company gets lost in the larger corporate bureaucracy, and sometimes additional resources will help grow the company much faster than it could have on its own.

What is BlueJeans?
BlueJeans is a video-conferencing tool used by enterprise customers like Facebook, Disney, Red Hat and Nordstrom. It doesn't have the consumer-level brand recognition of Zoom or WebEx, but it has grown to 15,000 customers since it launched in 2009.

The company has raised a total of $175 million, with the last deal coming in 2015 when it raised $76.5 million. That round was led by NEA Associates, but past investors included Accel, Norwest Venture Partners and former New York Yankees shortstop Derek Jeter, among others.

According to PitchBook data, the company's post-money valuation for that round was over $727 million, and while there wasn't an exact figure for last week's deal, it was pegged at less than $500 million by a Verizon spokesperson.

Alan Pelz-Sharpe, founder and principal analyst at Deep Analysis, which watches the enterprise collaboration space, says the telecom company got a good buy. "Verizon is getting one of the only true enterprise-grade online conferencing systems in the market at a pretty low price," he told TechCrunch. "On one level, all these systems do pretty much the same thing, but BlueJeans has always prided itself on superior sound and audio quality. It is also a system that scales well and can handle large numbers of participants as well, if not better, than its nearest competitors."

To the enterprise and beyond
While the time seems ripe for an acquisition like this, it's more complex than Verizon simply grabbing a video conference service in the midst of a crisis that disrupted how we work.

More importantly, says Constellation Research analyst Dion Hinchcliffe, it was a good choice for the enterprise users Verizon tends to target. "BlueJeans has offered one of the better experiences, almost in the same category of the rapidly ubiquitous Zoom service, but has long struggled to gain broad adoption," he said.

Tami Erwin, CEO of Verizon Business, says this acquisition augments the telecom company's product suite because "… customers have said that they really need Verizon to give them a portfolio of connectivity, and then platform capabilities that enable them to have applications and solutions to meet their unique business requirements. This [deal] fits right into that strategy." The company is particularly excited about the possibilities of pushing BlueJean's capabilities into areas like telemedicine and online education, she added.

"We believe that this platform gives us permission, with the kind of help that [the BlueJeans] team brings to the overall business, to really reimagine and redefine how healthcare will be provided and the role of video — and how education will be provided," Irwin said. "And we think that this positions us to accelerate work and solutions on behalf of those two verticals."

Hinchcliffe also sees this as a key aspect. "Their effort to go out of their way to deeply connect the acquisition to their 5G roadmap shows how critical this kind of capability will be to stay a serious player in mobile video communications," he said.

High rise BlueJeans

BlueJeans chairman and co-founder Krish Ramakrishnan says the company was considering different ways to grow before it approached Verizon with the initial reselling idea. "We felt that we needed a lot more capital to gain market share, and so we were looking at different ways to finance and to grow," Ramakrishnan told TechCrunch. "We could raise money and try to be an independent company, or find a big partner with lots of technology to gain market share."

The deal began last year as a partnership designed to expand go-to market capabilities, initially involving Verizon as an authorized reseller. Talk of an acquisition began a few months later and discussions started to accelerate in January, he said.

Gartner analyst Mike Fasciani, who covers digital workplace applications, says this acquisition gives BlueJeans the capital and lift it was seeking. "This acquisition answers questions for BlueJeans on how to grow its reach beyond the larger enterprise base. Verizon represents various routes to market across all market segments," he said.

But Fasciani points out that this is not a slam-dunk: "Verizon acquired a video meetings platform and an R&D team that is as innovative as any in the market today. But this raises questions for Verizon. Acquisitions like this are unusual for service providers like Verizon," he said.

He says the company will face obstacles around adding new applications like this into existing portfolios, sales practices and service operations, but sees the deal as mostly positive. "In this case, I think there is a clearer path to bring the BlueJeans video platform into existing UCaaS (Unified Communications as a Service) offerings as well as layering it on top of 5G network deployments," he said.

While the deal certainly didn't knock anyone's socks off in terms of sale price to money raised ratios, it did serve to pay off BlueJeans' investors and reward long-time employees, all of whom will now become part of Verizon.

Sometimes it takes time to see how deals like this play out, but with BlueJeans, Verizon gets enterprise-grade video conferencing at a time when there is a big future in this space, and BlueJeans gets a chance to fight another day with a deep-pocketed partner behind it.

A new approach allows unmanned aerial vehicles to deliver power wirelessly to remote sensors

By Michelle Hampson

Remote sensors play a valuable role in collecting data—but recharging these devices while they are scattered over vast and isolated areas can be tedious. A new system is designed to make the charging process easier by using unmanned aerial vehicles (UAVs) to deliver power using radio waves during a flyby. A specialized antenna on the sensor harvests the signals and converts them into electricity. The design is described in a study published 23 March in IEEE Sensors Letters.

Joseph Costantine and his colleagues at the American University of Beirut, in partnership with researchers at the Institute of Electronics, Computer, and Telecommunications Engineering in Italy, were exploring ways to remotely charge sensors using radio frequency waves (the same form of energy used to transmit Wi-Fi). However, a major challenge was that the source of the radio waves must be fairly close to the sensor in order to sufficiently charge it.

This prompted the researchers to consider the use of UAVs, which could soar over each sensor. "In addition, a UAV can follow an optimized trajectory that maximizes energy transfer to the sensors in question," Costantine explains. He says his team developed this system to control and recharge sensors used in agriculture, but that it could be extended to any situation where sensors are deployed in hard-to-reach areas.

In the proposed approach, a UAV transmits radio frequencies to each sensor, which has an antenna for detecting the signals. The signals are then conveyed to a rectifier, which converts the signals into electricity. This power can be used to charge the sensor and/or activate it.

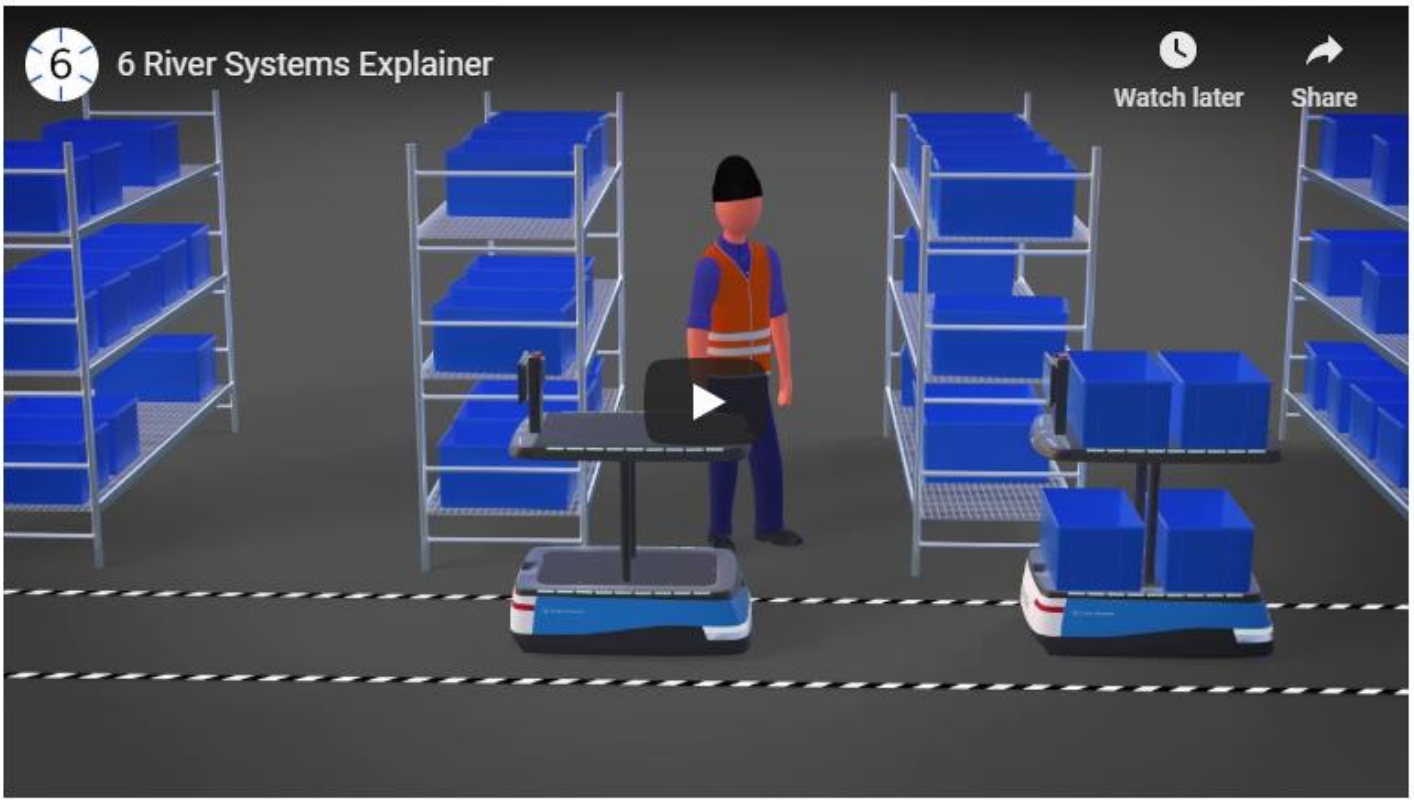
What's more, the UAV can target specific sensors. "The modulated signal transmitted by the UAV [encodes] an address that can selectively trigger a particular sensor—out of many—from sleep mode into active mode. The

system relies on purely passive components to achieve charging and on ultra-low power to trigger the wake-up protocol of a sensor," says Costantine.

In tests, the UAV could activate the sensor from a distance of 27.5 meters at a receiving power of -40 dBm. Charging required closer distances, at 1.2 meters and -18.2 dBm.

Now, the team is working to develop a load-independent rectenna (antenna and rectifier) that maintains high efficiency across a wide range of loads and frequencies. "Such a system could be connected (or plugged in) to any sensor to support charging or wake-up," Costantine says. "In addition, we are also working on further optimizing radio frequency energy harvesting from Wi-Fi signals by overcoming their intermittent nature, and increasing the number of sensors that can be specifically targeted in a given region."

6 River Systems' Chuck warehouse robot wins awards for product design



As major retailers and third-party logistics providers continue to hire tens of thousands of people, they are also looking for ways to retain and augment that workforce. Last week, 6 River Systems Inc. noted that its Chuck mobile robot was recognized with two Red Dot product design awards.

"These awards are recognition of what we've known all along," stated Chris Cacioppo, chief technology officer at 6 River Systems. "Chuck is not only the best collaborative robot for fulfillment operations; it's [also] an integral part of an industry-changing, cloud-based, wall-to-wall fulfillment solution that empowers warehouses to solve some of their greatest challenges."

Waltham, Mass.-based 6 River Systems was founded in 2015 by Jerome Dubois and Ryan Hamilton, who were previously executives at Kiva Systems (now Amazon Robotics). The company's systems are now operating in more than 20 facilities in the U.S., Canada, and Europe. Its customers include Lockheed Martin, DHL, XPO Logistics, and Office Depot.

6 River Systems, which was a 2019 RBR50 company, was acquired by Shopify Inc. last September for $450 million.

Chuck uses AI to help warehouse workers
Chuck uses artificial intelligence and machine learning to help warehouse associates work faster, said 6 River Systems. The collaborative mobile robot leads associates through their work zones to help them minimize walking, stay on task, and work more efficiently, according to the company.

Chuck can be used in all put-away, picking, counting, replenishment and sorting tasks without the need for changes

to an operation's infrastructure. It is configurable up to six levels to accommodate three times the workspace and twice the weight of any competitive offering, claimed the company.

6 Rivers' team of engineers, programmers, and partners designed Chuck to resemble other tools used in everyday life. The robot's directional lights resemble those of an automobile, and it uses familiar touch-screen controls, RF technology, and put-to-light cues. Chuck's engaging design and easy-to-use interface are intended to enable new associates to reach performance standards quickly.

Chuck won Red Dot Awards for Smart Products and Product Design. Source: 6 River Systems

Red Dot is a major design competition
In 1955, a jury convened for the first time to assess the best designs, and with a total of more than 18,000 entries, the Red Dot Award has become one of thee world's largest design competitions since 1990s. Previous winners include South Korea-based Doosan and Germany's KUKA.

In 2020, designers and companies from 60 countries entered more than 6,500 products in the Red Dot competition across 49 categories.

Chuck won awards for Product Design in Robotics and in the Smart Product meta-category. The Red Dot Award for Product Design offers designers and manufacturers from all over the world a platform for assessing their products.

The Smart Product meta-category looked at entries across industries. Winning proves that a product "successfully achieves the complex interaction between humans and technology in the age of Industry 4.0 and the Internet of Things," said the Red Dot organization.

"The winners of the Red Dot Award have proved that they have created excellent products worthy of winning an award," said Prof. Peter Zec, founder and CEO of Red Dot. "The products won over the jury, not only through their aesthetic, but also thanks to their incomparable functionality. With their designs, the award winners are setting new standards in their industry. I wish to congratulate them most sincerely on their success."

On June 22, 2020, Chuck will be added to the exhibition "Design on Stage" in the Red Dot Design Museum in Essen, Germany, with all of the award-winning products. From that date, 6 River Systems' winning product will also be presented in the online exhibition on the Red Dot website. The Red Dot Design Yearbook 2020/2021 will be available in July 2020.

AV: Come Together, Right Now, Over Safety

By Junko Yoshida

How many safety standards does it take to screw in the lightbulb in a highly automated vehicle? A few years ago, automotive market novices would have said, "None." These days, the number seems to keep increasing as the industry finally comes to grips with the technical challenges of producing demonstrably safe autonomous vehicles.

Driven by the winner-takes-all Internet platform business model, autonomous vehicle (AV) zealots were racing to develop the industry's first robocar. Their goal was simple. Dominate the AV platform so completely that everyone else in the industry would be forced to follow and license.

Fast forward to 2020. The go-it-alone, my-way-or-the-highway approach is driving on fumes. In contrast to a few years ago, leading automotive OEMs, Tier Ones and tech suppliers including chip vendors are more engaged in forming industry-wide coalitions to develop AV standards that have safety considerations at their core.

Close to ten industry initiatives are in the works, seeking to address different aspects of AV safety. Prominent among them are the existing ISO 26262 and SOTIF, and the newly-published UL 4600.

So, does this mean the automotive industry is finally coming together? Perhaps.

Collaboration is a new and alien concept for participants in the auto industry. When it comes to safety standards, of course, "everyone has different opinions," said Stefan Poledna, CTO of TTTech Auto, in a recent interview with EE Times, but "this is the general direction."

What changed?

The industry achieved Level 2 / Level 2+ autonomy so quickly that it vastly underestimated how much more difficult it would be to take the next leap to Level 3-5 technology. It has finally dawned on the AV industry that developing a safety-related computing system for Level 3-5 autonomy is "a grand challenge that shouldn't be addressed by a single player, but in an ecosystem," Poledna noted.

When an L3, L4 or L5 vehicle goes the wrong way on a one-way street, it's no longer the driver who's responsible — it's the carmaker. Poledna, trumpeting the obvious, said, "That's a big deal."

New ISO standard on horizon

Remember SaFAD (Safety First for Automated Driving)? It turns out the white paper published last July by 11 industry leaders (Aptiv, Audi, Baidu, BMW, Continental, Daimler, Fiat Chrysler Automobiles, HERE, Infineon, Intel and Volkswagen) is on its way to becoming a new ISO standard.

The white paper outlined "a comprehensive approach to safety relevant topics of automated driving." The objective of the publication, the authors said, "is to systematically break down safety principles into safety by design capabilities, elements and architectures and then to summarize the verification & validation methods in order to demonstrate the positive risk balance."

The ISO accepted that premise, allowing the industry to develop this into an ISO standard.

But what does it take to turn a "comprehensive approach" into a workable ISO standard? We asked SaFAD member Intel.

Jack Weast, Intel senior principal engineer and vice president of standards at Mobileye, explained, "First, we take the original SaFAD paper, clean it up, get rid of any color commentaries and reformat the technical meat of the document into the ISO standard."

Simon Fürst

Looking for a faster turnaround, Simon Fürst, principal expert autonomous driving technologies at BMW Group, who heads the committee, announced in a webcast called "The Autonomous," that his group is shooting for mid-2020 to publish its ISO Draft Technology Report (DTR) 4804.

Weast described the DTR as the first step for ISO standardization.
Several auto industry sources told us the new ISO standard might be a step in the right direction, but the caveat is that it takes years before it becomes the final standard. Further, they said that they find it too generic and too high-level to help automotive OEMs in the short term.
Intel's Weast acknowledged the scope of the [ISO] document is "pretty broad." But Weast defended it as "a big umbrella" covering discussions of "How would you define, derive, develop and test an automated driving system end to end."

Noting that the document offers "a useful structure," Weast said, "We are obviously supportive of the safety by design principles," and the document provides "a very well-thought-out way of doing things." Weast added, "This is why it's great to have an ISO document, which explains, 'hey, here's a good methodology in doing so.'"

'The Autonomous': Going one or two levels down

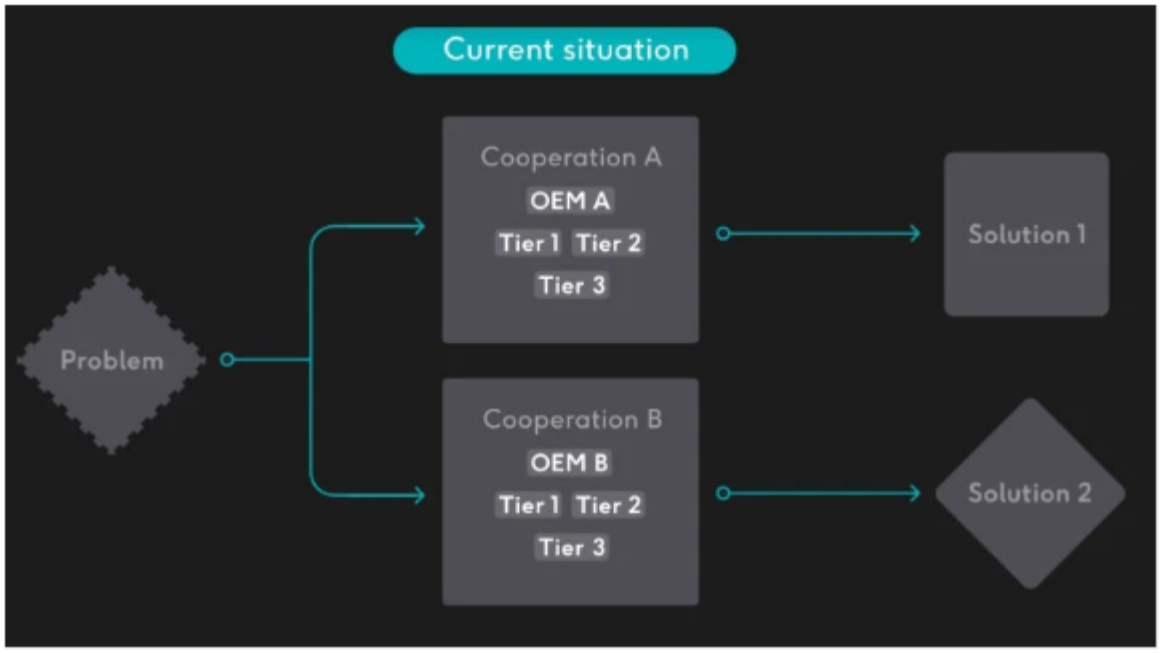
Stefan Poledna

TTTech Auto, which specializes in safe software and hardware systems for advanced vehicles, launched the initiative called "The Autonomous" (the webcast was named after the initiative).

TTTech Auto's CTO Poledna told *EE Times* that TTTechAuto is convening many players in the automotive ecosystem at its own event to "brainstorm and discuss" development of "a proving ground" for car OEMs, Tier Ones and chip vendors to test out the safety of their AV systems. "They need to have certain exchanges amongst themselves," he said, at a time when everyone is struggling to figure out what it takes to bring L3 and L4 cars *that are safe* to the market.

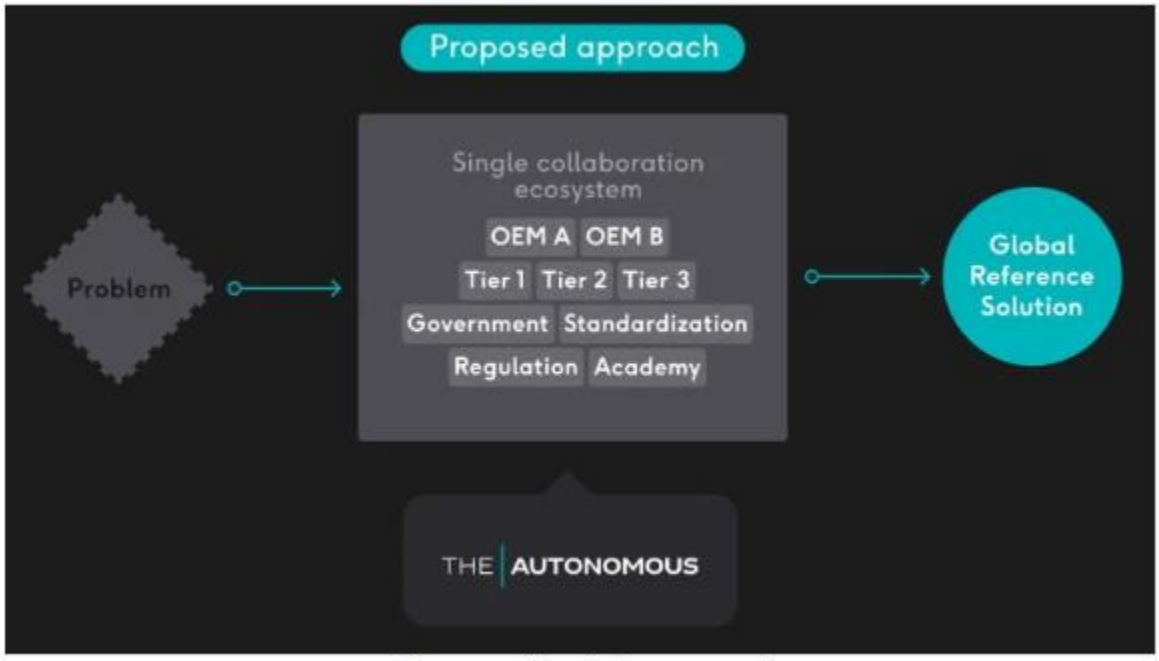
Poledna said that The Autonomous is fully aware of the many approaches — including different computing architecture, software algorithms and sensor fusions — pursued by different companies to ensure safety.
That's part of the reason for launching The Autonomous. TTTech Auto contends that players in the automotive industry need solutions much more specific, more concrete and quicker on the trigger. The aim of The Autonomous is to go one or two levels downs from the upcoming ISO DTR 4804 standard, to conceive "a reference design implementation" the AV industry can use.

The goal isn't about picking the winning black box, though.



(Source: The Autonomous)

Instead of building AVs around black boxes, carmakers would like to be able to mix and match different modules from different suppliers — safety modules, 'checker' modules (as in a 'doer-checker' model), calculation modules, etc. Assume one OEM opts for a safety module from Supplier A, which bears no resemblance, posing critical compatibility issues, to a safety module from Supplier B? Poledna argued that the AV industry must have "a common understanding of what the safety architecture would look like." The industry should have a common approach and common understanding on "interfaces" and "data structures," he explained.



(Source: The Autonomous)

On one hand, the ISO standard deemed too generic. On the other hand, too many players in the AV industry are already implementing different safety solutions on their own. How does The Autonomous plan to succeed as a "middle ground" solution?

Poledna said, "If we agree on 'doer-and-checker' as a generally acceptable safety approach, I'd consider it as a huge achievement." Further, he noted that he'd like to see the industry come to a collegial understanding on data structure, interfaces, and a definition of free space. The Autonomous is holding a series of workshops focused on such issues as computing architecture, AI, security and regulation. While encouraging participants to share best practices, the goal for The Autonomous group is to foster amity among key automotive players and publish documents and technical papers reflecting state-of-the-art solutions in the industry.

Narrowly focused

If The Autonomous is clicking one or two levels down from the ISO standard, Weast said that IEEE P2846, a group that Weast chairs, is boring down farther into the details, with specific focus on "a very narrow area of decision-making capability."

Jack Weast

The benefit of being narrowly-focused is that "we can go much deeper," he explained. In examining the decision-making process, "we also look at 'what kinds of assumptions we'd make about other road users," he said. Depending on the city where an AV is driving or on a situation (an intersection with an occluded view, for example), knowledge of the assumptions that apply in those specific cases is essential to creating a safety model for a decision-making block.

While the IEEE P2846 is focused on that decision-making block, AV safety standards in the end are likely to require close to a dozen different technical blocks for the industry to define and implement safety, Weast speculated. "We will need, for example, a safe operation block," which could be addressed by ISO 26262 and SOTIF standards, for example. Others include a behavior and traffic block, "which maps well with what IEEE P2846 offers," and things like a data recording block.

It is clear that "standards and interoperability are essential" to enable an ecosystem on which an entirely new market like AV can be built, Weast explained. However, he acknowledged that setting industry standards is always a balancing act. You need to create a robust market, but companies must feel free to differentiate.
Asked on what specific technologies the AV industry must come to agree, Weast said, it's something — from different suppliers when made commonly available — that will benefit everyone and lift all boats equally.

Take, for example, IEEE P2846.

If AV companies can't agree on what safety means (including a safe distance between cars, for example), they won't be able to make convincing arguments to government regulators for the safety of autonomous vehicles, he explained. The same goes for operational design domains (ODD). If a common template isn't applied to define ODD, the industry can't explain what exactly a certain vehicle is capable of doing where, in what conditions.

Despite an epidemic that prevents many standards organization members, including IEEE P2846 members, from traveling, Weast said the group still wants to complete its draft by the end of this year or by early 2021.
To expedite the process, the group has broken the work into four subgroups. One is identifying safety-related scenarios in which there are assumptions about other road users. Another is examining the attributes of safety models used within decision making. The third group is aligning definitions and taxonomy with those used by other standards as the best possible. The fourth group is documenting how the standard fits or complements other standards, "so that we can resolve some confusion and questions" about IEEE P2846, explained Weast.

A bit of the good news on IEEE P2846 is the election, added Weast. While Weast is the chair, the group elected a person from Waymo to be the vice chair and an Uber representative as secretary. For Waymo, this is a first; until now the company has opted to go it alone. "We now have a good representation from the chip industry, companies in the mobility as a service business, to car OEMs, Tier Ones and robotics companies," said Weast.

Its 20 members include: Aptiv, ARM, Baidu, Denso, Exponent, Fiat Chrysler (FCA), Google, Huawei, Horizon Robotics, Infineon, Intel, Kontrol, National Taiwan University, Nvidia, NXP, Qualcomm, Uber ATG, Valeo and Volkswagen.

Safety case

Separately, earlier this month, Underwriters Laboratories has completed its first standard for Autonomous Vehicles. Called UL 4600, it is published and now available at ULstandards.com.

Phil Koopman

Instead of prescribing how to do safety by following certain steps, UL 4600 offers a guide to "build the safety case" for an AV design, according to Phil Koopman, CTO of Edge Case Research, one of the authors of the standard. Acknowledging that no single standard can solve the world's autonomous product problem, the authors of UL 4600 have fixed a starting point by asking autonomous product designers to make a safety argument.

Koopman stressed that Underwriters Laboratories created a diverse body of international stakeholders on its Standards Technical Panel (STP) to develop the document. The STP consists of 32 members with voting rights, including representatives of government agencies, academia, autonomous vehicle developers, technology suppliers, testing & standards organizations and insurance companies. Its STP members include: Uber, Nissan, Argo AI, Aurora Innovation, Locomotion, Zenuity, Intel, Infineon, Bosch, Renesas, Ansys, Liberty Mutural, AXA, US Department of Transportation, and others.

What happens if Magic Leap shuts down?

By Lucas Matney

Since first uploading a YouTube teaser video of its tech five years ago, Magic Leap's presence in the augmented reality industry has been controversial.

Some have lauded the team's ambitions, while others I've talked to say the company's posturing has dissuaded investors from taking chances on other AR hardware startups, which has hampered the industry's advance.

Regardless of its impact, Magic Leap carries outsized weight, leading one to question what would happen to other AR companies if the company's situation worsened.

The company announced layoffs today, with reports indicating that it is dismissing around 1,000 employees — about half of the company. Magic Leap's added news of a major pivot to enterprise makes it seem like that wasn't its primary strategy over the past year. From my perspective, the company looks like it is on a path to a fire sale and will be dependent on executing a dramatic turnaround, which grows tougher under current economic conditions.

Magic Leap has few users, so a theoretical shutdown would likely have a lesser impact than other unicorn flare-outs; still, losing a company on the forefront of a technology lauded by many as the next ubiquitous platform will certainly impact others that are striving to bring this tech to market.

The impact for startups moving forward would be nuanced. Without a substantial software suite of its own, Magic Leap relied heavily on developer partnerships, though in recent months many of those seemed to promote enterprise use cases. AR/VR startups are already in a rough position, and one less developer platform could force more companies to de-prioritize headset-based platforms and shift their focus to mobile.

The COVID-19 crisis was already going to negatively impact frontier tech in a disproportional way, so the death of a handful of AR hardware startups and Magic Leap's downward trajectory will likely suppress investor interest in backing AR hardware makers aiming to beat Apple or Facebook to releasing a mainstream device. Investors that do approach the space will likely stay away from horizontal AR platforms in favor of more niche verticals with clear use cases. The overall environment seems poised to shrink in the near-term.

Image Credits: Bram Van Oost/EyeEm / Getty Images

Even without a shutdown, Magic Leap's shift away from a consumer focus is detrimental for Apple and Facebook. There are few developer pipelines for content optimized for AR headsets beyond Magic Leap, so if the company never returns to the consumer space and Apple or Facebook launches an AR device in the next few years, they will have to jump-start a developer ecosystem.

Building a developer platform in AR/VR is time-consuming and expensive. Magic Leap was dispatching millions in grants, funding AR-first titles that were unlike anything that had been created before. Apple aimed to do this with its iOS-based ARKit, but there has been little to entice major developers to create for a platform for which consumers have shown little appetite. Facebook has already spent billions on Oculus post-acquisition, building out its hardware and software platforms while bankrolling countless VR startups to create content for the headset.

While there is substantial crossover between developers building content for VR and AR at the moment, it's likely because few are building native AR content that capitalizes on the platform's inherent strengths. Apple has invested heavily in building technologies that can integrate real-world geometry into AR experiences, something for which VR developers don't have to accommodate.

A total shutdown of Magic Leap would only further complicate the missions of these large companies. Early reports seem to indicate that Apple is squarely focused on developing a consumer-focused AR product, though less is known about Facebook's plans. That said, years of uncontested dominance in the enterprise space by Microsoft with HoloLens would be bad for both companies.

Microsoft has largely appeared to be moving at its own pace, but Magic Leap has offered some competition for the software giant. Were the startup to shut down, Microsoft would be the only major tech company left with an AR device on the market, something that could lead to an early-mover advantage were the HoloLens division to push its learnings into a consumer product.

The augmented reality industry is young but maturing, and the path to upending mobile is now littered with dead startups. For existing tech giants, the theoretical loss of Magic Leap could mean a dry spell that pushes them to increase investment ahead of launching dedicated devices.

New data details the decline in Silicon Valley's Q1 venture activity

January was great. February was good. March was a mess.

By Alex Wihelm

Today we're unpacking some new data concerning what happened to Silicon Valley's venture capital market in Q1, with a special focus on private financings towards the end of the three-month period. If the deterioration in deal volume we'll go over today persists into Q2, the United States' largest startup market could be in for more than a bump as the global pandemic slows economic activity.

We've already talked to venture capitalists who invest in fintech, social companies, consumer startups, and other niches to understand the present state of the venture capital market. We're also looking through data on the global and domestic venture scene, digging into local data on Boston and Utah. Other cities and states will be examined in the coming weeks.

Fluid situations demand lots of attention.

However, up until March of 2020, the venture capital and startup market had one speed (fast) and one goal (growth). The new normal of the COVID-19 era is different, and with the help of some excellent data from Fenwick and West, a legal firm that works with technology companies, let's dig into how Silicon Valley's venture scene nosedived as Q1 came to a close.

January, February, Ouch

The venture capital scene in Silicon Valley got off to a hot start in 2020. Fenwick's collected data indicates that there were 126 financings in the region in January of this year — up more than 100% from the preceding year's January tally of 60.

In February of 2020, the financing tally fell to 60, a result that came in under the preceding year's February result of 64. That's a wash.

In March, however, venture activity got super sticky. According to the report, just 44 financings were put together in March 2020, a material percentage under the 61 that March 2019 saw. The 2020 results are a bit starker when listed in chronological order, month-over-month:

- Silicon Valley financings, January 2020: 126
- Silicon Valley financings, February 2020: 60 (-52.4% from January)
- Silicon Valley financings, March 2020: 44 (-26.7% from February)

January 2020 was an outstanding month, Fenwick notes, saying that it saw the "the largest number of venture financings in a single month in at least five years." The firm posits that some financings in the month could have been driven by economic worry (get that round done now), which makes good sense; there's been some discomfort in Silicon Valley in the last few quarters about raising before the music ended.

Whatever the reason, 2020 went from scalding hot to slow in under a quarter.

March 2020's series-level results are worth considering. In the month, compared to the year-ago period, Series A rounds were down 30%, Series B rounds fell a more modest 7%, Series C rounds dropped 45.5%, while Series D and E rounds fell 57.1% and 11.1%, respectively.

Falling prices
In honor of our new hunt for green shoots amidst the bad news, TechCrunch dug through the rest of the tables in the report, hoping to find some good news. There's not much.

On one hand, "up" rounds in Silicon Valley as a percent of the total only fell 2% in the quarter, from 81% in Q1 2019 to 79% in Q1 2020. But in each month of Q1 2020, the result was under its year-ago total, and the March 2020 data point had the lowest ratio of up rounds of any of the months detailed.

The only truly positive stat from the report itself comes with a stern caveat. In Q1 2020, the average price increase for Silicon Valley financings was 94%. That result was better than the Q1 2019 tally of 75%. However, January 2020 carried much of the weight for 2020, with its 117% average price gain falling to 46% by March. And both February and March 2020 saw average price gains that were less than their year-ago corresponding periods.

Not a lot of comfort there, then.

What this report does is take what our gut said happened and confirm our expectations with numbers. Alas.

Facebook's $5.7 billion bet on Indian giant Jio spells trouble for Amazon and Flipkart

By Manish Singh

Facebook's major bet on Jio Platforms could create a headache for mobile payments services that have amassed tens of millions of users while struggling to find a business model in the world's second-largest internet market.

The $5.7 billion investment, Facebook's second-largest to date, could also further its dominance in India — its biggest market by user count — by expanding the reach of consumer-facing services like WhatsApp and expanding its lead over ByteDance's TikTok, which has amassed more than 250 million Indian users in two years.

But based on what Facebook and Reliance Jio executives have shared — along with feedback from several industry analysts — the companies that need to worry most about this multi-billion-dollar bet are Walmart's Flipkart, Paytm and Amazon.

Facebook and Jio executives said their companies will work together to build solutions; their biggest synergy would revolve around JioMart and WhatsApp, given that Reliance Jio is India's top telecom network with more than 380 million subscribers.

One of those collaborations may allow users to find local stores around them on WhatsApp, talk to store operators and place orders from within the Facebook-owned instant messaging service, said Ajit Mohan, a Facebook VP who spearheads the company's business in India, in an interview with TechCrunch.

"You can browse shops and talk to the shop owner. And ultimately, where we do want to take this flow is for you to be able to place your orders," he said. Mohan refuted reports that Facebook saw the deal as an opportunity to turn WhatsApp into a so-called "super app," however.

Store listings would be powered by JioMart, a joint venture between Reliance Industries' Jio and Reliance Retail, the nation's largest retail chain. The 14-year-old Reliance Retail currently serves more than 3.5 million customers each week through more than 10,000 physical stores distributed across 6,500 cities and towns.

India has more than 60 million small businesses, more than half of which are mom-and-pop stores that largely remain offline even as half a billion Indians have gained telecom access in the last decade thanks in part to cut-rate 4G data and voice calls Jio began to offer in 2016.

"These small businesses are critical to the Indian economy. If you look at Facebook as a company, there has always been a focus on helping these businesses," said Mohan. "These small businesses, first-time entrepreneurs and new ventures leverage the Facebook platform to find new customers and expand to additional markets."

Jayanth Kolla, chief analyst and founder of research firm Convergence Catalyst, said the deal will directly impact Amazon and Walmart, as well as social commerce players like Club Factory that have amassed millions of customers in India.

Amazon and Walmart-owned Flipkart have poured billions of dollars into India, the biggest Asian market where they are allowed to operate. Earlier this year, Amazon chief executive Jeff Bezos said the company would invest $1 billion in the nation to help "digitize micro and small businesses in cities, towns, and villages across India, helping them reach more customers than ever before."

Despite those investments, the global e-commerce leader currently accounts for just 3% of overall retail in India. But at stake is an $800 billion retail market that is estimated to balloon to $1.3 trillion in the next five years. There is enough room for a new, giant player, analysts said.

SoftBank and Alibaba-backed Paytm attempted to become that formidable challenger to Amazon and Flipkart, but has struggled to make inroads. "Among the Indian players, I think Paytm is by far the most impacted by Wednesday's announcement," said Kolla.

For Paytm, another challenge is its reliance on Alibaba, the largest investor in Paytm Mall, its e-commerce venture. New Delhi amended its foreign direct investment policy last week to require government approvals on all new investments from Chinese investors.

"At a macro level, I see this as a United States and India versus China dynamic," said Kolla. "Players like Paytm that have relied on Chinese investors might face new difficulties in raising fresh capital. And those investments could take long to close." These regulatory hurdles have become more prevalent in recent years, and while Facebook has so far been at the receiving end of these troubles, things might change soon.

Last year, New Delhi prohibited Amazon and Flipkart from selling goods from companies in which they have a stake. Under current laws, foreign-owned e-commerce companies are not allowed to sell directly to customers. The idea is that these international players are only permitted to provide a marketplace that serves as "an information technology platform" and acts as a facilitator between "buyer and seller."

To bypass this restriction, Amazon and Flipkart acquired stakes in several of the biggest third-party sellers. When New Delhi closed the loophole, the two companies rushed to pull hundreds of thousands of items from their stores overnight.

One person who seems insulated — if not also a direct beneficiary — of all these policy changes is Reliance Industries' chairman Mukesh Ambani, also the richest man in India. Ambani is a close ally to Prime Minister Narendra Modi, and Jio, which is majorly owned by an Indian entity, has supported all the protectionist policy proposals the Indian government has proposed in the last two years.

While Amazon and Flipkart were scrambling to continue their shops in India, Ambani unveiled JioMart and launched an attack on foreign firms.

At an event last year attended by Modi, the soft-spoken billionaire invoked Mahatma Gandhi, who led India's effort to gain independence from England, by saying "we have to collectively launch a new movement against data colonization. For India to succeed in this data-driven revolution, we will have to migrate the control and ownership of Indian data back to India — in other words, Indian wealth back to every Indian.

"Honorable Prime Minister, I am sure you will make this one of the principal goals of your Digital India mission," he added.

In a video today, Ambani said, "In the very near future, JioMart, Jio's digital new commerce platform, and WhatsApp will empower nearly 3 crore (30 million) small Indian neighborhood shops [called kiranas] to digitally transact with every customer in their neighborhood. This means all of you can order and get faster delivery of day-to-day items, from nearby local shops. At the same time, small kiranas can grow their businesses and create new employment opportunities using digital technologies."

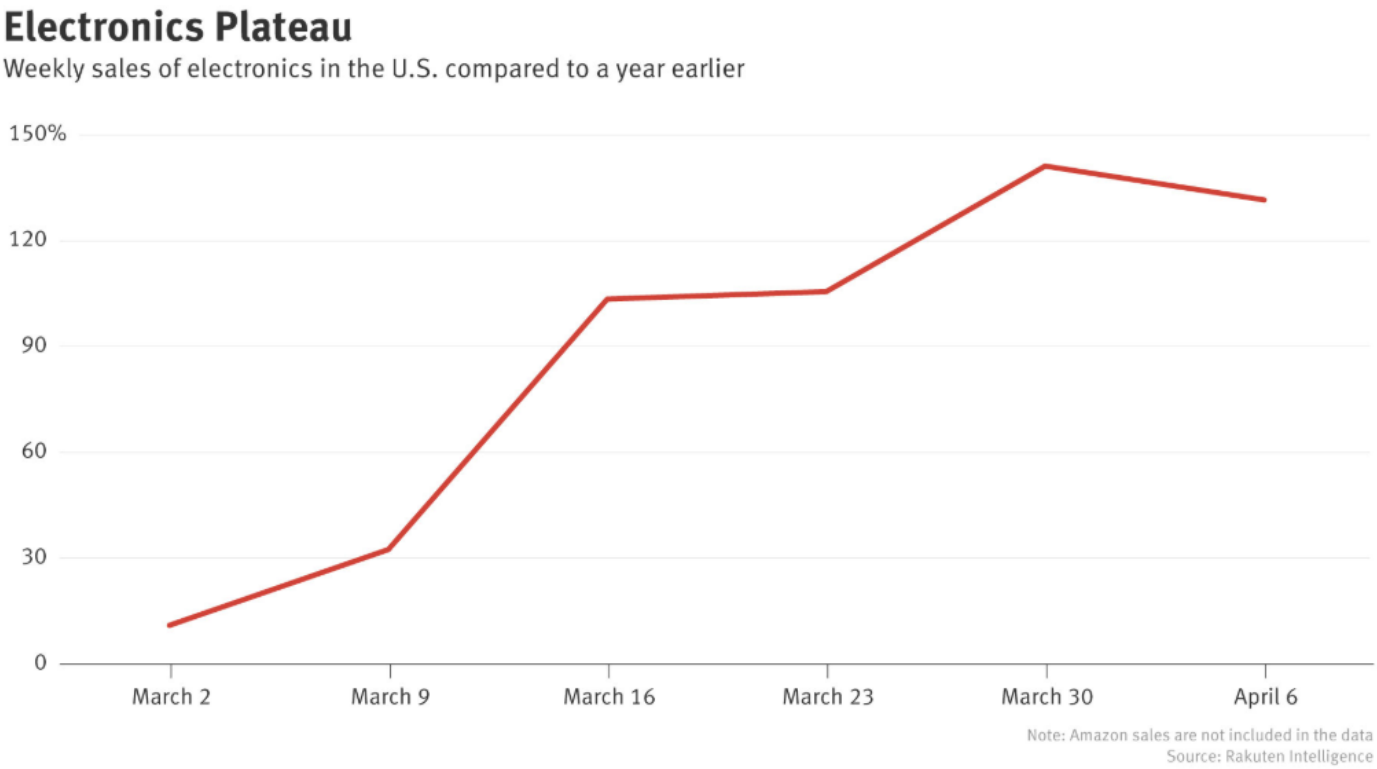
"Our visionary and most respected Prime Minister Shri Narendra Modi Ji has set two ambitious goals in his 'Digital India' mission for all Indians, especially for common Indians; and 'Ease of Doing Business' for all entrepreneurs,

especially for small entrepreneurs," said Ambani. "Today, I assure you that the synergy between Jio and Facebook will help realize these two goals."

For Facebook, which paid $19 billion to acquire WhatsApp, this synergy might be the company's best shot to turn the service, used by more than two billion people, into a money-making machine. Facebook has explored bringing advertisements to WhatsApp, but the company has reportedly put that plan on hold.

Boom in Home Electronics Sales Shows Signs of Peaking

By Nick Bastone



When cities across the U.S. shut down due to the coronavirus, consumers flocked online to beef up their home office and entertainment setups. The surge in spending for consumer electronics has extended into April, with only a slight cooling in growth, according to an analysis of email receipts from online transactions provided to The Information.

The research by e-commerce company Rakuten, which looked at data for over 1 million U.S. consumers, shows online sales of electronics rose 33% the week of March 9 versus the same week the year earlier, then surged 141% in the last week of March. By the following week, starting April 6, growth had started to wane, to 131%.

For the month of March, online sales of electronics rose 61% compared to the year-earlier, according to Rakuten's data, which does not include Amazon sales. Total U.S. retail sales fell more than 6% in March, according to the U.S. Commerce Department.

"With a lot of workers going into remote office situations, it's created an immediate-term opportunity for tech sales," said Steve Koenig, vice president of research for the Consumer Technology Association. "But we fully expect this to taper."

Demand for accessories that ease working from home has been particularly strong, according to Monoprice, an online electronics retailer. Orders for keyboards, mice and headsets with microphones were up 99% in March compared to last year, while orders for USB adapters skyrocketed 182%, the company said. Monoprice said its number of overall orders rose 25% in March compared to the same period last year.

This kind of surge is destined to be short-lived. Once people have made certain purchases, like high-definition TVs or wireless mesh routers, there's no need to upgrade those items for some time, the CTA's Koenig notes. Americans who lose their jobs or take pay cuts face new financial constraints. "The longer the health crisis remains in play, the more intense I think that downward pressure on spending becomes," he said.

The rise in online sales hasn't been enough to offset the impact of shelter-in-place mandates for brick-and-mortar retailers, whose foot traffic has vanished. Best Buy, which has shut its doors nationwide and moved to curbside pickup only, said last week that its overall sales fell about 30% between March 21 and April 11 compared to the same period a year earlier. As a result, it is temporarily furloughing 51,000 of its hourly store employees.

SoftBank, Legend Invest $150 Million in Didi Chuxing's Bike-Sharing Unit

By Yunan Zhang

China's ride-hailing giant Didi Chuxing has raised $150 million from SoftBank and Legend Capital for its bike-sharing unit, Qingju. This is the first time it has raised money from outside investors for the business, according to people with direct knowledge of the deal.

Media reports in recent days have suggested that Didi raised $1 billion for the bike-sharing unit. But $850 million of that came from Didi itself, which was continuing its previous investment in the unit, the people said. Didi first expanded into the bike-sharing market when it acquired Bluegogo, a bankrupt bike-sharing startup, two years ago.

Didi is pumping more money into the business as part of an effort, unveiled by its founder and CEO Cheng Wei last week, to reach 100 million daily trips globally in its ride-hailing and bike businesses in three years. The current number is about a third of that.

Didi, which dominates China's ride-hailing sector, is competing in bike sharing with much bigger rivals Hellobike, backed by Alibaba affiliate Ant Financial, and Meituan Dianping, a food-delivery and travel services giant that acquired a bike-sharing service two years ago. Expanding its bike services could help Didi defend its turf from encroachment by these companies, according to a person familiar with the thinking of Didi executives.

SoftBank is already one of Didi's largest shareholders, having participated in multiple fundraising rounds.

News of the deal comes as the global ride-hailing industry reels from the ravages of Covid-19, which has forced entire countries into lockdown. Uber and Lyft, which weren't profitable even before the pandemic, are struggling amid the collapse of usage.

China announced last week that its economy contracted in the first quarter, for the first time in decades. But in recent weeks, business has cautiously opened back up, following a dramatic slowing of the virus's spread. While most Chinese are returning to work, many are still shunning public transportation. The volume of ridership on Didi's car platforms has reached about 70% of what it was before the pandemic, according to people familiar with the data, though demand for longer-distance trips such as transportation to the airport remains weak.

And with spring's warmer weather, more commuters are turning to bikes, driving record numbers of rides. In Wuhan, the city where Covid-19 first emerged, usage of bike hailing surged as the city lifted draconian curbs on residents. According to China Daily, a state-run newspaper, Didi's bikes saw usage jump 90%, especially around the city's high-tech industrial zone. Hellobike's and Meituan's bikes also saw sharp increases in use, according to the report.

Didi's latest investment shows there might be life still in the bike-sharing space. The sector suffered a sharp setback after the collapse of bicycle app Ofo, which burned through $1.5 billion in venture capital.

There's also renewed interest in taking bikes electric, with electric-assist motors that make pedaling easier. Market leader Hellobike, which says it has more than 20 million daily rides, has expanded its fleet of electric-assist bikes to 320 cities. Li Kaizhu, co-founder and president of Hellobike, said the company expects its bike-sharing business, including electric-assisted bikes, to break even this year.

Didi plans to launch more electric-assisted bikes in smaller cities in China, which are generally underserved by public transportation and taxis.

Electronic skin fully powered by sweat can monitor health

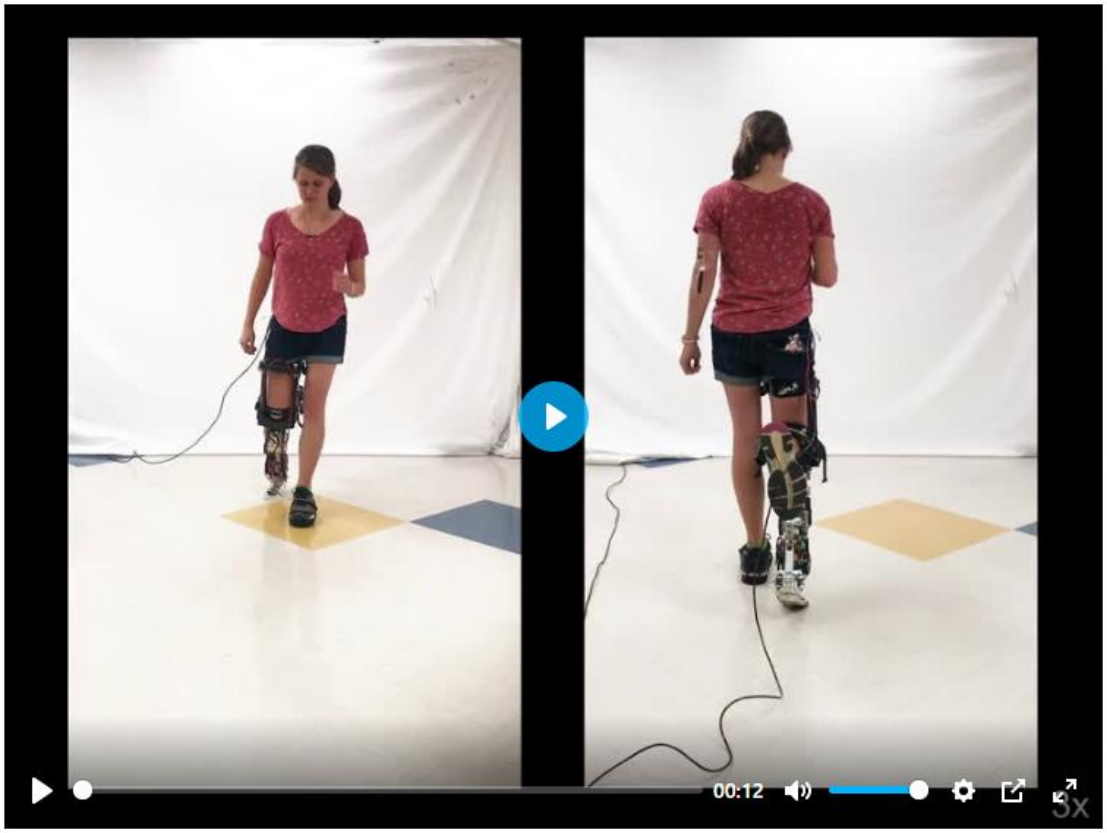
By Emily Velasco@ California Institute of Technology

One of the ways we experience the world around us is through our skin. From sensing temperature and pressure to pleasure or pain, the many nerve endings in our skin tell us a great deal.

Our skin can also tell the outside world a great deal about us as well. Moms press their hands against our foreheads to see if we have a fever. A date might see a blush rising on our cheeks during an intimate conversation. People at the gym might infer you are having a good workout from the beads of sweat on you.

But Caltech's Wei Gao, assistant professor in the Andrew and Peggy Cherng department of Medical Engineering wants to learn even more about you from your skin, and to that end, he has developed an electronic skin, or e-skin, that is applied directly on top of your real skin. The e-skin, made from soft, flexible rubber, can be embedded with sensors that monitor information like heart rate, body temperature, levels of blood sugar and metabolic byproducts that are indicators of health, and even the nerve signals that control our muscles. It does so without the need for a battery, as it runs solely on biofuel cells powered by one of the body's own waste products.

"One of the major challenges with these kinds of wearable devices is on the power side," says Gao. "Many people are using batteries, but that's not very sustainable. Some people have tried using solar cells or harvesting the power of human motion, but we wanted to know, 'Can we get sufficient energy from sweat to power the wearables?' and the answer is yes."



Video demonstrating use of the e-skin for robotic assistance. A user wearing the e-skin on the arm was able to control a leg prosthesis while walking. Credit: Yu et al., Sci. Robot. 5, eaaz7946 (2020)

Gao explains that human sweat contains very high levels of the chemical lactate, a compound generated as a by-product of normal metabolic processes, especially by muscles during exercise. The fuel cells built into the e-skin absorb that lactate and combine it with oxygen from the atmosphere, generating water and pyruvate, another by-product of metabolism. As they operate, the biofuel cells generate

enough electricity to power sensors and a Bluetooth device similar to the one that connects your phone to your car stereo, allowing the e-skin to transmit readings from its sensors wirelessly.

"While near-field communication is a common approach for many battery-free e-skin systems, it could be only used for power transfer and data readout over a very short distance," Gao says. "Bluetooth communication consumes higher power but is a more attractive approach with extended connectivity for practical medical and robotic applications."

Two strain sensors were placed on the hand and the elbow, respectively, and connected to the e-skin patch placed on the arm. The e-skin was able to wirelessly control the motion of a robotic arm in real time. The robotic arm recognized the gestures of the human arm and then approached and grabbed the target object. Credit: Yu et al., Sci. Robot. 5, eaaz7946 (2020)

Devising a power source that could run on sweat was not the only challenge in creating the e-skin, Gao says; it also needed to last a long time with high power intensity with minimal degradation. The biofuel cells are made from carbon nanotubes impregnated with a platinum/cobalt catalyst and composite mesh holding an enzyme that breaks down lactate. They can generate continuous, stable power output (as high as several milliwatts per square centimeter) over multiple days in human sweat.

Gao says the plan is to develop a variety of sensors that can be embedded in the e-skin so it can be used for multiple purposes.

"We want this system to be a platform," he says. "In addition to being a wearable biosensor, this can be a human-machine interface. The vital signs and molecular information collected using this platform could be used to design and optimize next-generation prosthetics. "

The paper describing the e-skin, titled, "Biofuel-powered soft electronic skin for multiplexed and wireless sensing," appears in the April 22 issue of Science Robotics.

More information: Y. Yu el al., "Biofuel-powered soft electronic skin with multiplexed and wireless sensing for human-machine interfaces," *Science Robotics* (2020). http://robotics.sciencemag.org … /scirobotics.aaz7946

Journal information: Science Robotics

The AV industry has had to reset expectations as it shifts its focus to Level 4 autonomy

By Mark Anderson

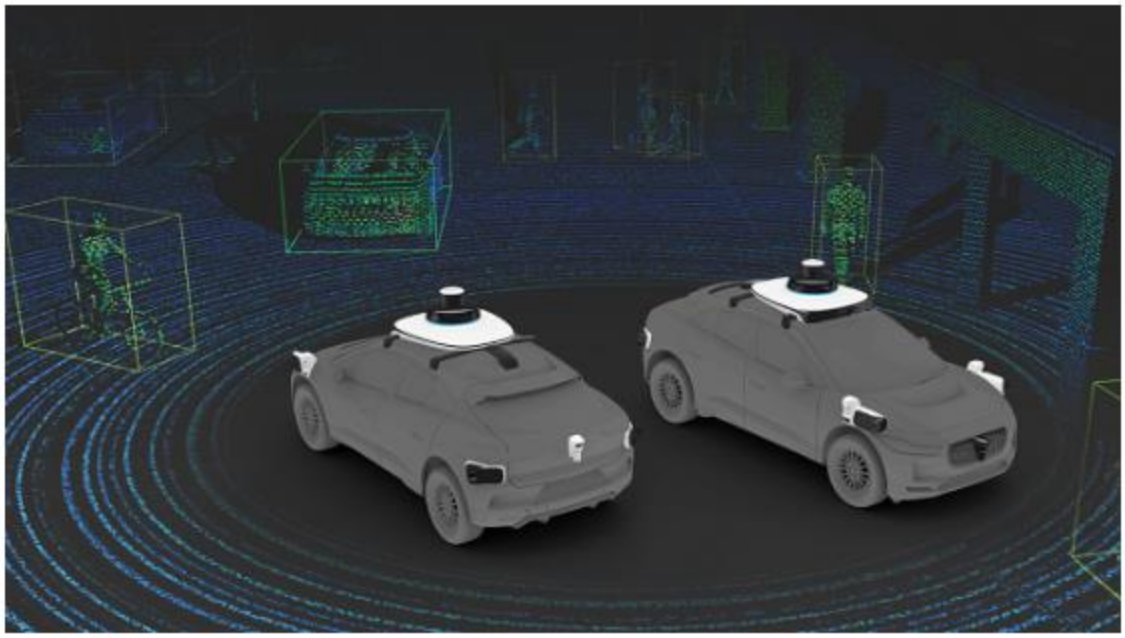


Image: Waymo

Stop and Go: Waymo temporarily suspended trials of its self-driving cars but has released large data sets that developers can use to help improve its algorithms in the meantime.

In March, because of the coronavirus, self-driving car companies, including Argo, Aurora, Cruise, Pony, and Waymo, suspended vehicle testing and operations that involved a human driver. Around the same time, Waymo and Ford released open data sets of information collected during autonomous-vehicle tests and challenged developers to use them to come up with faster and smarter self-driving algorithms.

These developments suggest the self-driving car industry still hopes to make meaningful progress on autonomous vehicles (AVs) this year. But the industry is undoubtedly slowed by the pandemic and facing a set of very hard problems that have gotten no easier to solve in the interim.

Five years ago, several companies including Nissan and Toyota promised self-driving cars in 2020. Lauren Isaac, the Denver-based director of business initiatives at the French self-driving vehicle company EasyMile, says AV hype was "at its peak" back then—and those predictions turned out to be far too rosy.

Now, Isaac says, many companies have turned their immediate attention away from developing fully autonomous Level 5 vehicles, which can operate in any conditions. Instead, the companies are focused on Level 4 automation, which refers to fully automated vehicles that operate within very specific geographical areas or weather conditions. "Today, pretty much all the technology developers are realizing that this is going to be a much more incremental process," she says.

For example, EasyMile's self-driving shuttles operate in airports, college campuses, and business parks. Isaac says the company's shuttles are all Level 4. Unlike Level 3 autonomy (which relies on a driver behind the wheel as its backup), the backup driver in a Level 4 vehicle is the vehicle itself.

"We have levels of redundancy for this technology," she says. "So with our driverless shuttles, we have multiple levels of braking systems, multiple levels of lidars. We have coverage for all systems looking at it from a lot of different angles."

Another challenge: There's no consensus on the fundamental question of how an AV looks at the world. Elon Musk has famously said that any AV manufacturer that uses lidar is "doomed." A 2019 Cornell research paper seemed to bolster the Tesla CEO's controversial claim by developing algorithms that can derive from stereo cameras 3D depth-perception capabilities that rival those of lidar.

However, open data sets have called lidar doomsayers into doubt, says Sam Abuelsamid, a Detroit-based principal analyst in mobility research at the industry consulting firm Navigant Research.

Abuelsamid highlighted a 2019 open data set from the AV company Aptiv, which the AI company Scale then analyzed using two independent sources: The first considered camera data only, while the second incorporated camera plus lidar data. The Scale team found camera-only (2D) data sometimes drew inaccurate "bounding boxes" around vehicles and made poorer predictions about where those vehicles would be going in the immediate future—one of the most important functions of any self-driving system.

"While 2D annotations may look superficially accurate, they often have deeper inaccuracies hiding beneath the surface," software engineer Nathan Hayflick of Scale wrote in a company blog about the team's Aptiv data set research. "Inaccurate data will harm the confidence of [machine learning] models whose outputs cascade down into the vehicle's prediction and planning software."

Abuelsamid says Scale's analysis of Aptiv's data brought home the importance of building AVs with redundant and complementary sensors—and shows why Musk's dismissal of lidar may be too glib. "The [lidar] point cloud gives you precise distance to each point on that vehicle," he says. "So you can now much more accurately calculate the trajectory of that vehicle. You have to have that to do proper prediction."

So how soon might the industry deliver self-driving cars to the masses? Emmanouil Chaniotakis is a lecturer in transport modeling and machine learning at University College London. Earlier this year, he and two researchers at the Technical University of Munich published a comprehensive review of all the studies they could find on the future of shared autonomous vehicles (SAVs).

They found the predictions—for robo-taxis, AV ride-hailing services, and other autonomous car-sharing possibilities—to be all over the map. One forecast had shared autonomous vehicles driving just 20 percent of all miles driven in 2040, while another model forecast them handling 70 percent of all miles driven by 2035.

So autonomous vehicles (shared or not), by some measures at least, could still be many years out. And it's worth remembering that previous predictions proved far too optimistic.

Neuromorphic Vision Sensors Eye the Future of Autonomy

By Anne-Françoise Pelé

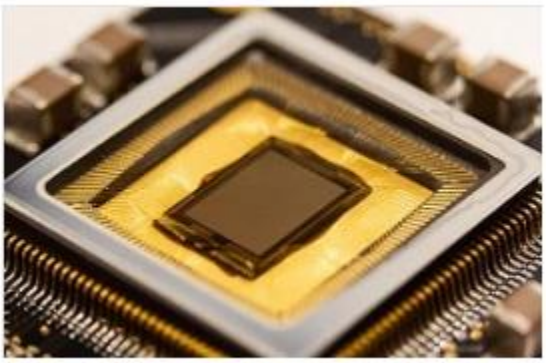
Neuromorphic vision sensors are bio-inspired cameras that capture the vitality of a scene, mitigating data redundancy and latency. Event-based, these sensors bring autonomy closer to reality and find utility in high-speed, vision-based applications in areas such as industrial automation, consumer electronics and autonomous vehicles.

"Why do we say that an event-based vision sensor is neuromorphic? Because each pixel is a neuron, and it totally makes sense to have the artificial intelligence next to the pixel," Pierre Cambou, principal analyst at Yole Développement (Lyon, France) told EE Times.

Dormant for years, the neuromorphic vision sensor industry has been staging a comeback in recent months. Last November, Samsung filed a trademark application for its Dynamic Vision Sensor technology aimed at mobile and tablet applications. "This was a surprise," Cambou said, "since Samsung had originally marketed DVS mainly for automotive advanced driver assistance systems."

In December, Sony quietly acquired Zurich-based Insightness, whose vision sensors allow motion detection within milliseconds even if the sensor itself is moving. And in February, shortly after raising an additional $28 million, Paris-based Prophesee reported during International Solid-State Circuits Conference a new, stacked event-based vision sensor jointly developed with Sony.

Neuromorphic sensing originates from the development of a "silicon retina" by Misha Mahowald at the Institute of Neuroinformatics and ETH Zurich in 1991. Mimicking the human retina, Mahowald explained, "this silicon retina reduces the bandwidth by subtracting average intensity levels from the image and reporting only spatial and temporal changes." This inspiration drives the concept behind the Dynamic Vision Sensor (DVS) and has led to the creation of a myriad of startups in recent years. The Swiss firm iniVation is among them.



iniVation's DAVIS346 DVS

Founded by pioneers of event-based vision in 2015, the Zurich-based company has developed a dynamic vision platform that combines hardware and software for high-performance machine vision systems. Its neuromorphic DVS chip, dubbed DAVIS346, emulates the properties of the human retina. Only local pixel-level changes are transmitted as they occur, resulting in a stream of events at microsecond time resolution, equivalent to conventional vision sensors—but with far less data. Power (up to 90 percent less), data storage and computational requirements are significantly reduced, while sensor dynamic range (above 120 dB) is increased thanks to local processing, the company claimed.

With a network of 300 customers, iniVation has collaborated on IBM's TrueNorth brain-inspired chip with researchers at the University of Pennsylvania, University of Zurich and the U.S. Defense Advanced Research Projects Agency. That research focused on autonomous drone flights. A European Union initiative focused on a smart sustainable city project.

Envisioning smart factories

A silent revolution is occurring in factories. Autonomy and automation go hand in hand, and behind many advances in manufacturing automation is machine vision. Unlike simple sensors, machine vision sensors generate large

amounts of data to identify defective systems, understand their deficiencies and enable rapid intervention. The results are cost savings and productivity gains.

Suitable for industrial vision, iniVation claimed its Dynamic Vision platform enables high-speed 3D infrastructure scanning for predictive maintenance, high-speed production inspection, particle, microscopy for fluorescent imaging and human motion analysis. In other words, it performs mundane or complex repetitive tasks at high speed with high accuracy and consistency.

"It has taken awhile for us to come with a good strategy," iniVation's CEO Kynan Eng said in an interview. While other companies perform high-speed counting, Eng said "it is no big deal counting objects at high speed" since conventional cameras can get "a thousand frames per second, even more." If applications don't need to respond immediately, then "there is no point using our sensors."

What is critical is latency rather than data throughput, and "our sensor deals with fast reaction time." For instance, "If you have a robot moving along, doing something, it needs to adjust its path in real time. The faster it can adjust, the faster it can move and detect its own errors."

"I would [categorize] industrial vision as a relatively low risk, but low volume market," said Eng. Hence, there has been little interest from venture funds. With an eye toward organic growth, iniVation is thinking in terms of economies of scale. Through its 2019 partnership with Samsung, iniVation shifted from manufacturing and silicon sales to selling cameras to the machine vision industry. "You can sell the $100 silicon, or you can package it in a camera and sell a $1,000 camera," noted the Yole analyst Cambou.

By moving towards the system, iniVation is moving up the value chain.

"We recognized that it did not make sense for us to become a chip company," Eng said. "We could raise a billion, and it would still not be enough to make the chip ourselves. People were asking us why our cameras were expensive and how we could make them cheap." Partnering with Samsung, "makes that question go away."

The need for quality has boosted machine vision in the food, packaging, consumer electronics, aerospace and the automotive industries. Eng said iniVation's goal is accessing higher volume markets.

Picturing the future of mobile

Event-based cameras only transmit changes of intensity. They do not suffer from motion blur and have a latency on the order of microseconds. Add to that very high dynamic range and a very low power consumption, making the cameras suitable for virtual and augmented reality applications. "This is a potentially large market, but it is not completely clear when it will become really huge," said Eng. "Right now, it is a niche."

Event-based cameras are also showing up in mobile devices. "The trick is to convince the handset makers to put yet another sensor on the back of their phones," said Eng. Originally, iniVation and other players produced cameras that only used DVS pixels. "These are good for dealing with high speed changes, but in many cases, people just want to take pictures of themselves and their food," Eng added. "What we did some years ago was to develop a sensor with our pixels and normal pixels. You can take normal pictures, do normal processing, and, for particular use cases, you can use our pixels."

Hence, handset makers don't have to make an either-or-decision, and the purchase price remains the same.

"A window for mobile will open in 2021 or 2022," said Cambou. "Today, we have five cameras on the back of a Huawei phone." Moving forward, he continued, "I don't see anything else than an always-on neuromorphic camera. Some people talk about multispectral, but I am more thinking about always-on awareness." An event-based camera could enable touchless interactions such as locking and unlocking phones.

As with Prophesee's collaboration with Sony, partnering with Samsung gives iniVation a leg up in the smartphone market. As always, Cambou said, it is a question of implementation. "The good idea of always-on awareness has been here for years, but now the question is how you implement it. It depends on the applications you serve and what the improvements you offer in terms of customer experience."

Making cars see

Event-based cameras are power-efficient because pixel activity is insignificant; almost no energy is needed for "silent" pixels. That's a selling point as autonomous vehicles transition from internal combustion to electric engines. For car companies, "power consumption is much more important than what I thought initially," said Eng. "In their current planning for electric cars, if a car uses a 4kW total power budget at constant speed, half of that is for moving the car and the other half is for the computing. Every watt you can save on the compute, you can add to the range of the car or have a smaller battery."

The company's Division Sensor Platform enables vehicle odometry, high speed simultaneous localization and mapping (SLAM) in tough lighting conditions and automated driver assistance. "The promise of the autonomous car will increase as the processing technology will develop," said Eng. "We will have a hybrid sensor, which will have both the frames and the events so the car companies can continue using what they have spent billions developing."

Sensors are key to unlocking autonomous vehicles. They also generate a ton of data, and systems "are heavily limited by the processing power," said Cambou. The addition of more cameras—and, with them, more data—means "the computing power explodes." One solution is improving data quality. "If you really want to solve autonomy, you will need more diversity quickly," the analyst said. "You will use lidars, thermal cameras, and hyperspectral cameras. I think car companies should also consider event-based cameras."

The potential of neuromorphic engineering remains largely untapped. Neuromorphic semiconductors, sensing and computing will become a $7.1 billion market by 2029, according to Yole. If all technical questions are solved within the next four to five years, the neuromorphic computing market could grow from $69 million in 2024 to $5 billion in 2029 and $21.3 billion in 2034. And the neuromorphic sensing market could rise from $34 million in 2024 to $2 billion in 2029 and $4.7 billion in 2034.

It's time to build

By Marc Andreessen

Every Western institution was unprepared for the coronavirus pandemic, despite many prior warnings. This monumental failure of institutional effectiveness will reverberate for the rest of the decade, but it's not too early to ask why, and what we need to do about it.

Many of us would like to pin the cause on one political party or another, on one government or another. But the harsh reality is that it all failed — no Western country, or state, or city was prepared — and despite hard work and often extraordinary sacrifice by many people within these institutions. So the problem runs deeper than your favorite political opponent or your home nation.

Part of the problem is clearly foresight, a failure of imagination. But the other part of the problem is what we didn't *do* in advance, and what we're failing to do now. And that is a failure of action, and specifically our widespread inability to *build*.

We see this today with the things we urgently need but don't have. We don't have enough coronavirus tests, or test materials — including, amazingly, cotton swabs and common reagents. We don't have enough ventilators, negative pressure rooms, and ICU beds. And we don't have enough surgical masks, eye shields, and medical gowns — as I write this, New York City has put out a desperate call for rain ponchos to be used as medical gowns. Rain ponchos! In 2020! In America!

We also don't have therapies or a vaccine — despite, again, years of advance warning about bat-borne coronaviruses. Our scientists will hopefully invent therapies and a vaccine, but then we may not have the manufacturing factories required to scale their production. And even then, we'll see if we can deploy therapies or a vaccine fast enough to matter — it took scientists 5 years to get regulatory testing approval for the new Ebola vaccine after that scourge's 2014 outbreak, at the cost of many lives.

In the U.S., we don't even have the ability to get federal bailout money to the people and businesses that need it. Tens of millions of laid off workers and their families, and many millions of small businesses, are in serious trouble *right now*, and we have no direct method to transfer them money without potentially disastrous delays. A government that collects money from all its citizens and businesses each year has never built a system to distribute money to us when it's needed most.

Why do we not have these things? Medical equipment and financial conduits involve no rocket science whatsoever. At least therapies and vaccines are hard! Making masks and transferring money are not hard. We could have these things but we chose not to — specifically we chose not to have the mechanisms, the factories, the systems to make these things. We chose not to *build*.

You don't just see this smug complacency, this satisfaction with the status quo and the unwillingness to build, in the pandemic, or in healthcare generally. You see it throughout Western life, and specifically throughout American life.

You see it in housing and the physical footprint of our cities. We can't build nearly enough housing in our cities with surging economic potential — which results in crazily skyrocketing housing prices in places like San Francisco, making it nearly impossible for regular people to move in and take the jobs of the future. We also can't build the cities themselves anymore. When the producers of HBO's "Westworld" wanted to portray the American city of the future, they didn't film in Seattle or Los Angeles or Austin — they went to Singapore. We should have gleaming

skyscrapers and spectacular living environments in all our best cities at levels way beyond what we have now; where are they?

You see it in education. We have top-end universities, yes, but with the capacity to teach only a microscopic percentage of the 4 million new 18 year olds in the U.S. each year, or the 120 million new 18 year olds in the world each year. Why not educate every 18 year old? Isn't that the most important thing we can possibly do? Why not build a far larger number of universities, or scale the ones we have way up? The last major innovation in K-12 education was Montessori, which traces back to the 1960s; we've been doing education research that's never reached practical deployment for 50 years since; why not build a lot more great K-12 schools using everything we now know? We know one-to-one tutoring can reliably increase education outcomes by two standard deviations (the Bloom two-sigma effect); we have the internet; why haven't we built systems to match every young learner with an older tutor to dramatically improve student success?

You see it in manufacturing. Contrary to conventional wisdom, American manufacturing output is higher than ever, but why has so much manufacturing been offshored to places with cheaper manual labor? We know how to build highly automated factories. We know the enormous number of higher paying jobs we would create to design and build and operate those factories. We know — and we're experiencing right now! — the strategic problem of relying on offshore manufacturing of key goods. Why aren't we building Elon Musk's "alien dreadnoughts" — giant, gleaming, state of the art factories producing every conceivable kind of product, at the highest possible quality and lowest possible cost — all throughout our country?

You see it in transportation. Where are the supersonic aircraft? Where are the millions of delivery drones? Where are the high speed trains, the soaring monorails, the hyperloops, and yes, the flying cars?

Is the problem money? That seems hard to believe when we have the money to wage endless wars in the Middle East and repeatedly bail out incumbent banks, airlines, and carmakers. The federal government just passed a $2 trillion coronavirus rescue package in two weeks! Is the problem capitalism? I'm with Nicholas Stern when he says that capitalism is how we take care of people we don't know — all of these fields are highly lucrative already and should be prime stomping grounds for capitalist investment, good both for the investor and the customers who are served. Is the problem technical competence? Clearly not, or we wouldn't have the homes and skyscrapers, schools and hospitals, cars and trains, computers and smartphones, that we already have.

The problem is desire. We need to *want* these things. The problem is inertia. We need to want these things more than we want to prevent these things. The problem is regulatory capture. We need to want new companies to build these things, even if incumbents don't like it, even if only to force the incumbents to build these things. And the problem is will. We need to build these things.

And we need to separate the imperative to build these things from ideology and politics. Both sides need to contribute to building.

The right starts out in a more natural, albeit compromised, place. The right is generally pro production, but is too often corrupted by forces that hold back market-based competition and the building of things. The right must fight hard against crony capitalism, regulatory capture, ossified oligopolies, risk-inducing offshoring, and investor-friendly buybacks in lieu of customer-friendly (and, over a longer period of time, even more investor-friendly) innovation.

It's time for full-throated, unapologetic, uncompromised political support from the right for aggressive investment in new products, in new industries, in new factories, in new science, in big leaps forward.

The left starts out with a stronger bias toward the public sector in many of these areas. To which I say, prove the superior model! Demonstrate that the public sector can build better hospitals, better schools, better transportation, better cities, better housing. Stop trying to protect the old, the entrenched, the irrelevant; commit the public sector

fully to the future. Milton Friedman once said the great public sector mistake is to judge policies and programs by their intentions rather than their results. Instead of taking that as an insult, take it as a challenge — build new things and show the results!

Show that new models of public sector healthcare can be inexpensive and effective — how about starting with the VA? When the next coronavirus comes along, blow us away! Even private universities like Harvard are lavished with public funding; why can't 100,000 or 1 million students a year attend Harvard? Why shouldn't regulators and taxpayers demand that Harvard build? Solve the climate crisis by building — energy experts say that all carbon-based electrical power generation on the planet could be replaced by a few thousand new zero-emission nuclear reactors, so let's build those. Maybe we can start with 10 new reactors? Then 100? Then the rest?

In fact, I think building is how we reboot the American dream. The things we build in huge quantities, like computers and TVs, drop rapidly in price. The things we don't, like housing, schools, and hospitals, skyrocket in price. What's the American dream? The opportunity to have a home of your own, and a family you can provide for. We need to break the rapidly escalating price curves for housing, education, and healthcare, to make sure that every American can realize the dream, and the only way to do that is to build.

Building isn't easy, or we'd already be doing all this. We need to demand more of our political leaders, of our CEOs, our entrepreneurs, our investors. We need to demand more of our culture, of our society. And we need to demand more from one another. We're all necessary, and we can all contribute, to building.

Every step of the way, to everyone around us, we should be asking the question, what are you building? What are you building directly, or helping other people to build, or teaching other people to build, or taking care of people who are building? If the work you're doing isn't either leading to something being built or taking care of people directly, we've failed you, and we need to get you into a position, an occupation, a career where you can contribute to building. There are always outstanding people in even the most broken systems — we need to get all the talent we can on the biggest problems we have, and on building the answers to those problems.

I expect this essay to be the target of criticism. Here's a modest proposal to my critics. Instead of attacking my ideas of what to build, conceive your own! What do you think we should build? There's an excellent chance I'll agree with you.

Our nation and our civilization were built on production, on building. Our forefathers and foremothers built roads and trains, farms and factories, then the computer, the microchip, the smartphone, and uncounted thousands of other things that we now take for granted, that are all around us, that define our lives and provide for our well-being. There is only one way to honor their legacy and to create the future we want for our own children and grandchildren, and that's to build.

5 Critical Features of mmWave Isolators for Higher Wave-Spectrum Frequencies

Improvements in the five critical characteristics of isolators benefit electronics manufacturers in the new path toward next-generation wireless systems.

By David Porterfield

Satisfying the inexhaustible future demand for wireless spectrum will mean taking advantage of the higher ends of the electromagnetic (EM) spectrum. Driven by 5G, 6G, and beyond; ultra-high definition video; autonomous vehicles; security applications; and IoT, designers must capitalize on the millimeter-wave (mmWave) bands, which presently cover 30 to 500 GHz, to fill spectrum requirements.

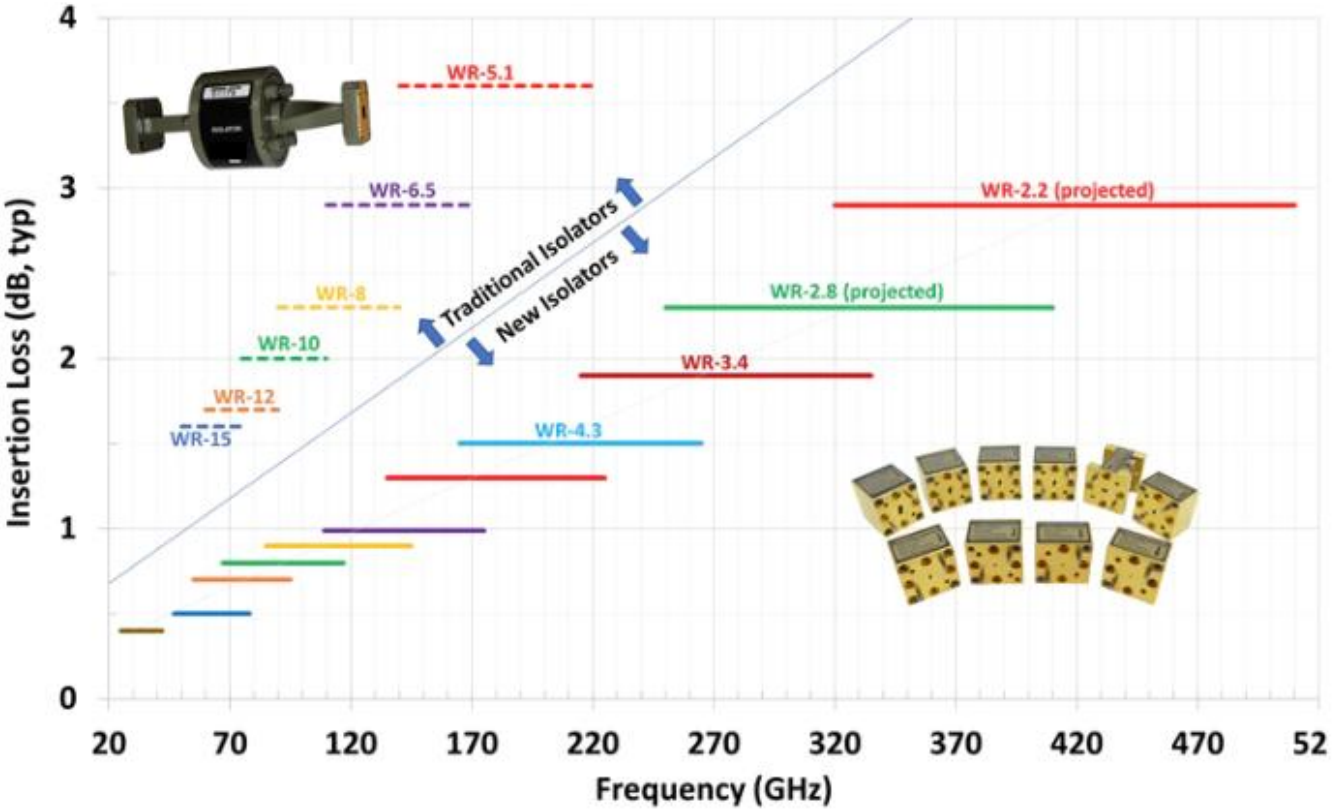
However, these higher frequencies present a significant problem that design engineers must address: standing waves. Without remediation, these unwanted waves can attenuate power output, distort the digital information on the carrier, and, in extreme cases, damage internal components (Fig. 1).

1. Without control, standing waves can attenuate power output, distort the digital information on the carrier, and, in extreme cases, damage internal components.

To counteract the problem of standing waves at lower microwave frequencies, engineers rely on Faraday rotation isolators—more commonly referred to simply as isolators. At their most basic level, an isolator is a two-port (input and output) component that allows EM signals to pass in one direction but absorbs them in the opposite direction (Fig. 2). However, traditional isolators fall short at the higher frequencies required for next-generation wireless applications.

2. An isolator is a two-port—input and output—component that enables electromagnetic signals to pass in one direction but absorbs them in the opposite direction. However, traditional isolators fall short at the higher frequencies required for next-gen wireless applications.

A big part of the problem is that the first isolators were designed over 50 years ago, with very few modifications since the original concept (Fig. 3). With recent advances, however, companies at the cutting edge of mmWave technologies are gaining the ability to launch products that operate optimally at stratospheric frequencies.



3. A big part of the problem is that the first isolators were designed more than a half-century ago, with very few modifications since the original concept. These isolators had good isolation but very high attenuation of the forward, input signal.

By understanding these advances in each of the five properties of isolator functionality, designers can better harness isolators to improve their mmWave products:

1. High isolation

Isolation is a measure of how much of the signal traveling in the reverse direction passes back through the isolator. Because isolators are intended to prevent or minimize this from happening, the higher the isolation, the better.

The issue that mmWave system designers face is impedance mismatches and the resulting reflections between components. In mmWave systems, the distance between components is often more than a wavelength, putting

reflected signals out of phase. This can perturb the operating point of the upstream component. As you sweep frequencies, the phase changes and you get nulls, dips, and degraded performance. However, when you insert an isolator between components, the reflected signal gets absorbed and the problem is resolved.

The highest possible isolation occurs when the reverse wave is rotated exactly 45 degrees into the plane of the isolator's resistive layer. Isolation can degrade by as much as 10 dB when the signal rotation is off by just 1 degree. The only way to confirm such precision is to fully characterize each isolator on a vector network analyzer. This validates total compliance, as opposed to just spot-checking at a couple of frequencies in the band.

2. Low insertion loss

While isolation is the namesake of these components, the suppression of the reverse wave can't come at the expense of attenuating the forward, input signal. Insertion loss is a measure of how much loss a signal incurs as it passes through the isolator in the forward direction.

For traditional-style isolators, insertion loss is low in the microwave bands. However, at mmWave frequencies, the loss becomes increasingly problematic. For instance, in the WR-10 band (75 to 110 GHz), the insertion loss can exceed 3 dB, meaning half of the signal power is lost. In the WR-5.1 band (140 to 220 GHz), the loss climbs to more than 5 dB. Because of such high losses, traditional isolators are often precluded for use in mmWave systems.

One of the biggest fears for any designer is that the isolator will significantly degrade the strength of the final output. It can be frustrating for engineers to try and tune the standing waves out of each system, usually with limited success. Many of the alternate methods used are narrowband in nature, so that the solution may work well only over an insufficiently narrow band of frequencies.

Faraday rotation isolators operate by using ferrite discs to rotate the signal. However, the traditional method to manufacture them has been to use ferrites that are substantially longer than the minimum required length, and then tune the magnetic bias field to achieve optimal performance. This delivers good isolation, but at a much higher insertion loss.

This workaround presents a two-fold problem. First, there's more of the lossy ferrite in the signal path, and second, the ferrite loss parameter increases at lower magnetization levels.

To minimize loss, it's essential that the ferrite length be reduced as much as possible. The biggest improvement in the latest designs developed for NASA saturates the ferrite with a strong magnetic bias field, which allows for the shortest possible length of ferrite to achieve the ideal 45 degrees of rotation (Fig. 4).

4. To counteract the problem of standing waves at higher mmWave frequencies, engineers are turning to isolators that were recently redesigned for NASA.

This lowers the insertion loss to less than 1 dB at 75 to 110 GHz and only 2 dB at 220 to 330 GHz.

3. Low port reflection
A good isolator must also have low port reflections. Voltage standing-wave ratio (VSWR) is a measure of the reflections at the input and output ports. A good range at mmWave frequencies is 1.5:1 or less; 1:1 equals no reflection.

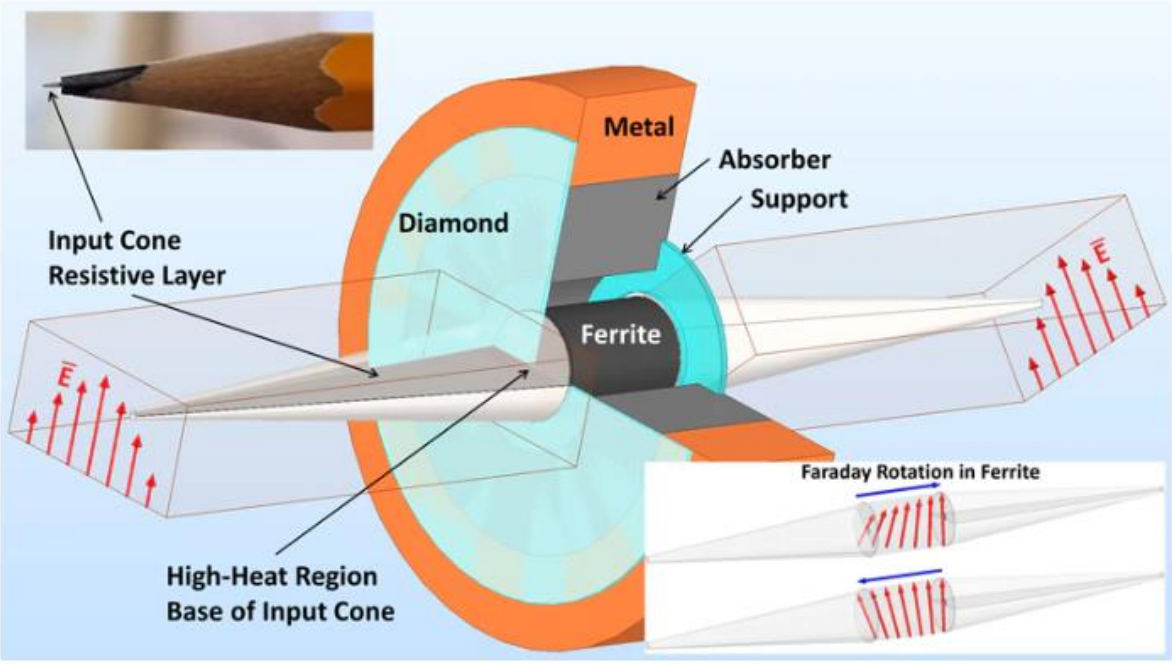
The importance of low port reflections is often overlooked. An isolator with high port reflections creates an alternate set of standing waves. The adjacent components are still adversely impacted by out-of-phase signals reflected into their ports. High isolation and low insertion loss are of little value if the port reflections are large.

4. High power rating
Power in the reverse traveling signal is absorbed in the isolator, resulting in heat. The more heat it can handle, the higher the power rating. Historically, high heat wasn't an issue as there was very little power available at mmWave frequencies. However, as higher power sources become available, power ratings become more important.

To handle the problem of high heat loads, some newer isolators are already incorporating diamond heatsinks into their design. Diamond is the ultimate thermal conductor, approaching 2200 W/m • K (watts per meter-Kelvin), more than five times higher than copper. Diamond effectively channels heat from the resistive layer in the isolator to the metal waveguide block, and thus lowers operating temperatures for improved reliability.

5. Small footprint
Minimizing the size and weight of mmWave components is especially important in today's wireless applications. A standard traditional-style isolator in the WR-10 band is about 3 inches long, with a cylindrical section in the center that's approximately 1.3 inches in diameter. However, the newest design shapes are rectangular and can be as small as 0.75 inches per side and 0.45 inches thick.

The same technology used to reduce insertion loss—utilizing the shortest possible length of ferrite—also partially accounts for the reduction in footprint (Fig. 5).



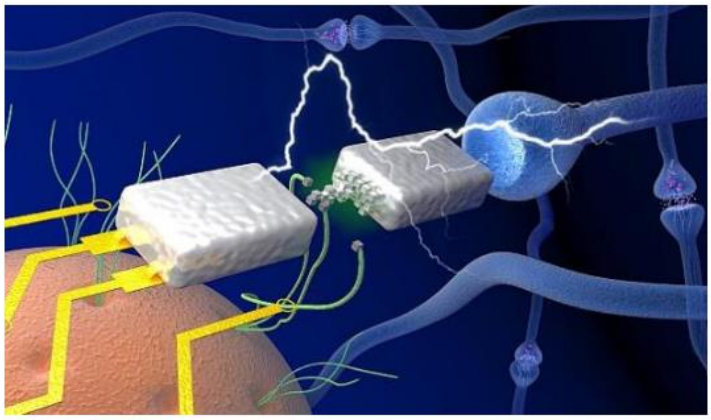
5. Micro Harmonics revolutionized the design of the Faraday rotation isolator. The new design delivers extremely low insertion loss at very high frequencies and a wide bandwidth, all within a more compact size.

In addition to the five critical characteristics, other properties of modern isolators improve their utility at mmWave frequencies, such as wide bandwidth. Standard waveguide bands typically extend to 40% on either side of the center frequency. Newer, high-performing isolators operate over extended bandwidths exceeding 50% from center frequency, giving designers greater freedom to build more bandwidth into their systems.

Additional advances include isolators that operate in cryogenic conditions. This is a critical characteristic, because a traditional isolator designed for room-temperature operation will perform poorly when cooled.

Neuromorphic memristor operates at biological voltages

By Rich Pell



Researchers at the University of Massachusetts Amherst say they have discovered how to use protein nanowires - biological, electricity conducting filaments - to make a neuromorphic memristor, or "memory transistor," device.

Such a device, say the researchers, runs extremely efficiently on very low power, as brains do, to carry signals between neurons, addressing one of the biggest hurdles to neuromorphic computing - being able to operate at neurological voltages. While most conventional computers operate at over 1 volt, the brain sends signals - called action potentials - between neurons at around 80 millivolts,

The researchers demonstrated that their bioinspired bio-voltage memristors function at the biological voltages of 40 - 100 mV.

"This is the first time that a device can function at the same voltage level as the brain," says electrical and computer engineering researcher Jun Yao, a co-author of a paper on the research. "People probably didn't even dare to hope that we could create a device that is as power-efficient as the biological counterparts in a brain, but now we have realistic evidence of ultra-low power computing capabilities. It's a concept breakthrough and we think it's going to cause a lot of exploration in electronics that work in the biological voltage regime."

The protein nanowires used in the research were harvested from the bacterium Geobacter. Geobacter's electrically conductive protein nanowires, say the researchers, offer many advantages over expensive silicon nanowires, which require toxic chemicals and high-energy processes to produce. Protein nanowires also are more stable in water or bodily fluids, an important feature for biomedical applications. The researchers sheared nanowires off the bacteria so only the conductive protein was used and then "put the purified nanowires through their paces" to see what they are capable of at different voltages. They experimented with a pulsing on-off pattern of positive-negative charge sent through a tiny metal thread in a memristor, which creates an electrical switch.

They used a metal thread because protein nanowires facilitate metal reduction, changing metal ion reactivity and electron transfer properties. This microbial ability is not surprising, say the researchers, because wild bacterial nanowires breathe and chemically reduce metals to get their energy the way we breathe oxygen.
As the on-off pulses create changes in the metal filaments, new branching and connections are created in the tiny device, which is 100 times smaller than the diameter of a human hair, creating an effect similar to learning – new connections – in a real brain.

"You can modulate the conductivity, or the plasticity of the nanowire-memristor synapse so it can emulate biological components for brain-inspired computing," says Yao. "Compared to a conventional computer, this device has a learning capability that is not software-based."

The researchers say they plan to follow up this discovery with more research on mechanisms, and to "fully explore the chemistry, biology and electronics" of protein nanowires in memristors. In addition, they plan to explore possible applications, which might, for example, include a device to monitor heart rate.

"This," says Yao, "offers hope in the feasibility that one day this device can talk to actual neurons in biological systems."

What are the risks, challenges and opportunities?

By Martin Vares

When most people think of startups, they picture hip loft offices, beanbags and charismatic CEOs with boundless enthusiasm and a seat-of-the-pants attitude. While this may be the case for some new businesses, particularly within tech, the picture for many startups is starkly different. Starting a brand new business in an industry such as manufacturing comes with a high level of risk. According to Failory.com, it is estimated that around 90% of startups in any industry are doomed to fail. On top of that, the failure rate for traditional manufacturing companies is pretty high at 51%. Only construction (53%) and information (63%) are higher.

STEERING CLEAR OF INDUSTRY CHALLENGES THAT SINK OTHER BUSINESSES

The manufacturing sector presents many challenges for a brand new business. The industry is facing a skills crisis, with around 22% of manufacturing workers due to retire within the next 10 years. The challenge will be to channel young talent into STEM careers, which includes manufacturing.

And as the sector moves towards digitisation and automation, new tech-based skill sets will be needed. Startups can't simply expect the right talent to be right there waiting to be hired. They may have to consider apprenticeships, partnering with educational institutions and taking steps to grow their own talent.

Manufacturing startups will also face challenges such as utilising new technologies, global competition and knowing when (and how) to scale their business. But entrepreneurs wanting to break into manufacturing shouldn't let failure rates and obstacles such as these scare them off.

HOW TECHNOLOGY CAN OPEN UP A WORLD OF NEW OPPORTUNITIES

While starting out in manufacturing of course comes with a great deal of risk, there are also enormously exciting opportunities to be seized. This is especially the case now that large markets are looking for ways to bring their supply chains back home.

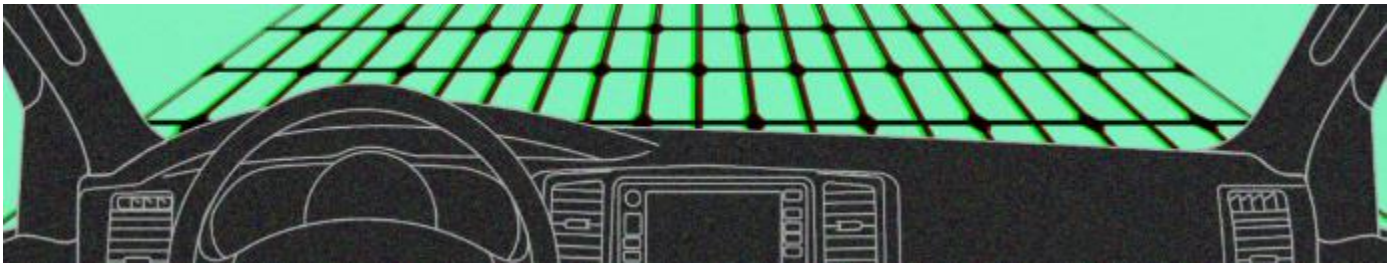
The company I co-founded, Fractory, is bringing metal fabrication online. It began as all good businesses do – with an idea, one based on filling an obvious and vital gap in the market. Realising that the procurement process in manufacturing was taking far too long, we developed a cloud-based online quoting system to improve efficiency and free up as much as 20% of an engineer's time. The lead times for each step in the manufacturing process can be reduced using Fractory's pioneering system that utilises in-house built algorithms.

But where Fractory stands apart from other startups is its position as both a manufacturing firm and an exciting tech innovator. Where others have built on existing systems, we invented our own – a pioneering cloud-based platform that's already transforming manufacturing procurement in the UK, Scandinavia and the Baltics.
The issues are the same everywhere, so an actual solution can be applied in different countries with ease. What was once seen as a niche workflow hack is rapidly turning into standard practice, as a whole new cloud manufacturing industry springs up.

As said in the beginning, the failure rates for both startups and manufacturing businesses are pretty high, which makes for a daunting combination. At the same time, there is a lot of talk about digitalisation, but the journey towards Industry 4 presents its hurdles.
So looking around, there are a few gaps to fill in the manufacturing sector to help the traditional companies overcome their problems. Harnessing technology to solve key industry issues is the key to opening up new opportunities for yourself and other companies alike.

The biggest myth about self-driving cars: That humans can sit back and enjoy the ride

The hype about autonomous vehicles misses one key point: Humans will still be vitally necessary for a very long time.



By Rana El Kaliouby

AI is sophisticated enough to take over the basic function of driving a vehicle, but driving entails so much more than just navigating a car. Human beings perform a vast variety of tasks in a car, and much of that job is dealing with other humans. Look at the role of the driver: only a part of his or her attention is focused on actually operating the vehicle. There are also ongoing interactions with others in the car—"Uh-oh, Michael is carsick and about to throw up! Can you turn down the music?" "Hey, you two kids had better stop fighting or I'm going to pull over." Or, for example, if another car is about to cut you off, your passengers will automatically check to see if you are aware of the situation and are prepared to react.

The fact is, human beings won't completely be out of the driver's seat anytime soon. We still have the edge over AI because we think like other human beings. We anticipate that other drivers or pedestrians may not always follow the rules of the road, or they may behave in irrational ways. If we see children playing ball near the road, we will mentally take note and be prepared to stop if a child runs into the street to retrieve the ball. We know this not from a driving manual, but from life experience. We instinctively respond to situations in a very human way. Eventually, learning algorithms will be developed to imitate some of our gut reactions, but this will take time.

So far, there's been little effort on the part of either the automobile industry or public safety officials to bring the public up to speed. When people hear the term autonomous car, they are often under the mistaken belief that the role of the human driver has been eliminated, that he or she is now relegated to the role of passenger.

"The biggest myth about automation is the more automation, the less you need human expertise. Actually, the more you automate, the more you need to educate, where, when, how etc.," observes Bryan Reimer, PhD, a research scientist at MIT's Center for Transportation and Logistics, a researcher in the AgeLab, and associate director of the New England University Transportation Center.

> "THE BIGGEST MYTH ABOUT AUTOMATION IS THE MORE AUTOMATION, THE LESS YOU NEED HUMAN EXPERTISE."
>
> BRYAN REIMER

Dr. Reimer, who has studied driver behavior as it relates to automation, raises an interesting point: As our automobiles assume more and more of the tasks of their operation, there is a risk that human beings will lose some of the real-world driving experiences that make us seasoned drivers. This is fine as long as the car remains in control. But in a world of semiautonomous vehicles, the drivers may become less equipped to handle the complicated maneuvers that would stump the software. As Dr. Reimer notes, "We unfortunately will get worse at driving, as humans learn from doing. The less we do, the less we learn. That's why a lot of the risks of this mixed system go up over time. If

we're no longer doing, we're no longer learning. So, that means the future is one of novice drivers, and we all know that novice drivers are even more risky than established, trained drivers."

So, there is a catch-22 here. If we lose our driving skills due to semiautomation, we won't be able to be as effective partners with our semiautonomous cars. Furthermore, the very nature of semiautonomous vehicles may lull some people into a false sense of security.

In addition, when we get behind the wheel of a car equipped with lots of sophisticated automated features, human beings revert to behavior that can actually make us less safe. It has to do with what psychologists call cognitive load, a field of research that began with a study of mice in a maze. In 1908, psychologists Robert Yerkes and John Dillingham Dodson found that mice given a low electric shock were motivated to finish a maze, but if the shock was too high, the mice gave up. This led to the famous Yerkes-Dodson law we still refer to today; its bell-shaped curve shows the relationship between arousal and performance.

When you move to the left of the curve, you are less aroused, and when you move to the right of the curve, you are over aroused. Finding the right amount of stress is tricky: If stress levels rise too high, it can result in cognitive overload, and people, like mice, shut down. If, however, stress levels dip below a certain point, there is a risk of cognitive underload, which can also impair human performance. For optimal performance you need to land on the just right spot on the curve. But maintaining the right level of arousal in a car can be tricky.

For decades, it was assumed that automation induced underload and would make people drowsy or less alert. In some instances, that was true. In the late 20th century, researchers noticed that this was exactly what was happening to pilots in cockpits as the once-labor-intensive tasks of flying a plane were replaced with computerized navigation and safety equipment. But cognitive underload in an automated car looks different from, say, that in a cockpit. When we are understimulated and veer to the left side of the bell curve, we often become bored and look for some other, nondriving activity to occupy our time, such as texting, making a call, eating, or watching a video.

"And that's where the fundamental premise of state management comes in, helping people to make better moment-to-moment decisions," Reimer explains.

Car companies are beginning to add features to keep drivers more fully engaged during periods when the car is in control. General Motors's 2018 Cadillac CT6 offers a Super Cruise system that enables "the first true hands free driving system for the freeway," on some U.S. highways, but it has a camera embedded in the steering column that tracks the driver's head position and eye moments to make sure that his eyes are on the road.

The ProPILOT Assist system offered on the Infiniti QX50 and Nissan Leaf takes a different approach to keep drivers engaged: in order to operate it, the driver must keep both hands on the wheel. These features help, but enabling cars to recognize and understand our emotions could also gauge human attention and mood, and keep the driver alert and ready to take the wheel.

The way we approach driver training will likely need an upgrade to accommodate the new world of semiautonomous cars. Perhaps we will need to periodically take refresher classes to maintain our driving skills, or practice on tracks like the Veoneer Smart City, which is filled with the kinds of unexpected challenges that occur in real life. But bottom line, it doesn't look like we're going to have to shut down our driving schools anytime soon.

Quectel Wireless Solutions, a leading global supplier of cellular and GNSS modules, has introduced two new series of Wi-Fi 6 modules. The first product in the lineup is the FG50X - an industrial-grade module based on the Qualcomm FastConnect 6800 mobile connectivity subsystem, which is designed to deliver faster, more secure, and more robust Wi-Fi experiences and enable new Bluetooth audio capabilities. The second product is an automotive-grade module - AF50T based on Qualcomm's most advanced automotive Wi-Fi solution, the QCA6696 automotive Wi-Fi 6 chip.

The two new modules series are designed to deliver enhanced performance in capacity, data rates, latency, power consumption and coverage. They will bring premium wireless performance to a variety of consumer, industrial and automotive applications, such as smart homes, MiFi, smart TVs, over-the-top (OTT) devices, industrial controls, customer premises equipment (CPE), the Internet of Vehicles and much more.

The Quectel FG50X Series and AF50T Modules support IEEE 802.11 ax and BT 5.1, and are backward compatible with 802.11 a/b/g/n/ac protocols. In addition to this, the low-power Wi-Fi 6 modules support Dual MAC, 2.4 GHz & 5 GHz Dual Bands Simultaneous (DBS) in 2X2+2X2 mode, MU-MIMO with 8x8 sounding, advanced Orthogonal Frequency Division Multiple Access (OFDMA) and 1024-QAM (Orthogonal Amplitude Modulation) capabilities, which can deliver faster, more secure and robust Wi-Fi performance, with a maximum data rate of up to 1774.5 Mbps. To address the differing demands of various IoT segments, Quectel has designed multiple variants of the FG50X series.

When used in combination with Quectel's 5G module RG500Q, the FG50X series offers a superior 5G and Wi-Fi 6 solution for MiFi and CPEs that is designed to ensure high-speed connections which can support up to 32 clients at a time, and guarantee smoother and more reliable connections for smart home gadgets and many other multi-user scenarios. It also reduces network congestion for complex indoor scenarios like home, shopping malls, schools, and factories. Moreover, the FG50X series utilizes the WPA3 encryption mode to greatly improve the security of Wi-Fi connections.

The automotive-grade Wi-Fi 6 module AF50T strictly adheres to the IATF 16949:2016 standards and complies with automotive quality processes including APQP and PPAP, which ensures they meet the rigorous requirements of the automotive segment. The AF50T is specifically designed for Internet of Vehicles (IoV) applications, such as in-vehicle infotainment and on-board diagnosis (OBD). The module's compact design of 19.5 × 21.5 × 2.3 mm in an LGA form factor permits automotive Tier 1 suppliers and OEMs to reduce their product size and design cost.

In addition to the automotive infotainment uses, the AF50T module when combined with Quectel's LTE-A + C-V2X module AG520R and 5G+ C-V2X module AG550Q makes an ideal LTE-A/5G + Wi-Fi/BT solution to address in-vehicle information processing demands, such as hot spot, data uploading and vehicle monitoring. Benefiting from its unique software and hardware functionality, the AF50T can effectively cope with channel interferences, and is also designed to work with the two C-V2X modules.

Engineering samples of the FG50X and AF50T modules are available now and have been provided to a range of customers for their new product designs, with the first wave of customer devices powered by FG50X modules expected in the market by May 2020.

Pandemic reset leads investors to focus on resilience, adaptability

By Mahendra Ramsinghani

For the vast majority of startup founders who were planning their capital raise in Q1 2020, the COVID-19 blow was so dramatic and sweeping, we cannot see all its effects at once.

One big question on the minds of most founders: How should we plan our next raise in terms of timing, valuation and amounts?

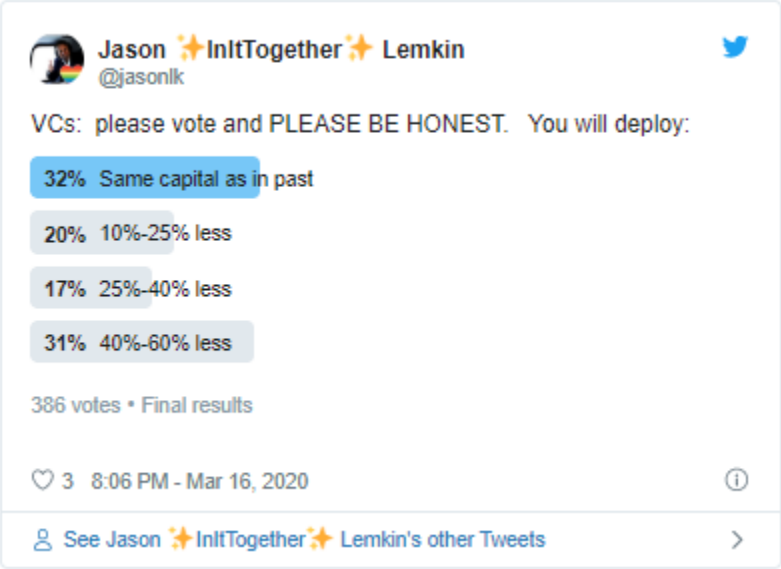
Sarah Guo, partner at Greylock Partners, says the fundraising environment has slowed down significantly, but founders who have built ties with VCs via informal coffee updates and check-ins are at a clear advantage. "Early-stage bets require relationship-building," says Guo, who has been investing in seed through Series B rounds.

Ram Shanmugam, founder and CEO of AutonomIQ*, a seed-stage code and process automation company, has been strengthening his relationships. For a company that has low operating expenses and a community of 600,000 developers, he says he is not fazed. "Our automation code brings efficiencies and in fact, we have nine inbound leads in Q2. Having said that, we are being realistic at the pace at which we can close these contracts."

Similarly, Fred Blumer, who exited Hughes Telematics at an enviable $750 million, says he is taking a more pragmatic approach to the Series A raise for his new company, Mile Auto. "We expect to have a 5x growth in our business in 2020, even after adjusting for COVID," he said. "Our pay-per-mile insurance is a great fit for people who are driving less." Because so many drivers are sheltering in place, legacy insurance companies are refunding hundreds of millions of dollars to customers, which offers an advantage (and an opportunity) to a startup like his.

"But we need to be patient and mindful. While our families, health and safety are top priority, we are staying focused on our customers," Blumer said. "Insurtech is a resilient arena, and in my past company we raised $100 million, so working with investors has never been a challenge. Keeping up with growth and perfecting the customer experience are what keep us up at night." He said he plans to get out in the market after investor confidence returns.

Which may be a good idea, considering Jason Lemkin's Twitter survey, where only 32% of respondents said they plan to deploy the same amount of capital as in the past. But another 30% are on the opposite end of the spectrum, deploying 40% to 60% less capital.



Lightspeed Partners (LSVP) recently announced a new fund with $4 billion of fresh capital.

"In this new environment, we will certainly continue to invest in ambitious, outlier founders tackling large problems with disruptive products and technologies," says Arif Janmohamed, an LSVP partner for over a decade. "That said, our decision-making velocity has become more deliberate as we invest more time with founders to understand their long-term vision, their commitment to build enduring businesses and to

dig into how they are planning to build their company in this different environment."

Similarly, Cack Wilhelm, a partner at $1.5 billion growth-stage fund IVP, says "time from first meeting to term sheet has slowed down. Companies are in the midst of reforecasting and adjusting their projections, and we are being deliberate about new opportunities."

Investors are also focusing more on adaptability and resilience. "In the COVID-19 market conditions, founder's traits such as leadership, adaptability and decisiveness are more pronounced than ever before," says Oren Yunger, partner at GGV Capital, which continues to deploy at the same pace and does not anticipate much changes. Jordan Cooper, partner at Pace Capital, has just raised a $150 million fund and does not have the baggage of an existing portfolio to worry about, a sentiment he expressed with a tweet: "I don't need 3- 6 months for the dust to settle. Am ready to lead your Series A right now."

"New firms like Pace who don't have 50 companies to support will be very active through this period. It's going to take a while for the folks who already sit on 16 boards to pick their heads up and proactively invest in the new normal," he says.

One key takeaway from these conversations is that investors with fresh capital could move faster, especially at seed and early stages. Earlier-stage companies have longer cycles to exit. But what about valuations? Can we expect the kind of love that Masayoshi Son of SoftBank fame showed to his founders? Not anymore.

Gopi Rangan, general partner at seed-stage insurtech-focused fund Sure Ventures, says "entrepreneurs still live in the euphoric pre-COVID times and are not ready to accept longer sales cycles. Being optimistic is good, but having a dose of pragmatism helps. I am tired of asking basic questions." Guo of Greylock echoes similar sentiments, noting, "we were overdue for a valuation correction pre-COVID, and I believe it will take multiple years to return to 2019 valuations."

Cooper shared a succinct view of the valuation trend: "The best proxy I have in the absence of hard data is how founders are adjusting round sizes. If you assume they are still budgeting similar dilution at the Series A round, say 20%, for a smaller raise of say $5 million instead of $8 million, that would suggest implied valuations is reduced by 30-40%. It's unclear how many of those rounds are actually clearing, but that's where the discovery price seems to land."

For later-stage investors, the public markets proxy are a reasonable starting point, said Jack Young, partner and head of venture capital at DTCP, a $350 million fund focused on expansion and growth-stage companies. "Valuation is a function of performance, as well as public market multiples. Cloud software multiples are trading around ~8x median EV/forward revenue but high-growth companies are double and outliers like Okta are Datadog much higher," he said.

Wilhem reminds us that VCs are simultaneously buyers and sellers: "Exit windows are closed, and will be for some time." Gaurav Bhasin, managing director at boutique technology M&A firm Allied Advisers, noted that deals are taking longer to close.

"Transaction times and efforts have increased," he said. "It's 2x longer and 2x harder to finish a transaction; lack of face-to-face interaction is typical in deals. These create challenges which are somewhat alleviated by collaboration tools. But the markets will open up gradually and quickly for technology sectors. Cash holdings of top S&P 500 Information Technology firms totaled $504.9B as of 31st March 2020. Among PE firms, reserves of dry powder is estimated to be around $1.5T are at record levels," he pointed out in a recent post.

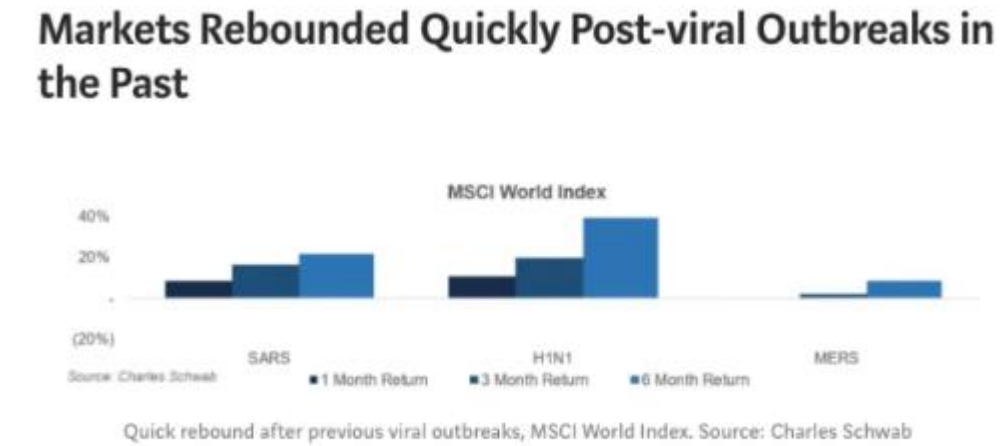


Image Credits: Allied Advisers

When public markets and exit windows slow down, later-stage investors exhibit more caution as their investment cycles are shorter compared to seed and early-stage investors. Yet the universal message was that for great companies, where teams are strong and performance is stellar, valuation is seldom an issue.

Sectors such as government and healthcare that were lagging in adoption of modern technologies were forced to make changes overnight as COVID-19 cured them of technology adoption inertia. The importance of cybersecurity became paramount — endpoint security, telehealth and distance learning just got a swift kick in the pants, as did communications. Gartner predicts that global 2020 IT spend post COVID-19 will drop by at least 5%, which translates to $196 billion. Cooper says that value is rapidly flowing out of deeply entrenched incumbents. With ~40% headcount reductions, there is no longer a switching cost to adopt automation.

Founders who have moved to an inside-sales model adjusted 2020 realistic projections (flat to a modest 20% growth from 2019) and reduced opex will certainly benefit from such moves. Buyers have slowed down their purchasing processes substantially. About 30% of the workforce is struggling unable to fulfill basic needs, and cash is king. Pretending that these macro events will not affect your startup is a clear sign of naïveté, or even narcissism.

While founders adapt, VCs have been forced to shift away from the old "touch-feel the CEO" investment processes. VCs are trying to come to terms with one fundamental challenge — should they close on a new investment without a face-to-face meeting with the management team?

Jack Young at DTCP has updated his social media profile picture with a #WFH. Like most firms, Greylock too is trying to figure out how to get comfortable with teams they have never met in person. While this shift can remove some subjective bias and lead to better data-driven decisions, early-stage companies do not have much data to share.

“It took about a year for the early-stage markets to open up after the 2008 crisis,” says Jordan. Will we see a similar pattern? The election cycles are upon us and politicians may use the crisis to further their advantage, often at the cost of delaying or creating economic trade-offs.

But the billion-dollar question is, what behaviors will sustain, and what reverts back to the mean?

“Crises are clarifying,” says Guo. “All effort is put toward first-order issues when companies don’t have the resources or time to spend on the second-order issues” In short, we start focusing on what matters most.

MIT develops machine-washable sensors that embed in clothing for constant vital sign monitoring

Sensors woven into a shirt can monitor vital signs

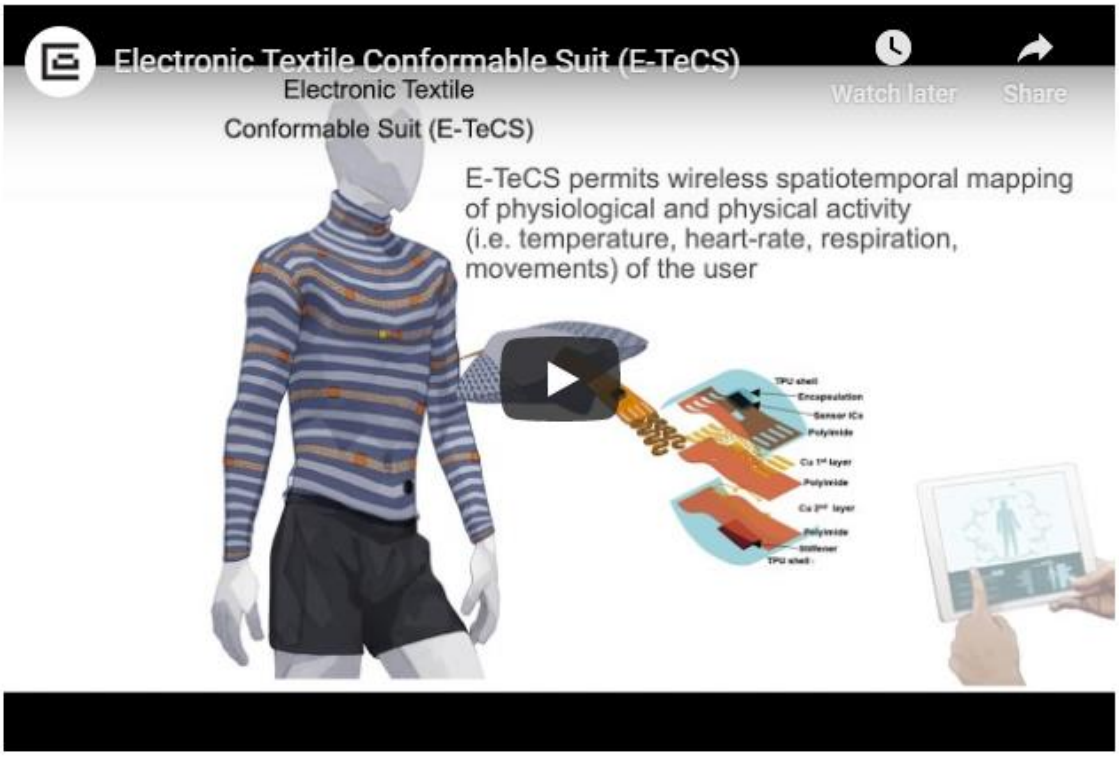
Sourced by MIT News Office

MIT researchers have developed a way to incorporate electronic sensors into stretchy fabrics, allowing them to create shirts or other garments that could be used to monitor vital signs such as temperature, respiration, and heart rate.

The sensor-embedded garments, which are machine washable, can be customized to fit close to the body of the person wearing them. The researchers envision that this type of sensing could be used for monitoring people who are ill, either at home or in the hospital, as well as athletes or astronauts.

"We can have any commercially available electronic parts or custom lab-made electronics embedded within the textiles that we wear every day, creating conformable garments," says Canan Dagdeviren, the LG Electronics Career Development Assistant Professor of Media Arts and Sciences at MIT. "These are customizable, so we can make garments for anyone who needs to have some physical data from their body like temperature, respiration rate, and so forth."

Dagdeviren is the senior author of a paper describing the new material today in the journal npg Flexible Electronics. MIT graduate student Irmandy Wicaksono is the lead author of the study. Several MIT undergraduates also contributed to the study through the Undergraduate Research Opportunities Program.



Embedded sensors
Other research groups have developed thin, skin-like patches that can measure temperature and other vital signs, but these are delicate and must be taped to the skin. Dagdeviren's Conformable Decoders group at the Media Lab set out to create garments more similar to the clothes we normally wear, using a stretchy fabric that has removable electronic sensors incorporated into it.

“In our case, the textile is not electrically functional. It’s just a passive element of our garment so that you can wear the devices comfortably and conformably during your daily activities,” Dagdeviren says. “Our main goal was to measure the physical activity of the body in terms of temperature, respiration, acceleration, all from the same body part, without requiring any fixture or any tape.”

The electronic sensors consist of long, flexible strips that are encased in epoxy and then woven into narrow channels in the fabric. These channels have small openings that allow the sensors to be exposed to the skin. For this study, the researchers designed a prototype shirt with 30 temperature sensors and an accelerometer that can measure the wearer’s movement, heart rate, and breathing rate. The garment can then transmit this data wirelessly to a smartphone.

The researchers chose their fabric — a polyester blend — for its moisture-wicking properties and its ability to conform to the skin, similar to compression shirts worn during exercise. Last summer, several of the researchers spent time at a factory in Shenzhen, China, to experiment with mass-producing the material used for the garments.

“From the outside it looks like a normal T-shirt, but from the inside, you can see the electronic parts which are touching your skin,” Dagdeviren says. “It compresses on your body, and the active parts of the sensors are exposed to the skin.”

The garments can be washed with the sensors embedded in them, and the sensors can also be removed and transferred to a different garment.

Remote monitoring
The researchers tested their prototype shirts as wearers exercised at the gym, allowing them to monitor changes in temperature, heart rate, and breathing rate. Because the sensors cover a large surface area of the body, the researchers can observe temperature changes in different parts of the body, and how those changes correlate with each other.

The shirts can be easily manufactured in different sizes to fit an array of ages and body types, Dagdeviren says. She plans to begin developing other types of garments, such as pants, and is working on incorporating additional sensors for monitoring blood oxygen levels and other indicators of health.

This kind of sensing could be useful for personalized telemedicine, allowing doctors to remotely monitor patients while patients remain at home, Dagdeviren says, or to monitor astronauts’ health while they’re in space.

“You don’t need to go to the doctor or do a video call,” Dagdeviren says. “Through this kind of data collection, I think doctors can make better assessments and help their patients in a better way.”

The research was funded by the MIT Media Lab Consortium and a NASA Translational Research Institute for Space Health Seed Grant from the MIT Media Lab Space Exploration Initiative.

Inside WhatsApp's Retreat on Ads

Worried about angering regulators and wanting to prioritize a broader integration of its services, Facebook pulled back last year from plans to introduce advertising to the messaging app it acquired in 2014. The tech giant still expects to eventually bring ads to WhatsApp, after it completes the multiyear effort to link all its social platforms.

By Alex Heath

After more than a year of preparation, WhatsApp was finally close to flipping the switch on advertising, kick-starting a plan to generate billions of dollars a year in revenue from one of Facebook's crown jewels, which it had acquired for $22 billion six years earlier.

Last fall, employees prepared to share details of the planned 2020 rollout at an internal sales gathering in Singapore. But after meeting with Facebook CEO Mark Zuckerberg ahead of the event, Will Cathcart, the new head of WhatsApp, relayed to staffers that the plan to implement ads had been shelved. Employees who had already booked their flights for the sales conference canceled their trips.

Zuckerberg suspended the push to introduce ads to the popular messaging app partly because Facebook wanted to avoid antagonizing regulators, according to people familiar with the matter. Facebook also feared angering WhatsApp users who valued the app's emphasis on privacy and who resisted the idea of having their accounts tied to Facebook.

While Facebook still intends to put ads in WhatsApp eventually, Zuckerberg decided last year to wait until the company had integrated its three social media platforms, Facebook, WhatsApp and Instagram—a process known as interoperability that might not be completed for a couple years. The integration, a top priority for Zuckerberg, will potentially make it easier to introduce ads in WhatsApp later.

Facebook's decision to pull back on putting ads in WhatsApp, a move long awaited by investors in the company, is a stark example of how heightened regulatory scrutiny has influenced how the social media giant does business.

A series of privacy scandals in recent years have bruised the company's reputation with lawmakers and consumers, culminating in a record $5 billion fine by the U.S. Federal Trade Commission last summer. Regulators also have been examining whether Facebook has amassed too much market power, and reportedly have looked into blocking the interoperability plan. Prominent critics including Facebook co-founder Chris Hughes and Sen. Elizabeth Warren have said the company should be forced to spin off Instagram and WhatsApp, its largest acquisitions.

As scrutiny of the company intensified last year, a senior Facebook policy official, Nick Clegg, warned executives that regulators, already wary of Facebook collecting more data about WhatsApp users, were likely to be skeptical of an advertising plan that linked the services together.

The plan to pitch WhatsApp ads once the messaging integration is ready appealed to executives who preferred to have Facebook confront the regulatory challenges all at once rather than in waves, said people familiar with the matter. Facebook's leaders also hoped that criticism of its business practices would diminish by then.

Facebook declined to make executives available to be interviewed for this article. The move to shelve the advertising plan for WhatsApp was first reported by The Wall Street Journal. But the reasoning behind the move, as well as the plan to introduce ads once Facebook's apps are connected, haven't been previously disclosed.

Usage of Facebook services, and WhatsApp in particular, is surging as the coronavirus pandemic forces people around the world to stay isolated and indoors. Meanwhile, ad rates are plummeting as companies cut their marketing budgets, depriving Facebook of near-term revenue from its core social network and Instagram.

WhatsApp could face more pressure in the coming months to generate revenue if Facebook's other sources of cash flow continue to shrink. While WhatsApp has a few monetization experiments, including software enabling businesses to provide customer support via text, they have been slow to gain traction.

Arm's Length

Roughly six years ago, at a time when Facebook's own messaging efforts were still nascent, Zuckerberg was eager to kick-start growth. And WhatsApp, which had fewer than 60 employees when it was acquired, was growing quickly in markets Facebook had yet to saturate, drawing people who used it heavily as a cheaper alternative to texting through wireless carriers.

"It's the only app we've ever seen with higher engagement than Facebook itself," Zuckerberg said on a conference call with investors to announce the WhatsApp deal in early 2014.

For the first three years after Facebook bought WhatsApp, it was largely ignored by its parent company. WhatsApp grew ever more popular, expanding its user base from 450 million in 2014 to 2 billion earlier this year. It is widely used in areas of the world including Western Europe and India, where Facebook's homegrown alternative, Messenger, has less of a footing.

WhatsApp and Facebook were an odd fit from the beginning. The app's two co-founders, Jan Koum and Brian Acton, disdained advertising and the user data collection that accompanies it, while Facebook makes the vast majority of its money from selling targeted ads. Koum has said his worldview was shaped by growing up in a poor family in Soviet-era Ukraine, where he lived in fear of government surveillance. In a 2011 tweet, Koum wrote that "advertising has us chasing cars and clothes, working jobs we hate so we can buy shit we don't need."

After the acquisition, Koum and Acton took great pains to distance their company from the rest of Facebook, keeping WhatsApp in a separate office in Mountain View, California, miles away from Facebook's headquarters in Menlo Park, California. Unlike Instagram, another marquee app that Facebook bought, the organization remains set up as a legal subsidiary, meaning employees sign WhatsApp-specific paperwork when they are hired or transfer in from another part of Facebook.

WhatsApp initially laid the groundwork to introduce ads in early 2017 with a feature called Status, which lets users post photos and videos that disappear after 24 hours. In a plan modeled after the way ads are integrated within Instagram's Stories feature, Facebook planned to sell ad space between user-generated photos and videos in Status. It expected the placement to appeal to marketers who wanted to run ads tailored to users' preferences, based on their Facebook activity. By 2018, WhatsApp's Status feature had 450 million users, versus 400 million for Instagram's Stories. But a key barrier to putting ads in WhatsApp is its privacy policy, which details how data collected by the app is used. While users often skim over or altogether ignore such wording, it is a legal agreement that regulators closely watch. When Facebook bought WhatsApp, it agreed to obtain the consent of users before making changes to how WhatsApp uses their data, including whether it planned to use that information for targeted ads.

In 2016, WhatsApp began sharing phone numbers and some other data, such as user reports of spam, with Facebook. The move angered regulators in Europe, who fined Facebook 110 million euros ($119 million) on the grounds that the company had pledged at the time of the acquisition it wouldn't connect the apps at all. In response to the pushback from regulators, Facebook still doesn't use the phone numbers of European WhatsApp users for ad targeting on its other services.

The penalty was relatively small for Facebook, but it signaled a new wave of scrutiny among regulators concerned

about the growing market clout of big tech companies.

Tensions Grow
Prodded by Zuckerberg and Facebook's No. 2 executive, Sheryl Sandberg, WhatsApp began preparing to implement ads in the summer of 2018, around the same time that Facebook told Wall Street investors it was seeing slowing revenue growth.

Both WhatsApp co-founders clashed with Zuckerberg and Sandberg over the advertising plan, which led to their departures. While Acton left the previous year as the plan was still brewing, Koum departed shortly after the announcement. Both men left behind hundreds of millions of dollars in unvested Facebook stock.

By early 2019, WhatsApp employees had drawn up a multiyear business plan, with ads bringing in billions of dollars a year in revenue within a few years, according to three people familiar with the figures. In May 2019, mockups of ads in WhatsApp were shown to attendees of a Facebook conference for marketers in Europe.

A series of privacy scandals in recent years have bruised the company's reputation with lawmakers and consumers.

WhatsApp messages are encrypted, and the app collects little user data. But thanks to the 2016 policy change that let Facebook collect the phone numbers of WhatsApp users, the company planned to match the numbers of WhatsApp users to their corresponding Facebook profiles, said three people involved with the effort. If it matched a number, Facebook would use what it knew about the user's behavior and interests on Facebook to personalize the ads they would see on WhatsApp.

If a WhatsApp user didn't have a Facebook profile that shared the same number, or opted out of Facebook's targeting, the user would merely see generic ads. Throughout 2019, teams from Facebook and WhatsApp debated whether to update the app's privacy policy to allow ads, and then deal with the potential blowback. On the Facebook side, executives worried that WhatsApp users would delete their Facebook accounts once they realized the two were linked. They also discussed how frequently ads should appear compared with ads on Instagram and Facebook.

At one point, Clegg, Facebook's global head of communications and public policy, said he couldn't sell the ad integration to regulators while the company also was beginning to discuss the integration plan for its apps. His concerns reflected the growing pressure on the company. Last year, the Federal Trade Commission, the Department of Justice, congressional lawmakers and a coalition of state attorneys general all announced antitrust investigations of Facebook.

Asked about the decision to halt WhatsApp's advertising plan, Acton, the WhatsApp co-founder, said in an email that "the irony is not lost on me" that Facebook jettisoned the plan that had been the catalyst for his departure from the company.

Acton is now executive chairman of the nonprofit Signal, which runs an eponymous encrypted messaging app. Koum couldn't be reached for comment.

Limited Revenue
Developing a revenue strategy for WhatsApp has become more urgent in recent years as Facebook's ad revenue growth from its cash cow, News Feed, has slowed. But executives have considered and rejected several ideas to

make money from the messaging service, including putting games into the app and charging businesses to be listed in a directory for WhatsApp users.

Another potential source of revenue, allowing WhatsApp users to send money to each other through the app, has been in testing for the past couple of years and has faced opposition from regulators in India, WhatsApp's largest market. WhatsApp doesn't collect fees from transactions between users through the app, and is instead subsidizing costs for the banks that are participating in the test.

WhatsApp's main source of revenue is a feature that lets businesses provide customer support via text. First introduced a few years ago, the functionality remains free for small businesses. Larger businesses are charged a few cents per message delivered to a customer. WhatsApp still requires businesses to apply for access to the program and hasn't disclosed revenue, but a person familiar with the matter said it took in less than $1 million per month last year. Since the coronavirus pandemic hit, WhatsApp has been giving away its business chat service to governments and nonprofits such as the World Health Organization, which operates an automated texting service to help inform people about the virus.

In an interview with The Information last month, WhatsApp's Cathcart said the free access given to governments and health organizations accounts for a "double-digit percentage of the use" of the app's business chat feature.

Facebook revealed another plan to monetize WhatsApp earlier this week when it invested $5.7 billion in Jio Platforms, a $66 billion Indian firm that includes the nation's largest wireless network, Reliance Jio. As part of the deal, Facebook said it would partner with Jio to let people in India use WhatsApp to find and purchase goods from local sellers.

In a statement addressing advertising plans for WhatsApp, a Facebook spokesperson said that "ads in Status remains a long-term opportunity for WhatsApp, and we believe it will be a great way for people to discover a business that is important to them in the future."

Regulators Home In

At the beginning of 2019, Zuckerberg put Facebook's Messenger group in charge of the company's plan to allow users to interact across its apps, which at the time engineers estimated would take at least two years to complete. The project is still in the early stages, with engineers simplifying the platforms' code before implementing more connections between them. WhatsApp will likely take longer to fully integrate than Facebook and Instagram, said a person involved with the project, due in part to the complexity of WhatsApp's encryption technology.

While Facebook executives have said that connecting the apps would make it easier for users to reach each other no matter what app they are using, critics have said it could make it more challenging for regulators to build an antitrust case.

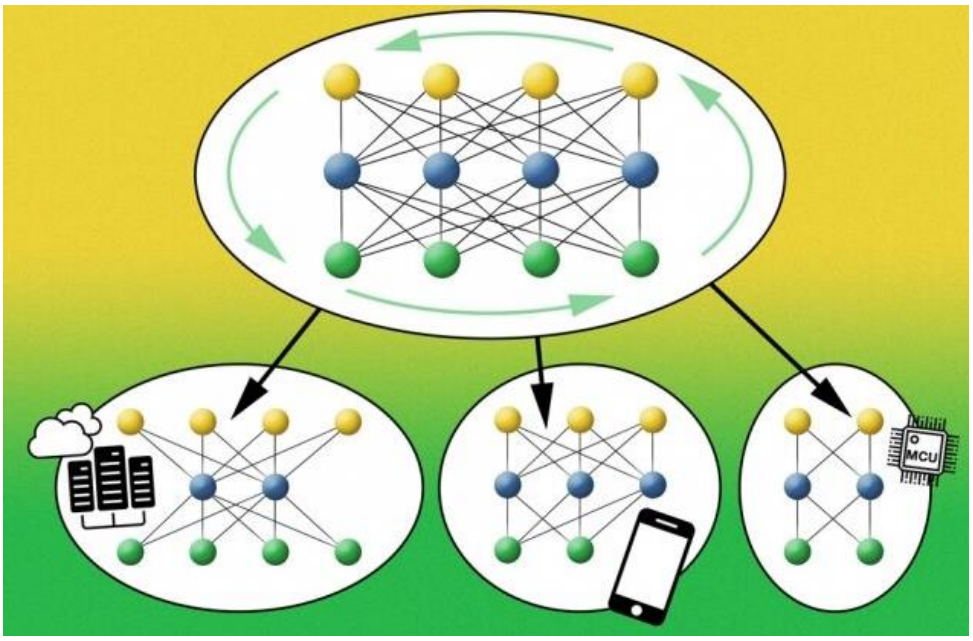
Such consolidation is a "chess move" companies use to make the case they can't be broken up because their properties are too intertwined, said Dina Srinivasan, a former advertising executive turned antitrust scholar who wrote a paper titled "The Antitrust Case Against Facebook."

Last year, Zuckerberg made the decision to affix "from Facebook" beneath both Instagram's and WhatsApp's logos and elsewhere in the apps—a move internally seen as a way to improve the reputation of Facebook's brand by association. Facebook is now working on a unified privacy policy for the time when it has linked all its apps and users can message across them, said people familiar with the matter.

As Facebook works to connect its apps behind the scenes, authorities are forging ahead with scrutiny of the company's market dominance. The Department of Justice has been privately interviewing competitors about their view of Facebook and its tactics. While the coronavirus outbreak is likely to slow the work as government staff adapt to working remotely, there is no sign that regulators will abandon the effort.

New system cuts the energy required for training and running neural networks

By Rob Matheson



MIT researchers have developed a new automated AI system with improved computational efficiency and a much smaller carbon footprint. The researchers' system trains one large neural network comprising many pretrained subnetworks of different sizes that can be tailored to diverse hardware platforms without retraining. Credit: MIT News, based on figures courtesy of the researchers

Artificial intelligence has become a focus of certain ethical concerns, but it also has some major sustainability issues.

Last June, researchers at the University of Massachusetts at Amherst released a startling report estimating that the amount of power required for training and searching a certain neural network architecture involves the emissions of roughly 626,000 pounds of carbon dioxide. That's equivalent to nearly five times the lifetime emissions of the average U.S. car, including its manufacturing.

This issue gets even more severe in the model deployment phase, where deep neural networks need to be deployed on diverse hardware platforms, each with different properties and computational resources.

MIT researchers have developed a new automated AI system for training and running certain neural networks. Results indicate that, by improving the computational efficiency of the system in some key ways, the system can cut down the pounds of carbon emissions involved—in some cases, down to low triple digits.

The researchers' system, which they call a once-for-all network, trains one large neural network comprising many pretrained subnetworks of different sizes that can be tailored to diverse hardware platforms without retraining. This dramatically reduces the energy usually required to train each specialized neural network for new platforms—which can include billions of internet of things (IoT) devices. Using the system to train a computer-vision model, they estimated that the process required roughly 1/1,300 the carbon emissions compared to today's state-of-the-art neural architecture search approaches, while reducing the inference time by 1.5-2.6 times.

"The aim is smaller, greener neural networks," says Song Han, an assistant professor in the Department of Electrical Engineering and Computer Science. "Searching efficient neural network architectures has until now had a huge carbon footprint. But we reduced that footprint by orders of magnitude with these new methods."

The work was carried out on Satori, an efficient computing cluster donated to MIT by IBM that is capable of performing 2 quadrillion calculations per second. The paper is being presented next week at the International Conference on Learning Representations. Joining Han on the paper are four undergraduate and graduate students from EECS, MIT-IBM Watson AI Lab, and Shanghai Jiao Tong University.

Creating a "once-for-all" network

The researchers built the system on a recent AI advance called AutoML (for automatic machine learning), which eliminates manual network design. Neural networks automatically search massive design spaces for network architectures tailored, for instance, to specific hardware platforms. But there's still a training efficiency issue: Each model has to be selected then trained from scratch for its platform architecture.

"How do we train all those networks efficiently for such a broad spectrum of devices—from a $10 IoT device to a $600 smartphone? Given the diversity of IoT devices, the computation cost of neural architecture search will explode," Han says.

The researchers invented an AutoML system that trains only a single, large "once-for-all" (OFA) network that serves as a "mother" network, nesting an extremely high number of subnetworks that are sparsely activated from the mother network. OFA shares all its learned weights with all subnetworks—meaning they come essentially pretrained. Thus, each subnetwork can operate independently at inference time without retraining.

The team trained an OFA convolutional neural network (CNN)—commonly used for image-processing tasks—with versatile architectural configurations, including different numbers of layers and "neurons," diverse filter sizes, and diverse input image resolutions. Given a specific platform, the system uses the OFA as the search space to find the best subnetwork based on the accuracy and latency tradeoffs that correlate to the platform's power and speed limits. For an IoT device, for instance, the system will find a smaller subnetwork. For smartphones, it will select larger subnetworks, but with different structures depending on individual battery lifetimes and computation resources. OFA decouples model training and architecture search, and spreads the one-time training cost across many inference hardware platforms and resource constraints.

This relies on a "progressive shrinking" algorithm that efficiently trains the OFA network to support all of the subnetworks simultaneously. It starts with training the full network with the maximum size, then progressively shrinks the sizes of the network to include smaller subnetworks. Smaller subnetworks are trained with the help of

large subnetworks to grow together. In the end, all of the subnetworks with different sizes are supported, allowing fast specialization based on the platform's power and speed limits. It supports many hardware devices with zero training cost when adding a new device.

In total, one OFA, the researchers found, can comprise more than 10 quintillion—that's a 1 followed by 19 zeroes—architectural settings, covering probably all platforms ever needed. But training the OFA and searching it ends up being far more efficient than spending hours training each neural network per platform. Moreover, OFA does not compromise accuracy or inference efficiency. Instead, it provides state-of-the-art ImageNet accuracy on mobile devices. And, compared with state-of-the-art industry-leading CNN models , the researchers say OFA provides 1.5-2.6 times speedup, with superior accuracy.

"That's a breakthrough technology," Han says. "If we want to run powerful AI on consumer devices, we have to figure out how to shrink AI down to size."

"The model is really compact. I am very excited to see OFA can keep pushing the boundary of efficient deep learning on edge devices," says Chuang Gan, a researcher at the MIT-IBM Watson AI Lab and co-author of the paper.

"If rapid progress in AI is to continue, we need to reduce its environmental impact," says John Cohn, an IBM fellow and member of the MIT-IBM Watson AI Lab. "The upside of developing methods to make AI models smaller and more efficient is that the models may also perform better."

More information: Once-for-All: Train One Network and Specialize it for Efficient Deployment on Diverse Hardware Platforms, arXiv:1908.09791 [cs.LG] https://arxiv.org/abs/1908.09791

By Jordan Silber, John Dado, John Clendenin, and Shane Goudey @ Cooley

As much of the world shelters in place, nearly every client conversation we have with our venture capital fund clients comes around to some version of the questions "what are you seeing" and "will all of this impact our fund raising plans". We acknowledge the lack of clarity, at present, regarding the eventual duration and depth of the global health pandemic, and the associated impact on financial markets. Nonetheless, as we are now several months into these events, we thought it timely to provide our observations, initial in nature as they may be, regarding the present market for venture capital fund raising.

As background, our commentary here is based on interactions with hundreds of venture capital firms, all differently positioned. The punch line of the situation is that the impact of COVID-19 on fund raising will inevitably interrelate with a manager's particular attributes: investment area of focus, geography, size, performance, LP base, investment team composition and location, amount of dry powder and proximity to natural fund raising time, and cash position of portfolio companies, among others. In addition, further developments in coming weeks and months in regard to macroeconomic conditions are also likely to factor into fund raising outcomes, particularly in respect of the potential association of the public markets' performance with ability and desire of institutions to commit to private investments (the "denominator effect"). The snapshot from our seat at the table looks something like this:

Timing of Fund Raising

As the pandemic unfolded, managers were in various stages of fund raising: some were in market already, some were soon to be, some had plans to go out later in 2020 and others had no such near term plans at all. Those that were already in market and on their way to their targets were best positioned to proceed and, with rare exception and not surprisingly, those deals have had the desired outcome for the sponsor.

As to funds being offered by established sponsors that were about to launch as the pandemic unfolded, in general we have seen more of them continue unabated, perhaps with slight adjustments to timing or target capital amounts. We are heartened to have seen some major closings including a billion dollar plus "one and done" a few weeks into U.S. shelter in place orders, and we are likewise enthusiastic about the near-term 2020 pipeline. We are not hearing from essentially any prominent managers in important investment sectors that they are making major changes to near-term 2020 fund raising plans, though in select cases minor changes might include small modifications to timing or the holding of an additional closing to accommodate latecomers with logistical delays due to the pandemic.

Where established funds were scheduled to launch later in 2020, a demand for a closer look at unfunded reserves and the adequacy of current capital for continued operations may arise, and managers are often being asked by LPs to be transparent and to disclose a thesis as to why additional capital is needed in the planned time frame. These managers may need to focus on explaining how they are working with portfolio companies to manage cash flow (thus indirectly reducing pressure on fund raising until a later time). Where there is a chance to push fund raising out in time to where there might be more clarity, not only regarding the course of the pandemic but also on valuations, that has been the preferred choice of some managers; however in at least a few cases managers are electing to accelerate fund raising based on cash needs or in some cases a view that it is better to go out before there might be even more uncertainty in financial markets. Interestingly, we note that some projects have also sprung to life on theses that are tied directly to an intent to capitalize on market dislocations (e.g., overcorrections) or with conviction based on anticipated lower valuations in future rounds of outstanding private companies. This is a new trend in our experience likely tied to "lessons learned" following the previous global financial crisis.

While the sample is more scattered, we sense hesitancy and are discussing various types of changes in plans among pure "emerging" managers who were in process or planning initial funds in the history of their franchises. We've had a number of related discussions tapping into our prior experiences in down markets and how emerging managers successfully or unsuccessfully navigated those choppy waters to meet their fund raising goals and LP base construction. At a minimum, some of the family offices or high net worth individuals that might have been the target audiences for emerging manager deals are reassessing their programs, and "go slow" orders do seem to be cropping up in some instances. On the other hand, we have already successfully closed first time funds during shelter in places times, including funds that were oversubscribed and engaged in cutbacks. So while the situation for emerging managers is not a "nuclear winter" by any means, in some cases there is evidence of more caution on behalf of investors and the need on the part of managers to proceed thoughtfully.

Market Segment and Past Performance

Drilling in slightly deeper, for funds about to be in market as the pandemic was declared, the investment area of focus, construction and dynamics of the management team as well as performance (as always) have seemed most pertinent to the outcome. The pandemic for now has arguably created "winners and losers" at the portfolio level; those managers focused on areas such as ed-tech, health care, remote enterprise, online entertainment, semiconductors, online communications and other similarly related sectors have in our recent experience mostly been encouraged by investors to go ahead with fund raising especially where there is any potential for a delay to leave the firm with inadequate dry powder for any period of time.

On the other end of the spectrum, managers focusing or overweight in consumer discretionary, retail, travel, hospitality, offline entertainment and the like have faced resistance in some cases, particularly where there is any perception that additional capital would be used to support distressed companies. Notably, more venture managers are technology and life sciences focused, as compared to retail and consumer, and inasmuch, the industry may prove somewhat resilient to current macroeconomic events.

The LPs' Point of View

Our observation from an LP standpoint has been that, in general, investors are continuing to go ahead with their process for deals that were significantly advanced (for example, where on-site due diligence had already been completed). Many of them appear to have taken note, looking back to 2008 and the aftermath of the financial crisis, of the value of having dry powder to make investments as purchase price multiples level off and then drop during times of crisis. Savvy firms we work with are highlighting this. For example, a prominent Silicon Valley venture manager recently highlighted at their annual meeting, held online, that they continued to invest at an ordinary if not heightened pace through the 2001 and 2008 down cycles and investors were very much better off for it.

Regarding deals scheduled to go out later in 2020, it remains to be seen if on-site due diligence will be successfully replaced by remote due diligence, to the extent global travel does not resume in the near term, and if not, how that impacts fund raising. With that said, as we witness fund managers pivot fairly successfully to remote operations, as well as to remote investor relations (i.e., web-based annual and LPAC meetings, etc.), it seems promising that a mere lack of travel will not itself have a materially detrimental impact on fund raising later this year, especially for those firms that have been nimble enough to efficiently and effectively migrate their flow of work to remote. One key for LPs will likely be whether they have already "been in business" with the particular fund sponsor in prior funds, or at least have had an in person visit with the team prior to the current lockdown on in person meetings, providing additional headwind for emerging managers as well as a potential headwind for established managers looking to increase their LP roster.

Another trend to point out is that the industry, pre-pandemic, has been responding to a landscape where private companies stay private and require support longer, as borne out by the formation and use of a myriad of SPVs and top-up funds to capture late stage investments in portfolio winners. We have not seen that currently abate, and if anything, some managers that may have done one-off SPVs in the past (especially where their focus is on in-demand market sectors), or may have simply let later stage opportunities go to others, may take this as a chance to launch a

growth fund product. Accordingly, there is the potential for a convergence of views and motivations: LPs understand the impact of the 2008 downturn on valuations and want access to these opportunities; and GPs have access to allocations in these sorts of deals and want to capitalize on that. Multiple products we are working on that are either in market now or coming to market soon will offer top-up fund vehicles to capture this perceived opportunity, and in general we think the trend of strategically raised SPVs and top-up funds is very likely to continue, if not expand.

A further observation relates to the "denominator effect". During the global financial crisis, many LPs significantly curtailed their investments in private funds as they became overweight as public markets fell. Commitments were cancelled and relationships were pruned. Our perception was that in many cases this was quite formulaic and rigid. While we have seen a small handful of institutions back out of recent deals specifically citing being overweight in privates, we are encouraged and hopeful that the rigidity of the position held in 2008 may have shifted. It would seem that taking into account post-2008 IRRs in the space, this is savvy. Many LPs have indicated to managers we work with that they now have greater, in some cases much greater, ability based on internal policy to break target limits where there is public market stress, so as to be positioned to capitalize on the potential for favorable private valuations moving ahead. We think this is healthy, and are glad to hear it. This evolving area deserves continued focus.

Finally, we have been watching developments as they relate to geography. Of the hundreds of venture firms we represent, somewhere around 15% of them are Asia-based. These firms and especially mainland China firms are a cycle ahead of U.S. firms, in the sense that their shelter in place orders came sooner, and have for now been lifted. We watch with interest the trend lines as these firms get back to business, at least for the time being. The initial observations are promising, in the sense that the return to work flows, and the resumption of investing if not fund raising, seem to us for now like a "V shaped bottom". This area deserves continued monitoring and we intend to watch Asia venture capital fund trends for potential signals about the U.S. market.

Advice to Managers

Our general advice to venture capital fund managers who are thinking about fund raising plans for 2020 or beyond is to assess your own unique situation, and talk to your investors. We have found that sometimes managers have assumed LPs would desire a fund raising freeze only to discover through analysis and discussion that, in fact, LPs wanted the manager to push ahead, if not also accelerate and/or create extra opportunities for later-stage deals. This is clearly not what every manager will discover on thoughtful diligence with their LPs, however it is important now more than ever to spend time having these detailed and honest conversations with LPs and formulating strategies around what is learned from them.

We are aware of a small number of prominent managers that are in frank conversation with their well-known investors, and highly institutional limited partners in certain of these cases have agreed to particular timing with respect to current or future fund raising plans, including delays in planned fund raising, made feasible by ready dry powder in existing funds. The wisdom of this type of collaboration is plain: doing the right thing for your investors nearly always makes sense in the long run, and we imagine that such managers will be well served by this collaboration when they do return to market.

Next Year's VC Funds May Be Hit Harder by Covid Recession, Says LP

By Kate Clark

For the people who invest in venture capital funds, the impact of Covid-19 is like watching a "slow-motion plane crash," Sapphire Ventures managing director Beezer Clarkson said in an interview with The Information. While VCs were still raising strongly in the first quarter, next year will be different. "In 2021, we will see more of an impact on fundraising," she said.

Clarkson, whose firm is a limited partner in VC funds such as Union Square Ventures and Data Collective, says venture investors are looking at their companies and "thinking which of them are going to make it." Limited partners will go through the same process with their funds, but later.

Beezer Clarkson, managing director at Sapphire Ventures

"LPs have to make decisions about their stronger performers versus those who aren't at the top of the pile," she said.

In the midst of a pandemic, LPs are taking fewer meetings with venture fund managers and are more reluctant to meet with new entrants to the VC market. Even established venture capitalists may have a harder time getting LPs to wire them money. As for exits, don't expect any big initial public offerings in the near future, she said.

A veteran of two financial crises, Clarkson got her start as a financial analyst at Morgan Stanley during the first dot-com boom. After transitioning to VC through investment roles at Omidyar Network and Draper Fisher Jurvetson, she started managing Sapphire's fund investment practice in 2012. Today, she invests in early-stage venture funds with capital from a $4 billion war chest. Clarkson talked to The Information last week from her home in Palo Alto.
The following Q&A has been edited.

Kate Clark: How are LPs feeling about the current environment? Beezer Clarkson: Most of the LPs we work with are institutional, so many of them, as an institution, have had ups and downs before, so I don"t see panic. It is unprecedented, but that doesn't mean people aren't prepared for ups and downs. We prepare for ups and downs in the cycle and we have thought about it, because a 10-year bull run is fantastic, but that"s not what every year is going to look like.

Startup founders are struggling to raise money but venture funds seem to be better capitalized than ever. Is the worst yet to come? Fundraising in Q1 was strong. There was a lot of capital raised, there were a bunch of billion-dollar funds raised, a significant number of mega funds. I think we are looking at close to $15 billion of capital raised just in Q1 of this year, which is significant. Then you just had Index and Lightspeed raise, and smaller firms like Zetta. I can see this year being over $20 billion raised, which isn't insignificant, right? The bigger question is actually next year. What happens then?

I think [in] 2021, we will see more of an impact on fundraising, whether it's because LPs have to make decisions about their stronger performers versus those who aren't at the top of the pile. Those are the decisions you have to make with limited dollars.

Right now, a lot of VCs are going through this process; they are looking at their reserves and their companies and thinking which of them are going to make it. Who am I going to keep investing in and who may not make it? For LPs, it's similar but it's more slow motion. Our next fund cycle may not be till 2022, so there's a while before you have to make a decision. It's more of a slow-motion plane crash.

Many venture capitalists I've talked to are worried about capital calls—whether LPs will be ready and willing to wire them money in the next few months when they need it to make new investments. Should this be such a big concern? I do think there is potential that individuals won't make capital calls, but those aren't the bulk of the dollars going into the established VC names that we know of. I don't know why people immediately hit the panic button on capital calls. We are seeing LPs ask [general partners] what the schedule of capital calls will be. There's a heightened focus on that, and GPs are conscious of the fact that lots of capital calls to LPs right now could be difficult for some LPs. They want to be sensitive to the pressures being put on the system.

Are you making new investments right now, particularly in fund managers whom you hadn't met pre–Covid-19? We are certainly talking to folks. I don''t think we are going to be locked inside forever, knock on wood. We are very grateful to be in a position to continue investing. The majority of the people we are talking to, though, we've heard of or have met in the past. LPs like to get to know a GP over a fund cycle because when you commit as an LP you are committing for an extraordinarily long time. With the sheltering in place, my biggest concern is that the restrictions on travel are extended beyond one to two more months. Then what's going to get hurt are the newer entrants to the venture market, especially those who are not part of existing networks.

Is there anything that can be done to ensure these new entrants are able to develop relationships with LPs, even during shelter-in-place orders? I don't have a great solution yet. What's made me concerned is I keep hearing the same thing when I talk to GPs and LPs, which is "I am talking to people I've met in the past." If those people are diverse, that's great, but the challenge in the past was that people's networks weren't particularly diverse. There isn't a simple answer.

It's tough to be a first-time fund manager right now. Should those out raising money for the first time even bother in this environment? It's a tough reality, I think, is the sad answer. If it's a new manager with an existing venture track record, I put their odds of raising higher than someone who has never managed before. I think this market will be particularly tough. I think a lot of folks might have to pause and get back out in September.

Do you have any advice for those aspiring fund managers right now? They'll know if they have a near-term shot at a first close, a minimum fund size. If you've got enough capital, if you're 80% of the way there, then call it done and get going, have your close and declare victory. Three months from now you can circle back and ask people for more money.

Are LPs expecting any M&A or IPO activity in the next year? I think taking a conservative view of when exits are coming would be a wise idea. We would be happy to be positively surprised. I have seen signs that companies are looking to do smaller acquisitions. I don't think we are going to see a huge IPO anytime in the near future. I don't want to be naively optimistic, but if the conversation is "How do you [do an] IPO in a recession?" the world knows how to respond to that. But the bigger question—"How do you [do an] IPO when people are [in] shelter in place?"—is much harder to answer.

Fund sizes have been growing and growing for years. Are we poised for a major correction to the VC fundraising market? I would be surprised if that's the case. If history is any guide, what you see in downturns, there's pressure on fund size and fewer people can raise large funds. Back in 2001 and 2002, people gave back money to LPs because they felt they couldn't invest it and get the returns they said they would, but I don't think we will see that. In '08 and '09, you didn't see that, but you saw people taking longer to invest their funds. I don't think venture is ending by any stretch. I think it's just going to be tougher and...more pressure will be put on the system.

Western Digital executives discuss what trends they expect to see in the storage arena in 2020.

By Laurie Iwami

As we enter a new decade, the amount and diversity of data is growing at an unprecedented pace. The storage industry ecosystem is working together to support this influx of data and emerging workloads with new paradigms in infrastructure, architectures and devices.

I sat down with several of our top executives to talk about what they expect to see in 2020. Here's what Siva Sivaram, president of Technology & Strategy, Phil Bullinger, senior vice president and general manager of Western Digital's Data Center business unit, and Yusuf Jamal, senior vice president of Western Digital's Devices business unit had to say.

We know data is growing in our increasingly connected world, but what kind of data is driving growth in the IoT/IIoT?

Sivaram: In 2020, non-mobile edge applications—from medical, automotive, industry, smart cities, airports, and more—will continue growing rapidly. Due to this increase in connected devices driven by 5G and IoT/IIoT, machine-generated data will begin to surpass human-generated data as the fastest-growing data source. IIoT and natural streaming data (video, AI/ML datasets, etc.) will contribute to the largest share of growth, driving the need for new at-scale, TCO-optimized data-center architectures that help IT and business leaders efficiently store, manage, and monetize the value of their data.

You mention AI/ML… with the rise in artificial intelligence/machine learning (AI/ML) specifically, what's ahead to support these new workloads?

Sivaram: In 2020, we will see a proliferation of customized AI chips hitting the market, and as a result, almost every vertical will begin to tap into the power of AI/ML.

Billions of dollars have been spent over the past few years to develop AI chips customized for specific workloads, such as facial recognition, natural language processing, network security, robotics, and automation. With RISC-V and other open-source technologies further lowering the barriers to purpose-built innovation, an influx of these customized AI semiconductor building blocks will be available in 2020, enabling systems designers to make AI/ML even more prolific across a variety of vertical industries, such as smart homes and cities, automotive, retail, healthcare, and telecommunications.

How can the industry manage IoT/IIoT security challenges from endpoints to edge to core?

Jamal: The rise of 5G and IoT is revolutionizing businesses and industries of all shapes and sizes, from oil and gas, agriculture, and manufacturing to autonomous vehicles and smart cities. With this comes billions of connected devices, monitors, and sensors all opening up vulnerabilities and security risks to sensitive data, systems, and architectures from endpoints to edge to core. Today's highly diverse use cases and proprietary IoT security solutions simply cannot reach economies of scale. This will drive the industry to embrace open security standards in software and hardware, new innovations in RISC-V instruction set architectures (ISAs), and standards-based devices and platforms.

Solutions that are open, customizable, comprehensive, stronger, and easier to use and adopt will lead to, and help accelerate, new developments and innovations throughout the ecosystem. This will be a shared defense to protect the data the world depends on. No company is or will be large enough to drive these changes without engaging the ecosystem and harnessing its collective power in the industry.

As the industry works together on open standards, what new data-center architectures will emerge to manage the growing volume and variety of data?

Bullinger: In the Zettabyte-scale Age, data infrastructure needs to be re-architected to address the growing scale and complexity of workloads, applications, and AI/IoT datasets. These constructs will involve multiple tiers of workload-optimized storage as well as new approaches to system software. Zoned Storage, an open-source initiative, will help enable customers to take advantage of zone block management across both SMR [shingled magnetic recording] HDDs and ZNS [zoned namespaces] SSDs for sequentially written, read-centric workloads. In 2020, we'll see a substantial amount of application and storage software investment in Zoned Storage to help drive more efficient storage tiers as data centers are redefined in the Zettabyte-scale Age.

As data centers meet the demands of the Zettabyte-scale Age, how will storage tiers evolve?

Bullinger: In 2020, tiering of data leveraging device, media, and fabric innovation will expand, not contract.

There will continue to be strong exabyte growth in read-centric applications in the data center, from AI, ML, and big-data analytics to a variety of business intelligence and accessible archive workloads. These at-scale use cases are driving a diverse set of performance, capacity, and cost-efficiency demands on storage tiers, as enterprises deliver increasingly differentiated services on their data infrastructure.

To meet these demands, data-center architecture will continue advancing toward a model where data-storage solutions will be consistently provisioned and accessed over fabrics, with the underlying storage platforms and devices delivering to a variety of SLAs [service level agreements], aligned with specific application needs. And while we certainly expect to expand the deployment of TLC and QLC flash in these at-scale, high-growth workloads for higher-performance use cases, the relentless demand for exabytes of cost-effective, scalable storage will continue to drive strong growth in capacity-enterprise HDD.

What about fabrics and composable architectures? What will we see in data centers in 2020?

Bullinger: In 2020, fabrics and composable will form a symbiotic relationship.

Ethernet fabrics are becoming the "Universal Backplane" of the data center, unifying how storage is shared, composed, and managed at scale to meet the demands of increasingly varied applications and workloads. In 2020, we'll see increasing adoption of composable, disaggregated storage solutions that efficiently scale over Ethernet fabrics and deliver the full performance potential of NVMe [Non-Voltage Memory Express] devices to diverse data-center applications. Composable storage will significantly increase the agility and flexibility in how enterprises provision and optimize their data infrastructure to meet dynamic application requirements.

Finally, as these new technologies, infrastructures, and workloads emerge, some have speculated the demise of the hard drive. What's your take on the future of HDDs?

Jamal: While many have predicted the demise of HDDs for years, there's simply no substitute for capacity-enterprise HDDs, which consistently meet growing data demands and deliver TCO value at scale for hyperscale data centers. Today, industry analyst firm IDC estimates that nearly 2/3 of the world's installed storage capacity consists of HDDs. IDC also expects that by 2023, 103 ZB will be created per year with 12 ZB stored—approximately 60% of the stored data will be at the core/edge data center.

Driven by this insatiable growth of data—by humans and machines—this mainstay technology will see new data-placement technologies, higher areal densities, mechanical innovation, intelligent data storage, and new materials innovations that will enable new capacity points and TCO at scale for the foreseeable future.

Airtable May Triple Valuation as Top Startups Attract Top Dollar, Even in Downturn

By Kate Clark

As some startups implore venture capitalists for lifelines, others are negotiating deals at eye-popping valuations without offering so much as a pitch deck.

Airtable, which makes cloud-based software for collaboration, has spoken to investors about raising at least $50 million in a round that would value the business at between $2.5 billion and $4 billion, according to several people familiar with the company's talks, which are informal. Airtable was valued at $1.1 billion in 2018.

CEO and co-founder Howie Liu said Airtable has seen a surge in interest from VC growth funds during the Covid-19 outbreak. It has $100 million "in the bank" from past fundraisings, he said, and described the company's capital-raising efforts as "evergreen and opportunistic." He declined to comment on valuation. Terms of the deal, which has not been finalized, could change.

"We've been fielding preemptive offers pretty much since we raised the Series C," he said. "There has been an increased amount of interest, maybe because of the secular trend in collaboration."

The wide range of bids reflects the uncertainty facing investors when it comes to pricing new stakes in companies. Late-stage valuations are tied to public company share prices, which have plunged over concerns of a coronavirus recession. Such worries are expected to reduce the number of investments made this year, according to PitchBook. Some startups have already shut down; at least 300 others have laid off workers, according to layoffs tracker Layoffs.fyi.

Still, companies perceived as better able to ride out the pullback, particularly those selling technology that helps remote workers do their jobs, are inking new deals—even if they weren't actively seeking new capital. Software startups including Notion, Figma, Carta and Confluent have begun raising new funds in recent weeks, for example.

Wish Lists

Venture capitalists are investing in companies that have long been on their wish lists. Founders, facing the first economic crisis in their young companies' histories, are becoming more willing to negotiate.

Airtable, envisioned in 2012 as a next-generation spreadsheet, had already raised $170 million from investors including Benchmark, Coatue Management and Thrive Capital. Now, as workers across the world shelter in place, Liu says the company is growing. As a result, the San Francisco–based company is fielding offers from funds rather than seeking a deal through a formal pitch. Its product is well suited for a remote workforce, allowing workers to plan projects and manage tasks using a shared database that doesn't require coding.

"I've definitely gotten a lot of pings from people who I met with maybe once or twice before who have rekindled or rereached out. Some have outright said, 'Hey, we have a thesis around your category,'" Liu said. "Depending on who it is, I don't [always] have the bandwidth or interest to reciprocate or reply."

These types of unsolicited offers and preemptive financings were commonplace before the Covid-19 shutdowns but have slowed as venture capitalists have focused more on supporting existing portfolio companies.

Notion, an enterprise collaboration tool focused on note taking, had earlier rebuffed offers of venture funding. Instead, the startup raised $10 million from angel investors at an $800 million valuation last summer, according to The Information's earlier reporting.

Not until the coronavirus outbreak hit did Notion seriously consider a venture round. Fearing economic uncertainty, founders Akshay Kothari and Ivan Zhao opened the company to the possibility of bigger investments. They turned first to Index Ventures, which had spent the past year and a half aggressively chasing Notion, said two people familiar with the matter. In a matter of days, Index Ventures partner Sarah Cannon, whose other investments include enterprise messaging app Quill, arranged the $50 million financing at a $2 billion valuation. The company could have raised funds at an even higher valuation, said several people. The New York Times first reported news of the deal. Notion did not respond to a request for comment.

Years of Talks

Notion's financing is representative of several deals that have come together amid the pandemic: They are the result of months or even years of conversations between founders and venture capitalists. Such is the case for Figma, an 8-year-old company that develops online tools for designers. It's in the process of closing a $200 million deal led by Andreessen Horowitz (also known as a16z), valuing the company at $2 billion, according to Forbes.

Similar to Index's pursuit of Notion, a16z had been chasing Figma co-founders Dylan Field and Evan Wallace for some time. Last year, a16z pitched Figma on leading its Series C round but lost the deal to competing investment firm Sequoia Capital, said one person familiar with the matter. The Sequoia-led deal, a $40 million financing in February 2019, valued the business at $440 million.

Figma declined to comment for this story. A representative for a16z said the firm "doesn't comment on rumors."

Carta, which makes a software tool that helps founders, investors and employees manage their equity stakes in startups, began discussing a deal with existing investors Tribe Capital and Lightspeed Venture Partners before the outbreak, said one person familiar with the discussions. Now they are co-leading an "opportunistic" round, which means the company will use the money to fuel growth, but doesn't immediately require a capital infusion. Bloomberg reported last week that the business planned to raise as much as $200 million at a $3 billion valuation. Carta declined to comment.

Confluent, a startup whose technology helps companies analyze the data they generate, raised its $250 million round, led by Coatue Management, at a $4.5 billion valuation. Confluent had been developing a relationship with the hedge fund and early-stage investor for over two years, said CEO Jay Kreps.

The 6-year-old company had planned to do its fundraising round in April, he said, but Coatue encouraged the business to accelerate the plans just before the virus outbreak. When it became clear the coronavirus would have an outsize impact on the economy, Confluent sped up the deal again.

"It's the worst possible environment in every way," said Kreps in an interview with The Information shortly after announcing the Series E financing. "But the world being crazy didn't make us want to have money in the bank any less."

The Takeaway

- *Airtable's next funding could value the company between $2.5 bn and $4 bn*
- *Figma, Notion, Carta and Confluent have also begun raising amid Covid-19*
- *Venture capitalists have greater appetite for collaboration and future of work software*