CB DIGEST FOR TECHNOLOGY

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

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AMC Entertainment Shares Jump On Report that Amazon Could Buy It
Shares of AMC Entertainment were up 30% Monday morning off a report by U.K's Daily Mail that the e-commerce giant had held talks about acquiring the struggling movie theater chain. Such an acquisition would for sure be a saving grace for AMC, which has been rumored to be close to having to file for bankruptcy as the coronavirus pandemic has forced the shut down of movie theaters across the country. However, Amazon is often rumored to be an acquirer of so many things–from movie studios to television networks, and nothing usually comes from it. While Amazon could probably acquire AMC at a good price, such a move would be a big departure from its core business.

Trump Administration Talks to Chip Makers About Building U.S. Plants
The Trump administration has held discussions with chip makers Intel and Taiwan Semiconductor Manufacturing Co., to open plants in the U.S. according to Reuters. Reuters said that Intel was in contact with the Pentagon to provide domestic sources for products, including opening up a foundry.

"Intel is well positioned to work with the U.S. government to operate a U.S.-owned commercial foundry and supply a broad range of secure microelectronics", Intel told Reuters in a statement.

Meanwhile TSMC, the Taiwanese company that is one of the biggest chip makers in the world and one of only a handful capable of making the most cutting edge kind, said it's in talks with the U.S. Department of Commerce about building a U.S. factory, but no final decision has been made. The Wall Street Journal, which first broke the story, said Apple was also part of the discussions, and U.S officials are also looking at Samsung.

Amid worsening U.S.-China ties and the highest unemployment in America since the Great Depression, tech companies are under pressure to bring manufacturing to the U.S. Some of that is to address growing concerns that the U.S. faces a security risks by relying on foreign countries, such as China, for supplies of key components of civil and military technology. Boosting domestic high-tech manufacturing would reverse a decades-long trend that has left the U.S. bereft of expertise in key areas and vulnerable to supply disruptions, whether from natural causes, as with Covid-19, or from political ones.

Eric Schmidt bows out of Google after 19 years
Former Google LLC Chief Executive Officer and Executive Chairman Eric Schmidt has reportedly quit the company for good after stepping down from his role as a technical adviser in February, according to a report in CNET Saturday that cited an unnamed source. The departure of Schmidt marks the end of an era for a company that has undergone some massive structural changes in recent years. Back in 2015 it established its parent company Alphabet Inc. that houses Google and several other bets it has made in recent years, such as Waymo LLC.

More recently in December, Google announced that its co-founders Larry Page and Sergey Brin were stepping down from their roles as CEO and president. They were replaced by Google chief Sundar Pichai, who is now Alphabet's CEO. Schmidt had been a key figure at Google for the best part of 20 years, having first joined the company as its CEO in 2001 after leaving his former employer Novell Inc. Brought in to give Google more credibility, Schmidt oversaw the company's rapid growth from a small, search engine startup to one of the largest companies in the world, branching out into services such as email, cloud computing and smartphones.

Twitter Adds Stanford AI Expert to Board
Twitter said Monday that Dr. Fei-Fei Li, a former vice president at Google and professor at Stanford University, would join its board as an independent director.

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The addition of Li brings sorely-needed expertise in artificial intelligence to Twitter's leadership. She served as the chief scientist of AI and machine learning for the Google Cloud organization and was director of Stanford's AI Lab for five years. Twitter has been slow to introduce AI for aiding in efforts like content moderation and personalization relative to its peers.

Li's appointment is also the result of a recent truce between Twitter and activist investor Elliott Management that stipulated the addition of several outside board directors. Part of that shakeup includes a temporary board committee that will evaluate Twitter's leadership structure and CEO succession plan.

SoftBank's Japanese Telco Business Predicts Profits Will Be Flat
Masayoshi Son's cash-cow domestic telecoms business continues to perform well, even as his ambitious tech investments in other parts of his empire collapse. SoftBank Corp., the telco unit of his SoftBank Group, said it predicted an operating profit of $8.6 billion for the current financial year, largely unchanged from last year, despite the economic blow that Covid-19 has had on the global economy.

Sony Unveils SWIR Sensors for Industrial Applications
Sony announces the upcoming release of two new SWIR image sensors for industrial equipment. The new sensors capture images in the visible and invisible spectrum and boast a compact size made possible by the industry's smallest 5μm pixel size. The new products employ Sony's original SenSWIR technology, in which photodiodes are formed on an InGaAs compound layer and are connected via Cu-Cu connection with the Si layer which forms the readout circuit.

When bonding the InGaAs layer, which forms the light receiving photodiodes, and the Si layer, which forms the readout circuit, using conventional bump connections, it is necessary to secure a certain bump pitch, which makes it difficult to achieve a smaller pixel size compared to current industrial CMOS sensors. This had made miniaturization a serious challenge. The Sony's new products, however, feature a smaller pixel pitch made possible by the Cu-Cu connection, resulting in the industry's smallest 5μm pixel size. This, in turn, makes it possible to reduce camera size while maintaining SXGA (IMX990)/VGA (IMX991) resolution, contributing to improved testing precision.

Sony's original SWIR image sensor technology is used to make the top InP layer,*4 which absorbs visible light, thinner, making it possible to transmit light to the InGaAs layer underneath, delivering high quantum efficiency even in the visible range. This design enables imaging in a broad range of wavelengths from 0.4μm to 1.7μm, enabling the use of a single camera instead of the conventional multiple that were required to capture visible light and SWIR.

California officials surrender to Elon Musk, allow Tesla Fremont plant to reopen
Tesla has been given a green light to reopen its Fremont, California after Elon Musk defied local lockdown restrictions to reopen on Monday. The standoff between Musk and California's Alameda County officials came to an end earlier today after the county agreed to let Tesla's factory in Fremont, California, reopen. The announcement came a day after CEO Elon Musk announced he was defying local government lockdown orders to restart production. The Alameda County Health Department released a statement late Tuesday saying the plant in Fremont will be allowed to go beyond basic operations starting next Monday if Tesla abides by its part of the agreement to adopt extra safety recommendations amid the coronavirus pandemic.

Top members of Google's Pixel team have left the company
Key Pixel team members Marc Levoy and Mario Queiroz are out at Google. The departures, first reported by The Information, have been confirmed on the pages of the former Distinguished Engineer and Pixel General Manager, respectively. Both members were key players on Google's smartphone hardware team before exiting earlier this year. Levoy was a key member of the Pixel imaging team, with an expertise in computational photography that helped make the smartphone's camera among the best in class. Queiroz was the number two on the Pixel team.

Silicon Valley faces tech exodus
Silicon Valley workers are rethinking their sky-high rents and considering moving now that major tech companies won't

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reopen their office this year. Facebook and Google won't bring back employees until 2021, while Twitter has given workers the option to work from home permanently. The looming exodus isn't just happening in San Francisco — many people in crowded cities are eyeing moves to less densely populated areas amid the pandemic. A new Zillow-Harris Poll survey found 66% of people teleworking would consider moving if work-from-home flexibility continues.

VisIC, ZF jointly develop GaN inverters for electric cars
The automotive supplier ZF Friedrichshafen AG and the Israeli power electronics company VisIC Technologies Ltd have signed an agreement to jointly develop power electronics components for electric vehicles. For ZF, the focus is on a highly efficient driveshaft; VisIC will contribute its GaN expertise. The partnership is expected to strengthen the partners' development efforts based on VisIC's D3GaN semiconductor technology. The activities will focus on 400-volt driveshaft applications covering the largest segment of the electric vehicle market.

According to VisIC CEO Tamara Baksht, the development marks nothing less than the breakthrough of GaN technology in the automotive industry. "VisIC's D3GaN technology is designed to meet the high reliability standards of the automotive industry and offers the lowest losses per $R_{ds(on)}$. It also simplifies system solution development and enables highly efficient and cost-effective powertrain solutions," said Baksht.

The adoption of wide band gap semiconductor technology, which includes silicon carbide and gallium nitride materials, would significantly strengthen ZF's competitive position in the development of the most cost-effective and efficient electric drive axles.

Aiways Develops Safer EV Battery, Announces Mobile Charging Robot Patents
The battery pack's sandwich structure reduces risk of battery safety incidents, and CARL the charging robot can be summoned via smartphone to charge your EV. Chinese EV manufacturer Aiways revealed further details of its 63-kWh battery pack, a multilayered "sandwich" battery pack that allows for a greater specific capacity of cells per kg while still ensuring adequate cooling and protection from damage. The company also announced it has been granted seven patents across Europe and China that cover its autonomous mobile charging robot CARL.

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MemSQL raises $50M in debt facility for its real-time database platform
As a number of startups get back into fundraising in earnest, one that is on a growth tear has closed a substantial debt round to hold on to more equity in the company as it inches to being cash-flow positive. MemSQL — the relational, real-time database used by organisations to query and analyse large pools of fast-moving data across cloud, hybrid and on-premise environments (customers include major banks, telecoms carriers, ride sharing giants, and even those building COVID-19 tracing apps) — has secured $50 million in debt, money that CEO Raj Verma says should keep it "well capitalised for the next several years" and puts it on the road to an IPO or potential private equity exit.

The funding is coming from Hercules Capital, which has some $4.3 billion under management and has an interesting history. On the one hand, it's invested in companies that include Facebook (this was back in 2012, when Facebook was still a startup), but it's also been in the news because its CEO was one of the high fliers accused in the college cheating scandal of 2019. MemSQL does not disclose its valuation but Verma confirmed it is now significantly higher than it was at its last equity raise of $30 million in 2018 when it was valued at about $270 million, per data from PitchBook.

Lives streaming platform M17 Entertainment raises $26.5M Series D funding to expand to US and other new markets
The Taiwan-based M17 announced that it has secured US$26.5 million in Series D funding to provide additional support for the Company's continued growth in Japan as well as its expansion to the US and other key new markets. The round was led by Vertex Growth Fund ("Vertex Growth"), alongside Stonebridge Korea Unicorn Venture Fund, Innoven Capital Singapore, Kaga Electronics Co., Ltd., and ASE Global Group in New York.

Founded in Taiwan in 2015, M17 Entertainment is the number one live streaming platform in Developed Asia and it has over 60% market share by revenue in both Japan and Taiwan. According to Frost and Sullivan, the pure-play live video streaming market in Developed Asia is expected to grow to US$3.3 billion by 2022, and Japan is expected to be the largest market with a market size of US$1.1 billion. M17 empowers artists and entertain the world through its platforms. Its live interactive platforms include its flagship live entertainment streaming app 17LIVE (Livit in English markets), as well as Meme Live and live streaming shopping platforms HandsUP and FBBuy.

TeleDentistry tech startup SmileSnap closes seed funding to let dentists and orthodontists see patients from anywhere with virtual consultations
SmileSnap, a Denver, Colorado-based TeleDentistry startup and a provider of orthodontic virtual consultation app to make oral healthcare accessible from anywhere, today (May 11, 2020) announced that it has closed a seed financing round to continue its momentum as the leading company in the teledental communications sector. The investments came from several renowned investors from the dental and orthodontic sector. The total amount of the funding was not disclosed.

SmileSnap was founded in 2018 by Greg Pellegrom, CEO, a 17-year veteran in dental and orthodontic sales, together with Jameson Stafford, CTO, who most recently served as VP of Corporate Development at Catalytic, Inc, a SaaS automation platform which has raised over $50m in capital from investors including Intel Capital and NEA. The funding will also be used to hire additional software engineering and product personnel to continue to enhance the SmileSnap product portfolio. The startup is already eyeing immediate Series A as it plans to its expand services.

Clyde raises $14 million Series A to help e-commerce businesses offer extended warranty plans
Four years ago, Brandon Gell was an architecture student who spent most of his time working on 3D printing modular housing. Now, he's the founder of Clyde, an extended warranty startup that wants to help small e-commerce businesses offer product protection. Today (May 11, 2020), the company announced it has raised a $14 million Series A led by Spark Capital with participation from Crosslink, RRE, Rea Sea Ventures, and others. Using Clyde, customers can access a dashboard, and e-commerce apps to manage their protection programs. For example, a user can see how many

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contracts were sold, how much revenue total those bring, and gross profit in real-time. It can also see which products are most often purchased with an extended warranty contract.

Distributed database startup MemSQL raises $50M in debt financing
SQL-based in-memory distributed database startup MemSQL Inc. said today it has raised $50 million via a debt facility to deliver new products and services to accelerate its growth. The debt financing was underwritten by Hercules Capital. Founded in 2011, MemSQL offers what it calls a No-Limits Database designed to power modern applications with a cloud-native scalable architecture. The distributed relational database uses SQL to query massive amounts of data while also supporting both transaction processing and analytics on the same engine.

Sports app Sleeper scores $20M in celeb-studded round
San Francisco-based Sleeper, developer of a social and gaming platform for sports, raised $20 million in a fresh Series B round. Andreessen Horowitz led the financing, which included participation from other backers, including NBA Stars Kevin Durant and Baron Davis, and NFL Pro Bowler JuJu Smith-Schuster.

DispatchTrack picks up $144M for home deliveries
San Jose-based DispatchTrack, provider of SaaS-based last-mile logistics tools, received its first investment of $144 million led by Spectrum Equity. Founders started the company 10 years ago after experiencing frustration while waiting for an at-home delivery.

Lilt lands $25M for AI translation
Lilt, a provider of artificial intelligence-powered enterprise translation software, raised $25 million in a Series B round led by Intel Capital. The financing brings total capital raised by the 5-year-old, San Francisco-based company to $37.5 million.

Nanit grabs $21M for baby tech
Nanit, which has developed a smart baby monitor and sleep tracker, secured $21 million in financing led by existing investors Jerusalem Venture Partners, Upfront Ventures, RRE Ventures and Rho Capital Partners. The New York company says it will use the proceeds for the next phase of its product development and to grow its global footprint.

IRP Systems secures $17M for electric mobility
IRP Systems, a maker of powertrain products like controllers, motors and battery management systems, has landed $17 million for its Series B round led by China's Fosun RZ Capital. Founded in 2008, the Israel-based company wants to speed up the adoption of electric mobility and bring it to the mass market

Stellar Health raises $10M for physician incentives
Health tech startup Stellar Health raised $10 million in an oversubscribed Series A round led by Point72 Ventures. The New York-based company offers a workflow platform for primary care providers who are focused on providing and tracking positive health outcomes.

Vise cinches $14.5M Series A
Vise, a New York City-based fintech startup that automates investment management for financial advisors using artificial intelligence, has closed $14.5 million in Series A funding to accelerate AI technology adoption among independent advisors. The round, which brings the total capital raised to over $16 million, was led by Sequoia Capital with participation from previous investors Founders Fund, Bling Capital, Human Capital, Lachy Groom, Steve Chen, co-founder of YouTube and Jon Xu, co-founder of FutureAdvisor.
Founded in 2016, by Samir Vasavada and Runik Mehrotra, Vise automates investment management for financial advisors using artificial intelligence. Vise harnesses the power of artificial intelligence to build personalized portfolios for financial advisors' clients. Vise has built a full-stack platform spanning the entire lifecycle of the advisor-client relationship, including designing personalized portfolios for clients, managing portfolios, and providing on-going intelligence. By doing so, Vise helps financial advisors focus on their most valuable resource — their client relationships.

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Kronologic closes seed round

Kronologic, an Austin-based developer of a SaaS-based platform that converts sales leads into meetings, has closed on $3.5 million in a seed financing round led by Silverton Partners.

Waymo banks another $750M

Waymo, the self-driving car unicorn spun out of Alphabet, has raised an additional $750 million, bringing its first external round to $3 billion. The fundraise follows an announcement that it will be resuming driving operations in metro Phoenix, with plans to begin doing so in San Francisco, Detroit and Los Angeles soon.

Semperis lands $40M for cybersecurity

Semperis, a profitable cybersecurity firm, raised a $40 million Series B funding round led by Insight Partners. The 7-year-old company is best known for providing security for Microsoft's Active Directory, before, during and after an attack.

Quizlet scores $30M for online learning

Learning platform Quizlet has raised $30 million in a Series C round led by General Atlantic. The San Francisco-based company uses activities and games to help students practice and master what they're learning.

ConverseNow raises cash for restaurant pickup

ConverseNow Technologies, an Austin-based startup with an AI-enabled platform that automates and personalizes restaurant orders on high-volume call channels, announced $3.25 million in seed-round funding led by Bala Investments. The company is targeting its offering to quick-service restaurants touting a "contactless" customer experience when orderin

Homeward secures $105M in debt and equity

Homeward, an Austin-based real estate startup that aims to help people buy homes faster, announced that it has secured $105 million in funding. The 18-month-old company raised $20 million in equity in a round led by Adams Street Partners, along with $85 million in debt financing from multiple lenders.

Clear Labs raises $18M to focus on COVID-19 diagnostics

Silicon Valley-based Clear Labs, a provider of genomic sequencing technology, has raised $18 million in a new round of funding led by Redmile Group. The company plans to use the funds to focus efforts on COVID-19 diagnostics.

Workvivo lands $16M for workplace engagement

Workvivo's efforts to turn lifeless all-company emails into engaging content for employees is attracting a fresh round of capital from investors. The Cork, Ireland-based company just raised $16 million in a Series A round backed by Tiger Global.

Dathena secures $12M Series A

Singapore-based Dathena Science, a provider of artificial intelligence-powered data protection and privacy management tools, raised $12 million in a Series A round led by Jungle Ventures.

Facebook buys Giphy for a reported $400M

Facebook is acquiring GIF search engine Giphy in a deal reportedly valued at around $400 million. Strategically, the deal makes sense, as half of Giphy's traffic comes from Facebook's apps, and Instagram in particular. Previously, New York-based Giphy raised about $150 million in venture funding.

DigitalOcean raises $50M at $1.15B valuation

DigitalOcean, which describes itself as "the cloud for developing modern apps," announced it has raised a $50 million Series C round at a valuation of $1.15 billion. Access Industries led the financing for the New York-based company, which says the COVID-19 pandemic has accelerated the transition of businesses to the cloud.

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Immunai launches with $20M to map immune system

Immunology startup Immunai came out of stealth mode with $20 million in a seed funding round backed by Viola Group and TLV Partners. The New York-based company's goal is to build the world's largest proprietary clinical immunology data set to better detect, diagnose and treat disease.

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By Kate Clark

Before the coronavirus outbreak, Brex had become the poster child of Silicon Valley largesse. By offering fellow startups high-limit charge cards, its 24-year-old founders had attracted illustrious investors like Kleiner Perkins, rocketing Brex to a $2.6 billion valuation. Flush with cash, it blanketed downtown San Francisco with advertisements, bought four companies, quadrupled its staff, started a magazine—and even opened a restaurant. All in just three years.

Today co-founders Henrique Dubugras and Pedro Franceschi are bracing for a harsher reality. Reeling from the coronavirus shutdowns, Brex customers including Airbnb, Outdoor Voices and ClassPass are slashing costs and cutting thousands of jobs. A replay of the 2001 dot-com crash, which wiped out a generation of promising upstarts, could be Brex's death knell. It has already cut credit limits to reduce its exposure, losing out on revenue it might have generated from these customers and angering some borrowers because it didn't warn them in advance.

Dubugras says they're ready for tough times. The Brazilian-born co-CEOs led their first company, an internet payments business, through one of the country's worst economic crises in its history. The experience taught them to stockpile money.

Before the coronavirus outbreak, Brex had raised $615 million in equity and debt funding, and—while still not profitable—it could have taken on even more. The San Francisco–based founders held informal talks with SoftBank last year that would have nearly doubled the company's valuation to $5 billion, The Information has learned. The talks were informal and didn't lead to an investment.

Even without that extra cash, Brex has about $300 million on its balance sheet, according to sources familiar with the company, and has discussed borrowing money through a convertible note, a form of debt that converts into equity at a later date, as further defense.

"People ask, 'Why do you raise money? You have infinite money.' But it always comes from a paranoia of 'Hey, if something happens—we've been through so much in Brazil,'" Dubugras said by phone.

"You live life assuming you might go into recession at any point in time."

Rapid Rise

Holed up in a New York City apartment with his girlfriend, his Mini Bernese Mountain Dog and his co-founder, Dubugras is spending his time sheltering in place like many others. He's binge-watching the "Mission: Impossible" films. He's reading startup saga "Super Pumped." Mostly, he's trying to shore up his 400-person company for what could be the deepest U.S. recession since the Great Depression.

The situation is a throwback to the co-founders' early days in São Paulo. As teenagers, they started a business just before Brazil fell into a yearslong recession followed by a political crisis. Still, their company, Pagar.me, thrived by helping other businesses profit from online sales. By the time they sold it in 2016 to attend Stanford University as undergraduates, it had processed $1.5 billion in gross merchandise volume.

The pair didn't last long at Stanford, dropping out after eight months and joining startup accelerator Y Combinator. They had grand plans to start a virtual reality company—but quickly ditched the idea for something more familiar.

"Inside YC, we saw that all these startups had raised a lot of money, sometimes millions of dollars, and they couldn't

get a corporate credit card," Dubugras said on the "DealMakers" podcast last year. "We thought that was really dumb."

Founded in early 2017 and launched the following year, Brex issues charge cards to startups without requiring a personal guarantee or a credit check. Instead, it considers the startup's investors and how much venture capital it has raised, and extends a limit that represents a portion of those funds. Brex says it can give credit limits 10 to 20 times higher than startups would normally obtain by monitoring customers' bank accounts and adjusting their limits, which can range from a few thousand to tens of millions of dollars.

Brex isn't the licensed lender. It makes money by taking a portion of the interchange fee, which is usually less than 2% of every transaction. A partner, Emigrant Bank, originates the loan. Brex buys it and then extends the credit to its customers. Customers have to pay off the balances, in full, after 30 or 60 days, or Brex deactivates the card. In its first year, Brex had no defaults, even though hundreds of its customers had shut down.

The model promised a novel way to break into the corporate card market—first with startups, then more broadly in the future with small businesses and eventually Fortune 500 companies. It attracted PayPal founders Peter Thiel and Max Levchin as early backers, as well as Micky Malka, a managing partner at global fintech fund Ribbit Capital who became Brex's first institutional investor in 2017.

By late 2018, the one-year-old startup was worth $1.1 billion after having raised $182 million from investors including IVP, Greenoaks Capital and DST Global. It was a remarkable ascent for such a young company.

Investors were tantalized by the prospect of taking on American Express, which posted $43.6 billion in revenue last year—and they were intrigued by the founders' youth. "I graduated school when they were born. They are sort of wise beyond their years," said Somesh Dash, a general partner at IVP.

A year later, Brex doubled its valuation again to $2.6 billion, raising $100 million in debt from Barclays, followed by a $100 million equity round led by Kleiner Perkins. It started a members-only club dubbed The Oval Room to give its cardholders a place to host meetings. It also expanded into cash management with Brex Cash. By the fall of 2019, more deep-pocketed investors had approached the founders. The SoftBank Vision Fund, which had gained notoriety for writing big checks to startups like WeWork, floated a deal valuing Brex at between $4 billion and $5 billion, according to people familiar with the matter. Brex and SoftBank declined to comment on the talks.

Brex ultimately did raise more money. The company turned from equity back to debt, closing a $200 million financing from Credit Suisse in December that it would use, along with debt from Barclays, to fund its loans.

Crisis Modeling
Then came the January reports of a highly contagious flu spreading in China. At first, it didn't seem like a big deal. "We kind of laughed at the article about handshakes like everyone else at the time," said Dubugras. "We were surprised." As the global death toll from the coronavirus mounted, they moved into contingency planning.

In late February, Chief Financial Officer Michael Tannenbaum prepared a presentation for Brex's lenders and financial partners to soothe their worries that Brex might hit a cash crunch. Dubugras outlined stress-case scenarios to the Brex board. In one, Dubugras imagined the company's response to revenues dropping 70%. In another, he outlined the possibility of defaults rising to 20 times their current levels.

"If shit goes really wrong, this is what it will look like," Dubugras said.

By the next month, the crisis had hit home. On March 10, Brex closed its cafe in San Francisco's South Park neighborhood after an employee tested positive for coronavirus. Offices across the U.S. began telling their staff to work from home. Dubugras and Franceschi decided to relocate to New York, where they had a two-bedroom rental for their frequent visits to Brex's office there.

Some customers were starting to suffer. Airlines were grounding flights, and shelter-in-place measures had effectively frozen business at any startup dependent on travel or in-person gatherings. Airbnb raised $2 billion in debt to survive. Fitness company ClassPass laid off or furloughed about half its staff. Each day seemed to bring another rash of bad news from other startups. Bird, Sonder, TripActions, Opendoor and hundreds of others were letting their workers go to stay afloat.

For a generation of fintech startups launched in a financial boom, it was a shock.

"So many of these players have benefited from benign economic environments," said Celent analyst Stephen Greer. "They were born in a good economic environment and haven't really tested the strength of their reserves."

Signs of Stress
Brex in April began lowering customer credit limits, a standard response from lenders in a recession. But the move jarred some customers given Brex's heavily cultivated image as a founder-friendly tech alternative to traditional banks.

One e-commerce entrepreneur said its Brex limit fell more than 90% overnight, to $45,000. Four customers said the company didn't notify them prior to the credit line reductions. Brex issued a blog post in mid-April trying to clarify the limits, which executives said were necessary to reduce its exposure amid the Covid-19 outbreak.

"What matters now is who emerges from this stronger than when they entered it," said Tannenbaum, who joined the company from peer-to-peer lender SoFi, in a mid-April interview. "It doesn't matter whose top-line growth is the most."

Other startup and small business lenders have also shown signs of distress. SoftBank-backed Kabbage reduced credit lines for small business customers to zero in early April. American Express said it had tripled its provision for credit card losses and would cut spending by roughly $3 billion this year. Delinquency rates for U.S. business loans are expected to rise to 6.5% by the end of this year, the highest since 1992, according to credit insurance company Euler Hermes.

Brex declined to comment on its default rates but confirmed that travel and entertainment spending has fallen significantly since mid-March, while spending on subscription software products like Amazon Web Services has been steadier.

The company has limited marketing and sales budgets for the foreseeable future and plans to slow hiring. For now, the founders aren't planning layoffs, unless "this is a three-year thing," says Dubugras.

He's optimistic about the post-coronavirus landscape, betting that there will be a boom in startup formation. He also hopes small businesses that have been more reluctant to abandon traditional lenders will be more keen on financial platforms like Brex.

First, it has to get through the downturn intact. The founders have said they have at least 24 months of cash. Its investors, including Malka and Dash, doubt Brex will exhaust its reserves. Before that happens, it could follow in the path of Stripe and Robinhood, two other buzzy fintech startups that have taken on more funding during the pandemic.

"They've always raised more equity than they needed," said Ribbit Capital's Malka, a board member. "I don't worry about capital because for teams like this, there is always capital."

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By Isabelle Kirkwood

Real estate firm Colliers International and Techstars have announced the 2020 Colliers Proptech Accelerator program, which helps proptech startups fine-tune business plans and explore pilots and partnerships, has been moved to 2021.

The organization said the decision to postpone the Toronto-based accelerator was made due to considerations regarding the health and safety of program participants during the COVID-19 pandemic. The accelerator's last cohort began in September 2019 and ended in December.

"Our commitment to the Colliers Proptech Accelerator is unwavering. [Managing director of Techstars] Ben Liao and Techstars will continue to build and enhance the program across multiple fronts through 2020 in partnership with Colliers, with the goal of making 2021 the best year yet," said Zach Michaud, vice president of strategic investments at Colliers International.

Rather than hosting a new cohort for this year, Colliers said it is working with its 2018 and 2019 alumni companies to deliver virtual tools that help people and businesses navigate the new challenges that the COVID-19 pandemic has surfaced. Michaud said digital tools, developed by companies like Finneo, RealAR, and Booqed, could give Colliers' clients an edge in the current business environment.

"As COVID-19 accelerates the commercial real estate industry's transition to digital solutions, we are seeing the potential benefits of our partnerships move into sharper focus," said Michaud. "The business tools they are providing such as lease abstraction, virtual office tours, and workplace occupancy analytics give our experts and clients a competitive advantage in these challenging times."

Colliers and Techstars join the many accelerator programs that have opted to postpone or virtually host their programming due to the pandemic. Techstars' Startup Weekend was held virtually last month, and NEXT Canada is also hosting its Venture Reveal on Zoom this week. Techstars has plans to run other accelerator programs virtually, with details on different terms and cohorts here.

All of Techstars' global programs running from June to September will be held virtually with a virtual demo day. The organization is also implementing virtual committees and screenings for future cohorts and plans to reassess when live events or meetings will be held in person.

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By Romain Dillet

Consumer **fintech startups** were massively successful in 2019, attracting millions of new users and disrupting traditional retail banks and financial services with mobile-first, consumer-oriented products. Despite the economic downturn in public markets and the massive wave of cuts at public and private companies in recent weeks, fintech startups have been raising a ton of money.

It feels like they're all building a war chest to survive the economic winter as traditional banks continue to iterate so they can catch up and offer more user-friendly services. This is not the time to raise fees, slow down on product development or plans to acquire new users.

Nine-figure rounds
Back in January, I looked at challenger banks and their growth trajectories, but since then, they have managed to attract even more customers. According to the most recent figures:

- Nubank has 20 million customers;
- Revolut has 10 million users;
- Chime has 8 million users;
- N26 has 5 million users;
- Monzo has 4 million users.

And that's without mentioning Starling Bank, Atom Bank, Bunq, Bnext, Paysend, etc. At some point, there will be as many challenger banks as non-challenger banks — perhaps we shouldn't call them *challenger* banks anymore.

Beyond these startups, trading app Robinhood recently reached 13 million users, international payments startup TransferWise has 7 million customers and cryptocurrency exchange Coinbase has 30 million users.

In recent weeks, Robinhood reported a new $280 million round at an $8.3 billion valuation, Stash, another mobile-first investment startup, raised a $112 million round, and N26 extended its Series D round by adding $100 million at a $3.5 billion valuation.

And of course, there's the round of all rounds — Stripe raised another $600 million as part of its Series G round ($850 million for the Series G alone), which means the startup is now valued at $36 billion. Clearly, the company is trying to stay private for as long as possible, so it's hard to call it a "startup" at this point.

Some of them also raised right before the economic downturn — they don't have a reason to raise again just yet. You can think about Revolut's $500 million round from February or Lydia, a French peer-to-peer payment app that raised $45 million in a round led by Tencent.

Consolidation is coming
When I talk to fintech CEOs about the market potential of their respective products, they always say it's a wide ocean of opportunities and they're not really competing with other startups — legacy players are the industry's dominant players.

In other words, there is enough room for many different fintech startups, and even better, they could all be growing at the same time. Still, it won't be easy: Monzo recently laid off 165 customer support staff and offered voluntary furloughs.

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Companies operating in this industry generate most of their revenue from paid financial products like credit cards, international transfers and insurance products; referral revenue from the integration of third-party financial products; interchange fees on card transactions, and premium subscriptions like Robinhood Gold and Revolut Premium.

Depending on the company, revenue can be up for some categories and down for others. For challenger bank N26, co-founder and CEO Valentin Stalf told me that spending volume is down "20 to 30% depending on the market," but subscriptions are "quite stable."

But many people are losing jobs and burning through their savings right now. And if you don't have money to invest, transfer back to your family as a remittance or spend in general, you're not going to generate a ton of revenue for fintech startups — except peer-to-peer lending marketplaces.

That's why some of the most visible fintech startups have been preparing for consolidation. Brex acquired not one, not two but three companies. It's a relatively small move as only 12 people are joining Brex as a result.

Revolut is looking at bigger targets, and not necessarily in the fintech space. Revolut co-founder and CEO Nikolay Storonsky told the Financial Times that his company could acquire a travel aggregator as some of those companies are running out of options. You could imagine buying flights or renting cars on Revolut in the future.

The financial sector is highly regulated industry and regulation differs from one country to another, so building a fintech startup in Europe is a very different experience than doing so in the U.S. I wouldn't have said this last year, but I can envision mergers between fintech startups that allow them to service more markets.

Building the financial super-app
Many fintech startups are trying to build super-apps — one financial hub to access multiple different services. WeChat and Alipay started this trend by bundling payments with e-commerce, transportation, savings accounts and more.

Given that the most popular consumer fintech services received a ton of funding, they have a real shot at achieving this goal. It'll leave little room to breathe for other fintech companies. And the current economic outlook is going to accelerate that trend toward building these hubs.

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Knowing the types of algorithms and what they accomplish can help finance executives ask the right questions when working with data.

By Chandu Chilakapati and Devin Rochford

Chief financial officers today face more opportunities to engage with machine learning within the corporate finance function of their organizations. As they encounter these projects, they'll work with employees and vendors and will need to communicate effectively to get the results they want.

The good news is that finance executives can have a working understanding of machine learning algorithms, even if they don't have a computer science background. As more organizations turn to machine learning to predict key business metrics and solve problems, learning how algorithms are applied and how to assess them will help financial professionals glean information to lead their organization's financial activity more effectively.

Machine learning is not a single methodology but rather an overarching term that covers a number of methodologies known as algorithms.

Enterprises use machine learning to classify data, predict future outcomes, and gain other insights. Predicting sales at new retail locations or determining which consumers will most likely buy certain products during an online shopping experience represent just two examples of machine learning.

A useful aspect about machine learning is that it is relatively easy to test a number of different algorithms simultaneously. However, this mass testing can create a situation where teams select an algorithm based on a limited number of quantitative criteria, namely accuracy and speed, without considering the methodology and implications of the algorithm. The following questions can help finance professionals better select the algorithm that best fits their unique task.

Four questions you should ask when assessing an algorithm:

1**. Is this a classification or prediction problem?** There are two main types of algorithms: classification and prediction. The first form of data analysis can be used to construct models that describe classes of data using labels. In the case of a financial institution, a model can be used to classify what loans are most risky and which are safer. Prediction models on the other hand, produce numerical outcome predictions based on data inputs. In the case of a retail store, such a model may attempt to predict how much a customer will spend during a typical sales event at the company.

Financial professionals can comprehend the value of classification by seeing how it handles a desired task. For example, classification of accounts receivables is one way machine learning algorithms can help CFOs make decisions. Suppose a company's usual accounts receivable cycle is 35 days, but that figure is simply an average of all payment terms. Machine learning algorithms provide more insight to help find relationships in the data without introducing human bias. That way, financial professionals can classify which invoices need to be paid in 30, 45, or 60 days. Applying the correct algorithms in the model can have a real business impact.

2. What is the selected algorithm's methodology? While finance leaders are not expected to develop their own algorithms, gaining an understanding of the algorithms used in their organizations is possible since most commonly deployed algorithms follow relatively intuitive methodologies.

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Two common methodologies are decision trees and Random Forest Regressors. A decision tree, as its name suggests, uses a branch-like model of binary decisions that lead to possible outcomes. Decision tree models are often deployed within corporate finance because of the types of data generated by typical finance functions and the problems financial professionals often seek to solve. A Random Forest Regressor is a model that uses subsets of data to build numerous smaller decision trees. It then aggregates the results to the individual trees to arrive at a prediction or classification. This methodology helps account for and reduces a variance in a single decision tree, which can lead to better predictions. CFOs typically don't need to understand the math beneath the surface of these two models to see the value of these concepts for solving real-world questions.

3. What are the limitations of algorithms and how are we mitigating them? No algorithm is perfect. That's why it's important to approach each one with a kind of healthy skepticism, just as you would your accountant or a trusted advisor. Each has excellent qualities, but each may have a particular weakness you have to account for. As with a trusted advisor, algorithms improve your decision-making skills in certain areas, but you don't rely on them completely in every circumstance.

With decision trees, there's a tendency that they will over-tune themselves toward the data, meaning they may struggle with data outside the sample. So, it's important to put a good deal of rigor into ensuring that the decision tree tests well beyond the dataset you provide it. As mentioned in our previous article, "cross contamination" of data is a potential issue when building machine learning models, so teams need to make sure the training and testing data sets are different, or you will end up with fundamentally flawed outcomes.

One limitation with Random Forest Regressors, or a prediction version of the Random Forest algorithm, is that they tend to produce averages instead of helpful insights at the far ends of the data. These models make predictions by building many decision trees on subsets of the data. As the algorithm runs through the trees, and observations are made, the prediction from each tree is averaged. When faced with observations at the extreme ends of data sets, it will often have a few trees that still predict a central result. In other words, those trees, even if they aren't in the majority, will still tend to pull predictions back toward the middle of the observation, creating a bias.

4. How are we communicating the results of our models and training our people to most effectively work with the algorithms? CFOs should provide context to their organizations and employees when working with machine learning. Ask yourself questions such as these: How can I help analysts make decisions? Do I understand which model is best for accomplishing a particular task, and which is not? Do I approach models with appropriate skepticism to find the accurate outcomes needed?

Nothing is flawless, and machine learning algorithms aren't exceptions to this. Users need to be able to understand the model's outputs and interrogate them effectively in order to gain the best possible organizational results when deploying machine learning.

A proper skepticism using the Random Forest Regressor would be to test the outcomes to see if they match your general understanding of reality. For example, if a CFO wanted to use such a model to predict the profitability of a group of enterprise-level services contracts she is weighing, the best practice would be to have another set of tests to help your team understand the risk that the model may classify highly unprofitable contracts with mildly unprofitable ones. A wise user would look deeper at the underlying circumstances of the company to see that the contract carries a much higher risk. A skeptical approach would prompt the user to override the situation to get a clearer picture and better outcome.

Understanding the types of algorithms in machine learning and what they accomplish can help CFOs ask the right questions when working with data. Applying skepticism is a healthy way to evaluate models and their outcomes. Both approaches will benefit financial professionals as they provide context to employees who are engaging machine learning in their organizations.

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By Todd Bishop

The rolling, UV-emitting robot is something Amazon is "working on for the future," according to the 60 Minutes report. (Amazon via 60 Minutes)

Amazon is developing a robot that would roll through grocery stores and distribution centers, using banks of ultraviolet light to kill viruses on surfaces.

The company provided "60 Minutes" with video of a prototype of the robot for a report Sunday night about Amazon's response to the COVID-19 crisis, and the backlash from workers who want the company to close down distribution centers for cleaning and disinfection when employees test positive.

It's part of a technological show-of-force from the company, seeking to demonstrate its efforts to battle COVID-19 in the face of criticism from employees and others.

In addition, 60 Minutes reports that Amazon is "trying to enforce social distancing by videotaping all its employees and using artificial intelligence to study their movements." The report notes that cameras are "also being used for contact tracing in order to identify workers who came in contact with a sick colleague and send them into quarantine."

The segment describes Amazon's UV-emitting robot as "something they're working on for the future," without providing a timeline or other details.

We've contacted Amazon for more details, and for comment on the 60 Minutes report.

It was the first glimpse of a concept that the company has hinted at previously. Brad Porter, vice president of robotics at Amazon, last week referenced the company's work on "mobile ultraviolet sanitation" in a LinkedIn post that he wrote in response to the resignation of fellow VP Tim Bray over the company's firing of employees who spoke out about the spread of COVID-19.

The company has declined to disclose the total number of Amazon workers who have tested positive. Jana Jumpp, an Amazon worker in Indiana who has been tracking confirmed cases, told 60 Minutes that at least 600 workers have been diagnosed with COVID-19. Other reports have put the number higher.

The segment included video of Amazon workers in a packed break room, not wearing masks or protective equipment.

Dave Clark, Amazon's senior vice president of operations, declined to confirm the number for 60 Minutes, telling correspondent Lesley Stahl that the case total "isn't particularly useful because it's relative to the size of the building and then the overall community infection rate."

"Amazon is seen as an essential service through this pandemic, but you have been very slow to install your workers' protections, and it's hurt your reputation," Stahl said to Clark. "You've been seen as a company that puts profits ahead of people."

Clark responded, "I could not disagree more strongly with the premise that we're late to this party. Quite to the contrary, I think we've been early on the curve to this (compared) to most employers, particularly major employers in the U.S."

He said infections at Amazon facilities have been happening at a rate "just under" the infection rate in surrounding communities.

Via a remote video connection, Clark gave Stahl a virtual tour of an Amazon fulfillment center, demonstrating some of the measures the company is taking in response to COVID-19. They included a nasal swab test for workers, rapid temperature checks when people enter the building, disinfectant misting equipment, and mobile hand-washing stations.

Amazon says it's spending $4 billion on its COVID-19 response this quarter alone. "Providing for customers and protecting employees as this crisis continues for more months is going to take skill, humility, invention, and money," said Amazon CEO Jeff Bezos in the company's recent earnings report.

Stahl last week detailed her own battle with and recovery from COVID-19.

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By Christopher Stern

Shortly after Microsoft's come-from-behind win over Amazon in a $10 billion Pentagon cloud computing contract last October, its CEO, Satya Nadella, credited the victory to the software giant's decision to rise above politics and focus on the needs of the client.

What Nadella didn't mention is that Microsoft for over a year quietly worked with another big tech company, Oracle, to prevent Amazon—the market leader in cloud computing—from walking away with the entire contract for the Joint Enterprise Defense Infrastructure, as the military project is known. Lobbyists for the two companies jointly pressed an influential political leader to make their case with the Pentagon, while the companies sponsored a task force at a conservative think tank that argued the military shouldn't award the contract to a single entity. Microsoft stopped making that argument after the Pentagon decided it would give the contract to one company.

Now, as Amazon sues the Trump administration to reverse its decision on the project, the battle between the internet giant and Microsoft—its rival on the other side of Lake Washington in the Seattle area—has spilled out into the open.

In the latest example, top communications executives at the companies traded barbs in blog posts last week. Frank Shaw, Microsoft's vice president of corporate communications, accused Amazon of putting American war fighters at a disadvantage by delaying much-needed modern technology upgrades with its legal protests. Drew Herdener, Amazon's vice president of global corporate communications, responded on Friday by accusing Microsoft of publishing "self-righteous and pontificating blog posts" and "trying to bully its way to an unjust victory."

For Microsoft, the mudslinging aimed at a competitor is a departure from the kinder, gentler image the company has cultivated over the past several years since Nadella took over as CEO. After playing the part of tech industry villain during its antitrust battles of the 1990s and early 2000s, Microsoft has managed to largely sidestep the regulatory scrutiny currently directed at its peers in big tech.

While Facebook, Google and Amazon play defense in Washington, D.C., and other centers of political power, Microsoft has positioned itself as a friend to governments on broad issues like regulating privacy and artificial intelligence, rather than a tech giant seeking to protect its own narrow self-interests. At the same time, Microsoft has mostly stopped publicly bashing competitors, as it used to do years ago in its rivalries with Google and the makers of various open-source technologies.

The enormous stakes in the JEDI contract may explain why Microsoft has dropped its courtly manner lately. The Pentagon deal could prove even more valuable than the $10 billion figure, providing a gateway to other government cloud deals worth $40 billion to $50 billion over the next five years, according to Wedbush Securities analyst Daniel Ives.

Winning such deals could play an important role in Microsoft's effort to catch up to Amazon Web Services, Amazon's cloud unit. In the first quarter, AWS accounted for 32% of cloud spending, almost double the share of Microsoft, the market's No. 2 competitor, estimates research firm Canalys.

Deal Politics
Last fall, when interviewed about Microsoft's unexpected victory in the JEDI competition, Nadella was asked whether President Trump's well-known animosity toward Amazon played a role.
Trump has repeatedly directed his ire at the internet retailer and its CEO, Jeff Bezos. His hostility appears to be connected to Bezos' personal ownership of The Washington Post, whose coverage of the Trump administration has long

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vexed the president. Nadella downplayed the idea that politics interfered in the process, saying that Microsoft won the deal on the merits of its bid.

"To me, it goes back to, if anything, Microsoft staying out of politics and staying focused on what the customer's needs are," Nadella told tech news site GeekWire.

But it would be a stretch to say Microsoft avoided politics entirely during the JEDI bidding process. Records show that Microsoft and Oracle—another contestant for the Pentagon project—began working together as early as April 2018, one month after the Defense Department released the first draft of its request for proposals for the JEDI contract.

That same month, Oracle CEO Safra Catz reportedly complained directly to President Donald Trump at a White House dinner over Amazon's perceived status as a shoe-in for the contract. Oracle's founder and chief technology officer, Larry Ellison, is one of Trump's most prominent supporters in Silicon Valley. Ellison held a Trump campaign fundraiser in February at one of his homes.

Oracle and Microsoft made strange bedfellows. The companies were old foes in the business software market in the 1990s and early 2000s, when Oracle played a leading role in attacking Microsoft for its business practices at the time.

The chief goal of joining forces was to pressure the Pentagon into breaking the contract into pieces rather than awarding it to a single company. The single-company scenario was widely seen as favoring Amazon because of its market leadership and history of providing cloud services to the CIA. To work toward defeating Amazon, Microsoft and Oracle in June 2018 jointly underwrote the formation of a task force on federal information technology services, run by the Hudson Institute, a conservative think tank based in Washington, D.C.

The Hudson Institute hosted three events over the next year, including a discussion of best practices for military procurement of cloud technology where panelists criticized the Pentagon's decision to go with a single source for the contract. Panelists at the events included former and current Defense Department officials, as well as artificial intelligence experts with the Navy. A spokesperson for the Hudson Institute had no comment.

That same year, lobbyists working for Microsoft and Oracle coordinated in an effort to press Rep. Steve Womack, a Republican from Arkansas, to argue in a letter to the Pentagon against going with a single JEDI contractor, The Wall Street Journal has previously reported.

Microsoft's Shaw told The Information that Microsoft worked with other technology companies to argue in favor of multiple winners of the JEDI contract, but ultimately dropped the effort.

"During the first half of 2018, a coalition of several technology companies, including Microsoft, believed that a multi-cloud solution was the best avenue ahead, and lobbied for it," Shaw said in a statement. "By August of that year, when the DoD made the decision to move with a single cloud bid, we complied and did not appeal further. Accordingly, the coalition dissolved."

"It's not surprising that Microsoft is trying to posture here, but anybody who's studied the cloud computing space will tell you that AWS has a much more functional, capable, cost-effective and operationally strong offering," an AWS spokesman said in a statement.

The coalition also included IBM, another early bidder for the JEDI contract, in addition to Oracle and Microsoft, according to people familiar with the situation. A spokesperson for IBM declined to comment.

Oracle's hopes of winning a piece of the JEDI contract dimmed in April 2019, when the Pentagon told the company that, along with IBM, it hadn't made the cut. That left Microsoft and Amazon alone for the final round of bidding. Oracle has

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launched legal challenges to protest its disqualification. Those challenges are continuing, with an appeal currently making its way through the federal courts.

"Oracle believes the taxpayer and war fighter benefit from robust competition, not preordained outcomes," Ken Glueck, executive vice president of Oracle, said. "Oracle's cloud is highly differentiated, more secure and performant than [those of] our competitors, but [the] DOD designed a process that precluded [it] from even evaluating our offerings."

In addition to expressing its concerns about awarding the entire contract to a single company, Oracle has also complained that the Pentagon had a conflict of interest since some DOD officials had professional and financial ties to Amazon.

Amazon, meanwhile, has filed its own lawsuit challenging the decision to award the contract to Microsoft. The core of the company's argument is that White House political influence tainted the process. It also argues that the Pentagon's process for evaluating the contract process was flawed.

A federal judge has put a hold on Microsoft's work on the contract until at least Aug. 17 or until the Pentagon responds to the concerns Amazon has raised about Microsoft's bid. Last week, Amazon launched a new complaint about the process directly to the Pentagon.

A 313-page report from the Office of Inspector General released last month found that the Pentagon didn't succumb to political pressure when it awarded the contract to Microsoft. The report did not assess whether the Pentagon erred when it picked Microsoft, but only reviewed the integrity of the process itself. The investigation found that potential conflicts of interest or improper influence from President Trump did not sway the Pentagon.

In an important caveat, however, the report noted that the White House blocked investigators from interviewing top Pentagon and executive branch officials about potential political interference.

Microsoft, meanwhile, has accused Amazon of in essence being a sore loser and blowing its chance at the JEDI contract by offering prices that were higher than Microsoft's. "Amazon alone made the choice to bid high, but now wants to find a way to avoid the consequences of its own bad business decisions," Shaw, the Microsoft communications executive, said in his blog post last week.

The Takeaway

Microsoft has said politics didn't play a role in its victory in a $10 billion cloud computing contract with the Pentagon, but the company quietly formed an alliance with Oracle two years ago to undermine Amazon in the bidding for the project.

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By Catherine Sbeglia

The Snapdragon 768G will deliver superior gaming performance, 5G connectivity and intelligent multi-camera capabilities

Qualcomm released its Snapdragon 768G Mobile Platform designed specifically for mobile gaming. As a subsequent release to the Snapdragon 765G — used in the Nokia 8.3 5G handset — the latest processor enables smart, immersive gaming experiences with the integration of truly global 5G, according to the company.

Snapdragon 768G offers a number of performance enhancements over Snapdragon 765G. For instance, while the 765G has a Kryo 475 CPU Prime core clock speed of 2.4 GHz, the 768G can reach speeds of up to 2.8 GHz. Further, the Qualcomm Adreno 620 GPU offers up to 15% performance increase, and it is the first 7-series platform to support for Adreno Updateable GPU Drivers, which gives gamers control of their GPU driver updates and settings to provide peak display refresh rates.

The Snapdragon 768G also promises to deliver superior gaming performance, 5G connectivity and intelligent multi-camera capabilities without killing the device's battery.

Additional features include:

- **Immersive Gaming**: Snapdragon 768G offers select Snapdragon Elite Gaming features to provide special game extensions and optimizations, smoother gameplay and more enhanced detail and colors with true 10-bit HDR to deliver high quality mobile gaming experiences, Qualcomm said. Combined with a bolstered Adreno 620 GPU for up to 15% faster graphics rendering than Snapdragon 765G and support for 120Hz display, users can enjoy life-like gaming experiences and leading performance per unit power.

- **Truly Global 5G**: Qualcomm said that the Snapdragon 768G with the Snapdragon X52 5G Modem-RF System supports all key regions and frequency bands, including 5G mmWave and sub-6 GHz, 5G SA and NSA modes, TDD and FDD with Dynamic Spectrum Sharing (DSS), global 5G roaming and support for multi-SIM. The Snapdragon X52 5G Modem-RF System is designed to deliver multi-gigabit peak download speeds of up to 3.7 Gbps and upload speeds of up to 1.6 Gbps, ensuring improved coverage and battery life.

- **5th Generation AI Engine**: The latest 5th generation Qualcomm AI Engine, combined with the X52 5G Modem-RF System, enhances "nearly every mobile experience" including camera, audio, voice and gaming, the company said. Snapdragon 768G's AI Engine "fuels mobile experiences that are sophisticated and seamless, supporting unique and innovative use cases like real-time translation and ultra-smooth AI-based lens filters for social media apps." Also, the low-power Qualcomm Sensing Hub enables devices to be "contextually aware of voice commands when using AI voice assistants and can automatically identify music that is playing around users."

Kedar Kondap, vice president, product management, Qualcomm said the company is "uniquely positioned to accelerate 5G commercialization at scale," suggesting that the Snapdragon 768G demonstrates this.
"Our expanding portfolio has the potential to make 5G accessible to billions of smartphone users around the world, he commented.

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By Kevin Dowd

The brick-and-mortar retail industry has been in a state of slow-motion crisis for several years now. The rise of ecommerce caused steep declines in foot traffic. A spate of private equity buyouts piled on billions of dollars in debt. One shopping-mall staple after another has limped toward layoffs, store closures and eventual bankruptcy, creating an ongoing mass-extinction event widely known as the retail apocalypse.

These trends have only accelerated during the first two months of the coronavirus crisis, resulting this week in bankruptcies from two iconic PE-backed retail chains. If this keeps up, what the industry thought was an apocalypse might end up being only a prelude to the real storm.

One of the world's biggest investors, though, is planning a new $5 billion effort to keep the wolves at bay.

America's retail chains are fighting for survival, which is one of 11 things you need to know from the past week:

1. Resuscitating retail
J. Crew, a defining retailer of prep apparel, began the week by filing for Chapter 11 protection on Monday. Neiman Marcus, a chain that embodied the idea of luxury retail during the 20th century, followed suit on Thursday. Neither filing came as much of a surprise, in part because of the heavy loads of buyout-fueled debt both companies have been carrying for the past several years.

TPG Capital and Leonard Green & Partners took J. Crew private for $3 billion in 2011, while Ares Management and the Canada Pension Plan Investment Board paid $6 billion for Neiman Marcus in 2013. J. Crew reportedly maintained a $1.7 billion debt load before the coronavirus crisis began, and Neiman Marcus was weighed down by a reported $5.1 billion in debt. Servicing the obligations on that debt was a tough ask in any economy; it became impossible when stores began to close and sales began dropping because of the pandemic.

Both J. Crew and Neiman Marcus will remain in business, with hopes of emerging from bankruptcy with more sustainable balance sheets. But it stands to reason that some of the negative effects caused by the coronavirus will carry on for months, or even years, to come. On that point, it's worth noting that not only PE-backed retailers are under stress: On Friday, for instance, Reuters reported that JC Penney is preparing to file for Chapter 11 as soon as this coming week.

The ties between private equity and retail remain plentiful, though, including one planned marriage that was called off this week. L Brands, the parent of Victoria's Secret, acquiesced to Sycamore Partners' desire to walk away from its $525 million deal to acquire 55% of the lingerie chain. In a previous lawsuit defending its right to scrap the deal, Sycamore reportedly cited pandemic-driven store closures as a breach of the agreement.

Dealings with private equity haven't always ended well for retail, but in some cases, buyout firms are also one of the few available sources of funding for companies in need of a boost. Raising capital on unideal terms is often better than not raising capital at all. A loss of appetite for retail deals among the broader PE industry could cause a spiderweb of effects across the economy.

Which is where Brookfield, a Canadian investment giant with more than $500 billion in assets under management, enters the picture. In the wake of this week's bankruptcies, the firm rolled out a $5 billion program that aims to fund retailers struggling amid the coronavirus, targeting companies with $250 million or more in revenue. The effort will be led by managing partner Ron Bloom, who helped orchestrate the US auto industry bailout in 2008.

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Brookfield and its many subsidiaries spread vast sums of capital across many strategies, but one of the firm's biggest bets is on real estate. It amassed a $15 billion portfolio of commercial real estate assets between 2016 and 2018, according to Institutional Investor, a collection that is said to include about 11% of all shopping malls in the US.

This is the best explanation for Brookfield's new $5 billion retail investment plan. If you own a bunch of shopping malls, you need brick-and-mortar stores to occupy those malls. You would prefer that large retail chains with dozens of locations spread across the country stay in business, so they can keep paying you rent. In essence, Brookfield's recent run of real estate acquisitions represented a long bet on physical retail.

And now, with that bet in danger of going bust, the firm is doubling down. Which is probably welcome news to struggling retailers across the nation. When you're in financial distress, it helps to have a $500 billion colossus in your corner.

2. Scooter shakeup
Uber agreed this week to lead a $170 million investment in fellow mobility company Lime at a $510 million valuation, a move that came in the immediate aftermath of reports that both companies were laying off about 14% of their workforce. Uber will merge Jump, its own bike- and scooter-sharing unit, with Lime as part of the deal, consolidating two major players in last-mile mobility. The deal represents a massive haircut for Lime: The company was valued at $2.4 billion just 10 months ago, according to PitchBook data.

3. Startup litigation
The once-inescapable WeWork saga continued to unfold this week, as co-founder Adam Neumann filed a lawsuit against SoftBank alleging the investor breached its contract with WeWork by walking away from a planned $3 billion secondary sale. Activist investor Elliott Management inserted itself into a separate startup lawsuit this week, reportedly agreeing to financially back interactive video specialist Eko in a suit accusing Quibi of stealing a key piece of technology for its recently launched mobile streaming service.

4. PE aggression
Silver Lake and Vista Equity Partners, two of the highest-profile tech investors in PE, lined up separate investments this week in Jio Platforms, a budding internet services giant in India. Silver Lake agreed to stake the company with $750 million and Vista offered up $1.5 billion, moves that come just two weeks after Facebook furnished Jio with a $5.7 billion investment. Bloomberg reported Friday that General Atlantic may also invest in the company. PE deal flow has slowed in recent weeks, but the Jio investments are a sign that opportunities remain, as KKR's executives highlighted this week during the firm's quarterly report.

5. Having a ball
CVC Capital Partners and Blackstone are in separate talks to invest in Serie A, the top flight of Italian soccer, the Financial Times reported this week. CVC is said to be mulling a deal to put €2 billion (about $2.2 billion) into the league for a 20% stake. On the other side of the Atlantic, the XFL is seeking a new owner, Axios reported. Launched by pro wrestling mogul Vince McMahon, the league had recently filed for Chapter 11 protection. It was five weeks into its inaugural season when the coronavirus brought action to a standstill.

6. Phone a friend
Just one month after Sprint and T-Mobile completed their combination, two of the biggest wireless carriers in the UK are planning a mega-merger of their own. Virgin Media (owned by Liberty Global) and O2 (owned by Telefónica) agreed to merge this week in a deal valued at a reported £31.4 billion (about $39 billion), one that will be structured as a joint venture between Liberty and Telefónica. The combined business expects to claim 46 million subscribers and £11 billion in annual revenue.

7. Zoo-ology

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Zoom Video Communications inked a pact this week to purchase Keybase, an encryption startup backed by Andreessen Horowitz, with the aim of deploying Keybase's services to address some of the security concerns that have arisen around Zoom in recent weeks. Similarly named startup Zoox was also in the news this week, with The Information reporting that the self-driving car startup is speaking to potential investors about either an outright sale or a new round of funding. Zoox was valued at $3.2 billion in 2018, according to PitchBook data.

8. Sidewalk talk

Sidewalk Labs, a subsidiary of Alphabet focused on smart cities, this week abandoned a long-running project to reimagine a portion of the Toronto waterfront, chalking up the death of the 12-acre dream to the coronavirus and related turmoil in the Toronto real estate market. Also this week, a spinoff from Sidewalk Labs called Sidewalk Infrastructure Partners raised $400 million to invest in tech-related infrastructure projects, according to Fortune.

9. Fintech unicorns

Stock-trading startup Robinhood confirmed earlier fundraising reports this week when it announced a new $280 million round led by Sequoia, valuing the company at $8.3 billion. In Europe, online banking startup N26 also brought in new funds, raising a $100 million-plus addition to its existing Series D that takes the round's total to $570 million.

10. Chowing down

Less than two months after raising $500 million, Impossible Foods is in talks with investors about bringing in even more cash, Bloomberg reported this week. The pandemic seems to be providing a boost to Impossible's business: The company also announced this week that its products will now be available in more than 1,700 supermarkets owned by Kroger, marking an 18-fold increase in its grocery-store footprint so far in 2020.

11. Grail's quest

While dealmaking has dried up in some sectors during the pandemic, healthcare companies working on potential life-saving technologies have continued to bring in VC. This week's biggest example was Grail, which banked $390 million in Series D funding. The capital will go toward the company's efforts to build a new test that could detect cancer earlier than current methods, which would in turn increase patients' chances for survival. The business has now reportedly raised nearly $2 billion in total backing.

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Farmers have come to rely on the internet of things to help them save water, choose the right amount of fertilizer, and find out how plants in distant fields are doing.

By Jon Gold

It's becoming increasingly difficult to find parts of the economy that haven't been affected by the burgeoning Internet of Things as instrumentation and networking technology combine to offer unprecedented new levels of visibility into the operation of everything from jet engines to breweries.

Even a business sector as traditional as agriculture is starting to change in response to the availability of connected sensors and machinery. We spoke to three working agricultural professionals to see how the technology of the IoT is changing the way they work.

Drones to count plants

For Caleb Hinkle, a graduate student studying crop and soil science at Virginia Tech, agricultural IoT has meant simplification and new capabilities. His work centers on comparative crop research, and one of his main IoT tools to make those comparisons is drone photography. Photographs can be analyzed to determine plant counts and surface area in large numbers of small plots, to compare which agronomic practices produce the best results.

The camera drones, part of a system centered on PrecisionHawk's smart agricultural software, connect to GPS satellites for precise positioning data, and send information back to the PrecisionHawk app via Wi-Fi. Hinkle can simply designate particular plots on a test farm, program a flight plan for the drones, and receive an accurate map of the area far more quickly than he was previously able to.

"So before, we would take 500 images in less than 10 minutes. Then you have 500 images that are all geolocated in space that need to be stitched together with no errors and no issues," he said. That processing used to take over an hour, which the new systems have cut down to as little as 20 minutes.

The data are also easier to subdivide and analyze with PrecisionHawk's system, said Hinkle. And with sophisticated cameras that can see in more wavelengths than the human eye – particularly in the near-infrared spectrum – there's additional insight to be gleaned. "Using their indexes we can categorize fields; this test is going better, this test is going worse," he said.

The analysis of the data is undoubtedly complicated, but the result is a relatively straightforward way to get an in-depth understanding of the health of test crops. A successful drone flight, in addition to simply being able to count plants, can automatically class them by size and even make a preliminary assessment of their vitality based on whether they're a healthy color or not.

Water rationing

For Roric Paulman, a farmer in arid southwestern Nebraska, agricultural IoT helps him tackle a crucially important concern – water. His is a custom farm of about 8,500 acres, which grows popcorn, potatoes and sugar beets, among other crops. Four-fifths of Paulman's land is irrigated by groundwater drawn from the Oglala aquifer. Given the climate – Nebraska is the most irrigated state in the nation – the state levies taxes on groundwater usage, making it a major contributor to Paulman's costs. "Conservation and stewardship go hand and hand with technology," he said.

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What Paulman describes as a "host" of embedded sensors measure specific qualities of the soil, mapping variations in temperature, moisture and a lot more in real-time. Similar instrumentation on planters and other working vehicles provides even more granular data.

This data allows for much more informed decision-making about where best to deploy the limited supply of groundwater available, and consequently minimize the costs incurred by using it. It's no longer about simply maximizing yield-per-drop-of-water, according to Paulman.

"It's the utilization of that drop and maybe even using less crop to provide a better ROI," he said.

Paulman uses a number of different agricultural IoT systems in his day-to-day operation. The fact that farms are generally run by a comparatively small number of people – which means that each worker has to wear a large number of hats – makes ease of use the critical consideration for choosing which apps or products to integrate.

"Myself and my son make 95% of the decisions on an operation this large. You don't have time to go to your desktop or get on a chat," he said. "We don't look at technology unless it comes right to your cellphone."

How much fertilizer?
Richard Flatman is the group viticulturalist for the Tahbilk Winery, a winemaker that runs four separate vineyards in southeastern Australia. Soil quality and monitoring, as you might expect, is a major concern of his, so he was eager to implement an agricultural IoT system for that purpose when they became available.

"I am based at one of the vineyards away from the main winery site so I make a lot of the vineyard decisions based on what I can see on a screen," he said. Each area of the vineyards gets treated differently, for example, the amount of water it gets, how much fertilizer is added to the water and the degree that it needs hands-on management.

Tahbilk's system, purchased and partially administered by fellow Australian firm The Yield, centers on 13 soil sensors reporting moisture data at four different levels beneath the vineyards, as well as four weather stations for above-ground information like temperature, wind speed and solar radiation. Every 15 minutes, the sensors send data via 6-LoWPAN to a local gateway, which reports collected results back to The Yield's cloud.

As with Roric Paulman's Nebraska farm, the major advantage has been savings on irrigation, even in the face of the particularly hot and dry seasons that the winery has experienced since installing the system. From September through December of last year, according to Flatman, the vineyards got just 20% of the average rainfall for that period, yet the company was able to cut back on irrigation water. Extrapolated over the course of a full growing season, that works out to a savings of more than $81,000.

"This is huge in not just monetary terms," he said. "Tahbilk is a very environmentally friendly company and the company is always willing to invest money for environmental benefit."

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By Eugene Demaitre
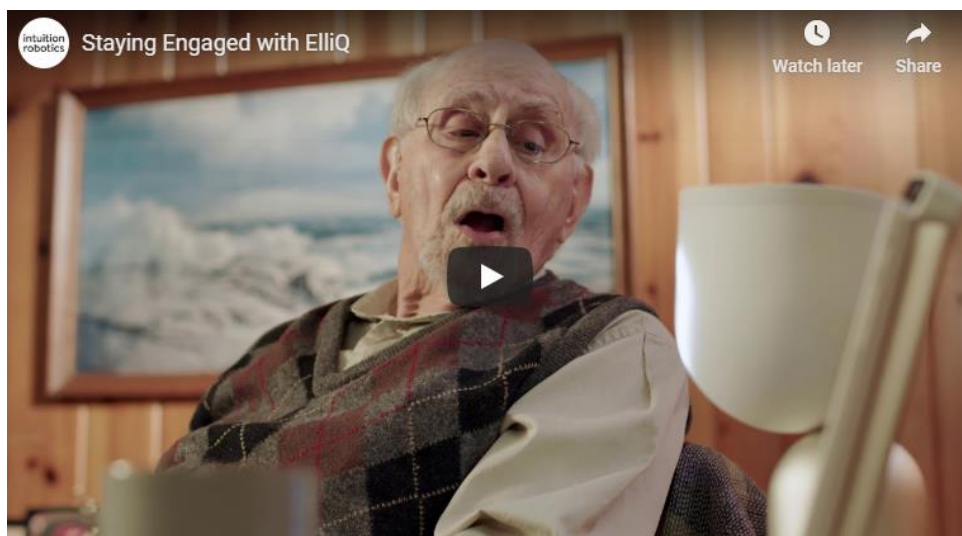
Not only has "social distancing" been necessary to slow the spread of the novel coronavirus worldwide, but it has also given everyone a sample of the isolation that older people regularly experience. People "aging in place" without regular care are particularly vulnerable to the mental and physical effects of isolation. Intuition Robotics Ltd. has designed its ElliQ "digital companion" and the "Q" artificial intelligence engine to address this challenge.

"Hopefully, more and more of us will understand what older adults are going through on a regular basis," said Dor Skuler, co-founder and CEO of Intuition Robotics. "While most people can use Zoom [for teleconferencing] or order food online, it's harder for our parents or grandparents to do so."

"There's a real shortage of care workers, and a nurse can see someone for only a half-hour a week," he told The Robot Report. "Up a third of the population is older, and a third is spent in isolation, which we know is like smoking 15 cigarettes per day in terms of health decline."

Ramat Gan, Israel-based Intuition Robotics has been beta-testing ElliQ, which spent 10,000 days in the homes of older adults in the U.S. in the past year. "We're testing in clusters where can provide support," Skuler said. "We pick a city and send 20 to 30 units."

Lockdown provides challenges and opportunities
Intuition Robotics was founded in 2016, and ElliQ is intended to help seniors stay mentally and physically active. Unlike other social robots, ElliQ was always designed with older adults in mind.

"We've been in lockdown in Israel, and I've been spending much of my days thinking about what will happen after the COVID-19 crisis," said Skuler. "The isolation of older people has been going on for a long time, without enough action from governments or society. We've been focusing our attention on ElliQ's users."

"We have staff in Europe and Israel, suppliers out of China, and customers in Japan and the U.S.," he said. "Everyone is dedicated and doing what they can from home. We just had a demonstration with some automakers, which shows creative ways of working from home. It's harder for those with children, but it's also hitting everyone at the same time."

"While ElliQ doesn't currently have a skill to order food, like smart speakers or smartphones, we've focused on harder things, like persistent relationships and interactions," said Skuler. "As a team, COVID-19 has helped us understand where to add more utility, either directly or with partners. Providing more utility is not as hard to do as understanding human engagement and routines."

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"It would be great for healthcare providers to see elders and relevant data before they get sick," he said. "Such devices are not yet covered by Medicaid or Medicare, but I hope policymakers will wake up and make elder care a priority."

Initial results promising for ElliQ
Although ElliQ is not designed to be humanoid, Intuition Robotics found that the digital companion was effective in reducing loneliness. A majority of the test users were between 80 and 90 years old, and each of them spent at least 90 consecutive days with the intelligent device.

The tests found that older adults interacted with ElliQ an average of eight times per day, as the robot reminded them to take medications, exercise, and contact loved ones. It can also provide information, conduct conversations based on an individual's preferences and habits, and play music.

"We found that acknowledgement shouldn't be underestimated — someone or something taking an interest in you," Skuler said. "Small things matter immensely for improving the quality of life, such asking the users if they slept well or what they had for lunch and referencing it later."

"With my own kids, they are calling my parents every day, putting something like that consistently into a routine is important," he added. "Even if there's no big news to tell, people need to have something recurring but ever-changing to look forward to. With ElliQ, we're adding data, news and information about the community, and who to contact — it reduces anxiety. We're also developing content to relieve boredom."

More recently, Intuition Robotics has made its Q cognitive AI, which powers ElliQ, available to third parties. Automakers have expressed interest as they search for ways to engage passengers in autonomous vehicles.

Robotics startups should expect struggles
Intuition Robotics *(* Chambiz DF 11 May 2019)* raised $36 million in Series B funding in February 2020, and its supporters include SPARX Group, OurCrowd, Toyota AI Ventures, and iRobot Corp.

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"We're grateful to have raised capital just prior to the shutdowns," Skuler said. "Our runway is now longer — certain plans will take longer to execute. A lot of Israel's initial stimulus spending went to old sectors, even though 60% of GDP [gross domestic product] is in high-tech."

"Clearly, the venture capital [VC] market is reacting in a similar way to the 2008 crisis, with extremely fast firings and layoffs within days of shelter-in-place orders," Skuler observed. "VCs were waiting for a downturn after unprecedented growth and inflated valuations. Change would have eventually happened anyway, but now early-stage company creation is most affected."

What does this mean for robotics and AI startups? "Any startup without funding for the next 24 months is going to struggle," replied Skuler. "If they don't have enough for the next 12 months, they're really going to struggle."

The global economic slowdown is forcing companies to focus on their core competencies, he added. "Larger companies will focus on survival, with innovation as an enabler to that and eventual expansion," said Skuler. "At the same time, a lot of amazing talent has been released into the workforce, and there will be acquisition opportunities."

ElliQ may lead next wave of human-machine interaction
"For consumer-based companies, it raises the questions of 'What else can I do remotely?' and 'If it happens again, what would I do differently?'" Skuler noted. "Automation and social robots have a big opportunity to provide more value, as a personalized, empathetic interface makes more sense."

"Anybody working in the fields of human-machine interaction or collaboration will hopefully get a bump, but not immediately," he predicted. "Robotic taxis, delivering medicine, and hospitality — anywhere we can help older people who have trouble with technology — those are points to be developed."

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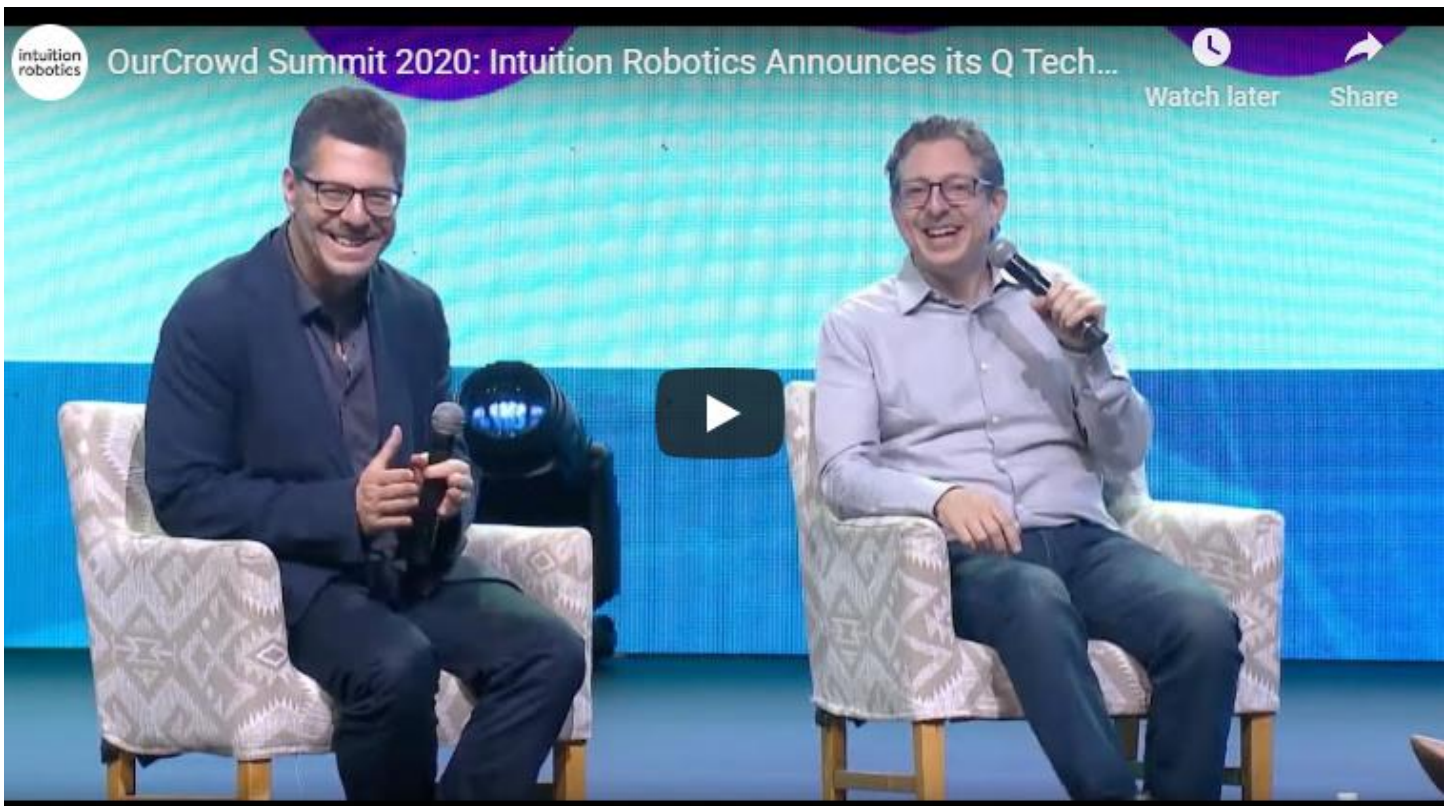
By Sue Marek

The U.S. Securities and Exchange Commission (SEC) is expected to decide later this month whether the New York Stock Exchange's (NYSE) plans to offer a new, high-speed wireless connection is anti-competitive.

The situation highlights the financial value of high-speed, low-latency connections, as well as how seemingly minor technological details – such as the difference between a wired connection and a wireless one, or the distance between a data center and a cell tower – can have significant implications.

At issue is the new 160-foot-tall E-Band millimeter wave (mmWave) cell tower that NYSE's parent company, Intercontinental Exchange Inc. (ICE), built at its data center in Mahwah, New Jersey, where NYSE's electronic trades are executed.

ICE, through its data services division, provides the wireless connectivity between third-party data centers and the Mahwah, NJ, data center. Its new tower transmits in the E-Band, a slice of mmWave spectrum that sits between 71GHz and 86GHz and is ideal for carrying ultra-high capacity traffic a very short distance (typically just one or two miles). Such connections can be even faster than wired, optical networks because sending signals through the air can be faster than sending signals through glass.

An anticompetitive connection?
However, several large investment firms, which also rely on high-speed networks to post bids and conduct trades, told the SEC that the NYSE's plan is unfair because it gives exclusive use of the mmWave tower to ICE. They also questioned the proposed fees that ICE says it will charge them if they want to use the wireless tower.

In a letter to the SEC, McKay Brothers said that because NYSE allowed ICE to build a private tower on the Mahwah data center's premises, it gave the company special treatment. And because the tower is physically closer to the exchange than other public poles that are outside of the Mahwah data center, the ICE tower will have an advantage in terms of latency and will be able to deliver faster trades than any competitors. "Market participants that use the wireless connections to receive selected market data receive a latency advantage in the initial distribution of that data from the Mahwah data center," McKay Brothers argued.

McKay Brothers operates long-haul microwave and hybrid microwave/fiber networks for stock exchanges, and it competes directly with ICE's data services division.

McKay Brothers isn't the only one concerned about the situation. The Securities Industry and Financial Markets Association (SIFMA) also submitted a letter to the SEC noting that the wireless connectivity offered by ICE should be considered part of NYSE because NYSE approved the wireless connectivity and it can't be duplicated or matched by any competitor. In addition, the SIFMA said that NYSE hasn't provided enough evidence that its fees are reasonable.

NYSE, for its part, insists that it is an indirect subsidiary of ICE and that ICE's data services business handles all wireless connectivity between the data centers and it is not controlled by the NYSE. NYSE also said that other investment firms that want a connection between a third-party data center and the Maywah data center can purchase one – ICE plans to charge other firms an initial fee of $10,000 per connection plus a monthly fee of up to $45,000 per month depending upon the bandwidth needed.

Why E-Band matters

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Stock exchanges have been using mmWave links in the E-Band to send data back and forth for trading for a number of years. But now that cellular networks are using mmWave for 5G, the E-Band is getting more attention.

According to Emmy Johnson, principal analyst with Skylight Research, which focuses on wireless last mile technologies, these types of specialized E-Band wireless systems that are used by stock exchanges sell for a very high price-tag. "It's not a shared line and is very high speed," Johnson said. "They beat the traditional links by fractions of a second, but when trading, that can mean the difference between getting a great buy/sell or a not so great buy/sell."

Companies like Aviat Networks are working with E-Band spectrum to provide wireless backhaul services for cell sites that need a higher capacity backhaul. Shaun McFall, senior vice president of corporate development at Aviat, said that the E-Band is used when a company needs a high-throughput connection. He said that E-Band mmWave can deliver data the shortest distance the fastest, explaining that it's even faster than optical because traveling through air is faster than glass. However, he noted that it does have some downsides – rain will cause the signal to fade and there are distance limitations.

McFall said Aviat often pairs an E-Band mmWave connection with a microwave circuit for reliability. Traffic that needs high reliability will go over the microwave connection and traffic that needs high speed will use the E-Band.

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By Mitch Wagner

Data centers are expanding to the network edge to meet demand by artificial intelligence and other applications requiring fast response times not available from traditional data center architectures.

The problem with traditional architectures is their centralized framework. Data often travels hundreds of miles from the edge to computers, then back again. That's fine when you're dealing with email, Google, Facebook and other applications delivered via the cloud. Human brains are slow computers, unable to register the lag time between, say, clicking on an email message in a browser and the message opening.

But AI and other emerging applications — Internet of things (IoT), cloud-based gaming, virtual reality — require much faster network response times, otherwise known as "latency." That means data center processing must move to the network edge. Edge computing can take place in small data centers, roughly the size of shipping containers, rather than the warehouse-sized edifices that currently power the cloud.

Startups such as EdgeMicro *(* Chambiz DF 11 January 2020)* and Vapor.io are deploying these "mini data centers."

Data center operators can still use their traditional structures, with fast networks and other hardware and software required to ensure the speedy response times needed for edge applications.

And edge data centers can reside on enterprise premises, or in exotic locations such as mines, ships and oilfields.

"The number one thing [driving edge computing] is the amount of data being created outside the data center," said Patrick Moorhead, president and principal analyst of Moor Insights & Strategy. The numbers of connected sensors will reach 1 trillion by 2024, primarily driven by smart cities and video.

Latency isn't the only problem requiring edge computing. "It's cost — that's really driving edge computing," Moorhead said. "Every time you bring data in [to a data center] you pay someone money. The Internet is not free." Internet providers charge for bandwidth, and cloud providers, like Amazon Web Services (AWS), have "egress charges" for moving data in and out of their clouds.

Organizations need computing at the edge in applications where they can't access connectivity: in a ship, down a mine shaft or on an oilfield. Meanwhile, a growing list of privacy regulations requires on-site data processing in some applications, especially healthcare.

"If you're a hospital you're flat-out not allowed to send any data into the cloud," Moorhead said. And even if it were allowed, bandwidth costs would make moving much of that data, particularly diagnostic images, prohibitively expensive.

Operators look to the edge
Digital Realty is one of the world's largest data centers operators, differentiating themselves via a global platform and infrastructure ranging from massive multi-megawatt facilities to individual cages and racks. The company has 267 data centers worldwide, in 20 countries.

Edge locations require a new kind of infrastructure. "By no means does it look like a traditional data center," Digital Realty CTO Chris Sharp said. "The size is much smaller, with workloads requiring a lot of power density and interconnection density." These mini data centers need to be lights-out, with no operations staff on-site. and multitenant support. Dense fiber connectivity back to the core cloud infrastructure also is a must.

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Digital Realty is in early stages of deploying mini data centers, with prototypes in Chicago, Atlanta and Dallas, in partnership with startup Vapor IO.

Mini data centers aren't the only option. In many locations, edge applications can run inside a conventional data center and still achieve the 5-msec latency needed for rapid application response times, said Russell Shriver, Digital Realty's director global service innovation. "For a lot of enterprises that are looking for an edge in major metro areas, that's going to be more than sufficient for their needs," he said.

The mini data center remains an emerging market. Indeed, Digital Realty competitor Equinix sees its existing facilities as serving edge needs for its service provider and enterprise customers, said Jim Poole, Equinix vice president of global business development. "Equinix, as it exists, is the edge," Poole asserted.

Equinix has more than 190 data centers in more than 44 major metropolitan areas worldwide. Much of the U.S. is already a10-msec round-trip access time over fiber from applications sitting in clusters of Equinix data centers. That latency covers 80 percent of the U.S. population. Before building new, mini data centers, companies and service providers are looking to maximize deployment of edge applications within that existing infrastructure.

Wireless creates bottleneck
While Equinix can achieve low latency over fiber, edge applications require wireless as well, and wireless remains a bottleneck for AI and other emerging edge applications. Current 4G wireless latency is 40 msec at best, and the average is between 60 to 120 msec, Poole said.

5G promises to slash latency. Hence, service providers are partnering with hyper-scale cloud service providers to take leverage improved performance. AWS and Verizon, for example, are teaming to connect an AWS data center in downtown Los Angeles to Verizon's radio access network (RAN) tower complex in the city. The project demonstrates they can create a sub-10 msec latency zone around the metro area, Poole said. That, in turn, could generate demand for mini data centers. "But until we fix this particular problem, nobody's going to spend the incremental capital," he said.

Additional, 5G "network slicing" capabilities will make it possible to deploy private, wireless networks for added control and security, Poole added.

For now, mini data centers are a promising technology lacking scale. According to Poole, "The reason you don't see people running around making big announcements of deploying hundreds and hundreds of these mini data centers is that people don't see the business case yet."

Nonetheless, Equinix does see use cases for modular data centers — not necessarily on the edge, but as a means to enter emerging markets where, for now, it makes little sense to build a $100 million data center.

AI driver
AI is generating big demand for edge computing, according to Kaladhar Voruganti, an Equinix senior fellow,

AI applications include two primary workloads: training and inferencing. Training is what it sounds like — teaching an AI model how to solve a problem. This process often involves organizing petabytes of data.

"Usually you need a lot of compute," Voruganti said. Training runs on power-hungry GPUs, with each fully loaded rack consuming up to 30 to 40 kilowatts. Training generally needs to run in a big data center to satisfy power requirements, as well as privacy and regulatory concerns in some applications.
Digital Realty has partnered with Nvidia to provide the hardware vendor's GPUs in colocation servers.

Once models are trained, the next step is inference, a process where the model applies what it has learned in training and puts it to work in a production application. Inference requires much less data crunching, and can run in a rapidly

deployed Docker or other software container at the network edge — in a smart phone, a Tesla or mini- or metro data centers.

"You might train it in the big cloud, and run the application and do the inference right on the factory floor, or Walmart, or the gas station," analyst Patrick Moorhead said

These sorts of AI applications can be used in a variety of cases. For example, an airline company might use "digital twins" for predictive maintenance. Or, as the economy opens up from the Covid-19 pandemic, a business could use AI to run heat-mapping and facial recognition to identify people entering a facility who might be infected.

Other applications requiring edge compute (and frequently using AI) include gaming, IoT, smart factories, shipping and logistics. Additionally, retail technologies require edge computing to deliver needed responsiveness.

Moorhead sees particular demand for edge data centers in retail. A "store of the future" like Amazon Go has hundreds of cameras, and likewise Walmart uses video to track customers. "They're driving the heck out of the need for this," he said.

Smart city planners are looking to use AI and other edge applications to promote health and safety, track infrastructure maintenance needs and manage traffic.

Other demands will come from transportation — including much-hyped self-driving cars — along with advanced manufacturing and visual inspection of products. The energy industry is also driving demand, particularly for remote inspection.

Special hardware requirements
Edge AI applications typically use flash storage for high performance, said Equinix's Voruganti. Those applications also require a high degree of networking connectivity, both from the device to the edge and to the data center. Links also are required between application components that might be running in different locations on the network, Poole said. "They need to have low latency between components and domains," he added.

Edge computing also needs to be rugged, for deployment in locations such as elevators, public transit turnstiles and mining equipment, Moorhead said. Shipboard computers must be salt-water resistant.

Edge computing also presents physical security challenges. Conventional hyper-scale data centers have near-military-grade security, but an edge data center in a rural area, unguarded, is susceptible to break-ins, or even an attacker carrying an entire remote data center off in a truck.

And the winners are….
Hyperclouds, enterprise vendors, telecom providers and data center operators all look like winners at the edge. "AWS is the big mothership. It's slowly but surely fielding a credible edge offering," Moorhead said.

The public cloud giant unveiled AWS Outposts, a hardware rack running its infrastructure software — the same infrastructure run in an AWS data center. Outposts can run on-premise, on the edge, or in a data center. AWS Snowball, an edge computing device, provides computing, memory and storage for remote environments such ships. Another Amazon offering called Wavelength is an edge device aimed at carriers, putting computer closer to the edge for 5G deployments.

On the software side, alternatives include AWS IoT Greengrass, an operating system that connects IoT devices to the cloud. Meanwhile, public cloud rival Microsoft provides its Azure cloud IoT-for-edge services while VMware also provides edge services. Moorhead said VMware is "surprisingly competitive in this space."

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Google, the other major public cloud vendor, has been a bit of a laggard, but is stepping up with its Anthos services for distributed cloud applications.

Meanwhile, IT infrastructure giants like Dell, Hewlett Packard Enterprise (edge servers) and Cisco (IoT networking) have an advantage since edge computing requires a big ecosystem, with tissue connecting on-premises infrastructure and the cloud, Moorhead said.

Emerging edge data centers vendors like Vapor IO also have an opportunity to redefine old technology, Moorhead reckons. "There have been data centers on the edge for 50 years. Any Walmart has a raised floor and a data center. If you go into a gas station or McDonald's they have a server on the wall," he said. "Where Vapor IO is really leaning-in is adding compute close to the network, specifically the 5G network."

Telco central offices also can be repurposed as mini data centers, creating opportunities for carriers. "A typical neighborhood has a cement bunker with analog lines and a bunch of racks in it," Moorhead said. "They're almost empty now. They have a lot of power. They're industrial strength — literally a cement bunker that would be hard to break into — and they have the power and cooling."

Equinix and Digital Reality assert they are well positioned at the edge given their strengths as global data center and network operators. "You can't defy physics," said Poole. "The telcos will do well — they can create access on the local level. There is no way to get around that."

He adds, "Data center companies such as Equinix that have a highly distributed footprint will do well because we are where the applications are today."

Adds Digital Realty's Sharp: "You need a global platform or you will have a hard time being successful. Customers are very cautious about doing deals with point providers in single markets. If you're not truly invested and have the wherewithal to support a global environment, you're not going to win.

"Customers don't want to manage 10 or 15 vendors to roll out an infrastructure," Sharp adds.

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The pandemic shows that businesses must take on a new responsibility for the health of their employees and customers. Here's a to-do list to get you started.

By Brain Solis

No matter how much time you've spent thinking through the future of work, it's time to rethink the future all over again. In my scenario planning, I didn't account for a world that would require overnight support for a remote workforce, new spaces that promote physical distancing, rotating shifts to minimize contact between people, or the provision of onsite medical testing as a result of a global pandemic. But here we are.

The trajectory for the future of work, and what work will even look like, is now forever changed as a result of COVID-19. One thing is for certain: The future is being defined today, shaped by the health and wellness of employees and customers.

As the world prepares to reopen the economy and get back to work, we will not be returning to the work experience we once knew or any form of business as usual. Every organization will reimagine work now and in evolving phases with a live virus still out in the wild. Organizations everywhere and in every industry are having to quickly learn how to protect people and promote health and safety, all while maximizing productivity and business success. To thrive in this new era, every company must now become a digital health company.

BEYOND "DIGITAL FIRST"
Becoming a health tech company adds to the list of aspirational metamorphoses as legacy organizations were already investing in becoming technology companies. Through digital transformation and innovation initiatives, the goal was to help traditional companies evolve into digital-first businesses, operationally and strategically. In the wake of the pandemic, companies must also plan at scale for phased reopenings; managing the health and wellness of employees, customers, and supporting ecosystems; and focusing on new growth opportunities.

Most companies didn't plan for this moment and don't have the necessary expertise and capabilities at the ready. This complicates and perhaps delays the ability of any company to safely reopen, operate, and grow.
It's all a work in progress, requiring an entirely new series of scenario planning to prepare—quickly but thoroughly—to get back to work while protecting employees and customers, during an active pandemic.

The questions to consider are practically innumerable, but answers for every scenario are necessary now and as we move forward. These include:

- How do we get our business set up for this new world?
- Do we need an expert advisory board and/or a chief health officer?
- How many people are allowed in a common workspace at any one time?
- How do we rethink conference rooms for live meetings?
- How do we fit people into an elevator safely and manage shifts for people to go up and down between floors?
- How should we establish health-centered protocols for future disruptions as they happen locally and globally?

Right now, someone in your organization should be tasked with developing the strategy and the playbook for reopening offices and retail spaces. Maybe that's you.

A digital health and work planning task force should also be assembled, one that consists of internal stakeholders

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and external medical and tech experts, assigned to introduce a phased approach to getting back to work, working safely, and managing the rollout of COVID-19-inspired roles, policies, processes, and technologies.

THE DIGITAL HEALTH PLAYBOOK

Ferrari has raced to become an early health-first company. In an interview with the BBC, Gianfranco Casati, Accenture's chief executive for growth markets, shared an example of Ferrari's "Back on Track" plan. (Clever name noted.) It was developed in conjunction with virologists and health experts to create a safer workplace for employees.

Disney executive chairman Bob Iger raised the notion of health checks at Disney parks around the world in an interview with *Barron's*. "Just as we now do bag checks for everybody that goes into our parks, it could be that at some point, we add a component of that that takes people's temperatures," he said.

It's also been reported that Disney employees will wear masks, sanitizer stations will be scattered throughout the parks, and density restrictions will limit the number of guests at any one time.

Thermal scanners and temperature tests will not catch infected employees, customers, or guests who are either asymptomatic or presymptomatic. But this is exactly why every organization has to become a digital healthcare company. Every solution will be unique to the workplace, even for state, country-wide, and global organizations.

I am the global innovation evangelist at Salesforce. Our founder and CEO, Marc Benioff, has led a massive effort to source and deliver 50 million pieces of personal protection equipment to medical professionals on the front lines.

We just released Work.com, a suite of COVID-19-inspired tools and services to help companies immediately integrate digital health capabilities, data, and best practices to help reopen and manage their workplaces while promoting employee wellness and safety. The goal is to help executives expertly accelerate their company's return-to-work readiness, give decision-makers a 360-degree view of employees, visitors, and their ecosystems across locations to operate safely, and help make data-driven decisions in real time to survive and eventually thrive and grow.

Salesforce has also released a playbook to help leaders assess their return-to-work readiness and guide them through detailed steps toward reopening and eventually growing the business. Here's a checklist of action items for companies that want to become digital health companies:

ESTABLISH HEALTH LEADERSHIP
- Consider hiring a chief health officer to advise on new and evolving programs, to help manage health today, and to foster a lack of disease across locations.
- Establish a "back to work" team led by a cross-functional group with representatives from digital health, IT, healthcare/medical, architecture and design, HR/EX (employee experience), and CX.

BECOME A TECHNOLOGY COMPANY
- Set up a centralized workplace COVID-19 digital command center with satellite hubs at key locations to support local workforces and customers.
- Create a data-centered culture to track employee and customer behaviors and on-site, local, and overall COVID-19 trends and hotspots; define data sources and seek to establish a single source of customer truth to drive better decisions and engagement.
- Extend data, insights, and societal impact to partners, supplies, and the broader ecosystem.

PLAN TO GET BACK TO WORK SAFELY
- Create a guideline matrix to aid rapid but informed decisions; connect government guidance, medical expert advice, local leadership, and data.
- Outline a unified plan to get back to work for employees and customers in retail environments.
- Establish safe workplace policies and processes for employees and customers.

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- Workdays begin and end with commuting, so consider how employees will get to and from offices.

REIMAGINE WORK, WORKSPACES, AND FLOW
- Design healthcare and wellness checks and measures at important milestones in the employee and customer journey (for instance, thermal scans, COVID-19 testing, antibody testing).
- Organize PPE sourcing (supply chain) and on-site distribution strategy and introduce sanitization stations in key locations where touching common items is second nature, such as around door handles, buttons, and switches.
- Establish a support protocol for employees who test positive and develop a digital certification protocol for recovered employees.
- Create a crisis task force and a response protocol for events, including a plan for sending employees back to work from home when necessary.
- Redesign space, offices, open areas, kitchens, conference rooms, lobbies, reception areas, and restrooms to promote physical distancing, provide safety barriers such as a clear shield between workstations, and guide movement and traffic flows (consider beacons or computer visioning to monitor and manage behavior).
- Introduce work shifts in order to control flow and workplace density.
- Rethink food and beverage distribution.
- Set up a regular deep-cleaning program.

MANAGE THE NEW WORKFORCE WITH CARE
- Offer an employee portal with real-time updates, resources, and policies, and introduce an employee and customer feedback loop that evolves over time.
- Train employees on all new processes and available resources; introduce clear signage on-site that promotes desired behaviors.
- Introduce assistance programs and resources, both analog and digital (mental health, childcare, COVID-related financial support).
- Develop employee health and wellness apps and encourage their adoption.
- Introduce new 1:1 check-in processes and employee surveys to monitor wellness.
- Update employee engagement programs; overcommunicate with the goal of keeping everyone informed, promoting wellness, and reducing anxiety.
- Track best practices.

AS THE ECONOMY REOPENS
Until there is a vaccine—assuming there ever is—the next normal of work will require organizations to become truly customer- and employee-centric and empathetic. This is uncharted territory, and it will continue to be as we test and learn. At the same time, this isn't our last pandemic, nor is this our last crisis. We should plan for another wave of COVID-19 infections. We should plan for natural disruptions to businesses locally and supply chains worldwide.

Becoming a digital health company is good for business, and it's good for people. Not only does it leave an organization prepared for operating in disruptive environments; it sends a message to the market that the organization is resilient and innovative.

In the past, companies took their time and shaped their own approach to becoming technology companies. For many, doing so was part of their digital transformation strategy. But digital transformation itself didn't evoke a sense of urgency for a unified, purposeful response. The pandemic exposed shortfalls in every digital transformation investment. Critical operational functions and business processes were broken, missing, or outdated. You could say that digital transformation itself was digitally disrupted.

When it comes to becoming a digital health company, we can't make the same mistakes. We have to get the planning, logistics, behavioral monitoring, and supporting technology and processes right, right now. The health and wellness of customers and employees are everything. In times of pandemic disruption, humanity is the killer app.

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While there is global potential to generate renewable energy at costs already competitive with fossil fuels, a means of storing and transporting this energy at a very large scale is a roadblock to large-scale investment, development and deployment. Ammonia produced from renewables can be a viable liquid fuel replacement for many current-day uses of fossil fuels, including as a shipping bunker fuel; as a diesel substitute in transportation; as a replacement fuel in power turbines; and even as a potential jet fuel. The global transportation of ammonia by pipeline and bulk carrier is already a well-developed technology.

Researchers at Monash University in Australia are proposing a roadmap to renewable ammonia being produced in the future at a scale that is significant in terms of global fossil fuel use. This, they suggest in a paper in *Joule*, will emerge via three overlapping technology generations:

- Generation 1 is based on an expansion of current-day Haber-Bosch ammonia production using CO_2 sequestration or offsets.
- Generation 2 moves the Haber-Bosch process to renewable sources of hydrogen.
- Generation 3 avoids the need for the Haber-Bosch process entirely by direct electrochemical conversion of N_2 to NH_3. One of the attractive features of generation 3 technology is that it can be implemented at any level of scale, from kW to GW, and in a highly distributed fashion.

Just over a century ago, the discoveries by Haber and Bosch made possible the industrial production of ammonia and ammonia-based fertilizers that today feed the world and are the source of most of our nitrogen-containing chemicals, materials, and pharmaceuticals. The process generates H_2 from natural gas or coal through steam reforming and combines it with N_2, which has been separated from air by a cryogenic process, to form NH_3.

The reaction between N_2 and H_2 requires temperatures in excess of 400 ˚C and pressures above 200 bar to be facile, and therefore the capital cost of plant and equipment is substantial. Ammonia production is currently responsible for ~1.0% of global greenhouse gas emissions (or about 1.4% of global CO_2 emissions); these values increase further if CO_2 emissions associated with natural gas extraction are included.

Over the last decade, momentum has been building to transform the Haber- Bosch (H-B) ammonia industry toward renewable sources of hydrogen, for example, from water electrolysis or solar thermal cycles. This goal has provided the background to the broader vision of ammonia becoming a transportable store of renewable energy that we will discuss in this paper. The challenge both for the existing industry, as well as a much-expanded renewable energy industry is, of course, economics.

—MacFarlane *et al.*

Generation 1. Gen 1 involves the use of carbon sequestration or offsets to bring the net carbon impact of the ammonia production to zero (blue ammonia). Carbon sequestration adds cost and plant complexity on top of the existing H-B technology. For this reason, the researchers said, it is likely to represent only a transitional solution, helping to establish a market for ammonia beyond the fertilizer and chemical industries.

Modern H-B plants produce ammonia at an energy cost of at least 8 MWh $tonne^{-1}$. Recognizing that the lower heating value (LHV) of ammonia is 5.2 MWh $tonne^{-1}$, this represents an energy efficiency of only 65%.

Generation 2. Gen 2 renewable ammonia is produced from H-B technology but employs renewable, rather than fossil-fuel-sourced, hydrogen. This has the advantage that existing H-B plants can be transitioned to this new hydrogen supply without major disruption or mothballing. Powered by fully renewable electricity derived from a 20 kW wind turbine, a

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Siemens demonstrator produces H_2, using a proton exchange membrane (PEM) water electrolyzer, to form around 30 kg NH_3 daily.

Gen 2 technology has significant long-term scope in terms of the ammonia economy, limited only by the substantial investment and long lead time required to establish new facilities.

Generation 3. Gen 3 technology is based on the electroreduction of N_2 to ammonia by direct or mediated means. The H-B process is no longer required; instead, the reaction is driven by electrochemical reduction and the H source is water.

There are several modes of this process being actively researched:

- eNRR in which an electrocatalyst enables direct electron and proton addition to the N_2 molecule; and
- indirect or mediated mechanisms in which a redox mediator such as Li^+ is first reduced and then, via a series of reactions, ammonia is produced and the mediator is regenerated.
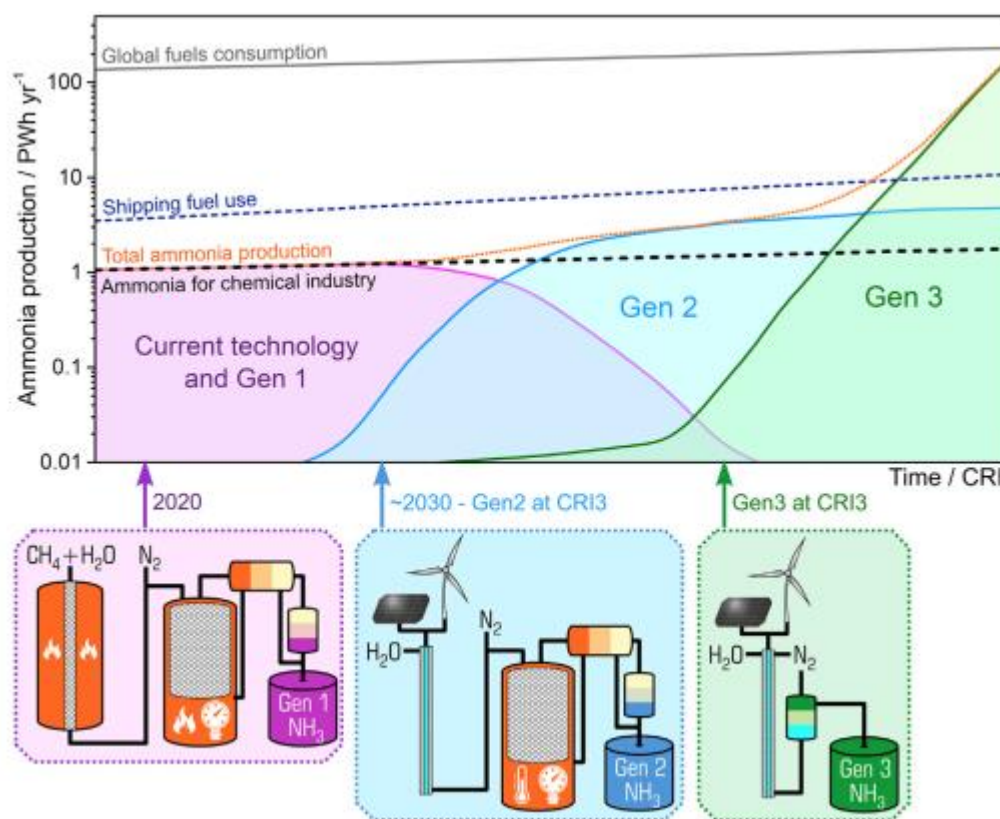
Ammonia economy roadmap showing current and projected contributions of current and Gen 1 (purple), Gen 2 (light blue), and Gen 3 (green) ammonia production technologies. Total NH_3 production is shown as a dotted orange curve. These projections are compared with the projected ammonia production for chemical industry, shipping fuel use (dashed dark blue, according to the predicted 3.6% annual increase over the next three decades), and global fuels consumption (solid gray, 2018 value taken from the BP Statistical Review of World Energy). Note the logarithmic ordinate scale. CRI is a commercial readiness index used by the Australian Renewable Energy Agency. Credit: Joule, MacFarlane et al.

Resources
- MacFarlane *et al.* (2020) "A Roadmap to the Ammonia Economy", *Joule* doi: 10.1016/ j.joule.2020.04.004

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Amazon will have felt downward ad pricing pressure due to lower advertiser demand, which is a trend seen across the ad industry. However, the fact that Amazon's ad operations are directly linked to its buoyant retail platform means that they have been less impacted by the crisis than other ad-reliant companies such as Facebook and Google. This was already a threat that the digital ad incumbents were facing up to before the crisis: both have been bolstering the "shoppability" of their platforms and ad formats and growing their presence across the entire customer journey for some time. Tying advertising directly to purchases is only going to grow in importance as online's share of retail continues to increase, and cash-strapped advertisers seek greater efficiencies in their campaigns. This isn't confined to the tech giants; NBCUniversal recently announced its own commerce engine, NBCUniversal Checkout, which allows viewers and readers to buy featured products without leaving editorial and video content across the company's properties. We expect the relevance of such strategies to soon grow for other broadcasters, publishers, OTT platform owners, and even retailers themselves.

Case in point: ByteDance's TikTok is currently testing a new "shop now" button ad format which will appear in videos from its most prominent influencers. This could mark a turning point in influencer marketing, the future monetization of social video platforms, and even commerce. Plus, its coincidence with TikTok's central role in the lockdown zeitgeist suggests that COVID-19's impact will be felt by brands, the media, and tech players not just in the short term, but for years to come.

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By Sarah Buhr

Rising healthcare costs, an aging population, stifling regulations and the complexity of present-day technological offerings make the trillion-dollar healthcare industry ripe for disruption.

Not only are we finding new and innovative ways to get medical help, this global pandemic has led to explosive growth in telemedicine, digital devices and health-tracking apps — much of which needs a digital overhaul for doctors' offices, insurance and the cumbersome HIPAA compliance.

While an infrastructure focus might not seem exciting, it is necessary to fix a broken, profit-driven system of paperwork and delays while the sick and suffering are saddled with mountains of debt.

Our current climate is the perfect illustration of just how critical new and innovative investments in the space truly are. It's also a lucrative opportunity. According to Deloitte, healthcare infrastructure is expected to continue growing above pace into 2023.

But finding those disruptive technologies is the tricky part. In a recent survey, we asked VCs to evaluate the digital health sector; for today, we reached out to active investors to find out what they are seeing within the healthcare infrastructure landscape, what they are most interested in right now and where they think the industry is headed.

In this survey, we hear from:

- Carl Byers, F-Prime Capital
- Arvind Gupta, SOSV
- Matt Brennan, General Catalyst
- Bilal Zuberi, Lux Capital
- Sundeep Peechu, Felicis Ventures
- Bryan Roberts, Venrock

Carl Byers, F-Prime Capital
Data and automation are the most interesting themes to me right now. We are only beginning to see the efficiencies and new capabilities opened up by getting the data organized and applying modern techniques. I'm more excited about the practical impact of robotic process automation (RPA) than I am enamored with AI, though both are exciting. I'd point to Notable Health in San Mateo as a company that has a great use of both technologies. I think we are about to embark on a new era of open data in healthcare where we finally solve the longstanding quest for interoperability with privacy mediated by patients. This will require a new developer ecosystem to come about built on new protocols rather than tired, legacy models. The key is for there to be demand pull from new services like virtual primary care (e.g. Firefly) or at-home solutions (like Ro or LetsGetChecked), instead of just a regulatory push (though that also will be important).

I'm spending time on RPA and open data, which is the key to improving healthcare B2B/infrastructure (see above). I think all markets have been overheated from a valuation standpoint, but if you find the right company, the opportunity is vast. If healthcare today is roughly 2x too expensive, getting data flowing is key to eliminating most of that waste. RPA can attack the administrative bloat while data exchange will allow doctors and patients to finally shop for the best value without the worry that something will be lost clinically in the translation.

As always, I'm looking for investments that go WAY UP in value. More seriously, I'm fascinated by the use of AI (e.g. Buoy) to enable a much more distributed, diverse and decentralized system of keeping people healthy. I also think wearables will move from being a nice-to-have luxury to more of a requirement for safety for certain vulnerable populations (and then more broadly). Technology is evolving such that wearables will not need to be a luxury device, but rather a foundational component of remote patient monitoring.

We need to move away from the idea that each provider has a separate island of information that is exchanged with other islands, but instead have one record per person that all providers read from and write to. I'd love to see someone create a universal patient ID that people want to use and that avoids the Orwellian fears that have held us back to date. The Apple-Google solution for COVID contact tracing might be an indicator of the types of architecture that can solve that riddle (i.e. public key cryptography applied to health data privacy/exchange).

COVID-19 has highlighted the risks of in-person, centralized care and made everyone from regulators to consumers much more open to care at home, enabled by technology. I think COVID-19 also has shone a bright light on the vast inequities in our health system where miracle cures stand side-by-side with public health disasters that are preventable. I think eventually we will view basic healthcare more like a utility: it needs to be regulated for quality and there are public goods that can be funded cheaply, so people are less fearful and so we can spend our creative energy on far higher value aspects of medicine and health.

How has COVID-19 impacted healthcare B2B/infrastructure startups operationally? Operationally, everyone sees now that data and automation are not just nice-to-have aspects of a well-run health system but actually essential to achieving the same levels of speed, reliability and cost that we have come to expect from technology-driven consumer-centric industries.

What advice do you have for your portfolio companies facing unprecedented surges right now?
Most startups spend huge amounts of time and money trying to find their market; once the market is found, it's all about scaling up. So the surges driven by COVID are accelerating the time frame for management teams to get serious about scaling.

The biggest cracks in the infrastructure are basic things that don't scale because they were never built well in the first place: patient and provider identification; data integration; price transparency; regulatory barriers; and removing as much as possible from the realm of the mystery of medicine (toward open, scalable knowledge bases).

Health systems are the most likely adopters of technology because they have the balance sheets and the business models to earn a strong ROI. The most important investments, however, will allow society to disintermediate those health systems which today are largely exploitative and counterproductive in their pricing, referrals, data hoarding and regulatory influence. We need alternatives enabled by technology to break down the health system oligopolies.

Arvind Gupta, SOSV
I think it is an area that is still overlooked by investors. Diagnostics have historically low multiples but new technologies and business models are changing that. People will begin to see this soon. Therapeutics is still seen as arcane or too risky. Data-driven healthcare using AI can often lead to confusing results if input data is not directly relevant. Like a game of telephone, the result is often distorted if measuring downstream and easily available proxy data rather than the direct biomarker readout.

What trends are you most excited about in healthcare B2B/infrastructure from an investing perspective?
New diagnostics that enable precise classification of disease all the way down to the personal level. Informational drug design and development.

What are you looking for in your next investment?

Great teams working on informational drugs, gene delivery, rapid massively multiplexed point of care diagnostics, consumer healthcare delivering healthcare outside the hospital and in the home.

Are there startups that you wish you would see in the industry but don't?
Full-stack startups looking to reinvent the healthcare industry rather than sell into it.

How has COVID-19 impacted the healthcare B2B/infrastructure investing landscape?
COVID-19 has definitely made the world of investors aware of the critical needs and problems with our healthcare system. There is a lot more interest in diagnostic and disease mitigation companies. There is also just a lot more interest in biology as a technology. Investors are starting to realize that biology is a technology that will power the next generation of startups.

How has COVID-19 impacted healthcare B2B/infrastructure startups operationally?
Hasn't really. They are deemed essential businesses so they are all working around the clock to develop COVID-19 solutions.

Clearly the lack of actual infrastructure to handle and triage a huge number of cases in the hospital and outside of the hospital. There needs to be a new system to give great quality healthcare outside the hospital.
Consumer healthcare will get bigger and bigger with à la carte and direct purchase options driving technology options.

Many VCs want to sit out investing at this time; we instead funded seven COVID-19 startups in four weeks, evaluated over 200 startups and took nonstop meetings to get it all done. I believe now is a great time to find amazing entrepreneurs and opportunities if you have a prepared mind.

Matt Brennan, General Catalyst
Innovation in healthcare infrastructure is subject to many complexities, such as the payer, provider, patient relationship; heavy regulation; privacy protections; and certainly not least, the fact that there are lives at stake. Despite those complexities, we're optimistic that by focusing on the underlying infrastructure supporting health systems, there is potential for significant progress in making healthcare fundamentally more efficient, higher quality and affordable.

More specifically, we are interested in technologies that enable real-time interoperability and that can provide insights based on the wealth of data available across healthcare ecosystems. Unlocking that data, especially between existing data systems, could help care teams work more efficiently and deliver better outcomes. We're also interested in areas like robotic process automation and AI/ML models that can reimagine workflows and make administrative processes more efficient.

Though telemedicine and other approaches to remote care aren't new, the COVID-19 pandemic has certainly accelerated interest in these technologies. We may find that with this health crisis that in many cases, remote care will turn out to have been safer, less costly and more patient-centric than care provided in institutional settings. There could be an acceleration coming out of the pandemic of work to create the platforms that will support a more distributed healthcare model in the near future. With worsening shortages of healthcare professionals, chronically under-served geographies and an aging population, these are the innovations that have the potential to make significant positive impact at a societal level.
Finally, the COVID-19 crisis challenged our healthcare systems in a way that they probably haven't been in decades. Our hospitals and healthcare professionals have done an incredible job rising to the occasion. There will likely be an opportunity that comes out of today's situation to build platforms that better connect hospitals and their communities and can provide scalable services in the event of the next pandemic-level crisis.

Bilal Zuberi, Lux Capital

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Through this stressful time, we are all recognizing how our healthcare infrastructure is actually quite vulnerable. Who could have imagined the biggest healthcare system in the world would run out of not just ventilators and dialysis machines, but of masks and PPE? Outside our hospital's telemedicine is helping millions receive care under lock-down, but it is under-reported how many physicians are able to participate only because they are for now able to use consumer apps like Zoom, Hangouts etc. Why does clinical software suck?

At Lux we continue to focus a large portion of our capital on investments in the broader life sciences/healthcare space: from new drug discovery tools and platforms, to distributed clinical trials and remote health solutions, to platforms enabling data interoperability and modern clinical software development. We have seen our healthcare, and non-healthcare companies, go to extraordinary lengths to provide support for the fight against COVID-19: from Recursion Pharma releasing first open-source morphological imaging data set on SARS-COV2 virus, and Primer using ML/AI to aggregate all scientific research on the topic, to DesktopMetal and Shapeways printing testing swabs and ventilator parts, and many others.

We learnt through this crisis that availability of capital wasn't the issue, but applicability of technology, and operationalization was hard. We need a system to rapidly test and deploy new technological solutions at scale. We need better and faster methods of drug and vaccine discovery/development/testing. We need better solutions to rapidly integrate new technologies into our healthcare system, including clinical and workflow software via open data architectures and interoperability, wearable and networked devices for individual and population health and low-cost at-home or on-site health monitoring tools. We need data interoperability to be able to provide care to a patient in any part of our country, and to mine high-quality data for better, and more useful, insights.

While a lot of our healthcare infrastructure will take a little bit of time recovering from the stress COVID placed on it, we anticipate this to provide a push to the system to adopt new technologies that enable distributed health, build resiliency in our delivery networks and deploy data-enabled healthcare. Hospital balance sheets might struggle in the short term to buy new technologies, but payers as well as large businesses might participate in infrastructure development and deployment in a bigger way. We anticipate selling to hospitals to be difficult in the short term, as they try to recover from the revenue shortfall they experienced during COVID-19, but will generally emerge more interested in adopting new technologies, digital and remote health solutions and automation in various functions. Needless to say, a wide-scale digital transformation of our healthcare industry is underway, and there is no looking back.

Sundeep Peechu, Felicis
Data infrastructure for providers/pharma and patient experience management for hospitals have been top of mind for the past year, but plenty of other areas like payments, cost transparency and claims management continue to be ripe for reinvention.

How much time are you spending on healthcare B2B/infrastructure right now? Is the market under-heated, over-heated or just right?
About a fifth of our investments in recent funds have been in healthcare, so we are quite active.

What are you looking for in your next investment?
I continue to look for teams that focus on a small critical solution, are relatively revenue-efficient and leverage that at scale into adjacent areas.

Are there startups that you wish you would see in the industry but don't?
We wish to find more "platform" companies that shrink the time/cost of creating new applications and that applies across a wide swath of healthcare.

How has COVID-19 impacted the healthcare B2B/infrastructure investing landscape?

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Some parts of the future have clearly been pulled in, like telemedicine and pharmacy delivery. Infra for early detection, contact tracing, better revenue management, etc., all seem very likely. Even basic things like healthcare logistics (ex: procuring PPE) has been found wanting, so there's a lot to fix.

How has COVID-19 impacted healthcare B2B/infrastructure startups operationally?
Most companies have scraped through Q1 with relatively low impact. The middle of the bell curve is bracing for a 30-50% impact in Q2. Once that data comes in, we will likely see more changes to underlying operations.

What advice do you have for your portfolio companies facing unprecedented surges right now?
Accommodate demand where margin positive and build the underlying tech to make it more efficient later.

**What are the biggest cracks emerging through this overnight adoption of healthcare B2B/infrastructure?**
The inability to scale testing despite the demand is glaring.

Bryan Roberts, Venrock
The delivery of healthcare in the U.S. is a very large ecosystem with enormous inefficiencies, cross incentives and entrenched interests. **Healthcare** is the largest employer in most U.S. counties and it puts dinner on a lot tables across the country. In fact, until the recent pandemic, healthcare jobs had been added every quarter for over a decade — including during the 2008-9 recession when the rest of the workforce dropped over nine million jobs. A huge, inefficient and important sector of the economy is often fertile ground for disruption by innovative startups. The several most important trends that we are focused on, for projects in which we get involved, are (1) information availability and (2) incentive alignment. The intersection of these is very powerful and both have been, historically, in short supply in healthcare.

COVID-19 will dramatically, positively change the growth and impact of technology enabled businesses in healthcare — most importantly (1) virtual medicine, not just in urgent care but in primary care, chronic diseases and mental health (all of which will offer a more convenient, higher-quality patient experience, as well as less expensive service); and (2) value-based care, where information is available and incentives are aligned to promote dramatically more efficient healthcare, with better outcomes.

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By Peter Grad
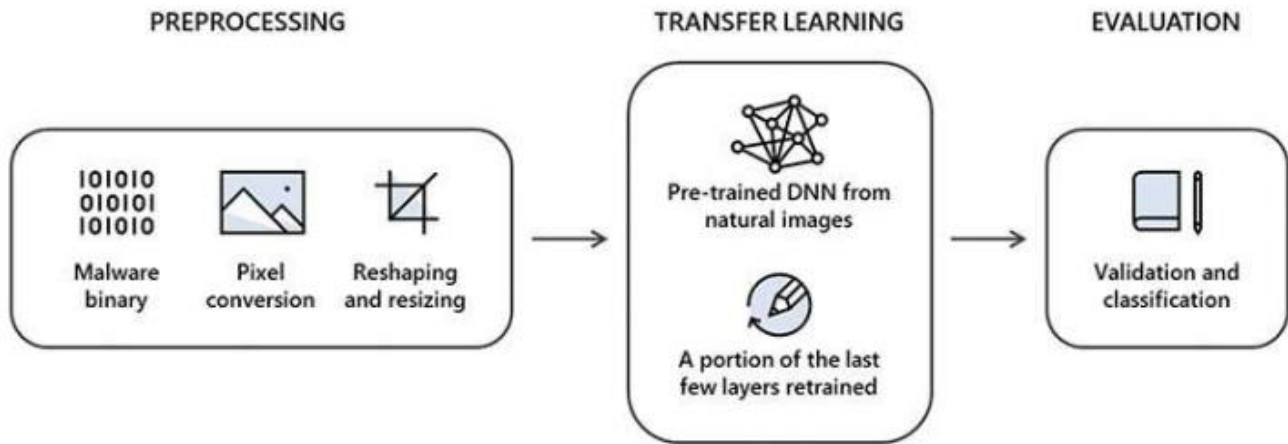
Credit: Microsoft

Two industry giants are working to get a clearer picture of how to combat malware—literally.

Members of Microsoft's Threat Protection Intelligence Team have joined representatives of Intel Labs to create images out of malware samples that can be used to detect malicious code.

Using an approach called static malware-as-image network analysis (STAMINA), researchers feed malware samples into a program that converts the data into grayscale images. They then analyze the samples for structural patterns that can be used to distinguish between benign and malicious code, and then rank the malicious suspects into degree of threat.

The study relied on earlier work by Intel on deep transfer learning for static malware classification. Deep learning is a component of artificial intelligence relying on machine learning, smart computer networks that learn on their own.

Static analysis permits malware detection without having to execute code or monitor runtime behavior.

Drawing on Microsoft's massive dataset of malware code collected through its Defender security system, the researchers say they achieved "high accuracy" in detecting malware and "low false positives."

With static analysis, most threats are detected before they are triggered, according to the Microsoft report posted on its security blog about STAMINA on May 8.

"While static analysis is typically associated with traditional detection methods," the report says, "it remains to be an important building block for AI-driven detection of malware. It is especially useful for pre-execution detection engines: static analysis disassembles code without having to run applications or monitor runtime behavior."

The study consisted of three steps: image conversion, transfer learning and evaluation. In a process that included pixel conversion and resizing, malware code drawn from 2.2 million infected files was converted into two-dimensional

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images. The next step used transfer learning to apply knowledge obtained about detected malware in one task to similarly structured unidentified code. The last step was evaluation.

The report states the STAMINA program achieved an accuracy of more than 99 percent identifying and categorizing malware samples, with a false positives rate of 2.6 percent.

In a white paper distributed by Intel, researchers explain: "As malware variants continue to grow, traditional signature-matching techniques cannot keep up. We looked to applying deep-learning techniques to avoid costly feature engineering and used machine-learning techniques to learn and build classification systems that can effectively identify malware program binaries."

For now, the program works best with smaller file sizes.

"For bigger size applications, STAMINA becomes less effective due to limitations in converting billions of pixels into JPEG images and then resizing them," the report says.

Microsoft Defender began as an anti-spyware program first offered with Windows XP and has subsequently expanded into a full anti-virus and anti-malware system as part of the Windows Security package included with Windows 10. In a 2018 study, leading spyware research lab AV-TEST found Defender achieved a 100 percent detection rate of malicious URL samples, and three false positives.

More information: *www.microsoft.com/security/blo … ware-classification/*
www.intel.com/content/www/us/e … tion-whitepaper.html

CHAMBIZ

Provided by the RoboticsTomorrow

Velodyne Lidar, Inc. *(* Chambiz DF 17 Feb 2017)* announced the NavVis *(* Chambiz DF 11 April 2020)* VLX wearable indoor mobile mapping system, launched today, is equipped with Velodyne lidar sensors to provide high-quality data capture of 3D measurements. NavVis VLX is designed for reality capture in complex built environments such as construction sites and multi-level towers.

Each NavVis VLX system uses two Puck LITE™ sensors to capture point cloud data needed to create building documentation including floorplans, 3D models and digital twins. NavVis VLX combines Velodyne image data with NavVis simultaneous localization and mapping (SLAM) technology to deliver survey-grade point clouds with a mobile device. Its compact, versatile design enables the system to map small, fragmented and narrow spaces as well as environments with many obstacles and uneven terrain.

"Velodyne sensors provide real-time 3D data to our mobile mapping systems. This valuable input has played an important role in developing the industry-leading SLAM algorithms that power our flagship mobile mapping system, NavVis M6," said Georg Schroth, NavVis CTO. "Now we are launching NavVis VLX, a complementary device that features the same ground-breaking SLAM technology in a compact, versatile design. We are very happy to have Velodyne be part of our efforts to provide laser scanning professionals with fast, efficient tools for scanning buildings that are capable of delivering survey-grade results."

"NavVis mobile mapping systems capture the data needed for as-built documentation, such as 3D models and floorplans as well as realistic digital factories for enterprise manufacturing facilities. Stakeholders can inspect, document and share information about buildings and factories to track milestones, plan relocations and improve both customer and employee experience," said Erich Smidt, Executive Director Europe, Velodyne Lidar. "The NavVis VLX system strongly

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demonstrates how the performance, range and compact form factor of Velodyne sensors enable companies to build innovative systems. The solution addresses specialized mobile mapping needs of AEC companies, surveyors and laser scanning professionals."

Velodyne Puck LITE sensors deliver a high-resolution image to measure and analyze indoor and outdoor environments. Designed for applications that require a sensor with a low weight and compact size, the Puck LITE delivers outstanding resolution and performance for mobile and UAV/drone applications. It provides a full 360-degree environmental view to deliver real-time 3D data.

About Velodyne Lidar

Velodyne provides smart, powerful lidar solutions for autonomy and driver assistance. Headquartered in San Jose, Calif., Velodyne is known worldwide for its portfolio of breakthrough lidar sensor technologies. Velodyne's founder, David Hall, invented real-time surround view lidar systems in 2005 as part of Velodyne Acoustics. Mr. Hall's invention revolutionized perception and autonomy for automotive, new mobility, mapping, robotics, and security. Velodyne's high-performance product line includes a broad range of sensing solutions, including the cost-effective Puck™, the versatile Ultra Puck™, the autonomy-advancing Alpha Prime™, the ADAS-optimized Velarray™, and the groundbreaking software for driver assistance, Vella™.

About NavVis

NavVis is a leading global provider of indoor spatial intelligence technology and solutions for enterprises, trusted by top companies including BMW, Daimler, Allianz, Lenovo and Deutsche Telekom. NavVis helps enterprises drive efficiencies and optimize business performance through its powerful digital twin platform for the indoors that enables accurate mapping at unprecedented speed and scale, immersive 3D visualization designed for collaboration and location-based apps that pioneer AI-powered positioning technology. Founded in 2013, NavVis is headquartered in Munich and has offices in New York and Shanghai. For more information, visit www.navvis.com.

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By mixing and manipulating an infrared laser, a team led by researchers at TU Wein (Vienna University of Technology) has generated a wide band of terahertz waves with relatively high efficiency.

By Bill Schweber

The terahertz segment of the electromagnetic spectrum exists in a sort of "twilight zone" between about 300 GHz (0.3 THz) to 3 THz (note that the upper boundary value is somewhat arbitrary, and some consider it to be 30 THz). It's bounded below by millimeter-wave RF (30 to 300 GHz) and above by optical wavelengths. Electromagnetic radiation below the terahertz band can be created by many sources and emitted by antennas, while the optical radiation above the terahertz band can be developed by solid-state lasers.

However, the major part of the terahertz span is largely a void. Although it's governed by Maxwell's equations just as the rest of the spectrum, it's relatively difficult to generate these waves as they're too high in frequency for even most leading-edge electronic components and too low for optical sourcing. Due to this and other problems, the terahertz region is far less explored and exploited than the RF or optical areas (see "References" at end of article).

Why even investigate the terahertz part of the spectrum? Among the many reasons are because it's there, of course; because it potentially has useful and fascinating characteristics; and it may be needed for 6G, 7G, or 8G wireless links. After all, 20 years ago, if you had told someone that there would be mass-market consumer products operating at ~10 GHz by the first part of the 21st century, you would have likely been called a wild-eyed dreamer.

Power Problems

However, the problem remains in terms of efficiently generating useful levels of power in the terahertz band. There are tabletop sources based on either optical rectification in electro-optic crystals or two-color filamentation in gases and liquids. With optical rectification, terahertz pulses with energy up to 0.9 mJ and THz conversion efficiency (ratio of generated THz energy to the input laser pulse energy) up to 3.7% have been generated, but the pulses are long (several picoseconds) with narrow spectra.

Unfortunately, the optical-damage threshold of electro-optic crystals prevents a significant increase in power. Furthermore, while there are no issues with optical damage when using the two-color filamentation approach, it generates only less-energetic near-infrared (NIR) laser pulses, and with a very low conversion efficiency of ~0.01%.

Efficient Source Breakthrough

Now, a research group based at TU Wein (Vienna University of Technology), in close cooperation with a team from the Institute of Electronic Structure and Laser (IESL) Foundation for Research and Technology-Hellas (FORTH) in Heraklion, Greece, and some help from Texas A&M University at Qatar, has developed a source that's both fairly efficient and can generate waves across the entire terahertz slice of spectrum. The experiment, with results they claim has broken previous records in these areas, was inspired by a theory developed in Texas A&M University, which predicted that long-wavelength laser pulses could be used to achieve extremely efficient terahertz generation in air plasma.

In the setup schematic (Fig. 1), the generation of the terahertz waves begins by sending infrared laser light through a nonlinear medium, where part of the infrared radiation is transformed into optical radiation at twice the initial frequency. The two radiation waves are then superimposed, creating an electromagnetic wave with an electric field having a very specific asymmetric shape.

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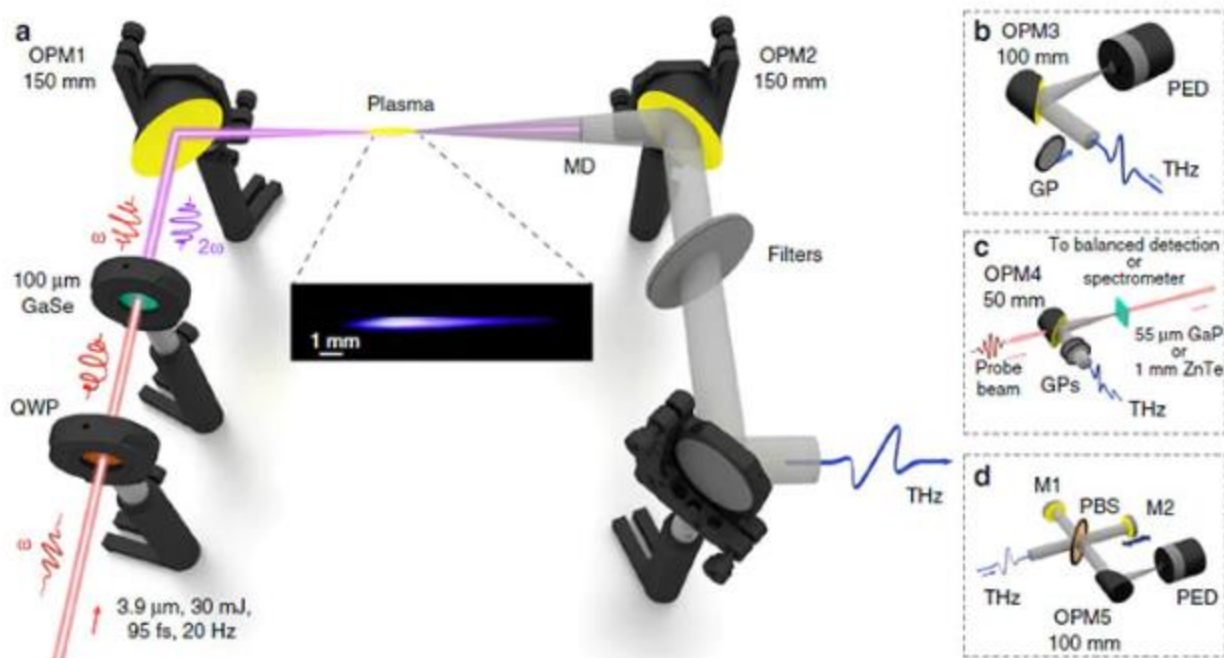
1. The setup for THz generation by two-color mid-infrared filaments (a). After the quarter wave plate (QWP), the 3.9-μm laser pulse passes through the gallium-selenide (GaSe) crystal and generates the second harmonic pulse. The two-color laser pulse is focused by an off-axis parabolic mirror (OPM1) in ambient air and forms a filament where the THz radiation is generated. A parabolic mirror (OPM2) gathers the emitted THz pulse and guides it into one of the detection setups. The metallic disk (MD) blocks the on-axis mid-infrared radiation and generated supercontinuum, while the conically emitted THz radiation passes around it. A set of lowpass filters filter out the remained unwanted radiation and prevent the saturation of the pyroelectric detector (PED) by the intense THz pulses. THz detection setups (b-d): The parabolic mirror (OPM3) focuses the THz pulse on the PED to measure its energy (b). The wire grid polarizer (GP), placed before the OPM3, makes it possible to characterize the THz polarization. For the electro-optic measurements, the parabolic mirror (OPM4) focuses the THz pulse into a 55-μm thick gallium phosphide (GaP) crystal (c). A pair of GPs reduces the THz field strength to ensure a linear response. The 680-nm synchronized probe pulse focuses into the GaP crystal through a hole in OPM4 and then is guided to the balanced detection setup. For the cross-phase modulation experiment, the GaP crystal is replaced by the 1-mm-thick zinc-telluride (ZnTe) crystal and the 761-nm probe pulse is guided to the spectrometer. The Michelson interferometer measures the THz field autocorrelation and consists of a pellicle beam splitter (PBS) and two flat mirrors: fixed (M1) and movable (M2) (d). At the exit, a parabolic mirror (OPM5) focuses the radiation on the PED. (Source: TU Wein)

But that's only the start of this process. The intense wave "rips" electrons out of the molecules in the air, turning the air into a glowing plasma. The special shape of the wave's electric field accelerates the electrons in such a way that they produce the desired terahertz radiation. As noted by team member Claudia Gollner (Fig. 2), "Our method is extremely efficient with 2.3% of the supplied energy converted into terahertz radiation. That is orders of magnitude more than can be achieved with other methods. This results in exceptionally high terahertz energies of almost 200 microjoules and terahertz-field amplitudes exceeding 100 MV per cm." She also added that their approach develops many wavelengths throughout the terahertz range to be emitted simultaneously, and the larger spectrum of different terahertz wavelengths yields the shorter and more intense pulses.

The details, including a review of existing methods of terahertz generation and their characteristics, are in their paper "Observation of extremely efficient terahertz generation from mid-infrared two-color laser filaments" published in *Nature Communications*, along with even-more detailed, equation-laced Supplementary Information.

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Provided by the Simons Foundation

Machine learning techniques accurately calculate the energy required to make — or break — simple molecules.

A new machine learning tool can calculate the energy required to make — or break — a molecule with higher accuracy than conventional methods. While the tool can currently only handle simple molecules, it paves the way for future insights in quantum chemistry.

"Using machine learning to solve the fundamental equations governing quantum chemistry has been an open problem for several years, and there's a lot of excitement around it right now," says co-creator Giuseppe Carleo, a research scientist at the Flatiron Institute's Center for Computational Quantum Physics in New York City. A better understanding of the formation and destruction of molecules, he says, could reveal the inner workings of the chemical reactions vital to life.

Carleo and collaborators Kenny Choo of the University of Zurich and Antonio Mezzacapo of the IBM Thomas J. Watson Research Center in Yorktown Heights, New York, present their work today (May 12, 2020) in Nature Communications.

The team's tool estimates the amount of energy needed to assemble or pull apart a molecule, such as water or ammonia. That calculation requires determining the molecule's electronic structure, which consists of the collective behavior of the electrons that bind the molecule together.

A molecule's electronic structure is a tricky thing to calculate, requiring the determination of all the potential states the molecule's electrons could be in, plus each state's probability.

Since electrons interact and become quantum mechanically entangled with one another, scientists can't treat them individually. With more electrons, more entanglements crop up, and the problem gets exponentially harder. Exact solutions don't exist for molecules more complex than the two electrons found in a pair of hydrogen atoms. Even approximations struggle with accuracy when they involve more than a few electrons.

One of the challenges is that a molecule's electronic structure includes states for an infinite number of orbitals going farther and farther from the atoms. Additionally, one electron is indistinguishable from another, and two electrons can't occupy the same state. The latter rule is a consequence of exchange symmetry, which governs what happens when identical particles switch states.

Mezzacapo and colleagues at IBM Quantum developed a method for constraining the number of orbitals considered and imposing exchange symmetry. This approach, based on methods developed for quantum computing applications, makes the problem more akin to scenarios where electrons are confined to preset locations, such as in a rigid lattice.

The similarity to rigid lattices was the key to making the problem more manageable. Carleo previously trained neural networks to reconstruct the behavior of electrons confined to the sites of a lattice. By extending those methods, the researchers could estimate solutions to Mezzacapo's compacted problems. The team's neural network calculates the probability of each state. Using this probability, the researchers can estimate the energy of a given state. The lowest energy level, dubbed the equilibrium energy, is where the molecule is the most stable.

The team's innovations made calculating a basic molecule's electronic structure simpler and faster. The researchers demonstrated the accuracy of their methods by estimating how much energy it would take to pull a real-world molecule apart, breaking its bonds. They ran calculations for dihydrogen (H_2), lithium hydride (LiH), ammonia (NH_3), water (H_2O),

diatomic carbon (C2) and dinitrogen (N2). For all the molecules, the team's estimates proved highly accurate even in ranges where existing methods struggle.

In the future, the researchers aim to tackle larger and more complex molecules by using more sophisticated neural networks. One goal is to handle chemicals like those found in the nitrogen cycle, in which biological processes build and break nitrogen-based molecules to make them usable for life. "We want this to be a tool that could be used by chemists to process these problems," Carleo says.

Carleo, Choo and Mezzacapo aren't alone in tapping machine learning to tackle problems in quantum chemistry. The researchers first presented their work on arXiv.org in September 2019. In that same month, a group in Germany and another at Google's DeepMind in London each released research using machine learning to reconstruct the electronic structure of molecules.

The other two groups use a similar approach to one another that doesn't limit the number of orbitals considered. This inclusiveness, however, is more computationally taxing, a drawback that will only worsen with more complex molecules. With the same computational resources, the approach by Carleo, Choo and Mezzacapo yields higher accuracy, but the simplifications made to obtain this accuracy could introduce biases.

"Overall, it's a trade-off between bias and accuracy, and it's unclear which of the two approaches has more potential for the future," Carleo says. "Only time will tell us which of these approaches can be scaled up to the challenging open problems in chemistry."

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By Alistair Laycock

The global pandemic has been a proving ground where the most agile and dynamic businesses have reacted fastest to the 'new normal' of the lockdown economy; restrictions on travel, the shutdown of physical stores or factories, and a huge rise in remote working. Against this backdrop, the question is no longer should organizations digitize, but, rather, how can they deliver a transformation that best prepares them to handle uncertain times and create opportunity from crisis.

Many of the organizations coping best or even thriving in the current crisis share a common attribute: they were already building a flexible digital platform for the future, embracing agile methodologies and building development teams with detailed domain knowledge who could be flexible and fast enough to move in response to unprecedented events.

One example is the UK's alarm-response specialist The Keyholding Company (KHC), which already had the foundations of a successful digital transformation in place--a long-term investment in the right technology, and a long-term investment in the right technology partner--which created the agility necessary to operate normally in a world that is anything but.

As an essential service, The Keyholding Company supports national infrastructure service-providers such as locks/unlocks and alarm-response; it's a private business that also eases pressure on public services, such as the police.

Before the pandemic, a national network of keywardens would lock and unlock buildings on behalf of the staff, but with businesses closed down this service was no longer required. Faced with losing a valuable revenue stream, The Keyholding Company realized that the lockdown actually presented an opportunity; while sites would stay locked and unstaffed, this meant there was a new demand for these sites to be visited by security staff, to check that the empty properties were secured and to act as a deterrent against crime. This called for a transformation of the existing service, replacing locks/unlocks with an entirely new service offering external and internal property patrols.

As a result of the ongoing relationship with Haulmont, its technology partner of four years, The Keyholding Company was able to build out its existing client-portal functionality and job processes and reconfigure them to support an entirely new product offering for scheduled patrols in just a few days. This kind of new product build would typically take weeks, if not months. However the experience and knowledge of both internal and supplier resources fast-tracked this process. The close working relationship between the Haulmont engineers and the internal IT experts was also crucial to this speed of delivery.

Lucas Gundry, technology director at KHC, believes "A bespoke enterprise platform with a dedicated development team allows you to make changes quickly. This is particularly important for smaller and mid-sized businesses, where you can gain a real competitive advantage by working on something unique while your competitors wait for their off the shelf systems to catch up."

For those looking to undertake any kind of digital transformation project, Lucas says, "you need speed now but always have to be thinking about the long term. Be brave and take risks but be really conscious of where you'll be in six months to make sure you won't get stuck. You need a zero-tolerance approach to legacy systems and always question everything. Be ruthless. And choose a technology partner who is invested in the project as much as you are. If they refuse to deliver a proof-of-concept then they are telling you they are ready to fail."

The Keyholding Company's ongoing digital-transformation project has enabled the business to function as close to normal as possible and even thrive in the new normal of the COVID-19 world. Thanks to this ability to retain key clients

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and even to add new business during the lockdown, Keyholding's staff are able to work safely in the knowledge that their jobs are secure, their day-to-day work is unaffected and morale remains high.

The argument for a digital transformation has never been stronger or more relevant. As business recovers from the lockdown, the aftermath of the current global pandemic will shift priorities, making a digital transformation a case of 'when' and not 'if'.

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By Sean Kinney

The notion of ecosystem development is a recurring part of the edge conversation. The idea is that a diversity of technologies and use cases need to be developed, requiring buy-in and coordination between not just technology vendors and network operators but also the end users who have unique problems. Similar technology can be brought to bear for AI-based video analytics for manufacturing quality control and access control for a commercial high-rise, but the buyer will have specific requirements related to its own IT structure, desired outcome, security and so forth.

Writing about the IBM Edge Ecosystem in a recent blog, Evaristus Mainsah, GM of the Cloud Paks Ecosystem, noted that, "making the promise of edge a reality requires an open ecosystem with diverse participants." The goal of its ecosystem development play is enable customers "to move data and applications seamlessly between private data centers, hybrid multi-cloud environments and the edge…IBM business partners can help their clients take advantage of 5G while acting on insights closer to where data is created by people, places and things."

Specific edge products announced at IBM Think Digital include:

- IBM Edge Application Manager to operate AI, analytics and IoT workloads; a single administrator can manage up to 10,000 edge nodes at the same time, according to the company.
- A range of edge apps and services for sets of vertical use cases, including IBM Visual Insights, IBM Production Optimization, IBM Connected Manufacturing, IBM Asset Optimization, IBM Maximo Worker Insights and IBM Visual Inspector.
- And the IBM Telco Network Cloud Manager for automated orchestration of virtualized network functions.

Core to the edge value proposition is near real-time ability to process data, largely data collected from IoT devices which run the gamut from HD cameras and motion sensors to drones and manufacturing robotics. Point being, 5G is complex and enabling the edge through a combination of distributed and centralized computing resources is just another vector of complexity.

As IBM's Marisa Viveros, vice president of strategy and offerings, Telecom, Media and Entertainment Industry, IBM Industry Platform, put it in a blog, in order to deliver innovative new 5G services, service providers "need to act quickly as 5G becomes more available…As we advance into the world of 5G, providers will need to transform their networks into hybrid multi-cloud platforms that can support large volumes of data and that can rapidly adapt to new challenges."

To get an idea of what this looks like in practice, IBM is working Singaporean carrier M1 and Samsung to trial 5G for manufacturing, including the use of AI and augmented reality for things like video analytics and predictive maintenance. Singapore has identified several key verticals for 5G adoption — including healthcare, manufacturing and maritime — and has set aside SG$40 million to develop the necessary supporting infrastructure and ecosystem.

Reflecting on IBM's telco cloud and edge announcements in a piece published by Forbes, Will Townsend, senior analyst, Carriers and Enterprise Networking, at Moor Insights and Strategy, described the company's goal as creating "blueprints to speed operator deployment of 5G edge-enabled solutions that have the potential to drive disruption in manufacturing, supply chain management, and more. IBM has incredible depth from a services perspective, and I expect that operators will see the value."

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Provided by the Civil Map

Where am I?

Accurate estimation of an autonomous vehicle's position and orientation known as "localization" is not just a prerequisite for decision making and path planning, it is critical for the safe operation of the vehicle. Autonomous vehicles are equipped with different types of sensors such as GPS, IMU, Camera, LiDAR, Wheel Encoders, and Radar that can all help localize the vehicle. Some of these sensors are redundant, providing independent measurements of the same property; while some are complementary, and when combined will provide a more complete representation of the phenomenon under observation. Traditionally, arriving at an accurate localization estimate involves sensor fusion — a process that takes data from different sensors and utilizes them to reduce the amount of uncertainty. In this article, we are going to talk about the challenges we experienced with sensor data fusion and what we have built to simplify the problem!

More is Not Always Better

Data Level Fusion vs. Localization Level Fusion

Data level fusion combines sensor data from different sources to produce a localization result.
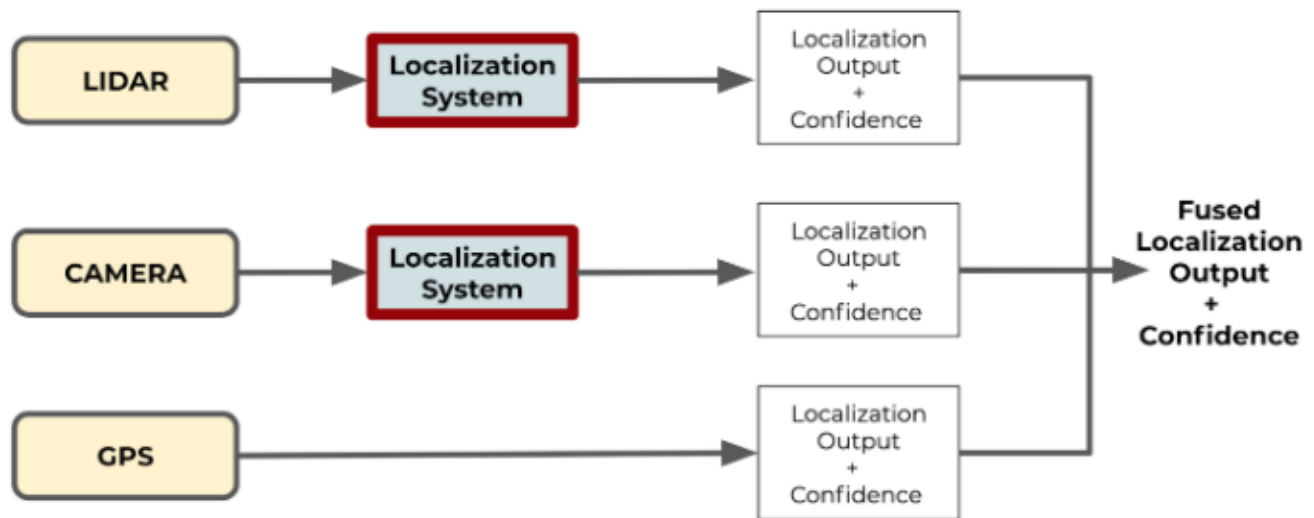
Data Level Fusion
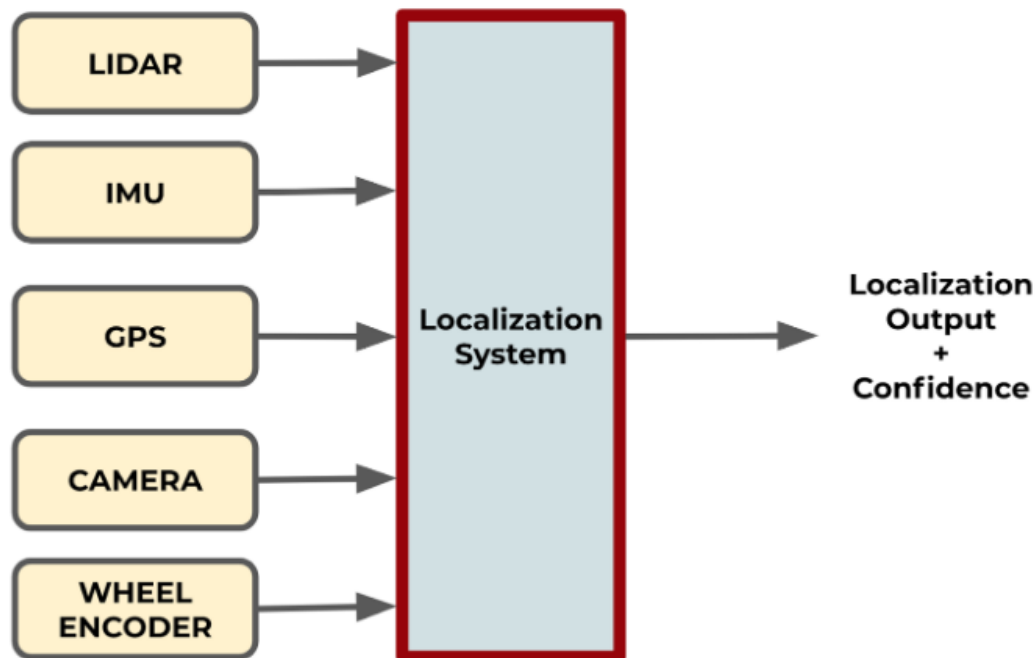
Data level fusion creates a more fragile system

The proposed Civil Maps structure for sensor fusion is a localization level fusion where localization estimates have been independently determined per sensor and can be fused as a final step.

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Localization Level Fusion

Individual localization outputs are more robust and can be optionally fused

The maxim generally followed in the industry is that *data level fusion* will produce more robust localization results than from a single sensor. This statement is true if the following conditions are met:

1. The **uncertainty estimations** for each sensor is accurate before fusing the results
2. The **calibration** between the sensors is accurate
3. The estimation from one sensor is **independent** from the other sensors

From our work at Civil Maps, we have found the industry to overestimate the above assumptions. Here are some of our learnings:

1. We compared high end GNSS systems and the generated point clouds with survey point clouds and found the error to be significantly higher than the sensor's estimated **uncertainty errors**. We have found the error estimation to be the worst in urban environments.
2. We implemented both online and offline **calibration** methods between sensors as well as used provided calibration data from clients. While there are a lot of strong methods available, sensor calibration has some level of inaccuracy.
3. We have seen numerous LiDAR localization methods that use GPS, IMU, camera or wheel odometry as inputs into the LiDAR localization. This approach no longer makes the LiDAR localization **independent** from the other sensors. If one of the provided sensors begins producing inaccurate data, the LiDAR localization could fail.

One can easily get overwhelmed and even *"freak out because the output becomes completely crazy"* when trying to integrate just one additional sensor (IMU) with LiDAR odometry! :)

While additional sensors can improve the performance in a tightly controlled system, **if you are building a robust software solution that works with different customers and different sensors,** *data level fusion* **creates a more fragile solution.** Sensor fusion is best done after each sensor has independently determined its localization output and confidence.

Simplifying the Problem

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At Civil Maps, we started with a sensor data fusion approach, and while sometimes the localization system had high performance, at other times it would not perform well due to a multitude of factors; the GPS performing poorly at that time of day, the tire pressure had changed so the wheel odometry calibration deteriorated, or the IMU was not calibrated correctly because of poor GPS. We believed there had to be a simpler solution and switched to only relying on the LiDAR. While it was initially a more difficult problem, we are now able to produce impressive, repeatable localization results using a LiDAR-only methodology. **The simpler your system is, the less that can go wrong.**

LiDAR-only Localization
LiDAR-only localization uses data from a LiDAR system to produce a localization output and confidence level. An added benefit is that it is now much easier to integrate with customers because we just need a rough GPS and the LiDAR stream. We provide an error estimation with our output so the customer can do the fusion themselves, if they want to. GPS can be especially helpful on highways with minimal 3D data, but the fusion should be done with the LiDAR localization output, and not the sensor data!

In the **next blog post**, we will go more in depth on the Civil Maps LiDAR-Localization system, and what is required to create a global correction system using just consumer GPS and LiDAR. Stay tuned!

We Are Excited… Are you?
Accurate localization using just one sensor unlocks a host of exciting applications like delivery bots without expensive GNSS systems or autonomous vehicles needing a robust primary or secondary localization system
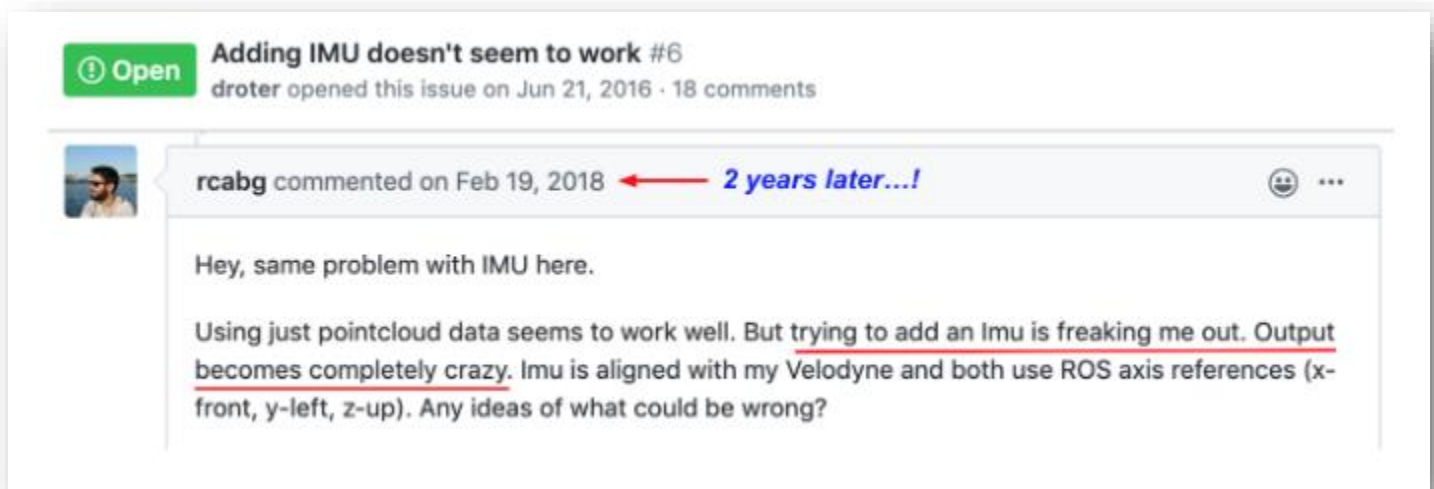
Sensor data integration issues from https://github.com/laboshinl/loam_velodyne/issues/6

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The idea that we go back to normal the moment we lift restrictions is unlikely, fanciful, even.

By Scott Bade

Global lobal trade watchers breathed a sigh of relief on January 15, 2020.

After two years of threats, tariffs and tweets, there was finally a truce in the trade war between the U.S. and China. The agreement signed by President Trump and Chinese Vice Premier Liu He in the Oval Office didn't resolve all trade tensions and maintained most of the $360 billion in tariffs the administration had put on Chinese goods. But for the first time in months, it looked like manufacturers, importers and shippers could start to put two difficult years behind them.

Then came COVID-19, at first a local disruption in Wuhan, China. Then it spread throughout Hubei province, causing havoc in a concentric circle that eventually engulfed the rest of China, where industrial production fell by more than 13.5% in the first two months of the year. When the virus spread everywhere, chaos ensued: Factories shuttered. Borders closed. Supply chains crumbled.

"It has had a cascading effect through the entire world's economy," says Anja Manuel, co-founder and managing partner of Rice, Hadley, Gates & Manuel LLC, an international strategic consulting firm based in Silicon Valley.

The crisis has caused a drastic contraction in global trade; the World Trade Organization estimates trade volumes will fall 13-20% in 2020. And spinning activity back up could be tricky: Even as China starts to get back online, the slowdown there could reduce worldwide exports by $50 billion this year. When factories do reopen, there's no guarantee whether they will have parts available or empty warehouses, says Manuel, who also serves on the advisory board of Flexport, a shipping logistics startup. "Our supply chains are so tightly-knit and so just-in-time that throw a few wrenches in it like we've just done, and it's going to be really hard to stand it back up again. The idea that we go back to normal the moment we lift restrictions is unlikely, fanciful, even."

Getting to that new normal, though, is a job that a number of logistics startups are embracing. Already on the rise, companies like Flexport, Haven and Factiv see a global trade crisis as a setback, but also an opportunity to demonstrate the value of their digital platforms in a very much analog industry.

Information is king
As companies along the global supply chain reel from these fast-moving events, they are increasingly turning to firms that can offer them information — and the options that come with it.

"In moments of lots of volatility, you want to make sure the data you're looking at is real," says Sanne Manders, Flexport's COO. "Where before you could get away with a weekly supply chain update, now you need accurate and timely data every minute. If you don't, you're not agile to make decisions."

For an historically analog industry, that means change, says Brad Klaus, CEO and co-founder of Haven, a startup that provides transportation management system software. The first problem software solves, he says, is visibility. "What's going on with my shipments? What's delayed? What's missing? Visibility into supply chains has become critical because it's not normal and therefore there are more exceptions than normal."

"It used to be if someone canceled a sailing, you had a month of notice," says Phil Levy, Flexport's chief economist. "Now you're getting notices for the next week or next day that a sailing won't take place. That means you need information and agility, which is where tech comes in."

The second problem, Klaus says, is managing volatility: "How do you manage rates optimally? How do we ship from ocean to air in some cases, or vice versa? Software is helping address those kinds of problems."

Companies that haven't embraced software to manage their supply chains are scrambling now to handle new tariffs, regulations, rules and standards for documentation — while still relying on manual processes like Excel and email. "It's hard to adapt to those new changes if you don't have a system that can manage those workflows and you're trying to do it through people and email and paper," Klaus says.

Manders concurs. "Digitalization is about having to spend less time managing your supply chain. It should run. [Flexport's] software reduces that by 60% and the quality of our data is four to fives times better than that shared on email because it's standardized."

In addition to providing extra customer support, Flexport has responded with new services, including a COVID-19 help center, an advisory team to help customers understand shifting regulations and closures and a feature that allows customers to prioritize shipments. "When things aren't going well, you need a lot of advice. Technology gives us a platform to provide it," says Manders. "Digitization is not an option; it's a necessity."

Working from home
Digitalization has another, more mundane benefit: enabling employees to work from home. "If you're a company that has to have their employees go into the office to create the necessary documents, get approvals you need when your organization interacts with your shipping partners — you're very much being disrupted," says Haven's Klaus. "But if you're using a cloud-based software like Haven and you can log in from anywhere, you're certainly not as disrupted."

Manders concedes that as a tech company, Flexport's staff has shifted to working from home with ease, but as a freight company, there have been complications — adjusting to physical distancing in warehouses has slowed down operations, for example. And software only takes things so far; most clients, he says, want to ultimately speak with an advisor in such volatile times.

But that newfound interest in logistics has spurred tech firms to engage with customers in new ways. "I don't think I ever would have thought supply chains were a hot topic," says Dave Evans, CEO and co-founder of Fictiv, which describes itself as a hardware manufacturing ecosystem. But, he adds, between the trade war and pandemic, "supply chain has been one of the primary themes in the boardroom in 2020."

"People are craving information," says Manders. "They want to understand how the world works and what it means for their supply chain." To meet demand, both Flexport and Fictiv are producing frequent blog posts and webinars. Fictiv's features Evans interviewing experts across the logistics field.

All the information in the world can't change the simple economic reality, that consumer sentiment is down and more sectors are losers than winners. Many clients have canceled orders and others are having to negotiate payment terms. With so much volatility in the wider economy, making a bet on a big order — and then shipping it across an ocean — is a risky proposition no matter how easy the logistics are.

How the disrupters became the first defense against disruption
If the coronavirus pandemic has uniquely disrupted the logistics industry, it has also offered an unconventional opportunity for the disruptors: sourcing and distributing medical supplies and personal protective gear (PPE) amid a global supply crunch.

The challenges are multifold, Manders tells me. First, many PPE buyers are used to domestic supply chains and are simply inexperienced sourcing PPE from China. Second, it's the "Wild West; lots of gold diggers think they can make a quick buck on masks." Third, "regulation is changing every minute," and while some of that is a result of attempts at quality control, the result is it's "very hard to read because it's so fast."

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Meanwhile, there is "total chaos" at airports because there's "way too much PPE for air capacity. The waiting time to deliver cargo from passenger terminals is 28 hours because they aren't prepared for it. I've seen videos where it's like, 'how are you ever going to get a forklift in there?' "

In addition to their normal services, logistics companies are finding new ways to apply their technology to these challenges. Flexport has started a new center of excellence for PPE customs regulation, for example. Meanwhile, Fictiv is leveraging its data and artificial intelligence technology to instantaneously provide quotes to medical device companies seeking to make new orders — and to link together new actors in the medical supply chain. "If I can help connect a government agency with a supply-chain manager in a hospital with manufacturers," says co-founder Evans, "all of those elements create a better ecosystem." That includes working with California Gov. Gavin Newsom's team to build a marketplace for medical goods.

Fictiv is also helping traditional manufacturers shift to making medical devices and PPE. "We spun up tools in the U.S. and China to be able to have the capacity to produce over a million units of face shields a month by leveraging existing supply that was maybe doing automotive or consumer, but because they have excess capacity, we were able to fill it with PPE," Evans says, adding that the profits are being sent to the WHO fund for front-line workers. The firm is also exploring greater use of technologies like additive manufacturing and 3D printing.

Meanwhile, Flexport.org partnered with former California Gov. Arnold Schwarzenegger and other celebrities to launch the Frontline Responder Fund, which has funded the purchase of PPE and medical supplies for front-line workers and facilitated their delivery using Flexport's logistics. Flexport is similarly a leading member of the C19 Coalition, a public-private partnership that aims to double PPE production and distribution, through which it is providing pro bono advisory customs clearance services to suppliers and helping new manufacturers cut through red tape. Altogether, Flexport says it has moved 92 million units of medical gear, including at least 10 million through its nonprofit arm.

Looking (freight) forward
Moving forward, the pandemic might cause a bump in the road in the logistics tech space but will not likely cause a major setback. "We don't see cancellations yet," says Manders. "We don't think we will stop growing. We've been growing 80% year on year, so even if the market is down 20 or 30%, we'll be net positive."

That's because it's exactly the type of digital disruption these firms are pursuing that is smoothing over the uncertainties that come with COVID-19. And those who are behind the curve know it. "We see a lot of adoption of digital technology [happening in] the second half of the year [as companies] dealing with disruption look for solutions in the next few months," says Haven's Klaus. "These organizations are realizing that to compete in the future will mean digitizing their operations more, especially in a world where people work from home more often. It will be critical to have cloud-based software solutions."

But they're also preparing for the inevitable changes. The pandemic has "caused serious examination about how comfortable people are with the system we have," says Levy, the Flexport economist.

Despite calls by some politicians to bring back critical industries and supply chains, he doesn't think that's likely. "You have the same price pressure in the long run and if you have a U.S. company that re-shores everything, that will raise its costs. Will customers pay more competing against a German or Canadian company that uses more efficient suppliers? I don't think experience would suggest that they are. If you want to insulate yourself, it's going to be really costly."

Ironically, for an industry that has been slow to disrupt, decades of prioritizing efficiency and failing to modernize have left the global freight industry vulnerable to disruption. Innovation seems inevitable.

COVID-19 is accelerating trends, says Flexport's Manders, that bode well for technology firms. "This situation has created a new sense of urgency. We've been having conversations with our customers around 'what can you do to

reframe your mission?' 'Are you there to save costs on ocean freight or get goods to stores?' But you need data and options." That means digitization, software and network effects, the elements logistics tech firms provide.

Evans agrees. "Everyone wants to talk about COVID and the disruption to the supply chain, but I think that's a very narrow slice. Supply chain disruption happens due to large macro events — earthquakes, trade policy, a pandemic. In the past, either severity or frequency gets people to change. We've [now] had severity and frequency with tariffs followed by a pandemic. There's no way supply chains will continue to run with the risk they've had. But people won't be willing to pay more because of supply chain inefficiencies. So supply chain leaders are going to have to figure out how to keep the same cost structure while reducing risk. And the only answer I have to that is technology."

It remains to be seen whether or not manufacturers agree. Decades of prioritizing efficiency over redundancy and relying on dated technologies left them uniquely vulnerable to shocks in the supply chain. Only time will tell if the twin shocks of COVID-19 and the trade war will prove enough to provoke the digital revolution that some in Silicon Valley think they need.

CHAMBIZ

By Kate Clark @ The Information

Ann Miura-Ko is no stranger to investing during a crisis. She got her start in venture capital as an analyst on September 10, 2001. She co-founded her seed-stage fund, Floodgate, in 2008 just as Bear Stearns was collapsing.

The current shock set off by the global coronavirus pandemic seems worse. "This is actually a fundamental reset. It's not just an economic event. It's not just a healthcare crisis. It's a pervasive, system-changing, life-altering series of events," said Miura-Ko in a phone interview from her home in Palo Alto, California, last week.

Miura-Ko was getting a doctorate in math modeling of cybersecurity at Stanford University when she started Floodgate with tech executive Mike Maples Jr. She was one of the first women venture capitalists to head her own firm.

Floodgate is known for Miura-Ko's early investment in ride-hailing business Lyft. She also backed media company Refinery29 (later bought by Vice), coding boot camp Thinkful, and, most recently, mobile live-streaming shopping app Popshop Live. She and Maples invest out of Floodgate's sixth flagship fund, worth $131 million.

Under the shelter-in-place mandates, she's been meeting with six to eight companies a week and is optimistic that a new generation of startups will rise out of the ashes of the current crisis. "We haven't had a shock like that in a really long period of time," she said.

Yet social distancing has made it hard to have the deal talks that led to tech M&A, as well as exits for investors, after the 2008 crisis. She predicts more pain ahead for startups. "I don't think the bad news is behind us by any stretch," she said, referring to layoffs.

The following Q&A has been edited for brevity and clarity.

The Information: Does the economic impact of Covid-19 bear any resemblance to past downturns?

Ann Miura-Ko: That's the eternal debate we are having with other [venture capitalists]. Some parts of this bear a resemblance. Then there are parts of it that are so fundamentally different it almost feels like when we emerge from this world, we will have changed so much. It's kind of like we're coming out of war. It's impacting everything globally and universally. This is actually a fundamental reset. It's not just an economic event. It's not just a health care crisis. It's a pervasive, system-changing, life-altering series of events and policy decisions, and because of that [scope] the impact we see will be much greater than anything we can possibly imagine.

How are you spotting new investment opportunities in such a dark time?

The work process is different in the sense that the first meetings are all over Zoom. I'm still meeting with somewhere between six to 10 companies a week, which is sort of what I've always done in the past. I am still trying to get my footing in terms of where I see the most interesting opportunities.

I've had this thesis around Iron Man suits for the "solo-preneur." What are different ways in which you can give software to solo-preneurs to make them competitive in an increasingly competitive market? We had one company called Dumpling that allows people to set up their own storefronts as grocery shoppers for other people. It's done really well in this economic climate. A company that I just recently invested in is called Popshop Live. They basically enable brick-and-mortar storefronts to put up video storefronts.

Layoffs are hitting Silicon Valley startups hard right now. Do you expect another wave of job cuts?

We are all bracing ourselves. I don't think the bad news is behind us by any stretch. There are some companies that have been aggressive about their stance; they've decided to go for the pain early on. I don't think those companies will have to go at it again. Companies that were more conservative in the sense that they didn't cut as aggressively going into the second quarter, I think they will have to face the music a second time.

What advice are you giving your existing portfolio companies right now?

We are telling our startups, "Hey, you might have had product market fit in January, but that doesn't guarantee you product market fit in July, because the world has changed." It's important for tech companies to recognize that. There are all of these different shocks to the system and we still don't know what the impacts of those are.

Another thing we say to our investments is "Hey, you guys need to do a full inventory of your customers. Your customers have changed. If your customers are in a different position, then you could be in a world of hurt." Like anyone who's been serving restaurants or small businesses—those are changing pretty dramatically.

"How much of your product is for a world that existed pre-Covid and how much do we believe that world will come back post-Covid? What will the world look like in three to six months?"

A lot of venture capitalists say the best companies are built in downturns. What do you think?

When I think back to my experience in 2001 and 2008, I saw some really interesting companies formed during those periods of time. When you have a shakeup in the general economy, you see really interesting shifts take place.

There's been a shift in society that will impact an entire generation. The changes are already impacting consumer spend and we are seeing it in terms of how people spend their time. Those things never change dramatically unless there's a huge shock to the system, and we haven't had a shock like that in a really long period of time.

A shock creates a canvas that is really interesting. That's the piece that makes me optimistic. The piece that tears me up is that you look at these small businesses and I don't know how much longer they can hold on.

In a different economic climate where fundraising isn't so simple, it does require courage to start a company. That will separate out folks who really have that desire to have their vision become a reality from those who just wanted to try out being a founder.

How has the financing landscape changed amid Covid-19?

The thing I thought was interesting in my first foray into VC was that the 2001 to 2003 time frame was just a very slow financing timeline; not a lot of deals were done. We also did not see very many exits in that period. But 2008 was a very different kind of downturn. From 2008 to 2012, M&A... was pretty active. In fact, it was during that time we saw really nice dual track exits for early-stage companies.

Tech businesses were acquired and acquiring companies at a pretty rapid rate. I'm not 100% sure we will see a similar type of activity. Tech companies in general have just become a lot more price conscious and it's just harder to meet someone because of Covid. That makes the process of deal-making pretty difficult, which generally impacts the whole landscape.

If you have a healthy exit environment, cash is getting returned to limited partners, and limited partners are excited about VC.

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Israeli startup Sonarax is ready for a touchless new world with its ready-to-install ultrasonic data-transmission technology.

By Abigail Klein Leichman

The Covid-19 crisis will pass, but some things will never go back to normal. We will remain wary of elevator buttons, ATM touchpads, intercoms, fingerprint scanners, employee timeclocks and all other surfaces touched by countless hands. The Israeli startup Sonarax *(*Chambiz DF 11 May 2019)* is ready for that new touchless reality with a ready-to-install ultrasonic data-transmission technology. You'll touch only your smartphone in order to check in, check out or ride the elevator.

"Ultrasonic data connectivity is a great solution for many tasks," Sonarax Chief Commercial Officer Nimrod May tells ISRAEL21c.

The machine-to-machine technology uses soundwaves to transfer data between any devices equipped with a speaker and microphone. For the data exchange to work, Sonarax's SDK (software development kit) must be implemented on both sides. On your mobile phone it can be added to an existing or dedicated app. So, for example, employees will hold their smartphone near an access control device to enter the office building, summon the elevator and "punch" a timeclock. The audio signals communicate automatically once the user opens the phone's speaker.

Delivering data over soundwaves
"It all began with Roni Papo, an engineer from the Technion, who had the vision and passion to harness soundwaves in order to deliver data," says May. "He developed algorithms to send data in small packages over soundwaves."

Papo chose an ultrasonic range that humans cannot hear (it doesn't bother dogs either, says May).

Incubated in 2016 at Haifa's hiCenter Ventures, Sonarax signed integration agreements with leading semiconductor companies such as Cadence, Knowles and Ceva. Clients are using the startup's award-winning technology for touchless access, payments, authentication, location-based services, marketing promotions and indoor positioning.

Some European universities have embedded the SDK into classroom touchpads and student apps for attendance verification. A European museum put it on the visitor app for indoor navigation and information. Fans at an Israeli sports stadium used it to trigger a sonic lightshow in tandem with the stadium's PA system.

Sonarax and Covid
And then came the pandemic.

"Four months ago, an invisible enemy began affecting our lives and making us rethink the way we interact with our physical surroundings," May says.

"We became more aware of potential dangers of pressing the buttons on a vending machine, ATM or pedestrian crosswalk."

Manufacturers of elevators and access control systems – even casino games – have approached Sonarax to help them offer touch-free options.

"People will use their mobile phone as a third hand," says May.

Sonarax's technology also provides an effective social-distancing tool, says May.

"Soundwaves can measure distance and positioning. That facilitates anyone launching an app to make sure people are maintaining proper social distance. Our SDK would calibrate the parameter and notify people if they are crossing the line."

Google and Apple recently announced a joint venture to enable contact tracing using Bluetooth technology.

However, "Bluetooth is not as good as what we offer," Sonarax VP Product Ariel Ben Lulu tells ISRAEL21c.

"Ultrasonic transmission is much more accurate, secure, private and cost effective. It's even 'greener' because it has zero radio frequency emissions."

What makes it more accurate?

"Unlike Wi-Fi and Bluetooth, which use high-frequency radio waves that cross through walls or other hard surfaces, ultrasonic waves don't cross walls and can be contained to any defined space," Ben Lulu explains.

"If someone in the next office has corona, Bluetooth or Wi-Fi will indicate that the person is right next to you. Our solution will not falsely read and report such data because we are able to differentiate and accurately tell apart locations down to a distance of 30 centimeters. So indication of risk is much more reliable."

Sonarax CEO Uri Heller. Photo: courtesy
Under the management of high-tech entrepreneur Uri Heller, Sonarax has 14 employees in its Haifa office. At the nearby Technion, students continue to find additional uses for the technology.

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"Helping to slow down or stop the virus transmission risks involved in sharing touchpads, whether for gating access or making payments, is our greatest motivator in making this technology available," said Heller.

"Flattening the curve through everyday social distancing practices is what all communities are striving for, and institutions and enterprises are looking for practical answers that don't require heavy investments or major retooling of their existing systems. We're here to provide those answers."

Faster transmission

Sonarax is not without competition. Ultrasonic data transmission also forms the basis of two other companies, Listnr and Copsonic.

Ben Lulu asserts that Sonarax technology is 10 times faster and therefore more reliable.

"A big issue is the speed at which we can transmit data. We can transmit 1,000 bits per second, while our competitors can only transmit 200 bits per second," he says.

"And we have unique capabilities, including the ability to work during movement, meaning you don't need to stay still while communicating."

Concludes May: "This is our time to prove that ultrasonic connectivity is an amazing technology that can make the world a better place."

CHAMBIZ

Provided by The Microwave Journal

5G will deliver more data to more devices with lower latency and higher consistency than previous-generation technologies. A large number of subscribers are anticipated to adopt the 5G network. To accommodate these users, there is a need for a larger bandwidth. Limited bandwidth is available in the mobile frequency spectrum (i.e., below mmWave band); hence, the mmWave band has been explored for a larger bandwidth. mmWave technology offers several advantages, such as high-speed data transfer (large bandwidth), high resolution, low interference (systems with high immunity to cramming), small form factor (small component sizes, such as smaller antenna dimensions), increased security, and cost-effectiveness; all these features make mmWave technology ideal for 5G network. For 5G, antennas are most likely to operate 24, 26, 28, 37, and 39 GHz as at high frequencies, the wavelengths are very short, allowing many antenna elements to be placed in a compact, highly directive aperture.

According to Sachin Garg, Associate Vice President, Semiconductor and Electronics at MarketsandMarkets, "mmWave is likely to play a key role to support the burgeoning mobile data traffic growth. High data transfer rate offered by this spectrum, the growing involvement of various telecom service providers, and favorable federal mandates are driving the market growth for this frequency band."

5G chipset for mmWave
"RFICs are likely to play an integral role in the production and commercialization of consumer electronic devices, next-generation base stations, and other radio access products", said Anand Shanker, senior analyst, Semiconductor and Electronics at MarketsandMarkets. It is developed to reinforce the overall performance of the 5G base station in terms of high efficiency and compact form factors. Advancements have been made in RF silicon that allow a large number of RF chains to be supported in large antenna arrays. RFICs play an important role in network infrastructure. RFIC chips are mainly used in small cells and macrocells. Also, they are

used for enabling radio-based communication. Companies such as Qualcomm, Intel, Huawei, Samsung, Anokiwave, Qorvo, Broadcom, and Analog Devices are major companies developing chipsets and chipset-based products that find application in the 5G network infrastructure.
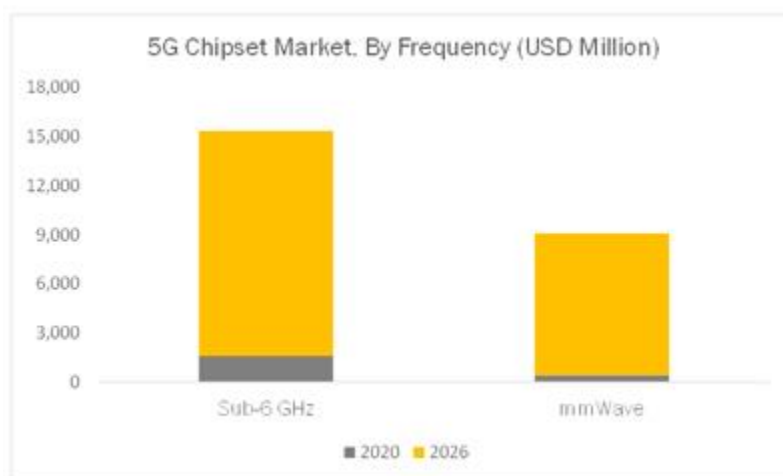
The 5G chipset market for mmWave is estimated at USD 0.4 billion in 2020 and is expected to reach USD 8.6 billion by 2026, at a CAGR of 53.1% between 2020 and 2026. The market includes RFICs, mmWave ICs, and baseband ICs used in 5G devices and network infrastructure.

5G mmWave and massive MIMO
Massive MIMO antenna is anticipated to play a critical role in the 5G market. It is widely expected that massive MIMO will be a key enabler and foundational component of the fully functional 5G network. One of the key roles of any 5G network will be to handle the huge increase in data usage, and MIMO can address this requirement. The densely packed antenna arrays of 5G mmWave allow massive MIMO to be achieved with a small form factor. The large array gain overcomes low per-antenna SNR and shadowing. Joint capabilities of the bandwidth in the mmWave frequency bands

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and high multiplexing gains achievable with massive antenna arrays can significantly raise user throughput, enhance spectral and energy efficiencies, and increase the capacity of mobile networks.

Massive MIMO Market, By Type of Antenna (USD Million)
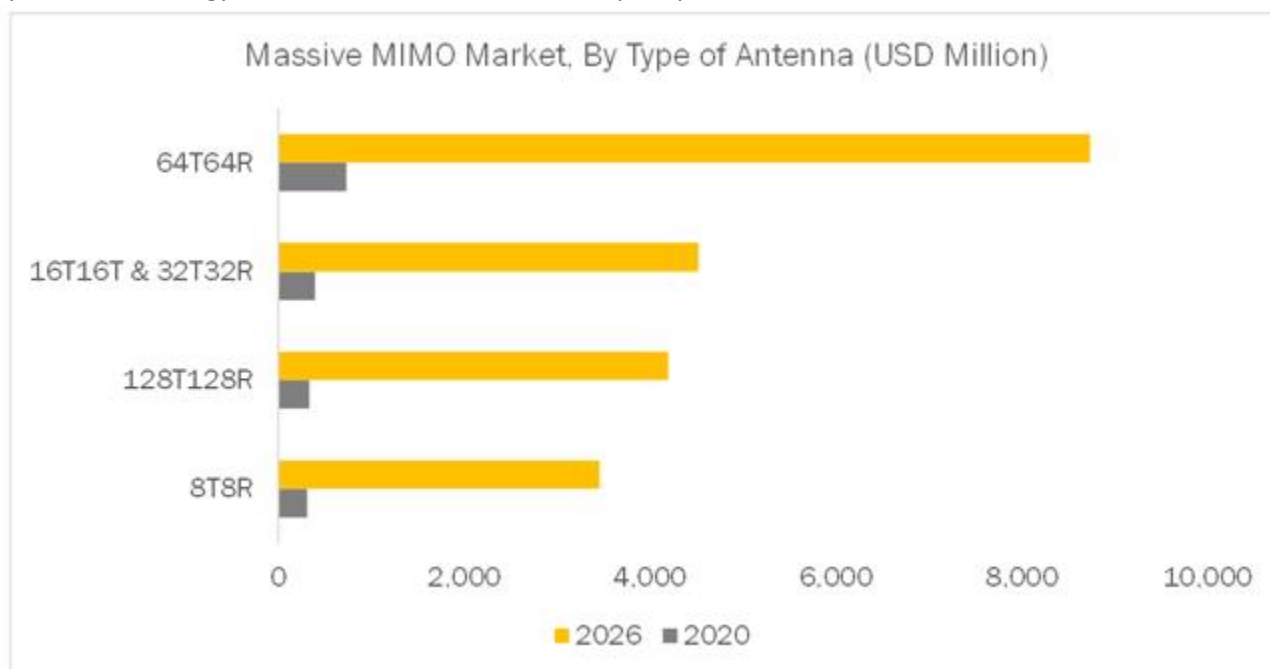
The Massive MIMO market is estimated to be valued at USD 1.7 billion in 2020 and is projected to reach USD 20.9 billion by 2026, at a CAGR of 41.6% between 2020 and 2026.

Opportunities for 5G mmWave
5G mmWave is more focused on deployments in existing dense urban markets. Indoor venues such as convention centers, concerts, malls, stadiums, and indoor enterprises such as offices, shop floors, meeting rooms are challenged with limited network capacity. This presents a huge opportunity for mmWave in providing fixed wireless access in such crowded areas. mmWave's wider bandwidth and high spatial multiplexing gains allow mobile operators to provide gigabit, low-latency connectivity to a large number of users.

By Monica Nickelsburg

Three years ago, thousands of candy-colored shared bicycles appeared on Seattle streets, rebranding the characteristically gray-green city with a theme park aesthetic. Despite complaints about clutter, the arrival of dockless bike-share in the U.S. carried an optimistic vision of the future to match the cheerful paint jobs. Seattle would offer a bold, bright, more environmentally-friendly way to get around. The future would be shared, and green (and yellow and red).

But today, Seattle's shared bicycles have all but disappeared from city streets as mobility companies that were already losing money absorb the shock of the coronavirus crisis. Seattle's newly vacant streets reflect broader shifts in the largely untested micro-mobility industry.

It may not be the end of the road for scooter and bike-share, but the industry will look quite different on the other side of the pandemic.

The companies that operate dockless bike and scooter rental services are cutting staff, posting losses, and pulling out of cities as they attempt to weather the coronavirus storm. But what demand for micro-mobility will look like after cities open back up remains an open question.

We talked to transportation companies, city officials, and experts about what the future of micro-mobility looks like. Here are the key takeaways:

- The industry will become more consolidated as smaller players fold, but the companies that manage to hang on could see a resurgence in popularity down the line as consumers shy away from crowded public transit.
- Transportation has ground to a halt as widespread shutdown orders have shifted work and education online. As many companies consider a permanent shift to telecommuting, it isn't clear if demand for mobility services will ever return to pre-pandemic levels.
- Micro-mobility companies will curb their previously lofty ambitions and focus on profitability over growth.

A micro-mobility test lab
Seattle pioneered dockless bike-share in the United States with its novel 2017 pilot. Three vendors were permitted to launch in Seattle, fueled by eager venture capital cash.

Over the next three years, many of those bicycles disappeared, casualties of a quickly evolving industry. Spin pivoted to electric shared scooters and pulled out of Seattle when it couldn't get permission to deploy the new mobility devices. Ofo shut down operations in the U.S., unable to make the tricky economics of bike-share work. That left Lime, the company behind the bright green bikes and scooters in cities around the country. But Lime wasn't the only game in town for long.

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Uber rolled out its newly acquired Jump bike-share service in Seattle in 2018. Red and green bikes competed for Seattle riders until December of last year when Lime removed its bikes from the city in anticipation of a scooter-share pilot slated to start this spring.
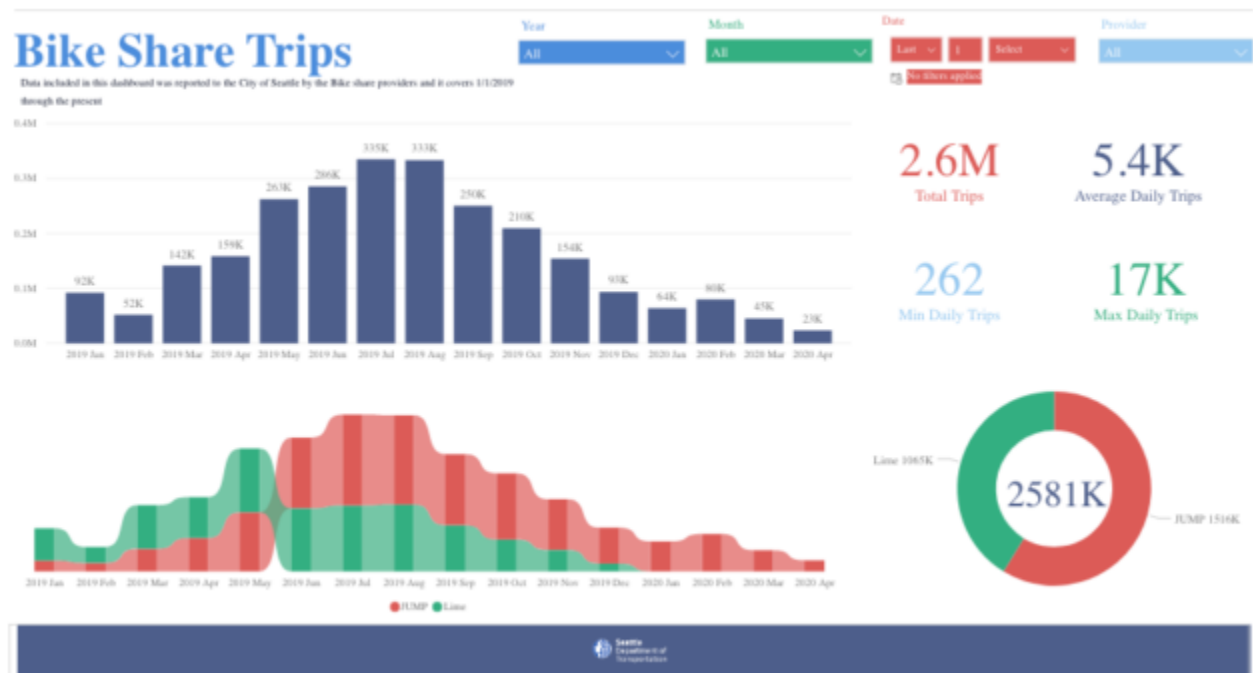
Seattle bike-share data from Jan. 1 – present.

There were more than 2.2 million bike-share rides in Seattle last year, averaging more than 6,000 per day, according to the Seattle Department of Transportation.

Then COVID-19 hit — and it hit micro-mobility hard.

Coronavirus curveball
In mid-April, Lime began winding down service in all of its markets except South Korea, where the coronavirus appeared under control. The company felt the impacts almost immediately. By the end of April, Lime laid off 80 employees, about 13% of its total workforce.

"Almost overnight, our company went from being on the eve of accomplishing an unprecedented milestone — the first next-generation micro-mobility company to reach profitability — to one where we had to pause operations in 99% of our markets worldwide to support cities' efforts at social distancing," Lime CEO Brad Bao said in an email to employees. "Needless to say, while we thought we had planned for all possibilities this year, we did not anticipate a global pandemic."

The same day Lime announced layoffs, Lyft pulled its scooter service from Oakland, Austin, and San Jose, Calif., permanently. The announcement followed 982 layoffs at Lyft. A few weeks earlier, the once high-flying scooter startup Bird laid off 406 employees, about 30% of its staff.

Last week, Seattle's rival bike-share operators announced they would join forces as both companies suffer blows from the pandemic. Uber led a $170 million investment round in Lime and agreed to hand its Jump bike-share business over to the micro-mobility upstart. The announcement came amid 3,700 layoffs at Uber, amounting to 14% of its global workforce. The company posted a $2.9 billion net loss for the first quarter of 2020 and CEO Dara Khosrowshahi told investors gross bookings in major cities are down as much at 70%. Jump pulled bikes from Sacramento following the acquisition.

"The entities that have the financial wherewithal, the retained capital and the access to money, are the ones that are going to move forward and prosper and [consolidate]," said Jay Townley, founding partner of the micro-mobility consultancy firm Human Powered Solutions. "The smaller entities — in all sectors but certainly micro-mobility — are going to struggle and will have a great deal of difficulty surviving."

Jump bikes also disappeared from Seattle streets as the companies prepare for the shift in control, though Lime says they will return soon. Lime did not give a specific timeline but said riders can expect an email with more information within 30 days.

"Whether Lime brings bikes back or not, it's time to talk about what the next phase of bike share looks like in Seattle … It's hard to think of another sustainable transportation program that has created such a swift, low-cost and effective shift in how people move around our city," wrote Seattle Bike Blog's Tom Fucoloro when Jump bikes started disappearing. "Losing bike share would be a big step backwards for our city."

Seattle scooter pilot idles
Meanwhile, the electric scooter-share pilot Seattle Mayor Jenny Durkan announced last year remains in limbo. The program is in the environmental impact review process awaiting a decision from a city hearing examiner before it can move forward.

"With that said, we recognize that the COVID-19 has impacted all areas of life including new mobility companies, and we are evaluating our options with these impacts in mind," said Ethan Bergerson, communications lead for the Seattle Department of Transportation.

Before the pandemic, Uber, Lyft, Lime, Spin, Bird, Ojo, and a handful of other companies all expressed interest in launching scooter-share services in Seattle, according to emails obtained by GeekWire via a public records request. But it isn't clear which of those services will still be operational and eager to rollout in Seattle or other markets when cities re-open.

Before the sudden proliferation of dockless bike-share, cities across the country debated whether the new mode of transportation should be public or private. Seattle first opted for a hybrid of the two, launching a public-private bike-share service called Pronto in 2014. But the program became insolvent due to operating losses and ultimately shut down three years later. Seattle's private bike-share program saw 10-20 times higher ridership last year than Pronto, according to SDOT.

Portland's public-private service, Biketown, fared better and allowed the city transportation officials to slash ride costs to 1 cent per minute in April to promote safe travel amid the pandemic.

Update: Lime and Bird said Thursday that they will deploy small scooter fleets in Portland to help healthcare workers get around, The Oregonian reports.

Micro-mobility companies were already struggling to make the economics of their cost-intensive businesses work before the pandemic struck. Backed by more than $6 billion in venture capital funding since 2018, they focused on growth and user adoption in the hopes of eventually turning a profit.

As their businesses grind to a halt, the return of micro-mobility will likely mean fewer competitors and more modest ambitions. Lime, for example, is focusing on markets it believes have the highest chances of success.

"We have shifted our focus as a company from growth and expansion to profitability, building a sustainable long-lasting business where we control our own destiny through profitability," said Alex Youn, who works in communications for

Lime. "We will continue to analyze the performance of every market as we have over the past two years, to determine whether cities meet our minimum business volume requirements."

It's a major shift in strategy from the days when a crowded field of mobility companies sought to elbow each other out of the way by launching in as many cities as possible.

The road ahead
Despite strong headwinds, mobility companies that do manage to stay afloat could benefit from the new landscape.

Lime ridership in South Korea has returned to about 80% of what it was prior to the pandemic, according to Jonathan Hopkins, who works in government affairs for the company. Two weeks ago, Lime launched a program in select cities that provides small fleets of scooters to help essential workers get around. Hopkins said Lime is seeing strong adoption of the program in Salt Lake City, despite strict social distancing mandates.

When Jump bikes were still in operation in Seattle, the company disinfected them whenever they were serviced. Lime has enhanced cleaning methods and frequency in markets where it is operational.

"When we get to a point where the pandemic is eased, and there are treatments, and there is a vaccine, consumers still are going to be reluctant … to get into crowded transportation environments and are looking for alternate ways to get to or from work or school or shopping [centers]," Townley said. "Bicycles and human-powered transportation are certainly an attractive way to continue to social distance and to allay fears of the ramifications of being in crowded environments for several years to come."

The micro-mobility survivors will also face fewer competitors, which was once a key challenge.

But the ultimate longevity of the industry will depend on whether it can find an economically viable business model. As investors become more conservative, telecommuting becomes more prevalent, and city dwellers limit their travel, micro-mobility faces an uphill climb.

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BMW Group has selected the new NVIDIA Isaac robotics platform to enhance its automotive factories, utilizing logistics robots built on advanced AI computing and visualization technologies.

The collaboration centers on implementing an end-to-end system based on NVIDIA technologies—from training and testing through to deployment—with robots developed using one software architecture, running on NVIDIA's open Isaac robotics platform.

BMW Group's objective is to enhance logistics factory flow to produce custom-configured cars more rapidly and efficiently. Once developed, the system will be deployed to BMW Group factories worldwide.

> *BMW Group's use of NVIDIA's Isaac robotics platform to reimagine their factory is revolutionary. BMW Group is leading the way to the era of robotic factories, harnessing breakthroughs in AI and robotics technologies to create the next level of highly customizable, just-in-time, just-in-sequence manufacturing.*
> —Jensen Huang, founder and CEO of NVIDIA

The collaboration uses NVIDIA DGX AI systems and Isaac simulation technology to train and test the robots; NVIDIA Quadro ray-tracing GPUs to render synthetic machine parts to enhance the training; and a new lineup of multiple AI-enabled robots built on the Isaac software development kit, powered by high-performance NVIDIA Jetson and EGX edge computers.

BMW Group's supply chain takes millions of parts flowing into a factory from more than 4,500 supplier sites, involving 230,000 unique part numbers, and in growing volumes as BMW Group's car sales have doubled over the past 10 years to 2.5 million vehicles. Moreover, BMW Group vehicles are offered to customers with an average of 100 different options, resulting in 99% of customer orders being uniquely different for each other. This creates an immense challenge for factory logistics.

To optimize the enormous complexity of this material flow, autonomous AI-powered logistics robots now assist the current production process in order to assemble highly customized vehicles on the same production line.

> *Ultimately, the sheer volume of possible configurations became a challenge to BMW Group production in three fundamental areas: computing, logistics planning, and data analysis.*
> —Jürgen Maidl, senior vice president of Logistics for the BMW Group

BMW Group's response is to use NVIDIA's Isaac robotics platform to develop five AI-enabled robots to improve their logistics workflow, powered by a variety of NVIDIA Jetson AGX Xavier and EGX edge computers. These include both navigation robots to transport material autonomously, as well as manipulation robots to select and organize parts. Developed on the NVIDIA Isaac SDK, the robots utilize a number of powerful deep neural networks, addressing perception, segmentation, pose estimation and human pose estimation to perceive their environment, detect objects, navigate autonomously and move objects. These robots are trained both on real and synthetic data using NVIDIA GPUs to render ray-traced machine parts in a variety of lighting and occlusion conditions to augment real data.

The real and synthetic data are then used to train deep neural networks on NVIDIA DGX systems. The robots are then continuously tested in NVIDIA's Isaac Simulators for both navigation and manipulation, operating on NVIDIA's Omniverse platform, where multiple BMW Group personnel in different geographies can all work in one simulated environment.

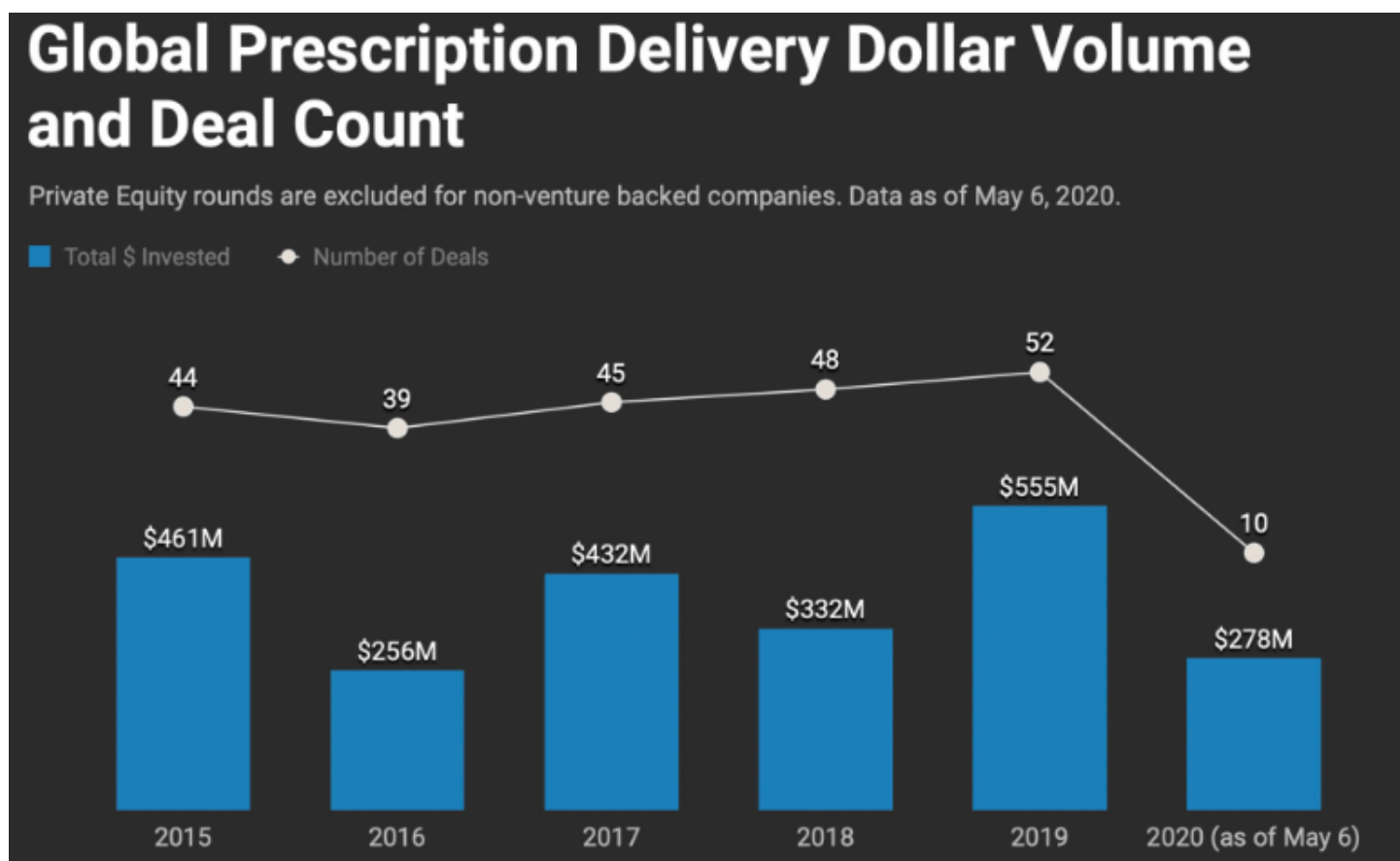CHAMBIZ

By Sophia Kunthara

Perhaps one of the biggest shifts during the COVID-19 pandemic is the number of patients turning to technology to communicate with their doctors. But the increasing popularity of telemedicine is helping at least one other kind of business: prescription delivery startups.

Since the COVID-19 pandemic took hold, some prescription delivery startups are seeing a surge in demand from new users turning to the convenience of delivery. For Mountain View, California-based startup NowRx, the company is seeing an increasing number of referrals from physicians.

"Now, because of coronavirus, the market's becoming more educated about other options, other delivery pharmacies," CEO Cary Breese said in an interview with Crunchbase News. NowRx is a full-service pharmacy that accepts all major insurance company plans and offers free same-day delivery.

From a revenue standpoint, NowRx's first quarter of 2020 is up 30 percent compared to the fourth quarter of 2019, Breese said. And the company has seen the number of new customers increase by 84 percent in Q1 so far, compared to Q4 of 2019.

Last year proved to be the biggest for prescription delivery startup funding in terms of both number of deals and dollars for the past five years. There were 52 funding rounds for prescription delivery companies last year, amounting to $555 million, according to Crunchbase data.

Global Prescription Delivery Dollar Volume and Deal Count

Private Equity rounds are excluded for non-venture backed companies. Data as of May 6, 2020.

■ Total $ Invested ● Number of Deals

	2015	2016	2017	2018	2019	2020 (as of May 6)
Number of Deals	44	39	45	48	52	10
Total $ Invested	$461M	$256M	$432M	$332M	$555M	$278M

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New players in the pharmacy market

Large pharmacies like Walgreens and CVS also offer prescription delivery services, but a growing number of prescription delivery startups have sprung up and funding rounds for them have been steadily climbing. It should be noted that the majority of VC funding for prescription delivery companies so far this year went to Alto Pharmacy. The company raised a $250 million Series D in January, and that makes up the bulk of the $278 million raised so far, according to Crunchbase.

Karen Martell, Alto Pharmacy's vice president of business and strategy, also pointed to the rise of telemedicine as helping drive patients to prescription delivery services. Both Alto Pharmacy and NowRx work with physicians to get the message out about their pharmacies to patients.

With the sudden pivot to working from home, doctors have had to quickly figure out how to care for patients when they couldn't see them in person. Many turned to telemedicine, and Martell said that helped drive new customers to Alto Pharmacy.

"It's an indication of health care, having worked with doctors so closely at Alto, there's often some resistance or a slow pace of change in health care. … I think with this, there's just tremendous innovation and change, and that's really encouraging to us as we're trying to provide better access to medication," Martell said.

NowRx's Breese echoed a similar sentiment, saying few patients will want to leave their house to pick up a prescription after experiencing the convenience of a virtual visit at home.

"The last thing you want to tell that patient (after a virtual appointment) is get out of your pajamas, put on your clothes, walk down to CVS and stand in line," Breese said.

It's not just full-service pharmacies like Alto and NowRx that are seeing an increase in demand. Other companies like telehealth startup Nurx and The Pill Club are seeing more users requesting prescriptions, in their case, for birth control.

Nurx saw a 50 percent increase in new patients for birth control since March; the company now has 250,000 patients for birth control. There's an increase in demand for all of Nurx's services, according to company spokeswoman Allison Hoffman, but birth control is the most in demand. The morning-after pill is in high demand as well, Hoffman said.

The Pill Club saw 30 percent more patients in California sign up for the service in March, compared to February. Also in the state, the startup shipped about 50 percent more orders of a one-year supply of birth control to new patients during the extended shelter-in-place order, according to a company representative. The Pill Club also shipped about 20 percent more emergency contraception to new patients in California in March, compared to February.

Prescription delivery post-COVID

The COVID-19 pandemic has made several behaviors the norm during quarantine: grocery delivery, Zoom happy hours and wearing masks when leaving the house. But it begs the question of which of these "quarantine habits" will stick around once life becomes more normal.

Prescription delivery may be one of them.

"Once people experience it … there's really no going back," Martell said.

One of the key indicators Alto looks for in terms of "stickiness" is if a new customer who receives a prescription transfers other medications to Alto as well. The company has seen a large spike in additional transfers, and had to staff-up as a result.

"I believe that delivery pharmacy is going to stick," Breese said. "I think it's going to continue to persist beyond this immediate surge. I believe it's shifting into the mainstream and it's going to be a permanent, paradigm shift."

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