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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Amazon Reportedly in Talks to Buy Self-Driving Car Startup Zoox
Amazon is reportedly considering an acquisition of Zoox, the developer of an electric self-driving taxi that it designed from scratch, according to the Wall Street Journal. There were no additional details in the report, which comes three weeks after The Information reported Zoox was for sale and being shopped by boutique investment bank Qatalyst Partners. The self-driving vehicle industry has been holding its breath while the process plays out, given that Zoox had raised nearly $1 billion in funding and has one of the biggest software and hardware teams in the field, even after recent layoffs.

Amazon has an under-the-radar team working on self-driving vehicle tech, but such an acquisition—likely to be above $1 billion—would thrust the commerce firm into a costly and long-term effort to develop and commercialize automated driving. Amazon previously invested in a rival firm called Aurora Innovation as well as in electric truck maker Rivian

Harmonic Drive Introduces New Lightweight Versions of Select Gearhead Products.
Harmonic Drive LLC, a leader in high precision motion control introduces new lightweight versions of select gearhead products. The new gearheads are ideal for designs where weight is a critical factor. Building on the success of Harmonic Drive LLCs current gear units, new lightweight versions were the next logical evolution of the CS/ SH product lines. With weight reductions of 20-30% without any reduction in torque ratings, the Lightweight (LW) gear units provide exceptional torque density

Salesforce, Dell Seeing Mixed Impact From Covid-19
Dell Technologies and Salesforce each saw a mixed impact from the Covid-19 crisis, the companies reported for the April quarter. Salesforce's sales grew 30% during its first quarter compared to last year, in part because the software-as-a-service model translates well to working from home. But Salesforce's operating cash flow dropped 5% to $1.86 billion, as some customers delayed payments and others were granted financial flexibility, CFO Mark Hawkins said on an earnings call. Dell, whose first-quarter sales were flat compared to last year at $21.9 billion, saw a boost in areas like banking, financial services, government, healthcare and life sciences, all of which grew 15% to 20% during the quarter, according to COO Jeff Clarke. Dell also has customers that have delayed payments due to lockdowns.

While Salesforce's results beat expectations for its first quarter, it cut its full-year forecast from $21.1 billion to $20 billion. This would represent 17% annual growth, compared to 29% and 26% the previous two fiscal years. Salesforce shares fell 4% in after-hours trading.

Dell said demand was strong in February and March but started to weaken in April. The company said it expects fiscal second-quarter sales to be "seasonally lower" than the growth of 6% to 8% it has seen in previous years. Dell shares rose nearly 8% in after-hours trading.

HBO Max Sees 90,000 Mobile Downloads on Day One
On its first day, 90,000 people downloaded WarnerMedia's HBO Max app, according to SensorTower data. That's far below the 4 million people who downloaded Disney+ on its first day last fall or even the 300,000 people who downloaded Quibi on its first day in April. At $15 a month, it's not entirely a surprise that people aren't rushing to download the new service–which is the last of the major video streaming services to come to market.

But the data only counts mobile downloads–so it doesn't include anyone who gets HBO Max through their cable provider–like Comcast, which announced a deal to distribute HBO Max on Wednesday. It also doesn't count any of the people who upgraded for free from the previous HBO Now streaming service to HBO Max.

The real question for all of these services is how many people will pay to subscribe to them. With so many free promotions going on, getting scale isn't as hard as acquiring and keeping paying customers.

Financial Services Company Marqeta Valued at $4.3 Billion
Delaying an initial public offering, 10-year-old fintech company Marqeta has raised another $150 million in venture capital funding from an undisclosed investor. The round more than doubles its valuation to $4.3 billion. Marqeta is backed by Coatue Management, Vitruvian Partners, Visa, Goldman Sachs, 83North, Granite Ventures and ICONIQ Capital.

The Oakland-based business helps companies like Square, Uber, Affirm, Instacart and DoorDash issue cards to their customers. It follows other top fintech companies including Brex and Stripe, which have also successfully raised large rounds of capital amid the coronavirus crisis.

Qualcomm's first Wi-Fi 6E chips are here
Qualcomm is announcing its first chips with support for Wi-Fi 6E, the brand-new version of Wi-Fi that should be faster and more reliable thanks to its access to an expansive additional range of airwaves over which to broadcast.

Two sets of products are being announced on Thursday: one for phones, which should ship in the second half the year, and one for routers, which will start shipping immediately. The key feature of all these chips is support for Wi-Fi 6E, which takes advantage of the 6GHz spectrum that was newly opened up for Wi-Fi in the US by the Federal Communications Commission last month. It's the largest expansion of Wi-Fi spectrum ever, which should result in some big performance gains.

SoftBank Leads $500 Million Investment in Didi Chuxing's Autonomous Driving Unit
SoftBank has led an investment of $500 million into the autonomous driving unit of Didi Chuxing. The Information first reported about the talks between the Japanese tech conglomerate and the Chinese ride-hailing app in March.

The investment comes even as American autonomous driving companies struggle with making the technology work and try to raise enough capital to keep going. Amazon is reportedly considering an acquisition of Zoox, the developer of an electric self-driving taxi that it designed from scratch. Other Chinese autonomous driving startups are also trying to raise capital. Pony.ai raised $462 million earlier this year in a round led by Toyota.

Cisco to buy ThousandEyes for $1B
Cisco is buying network intelligence startup ThousandEyes in a deal reportedly valued at around $1 billion. San Francisco-based ThousandEyes, which previously raised $110 million in venture funding, provides tools to help IT teams determine what's braking or slowing down apps and websites.

Didi raises over $500M for autonomous driving
China's ride-hailing giant Didi Chuxing raised more than $500 million for its autonomous driving subsidiary in a funding round led by SoftBank's Vision Fund 2. The financing is the first fundraising round for that business since it was spun off into its own company in August.

RemoteHQ raises $2.7M seed round
RemoteHQ, a Boston-based startup with a virtual office platform aimed at helping employees work from anywhere, has raised $2.7 million in a seed round led by TECHU and Underscore VC.

Apeel raises $250M to extend produce freshness
Apeel Sciences, which creates a natural coating for fruits and vegetables to keep them fresh longer, has raised $250 million in new funding at a valuation of over $1 billion, the company announced on Tuesday. GIC, Singapore's sovereign wealth fund, has led the round with participation from existing investors including Viking Global Investors, Upfront Ventures, Tao Capital Partners and Rock Creek Group. Celebrities Oprah Winfrey and Katy Perry are also investors in the Goleta, Calif.-based business.

Apeel's coatings slow water loss and oxidations that cause food to spoil. Disruptions to the food supply chain have made extending the shelf life of fruits and veggies more critical than ever, the company said in a statement.

Commonwealth Fusion powers up with $84M more
Commonwealth Fusion Systems, an MIT spinoff focused on commercializing fusion energy, announced it has raised $84 million in the second tranche of a Series A round. Temasek led the new financing, which brings the Cambridge, Massachusetts-based company's total funding to $200 million since its 2018 inception.

Scandit raises $80M for computer vision
Scandit, a startup based in Switzerland that offers technology for scanning store shelves, has raised $80 million in Series C-related funding led by G2VP. The company's platform combines barcode scanning, text and object recognition, and augmented reality for any camera-equipped smart device.

Spectrm secures $3M to convert conversations to sales
Conversational marketing platform Spectrm raised $3 million in Series A funding from Runa Capital. The Berlin-based company uses artificial intelligence to help clients steer potential customers to purchases via conversational marketing.

European Uber rival Bolt raises $110 million in new funding; now valued at $1.9 billion
Bolt announced it has raised $109.86 million (€100 million) in new funding to scale its product segments from ride-hailing to micro-mobility and food delivery in Europe and Africa. The latest investment round, which now puts the company $1.9 billion valuation, came from Naya Capital Management, the global investment manager founded in 2012 by Masroor Siddiqui, a former partner at The Children's Investment Fund. The funding comes at a time when Bolt suffered a 75% drop in revenues around mid-March as countries across Europe began introducing lockdown restrictions to stem the spread of Covid-19. Bolt rivals, such as Uber and Ola, were also affected. However, Bolt claims it hasn't had to lay people off to cope with the impact of the pandemic.

AI is more data-hungry than ever, and DefinedCrowd raises $50M B round to feed it
As AI has grown from niche to mission-critical technology, the companies that enable it have multiplied and in many cases prospered. A good example of that success is DefinedCrowd *(*Chambiz DF 25 January 2020)*, which has gone from the Disrupt stage to globe-spanning AI toolkit to the Fortune 500 in just a couple of years. The company just raised a new $50.5 million B round to further fuel its expansion.

DefinedCrowd doesn't make AI, but rather supplies data used to create it, specializing in natural language processing. After all, someone has to vet the 500 different ways you could ask for the weather — otherwise it would be much more difficult for machine learning systems to tell what users mean. The same goes for computer vision, sentiment recognition and other domains for which the company creates and sorts data. DefinedCrowd has a paid community hundreds of thousands strong doing this highly necessary but voluminous work.

SmartRent lands $60M Series C
Home automation startup SmartRent raised $60 million in a Series C round led by Spark Capital. The Scottsdale, Arizona-based company makes software and hardware to manage smart devices to control things like lights, thermostats and gates in multifamily housing complexes.

Q32 Bio secures $46M for immunity therapeutics
Cambridge, Massachusetts-based Q32 Bio, a biotechnology company developing treatments for patients with severe autoimmune and inflammatory diseases, secured $46 million in a Series A round led by Atlas Venture.

Fernish raises $15M for upscale furnishings
Fernish, a startup that gives people a way to rent upscale furniture and decor online, has raised $15 million in a Series A round led by Khosla Ventures. With this latest investment, Los Angeles-based Fernish has now raised a total of $45 million since its 2017 inception.

Thoma Bravo eyes $16.5B for next flagship fund
Thoma Bravo has been on a fundraising tear over the last few years, gathering billions of dollars from LPs to pour into deals in the tech sector. Now, the San Francisco-based firm is back on the market with its 14th flagship fund, which has an initial target of $16.5 billion, according to an SEC filing. If Thoma Bravo hits that target, it will mark another significant fundraising step-up in a relatively short amount of time. The firm closed its previous flagship fund on $12.6 billion in January 2019, less than two-and-a-half years after that vehicle's predecessor closed on $7.6 billion.

Previous reports have indicated Thoma Bravo is also currently raising its third middle-market fund with a $3 billion goal, as well as a debut small-cap vehicle seeking $1 billion. The investor has had a busy 2020 despite the presence of a pandemic. It acquired cybersecurity company Sophos at a $3.9 billion valuation in March. Earlier this month, Thoma Bravo-backed Apttus purchased Conga in a deal that valued the rival software business at a reported $715 million. And a week later, the firm sold Idaptive, an identity software provider, to software company CyberArk for $70 million.

VergeSense, Whose Sensors Track Movement In Office Space, Bags $9M In Funding
VergeSense, a company specializing in sensors that monitor commercial space interiors, has closed on a $9M round of funding. The new funding brings the total raised by the San Francisco-based proptech startup to $10.6M. The basis of VergeSense's tech is a ceiling-mounted sensor that generates data about where people are in an office environment and their congregation patterns, including how far apart they are. Before the coronavirus pandemic, the goal of such data collection was to encourage "workplace collisions," or close-quarter encounters among office workers to facilitate idea sharing, Tech Crunch reports. The platform has now pivoted to data on how people are keeping apart, to help devise social distancing strategies as offices reopen, according to the company, which said its platform gets smarter with its recommendations over time.

Pie Insurance closes on $127M for workers' comp

Pie Insurance, a Washington, D.C.-based startup offering workers' compensation insurance to small businesses, has closed on $127 million in new financing. Of that, $100 million in equity will go toward the creation of a new holding company that will purchase licensed insurance companies

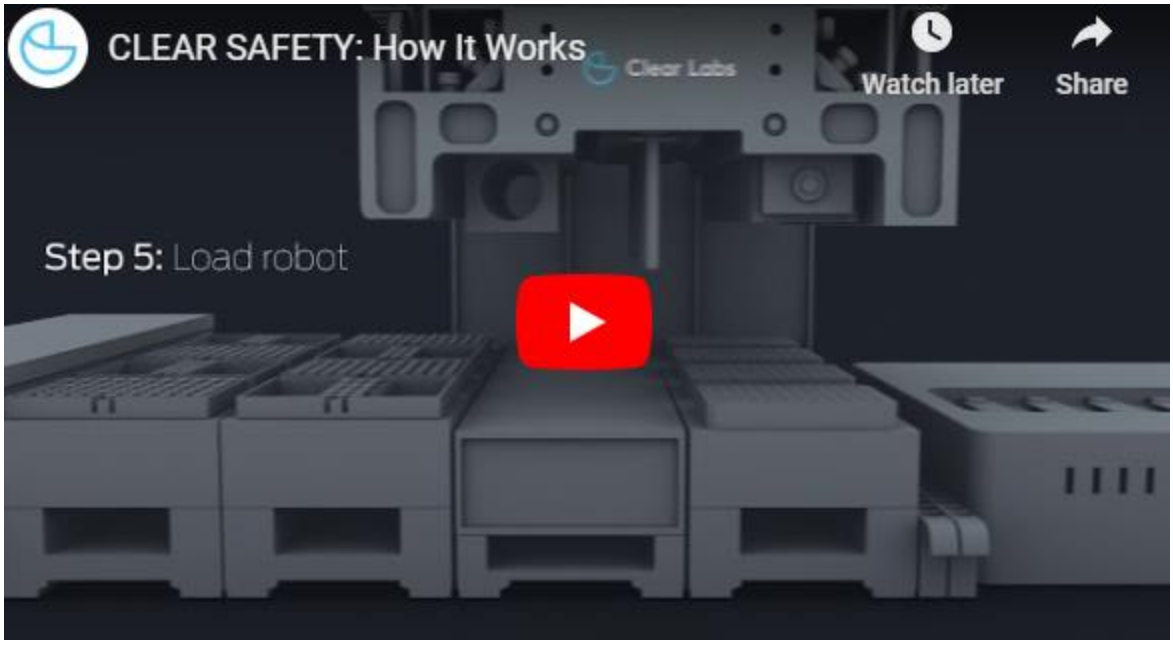
Wasabi secures $30M as cloud storage heats up
Wasabi Technologies, which describes itself as a "hot" cloud storage company, announced today the close of a $30 million Series B round extension led by Forestay Capital. The financing brings the Boston-based startup's total raised since its 2017 inception to nearly $110 million.

Tia, Stork Club raise funding for women's health
Tia and Stork Club, two startups with platforms assisting women with health care, announced investments Thursday. Tia, a portal for women's health information operating out of headquarters in New York and San Francisco, raised $24 million in a Series A round led by Threshold Ventures. Stork Club, a maternity care insurance platform based in San Francisco, secured a $2.7 million seed round led by Bowery Capital and Slow Ventures.

Almanac lands $9M for open-source templates
Almanac, an online platform for creating and sharing open-source work documents, announced a $9 million seed round of funding led by Floodgate founding partner Mike Maples. Founded in early 2019, the San Francisco-based company touts what it calls the world's largest library of customizable business documents and standard operating procedures.

Case Study At-A-Glance: Clear Labs' automated food safety platform to COVID-19 testing

Clear Labs, a biotech company that provides automated safety technologies to food manufacturers, has raised $18 million in a round of funding from a raft of high-profile investors, including Alphabet's GV, private equity firm Redmile Group, Menlo Ventures, and Khosla Ventures on May 14.



The Menlo Park, California-based company said it would use this cash injection to not only continue commercializing its product in the food safety sector but to also reappropriate its "next-generation sequencing" technology for the clinical market — particularly for COVID-19 diagnostic tests.

Founded in 2014, Clear Labs offers software that analyzes the molecular makeup of food to help brands ensure the quality of their products and adhere to food safety standards, including mitigating contamination and other risks and proving products are GMO-free. Automation is a central facet of its proposition, including sample barcoding and robotic pipetting, which minimizes the need for manual handling and reduces the risk of human error.

While Clear Labs is continuing to invest in this core business, it's also looking to help address the global need for COVID-19 testing technology. Clear Labs CEO Sasan Amini said the company will now offer its entire platform, including hardware and cloud-based bioinformatics, to clinical laboratories, academic research institutions, and hospitals to expand their testing capacity and enable "a more accurate diagnostic test result."

"With COVID, we realized that what we created for food safety had given us a platform that's easy to use, cost-effective, and leverages DNA sequencing to make the existing standard obsolete," he told VentureBeat. "It could just as easily be extended into the clinical market, and COVID-19 was the perfect opportunity to accelerate our focus within the space."

Among the tech's key selling points is its automation, which reduces the need to have specialized operators on-hand at all times.

"The hardware is an integrated system that takes care of sample prep, library prep, and sequencing, managing all

liquid handling in the process," Amini continued. "This eliminates any manual intervention needed by lab operators — reducing cost and dramatically decreasing error rate — and upfront work is as simple as existing workflows."

Clear Labs had previously raised around $45 million, and its latest cash injection is perhaps evidence of the urgent need to increase COVID-19 testing capacity, which most experts consider to be a critical tactic in curbing the pandemic. Just a few weeks back, LetsGetChecked locked down $71 million in fresh funding to bring at-home coronavirus test kits to market.

However, while a shortage of test kits is one of the key issues facing the U.S. and other countries, many of the current screening practices culminate in high false-negative rates. And testing for asymptomatic patients is also limited, which can make it hard for health care professionals to fully grasp how the virus spreads. Clear Labs' genomics-based test promises to deliver higher accuracy while keeping up with the evolution of the virus as it mutates.

The company said it's already working with "leading" hospitals, universities, and labs on deploying the test, and it expects to receive Emergency Use Authorization (EUA) from the Food and Drug Administration (FDA) in the coming days.

"The power of the platform is that it can be quickly deployed — it doesn't take roomfuls of equipment or extensive training to get up and running," Amini added.

By Kate Clark and Shai Oster

When an oxygen tank exploded aboard the ill-fated Apollo 13 in 1970, a team of NASA engineers used cardboard, plastic bags and duct tape to rescue the astronauts on board.

Andreessen Horowitz general partner Vijay Pande, who invests out of the firm's $750 million biotech fund, likens the Apollo 13 engineers to the entrepreneurs developing new technologies in response to Covid-19.

"It's a triumph of engineering to find a way out," Pande said. "Hopefully we can do it quickly so everyone can go back to normal. And as we rebuild the things that need to be rebuilt, we can ask ourselves: How can we avoid this in the future?"

The pandemic has sparked newfound interest in how technology can accelerate treatments and limit the spread of fatal diseases. Yet some venture capitalists have been investing at the intersection of health and technology for years. They've already made bets on companies like Cricket Health, which combines virtual and at-home care for kidney disease patients, and WeDoctor, a telemedicine company that's planning a $10 billion Hong Kong initial public offering.

Established biotech investors such as Venrock partner Bob Kocher, Qiming Venture Partners managing partner Nisa Leung, and Annie Lamont, co-founder of Oak HC/FT, are hopeful that new technologies are on their way to defeating the coronavirus. They say the crisis has already started to transform health care.

"This is a moment where the whole industry is applying its expertise to solve a problem that's an enormous public health problem," said Foresite Capital managing director Vikram Bajaj.

Annie Lamont, co-founder and managing partner, Oak HC/FT
Longtime health-tech investor Lamont had predicted surging demand for virtual care. When the pandemic halted most trips to the doctor's office, other investors fell in line with her view.

Six of her portfolio companies—including Maven, which connects women to doctors specializing in fertility and pregnancy, and Olive, which automates administrative tasks for health care workers—have raised follow-on financings with new investors leading the rounds since March. These companies have more than doubled their valuations, on average, across the new funding, Lamont said.

"[Covid-19] is an accelerant to the trends we're investing in," Lamont said from her home in Connecticut, where her husband, Ned Lamont, is the state's governor. "The things we focus on: virtualization, home care, primary care. These are all really important trends right now."

Lamont joined VC and private equity firm Oak Investment Partners in 1986 and helped spin out its health care and fintech practices in 2014 to form Oak HC/FT. By then, she'd already helped guide several companies to successful exits, including Health Dialog, sold to British United Provident Association for $775 million in 2007, and Benefitfocus, which raised $70 million in a 2013 IPO.

More recently, she's backed children's behavioral health company Emilio Health and Cricket Health. The crisis has driven home the need to invest in technology that helps the provider as well as the patient.

"Primary care doctors, many of them, are still independent small practices," Lamont said. "They are financially

distressed. They need to be part of something larger."

The pandemic has already made some existing technology more attractive, she notes. Now doctors and consumers are realizing some home-based care may be safer than a visit to the doctor's office. Lamont has invested in VillageMD, which facilitates doctor visits to patients' homes.

"Just think about what's happened in the nursing home the last couple of months. You don't want to be in the nursing home. It's a death trap," she said.

Vijay Pande, general partner at Andreessen Horowitz
For most of his career, Pande was a professor of chemistry, structural biology and computer science at Stanford University. Then in 2014 he joined Andreessen Horowitz, a firm known for its investments in Internet companies like Facebook—not in health care.

Yet Andreessen Horowitz, dubbed a16z, realized that new technologies could transform health and medicine just as software has disrupted traditional industries like manufacturing and agriculture.

Pande became a founding investor in the firm's debut bio fund the following year and now invests alongside general partners Jorge Conde, Julie Yoo and Vineeta Agarwala.

Themes Pande and his team were already exploring have become more important during the Covid-19 outbreak.

These include using machine learning to transform diagnostics and therapeutics, as well as brainstorming new approaches to health care delivery, like home-based care and telemedicine.

Last week, the a16z team announced its investment in Octant, a startup using synthetic biology, a cutting-edge field that applies engineering principles to biology to find new drugs.

Pande has also backed BioAge, which is developing drugs to increase human lifespans; Freenome, a startup developing a blood test to detect and treat cancer; and Omada Health, a virtual-care startup that just raised $57 million.

The current crisis should speed up regulatory changes for telemedicine, he says. Already, biotech advances are visible in how drug companies respond to the crisis. Though they still need months to develop a vaccine, the process is much faster today than it would have been only five years ago.

"Whether it's going to [take] six months or 18 months—it's hard to predict. We are just in the beginning of this major shift of tech merging into this space. If Covid were to hit 10 years from now, it would be a fundamentally different future," he said.

Nisa Leung, managing partner, Qiming Venture Partners
When SARS hit China in 2003, the country didn't have medical tests for the new illness and had to send samples abroad, recalls Leung, who was just graduating from business school at Stanford University then.

A decade later, as a venture capitalist for Qiming Venture Partners in Hong Kong, she has invested in just the sort of medical diagnostics companies that China lacked. Leung believed that China's aging population would need more lab tests—even though "there were a lot of people in the U.S. saying don't invest in diagnostics because it's boring."

Those bets have paid off. In March Chinese health regulators granted one of those early investments, Rendu Biotechnology, emergency approval for a kit to diagnose Covid-19.

It's an illustration of how much China's medical landscape has changed in the past two decades, though flaws remain. Even as the U.S. and China trade accusations over the global coronavirus pandemic, Chinese health care firms have attracted VC investment and are doing deals abroad.

In the first quarter of this year in China, for the first time private equity invested more in health care than in the technology, media and telecom sector, Leung said. Qiming-backed CanSino Biologics, already approved for Phase II human clinical trials in China, is working with the Canadian government on developing a coronavirus vaccine.

In April, Qiming closed a new $1.1 billion fund focused on early-stage health care, tech and media investments. Over the past 12 months, Leung had three companies publicly list shares, including CanSino Biologics, heart-valve maker Venus MedTech and drug research firm Schrödinger.

"We had 14 IPOs in the last 20 months, and we will have 20 companies in the next 24 months," Leung said. Most are likely to list in China or Hong Kong.

More broadly, Leung thinks China can point the way to lower drug prices, much as its vast manufacturing base has lowered prices for other items like clothing or computers. China's government has pursued a policy to bring imported and domestic drug prices down. "When we invest in health, we want to invest in drugs that work and are also affordable," she said.

Bob Kocher, partner, Venrock

The virus outbreak has been devastating for elderly people. Venrock's Kocher, a former doctor, sees a need for more technologies to care for America's aging population.

"They are high risk," said Kocher, who is also part of a California state task force on coronavirus testing. "We are going to ask them to stay home for many, many more months. They are going to need more at-home services."

Kocher came to Venrock in 2011 after serving in the Obama administration. The firm, founded in 1969 as the venture arm of the Rockefeller family, turned to health care investing in the 1980s.

From Venrock's base in Palo Alto, Calif., Kocher focuses on startups that make health care workers more effective. He has invested in Suki, an artificial intelligence-powered voice assistant for doctors; Virta Health, an online clinic focused on treating diabetes; and Doctor on Demand, another virtual-care startup. Venrock's recent wins include the $3.6 billion IPO of 10x Genomics.

As many startups cut costs, health tech companies have been raising money and avoiding layoffs. Tech investors who rarely invest in health care have noticed their resilience. Kocher's Lyra Health, for example, raised $75 million at a valuation of $557 million in March from firms that don't typically invest in biotech, including IVP and Meritech Capital Partners, according to PitchBook.

"The whole world has realized the things I invest in make health care more affordable, which is exactly what we need in a pandemic," Kocher said. "These are things I've been betting on for over a decade, and now the time has come."

Kocher expects poor economic conditions to be a boon for health tech, just as the 2008 financial crisis drove investments in health care. "Post the recession and post the Affordable Care Act, there's been a decade of unparalleled growth in health care IT. I think this recession will be even more of a tailwind driving health care IT adoption and investment," he said.

Vikram Bajaj, managing director, Foresite Capital

Bajaj is building next-generation biotech companies from the ground up. A managing director of the nearly 10-year-old health care fund Foresite Capital, he co-founded Foresite Labs, an incubator program, last year. It's apt timing for the new project, meant to help biotech entrepreneurs leverage data science and other new technologies through shared resources and expert advisors. Bajaj said he hopes a number of companies will roll out of the incubator in the next year.

"What we are finding is [that] the current crisis has exacerbated all of the problems in the health care economy and that very efficient and creative solutions will be needed to recover from it," Bajaj said.

In particular, there's an urgent need for startups developing at-home coronavirus tests, he said. Several companies are trying to figure out a fix.

Bajaj joined Foresite in 2017 after serving as chief scientific officer at Grail. Backed by hundreds of millions in venture capital, Grail is developing a blood test to detect cancer early. Bajaj also previously held the CSO title at Verily, Alphabet's life sciences subsidiary.

Since joining Foresite, he has worked on deals for genetic testing kit provider Color Genomics; Mindstrong, a mental health care company valued at over $200 million; and genetic sequencing company Element Biosciences. In response to Covid-19, he's putting capital to work in companies that can make a difference in the short term.

He's keeping a close watch on vaccine development and tools that facilitate a safe return to normal life. "Everything that's happening with Covid is foremost in my thinking," Bajaj said. "There are great unmet medical needs that face us now. We are focused on finding investable opportunities there."

VC poised for another shakeup as workers abandon tech hubs

By Alexander Davis

After a decade of hyperactive growth, America's tech hubs now are in danger of sharp reversals.

It may seem like a distant memory, but downtown San Francisco was still largely a financial center only 10 years ago, when its conversion into a bro-dominated tech capital of the universe wasn't yet in full bloom. Back then, the tech industry was known for being dispersed across the suburban towns of Silicon Valley, and venture capitalists famously lined Sand Hill Road in Menlo Park.

Eventually, tech companies large and small flocked to downtown San Francisco, and the urban workforce took on a very different look. Startups—some wooed by generous tax breaks—converged on a gritty central district and helped reshape the urban core. A similar trend has played out in cities from Seattle to Cincinnati. Thousands of tech workers poured into San Francisco as an influx of new-generation companies like Salesforce, Uber and Airbnb created densely packed, high-style urban tech campuses. That attracted droves of venture capitalists—long sequestered in quiet office parks outside the city—who were soon springing up to hobnob with founders or other investors, seemingly on every street corner.

But today, all of that is threatening to come apart at the seams.

The age of the pandemic has jolted a string of companies into favoring work-from-home policies. Seattle-based Amazon and Microsoft have emptied their offices at least into the fall. In the Bay Area, Google workers can work from home through the end of the year, and Twitter and Facebook essentially have encouraged employees to abandon offices for good.

Their practices could be influential for countless other companies. Thousands of engineers and product managers could be working via Slack channels from literally anywhere. "Not everyone wants to be downtown," said Clara Brenner, managing partner with the San Francisco VC firm Urban Innovation Fund.

These changes, amplified by waves of startup layoffs and retail business failures, have begun a morbid transformation of downtown tech hubs. A historically concentrated web of wealth and talent is about to lose people—the glue that bound the new tech ecosystem together. Depending on the extent and permanence of the exodus, startups won't have much incentive to keep offices in town as they increasingly resort to distributed workforces. This could have a ripple effect for the new generation of VCs based downtown, as well as the traditional Silicon Valley firms that converted the city's South of Market warehouses into their satellite offices.

If entrepreneurs and investors aren't hanging out downtown and holding meetings at Blue Bottle Coffee, what reason do VC firms like Sequoia and Andreessen Horowitz have to stick around? As the pandemic shakeout widens, venture firms may choose to retreat. Small VCs could be on their own. And Sand Hill Road may even reclaim its role as the valley's gatekeeper of deal flow.

Israeli scientists created the world's first 3D-printed heart using human cells

By Nickie Louise

According to CDC, one person dies every 37 seconds in the United States from cardiovascular disease. About 647,000 Americans die from heart disease each year—that's 1 in every 4 deaths. That's more than the number of people who died from the ongoing coronavirus pandemic. Heart disease costs the United States about $219 billion each year from 2014 to 2015. Cardiovascular diseases are the number one cause of death in industrialized nations. To date, heart transplantation is the only treatment for patients with end-stage heart failure. Since the number of cardiac donors is limited, there is a need to develop new approaches to regenerate the infarcted heart.

However, this is hope. Scientists at Tel Aviv University in Israel have printed the world's first 3D heart complete with blood vessels using a patient's tissue, vessels, collagen, and biological molecules. Even though challenges remain, The extraordinary breakthrough could one day be used to heal hearts or engineer new ones for transplants and render organ donation obsolete.

To "print" the 3D printed heart, Israeli scientists used "personalized hydrogel" made of collagen, a protein that supports the cell structures, to form "bioinks." The hydrogel originated from fatty tissues extracted from human test subjects. The breakthrough was reported by lead scientists Prof. Tal Dvir, Dr. Assaf Shapira of TAU's Faculty of Life Sciences and Nadav Noor, his doctoral student, in Advanced Science journal.

Among the challenges that remain is finding a way to generate enough cells to create the tissue required to "print" a human-sized heart. True, the heart is the size of a rabbit's, and it doesn't actually work yet. Dvir pointed out however that "printing" a human-size heart involves basically the same technology.

Below is an excerpt of how the scientists described the process:

> *Here, a simple approach to 3D-print thick, vascularized, and perfusable cardiac patches that completely match the immunological, cellular, biochemical, and anatomical properties of the patient is reported. To this end, a biopsy of an omental tissue is taken from patients. While the cells are reprogrammed to become pluripotent stem cells, and differentiated to cardiomyocytes and endothelial cells, the extracellular matrix is processed into a personalized hydrogel. Following, the two cell types are separately combined with hydrogels to form bioinks for the parenchymal cardiac tissue and blood vessels. The ability to print functional vascularized patches according to the patient's anatomy is demonstrated.*

By the way, this is not the first time 3D printing technology was used to print organs. However, this is the first time human cells are used to print organs. For example, in 2017, a team of researchers at ETH Zurich created a 3D printed artificial heart. But rather than using human tissue, the researchers used a flexible material.

What should startup founders know before negotiating with corporate VCs?

By Scott Orn, Bill Growney

Corporate venture capitalists (CVCs) are booming in the startup space as large companies look to take advantage of the fast-paced innovation and original thinking that entrepreneurs offer.

For startups, taking funding from CVCs can come with many benefits, including new opportunities for marketing, partnerships and sales channels. Still, no founder should consider a corporate investor "just another VC." CVCs come with their own set of priorities, strategic objectives and rules.

When it comes to choosing a CVC with which to enter negotiations, the most important step is doing your own diligence beforehand. An entrepreneur's goal is to find the perfect match to partner with and guide you as you grow your business. So before you start discussing terms, you'll want to understand what's driving the CVC's interest in venture investing.

While traditional VCs are purely financially driven, CVCs can be in the venture game for a variety of reasons, including finding new technology that might generate marketplace demand for their products. An example is Amazon's Alexa fund, which invested into emerging companies that drive use and adoption of Alexa. Alternatively, a CVC's parent company may be looking to invest in tech that will help them operate their own products more efficiently, such as Comcast Ventures investing in DocuSign.

As a rule of thumb, the bigger CVC funds like GV and Comcast tend to be financially driven, meaning they'll be approaching negotiations through a financial lens. As such, the negotiating process more closely resembles an institutional fund. You as a founder have to do the work to figure out what's driving your CVC — is this a customer acquisition or distribution opportunity? Or are they seeking to find a source of knowledge transfer and/or bring new tech into their parent company?

"Before negotiating, always look at a CVC's existing portfolio," says Rick Prostko, managing director at Comcast Ventures. "Have they made a lot of investments, at what stage, and with whom? From this information you'll see the strategic thinking of the CVC, and you can determine how best to position yourself when you begin negotiations."

You also can ask the CVC directly about what drives their decision-making, who makes the ultimate calls, how they decide the amount of an investment and the length of their typical deal time frame.

"Any venture investment is a marriage, and entrepreneurs should approach it as such," says Grant Allen, general partner at SE Ventures, the CVC arm of Schneider Electric. "Founders should talk to CEOs who are already in a CVC's portfolio, as well as CEOs who have tried to do a deal with the group, and ask them all how the negotiations went."

Questions to anticipate during negotiations with a CVC

Once you've determined that a CVC would be a good partner and you're ready to negotiate a deal, it's important to know the ropes. You'll be facing some scenarios and questions that you won't find with traditional VCs, so you'll want to be prepared and stay several steps ahead.

The following questions will guide you through negotiations and help you avoid common pitfalls.

Do they want a board seat? To the extent that a CVC is motivated by more than the pure financial return from the investment itself, a CVC's potential for a conflict of interest is greater than it would be for a financial investor sitting on your board. While a venture fund's sole goal is to increase ROI and maximize the financial return from your

company, a CVC has more than just the monetary future of your company at stake. Many CVCs have motives tied up with their parent company, including wrapping up your tech and preventing their competitors from getting access to it.

Given this potential for conflict, if a CVC takes a board seat, it's important to negotiate whether you can force him or her to recuse him/herself from a board meeting if a conflict-causing situation arises, such as the need to make a strategic decision involving one of the parent company's competitors. It's not uncommon for a startup to seek a deal with a CVC's competitors at some point down the line. With this in mind, be sure to negotiate the board rights ahead of time to avoid any complications down the road.

Sometimes you can ask a CVC to accept an observer seat and back them down from a board seat, and if the investment is small, founders can push back on the grounds that the CVC hasn't invested enough to warrant it.

"Ultimately, if a CVC is leading the round and/or their heart is set on having the board seat, it's tough to talk them out of it," says Allen.

Keep in mind that it also could benefit a startup to have a high-value-add CVC on the board. "If the CVC group is well-run and the potential board member can offer unique expertise, then there could be major upside to having them," says Eric Budin, director at Touchdown Ventures.

Do they want to lead your round? CVCs can and do lead investment rounds. Major CVCs like Intel Capital even lead the vast majority of their deals. When it comes to seeking a lead investor, the biggest factor to note is ensuring that you have the proper skills in the boardroom — many financial VCs have great track records as company builders, so if you can get a top institutional VC in your next round, go for it. But in a more complex industry such as energy, having a corporate-backed fund can help tremendously.

"Startups should be selfish when it comes to adding investors to their cap table," says Allen. "Take money from one or two great institutional VCs, then look to CVCs who can provide a new angle that traditional VCs can't offer. Pure financial VCs can bring a wealth of knowledge around company building, but can they really turn on revenue, especially in more difficult industries like energy, automotive and industrials?"

Do they understand your future fundraising strategy? Sophisticated CVCs know that your early-stage company will be raising future rounds — but less sophisticated ones may not. As we've discussed before, it's critical that you determine which type of CVC you're dealing with from the outset. Still, once you hit negotiations, it's always useful to establish that you'll likely be raising future rounds, which will require CVCs to make a decision to invest their pro rata or face ownership dilution. An experienced CVC will understand that if they decline to participate up to the pro rata, it could send a negative signal to other potential investors. Take this opportunity to lay out future plans and intentions of your startup in order to set expectations and avoid conflicts down the line.

Will they be using knowledgeable and experienced lawyers? Don't forget to ask about the lawyers who will be closing the deal! If the CVC plans to use in-house counsel, that may be a red flag. Even the best attorneys inside large corporations may not have the experience to know how to negotiate a VC deal. Often, a CVC will follow lead investors and rely on the firm that the lead is using. But if a CVC is leading your round, you'll want to ask and make sure they're planning to use a law firm with experience representing CVCs in venture financings.

If you're at all uneasy, feel free to suggest an option to the CVC: "The lead VC on our round is working with X attorney, so do you want to see if they can represent you on this as well?"

Will they adhere to your rules on ownership percentages? As a rule, don't let any single CVC own more than 19.9% of your company. If they own more than that, the CVC's parent company will likely need to consolidate your financials into their annual and quarterly reports. If that happens, you'll be required to get an expensive audit done, meet

strict reporting deadlines and invest in financial planning and projections, all of which can hinder your bottom line. It's crucial to stay aware of ownership percentages during every round that the CVC participates in — and if you think the CVC plans to increase their ownership over time, you'll want to offer some cap table sensitivity projections during negotiations to ensure that the CVC won't trip any ownership levels in future rounds.

Ideally, before you enter negotiations you'll have the chance to ask how the CVC thinks about ownership percentages and pro rata rights, which will enable you to stay prepared for this part of discussions. A CVC's view on both will be tied to the objective of their fund — is this CVC investing in products and companies that they ultimately want to own, or sprinkling drive-by investments across a number of companies to see what develops in the future?

Will they waive audit requirements? As we mentioned above, do everything you can to avoid any audit obligations. Audits are notoriously time-consuming and expensive — we've seen audits by Big Four firms cost startups over $30,000. While many investor rights agreements "require" an audit, traditional VCs usually waive this requirement to avoid wasting a founder's time and money. You want a CVC investor to do the same. This is an issue where working with an experienced law firm can help you avoid trouble down the road.

Will they demand a Right of First Refusal (ROFR) on a sale of your company? This one is crucial, for the simple reason that you'll want to give a resounding "no!" Under no circumstances should you let a CVC get a ROFR, which would give the parent corporation the right to "beat" any other potential acquirer if and when you try to sell your startup. In practice, a ROFR means that no smart competitor to the parent organization will try to purchase your company because they know the CVC's corporate arm will be able to swoop in and steal the deal. If a CVC requests a ROFR, you can usually negotiate it down to a notice right, which means that you'll put the parent company on notice if and when you plan to sell. But even a notice right can give the corporation more information than you'd want a potential bidder to have once you begin looking for buyers.

"You want a CVC who is entrepreneur-friendly, who isn't looking for onerous terms or significant exclusivity that could harm your business," says Budin.

Ask other CEOs how they did it

The best prep you can do for a CVC negotiation process is to speak with other CEOs who have done deals with the CVC. Ask these CEOs how difficult the investors were to work with during diligence, if they were supportive of the CEO's needs during negotiations, how hard the CEOs pushed back, on what, and whether they hit any snags. This feedback can give you invaluable leverage during the deal-making process.

"You as an entrepreneur have every right to get references for your investors," says Allen. "And if you find out during this process that they haven't actually done a lot of deals, that's important information as well."

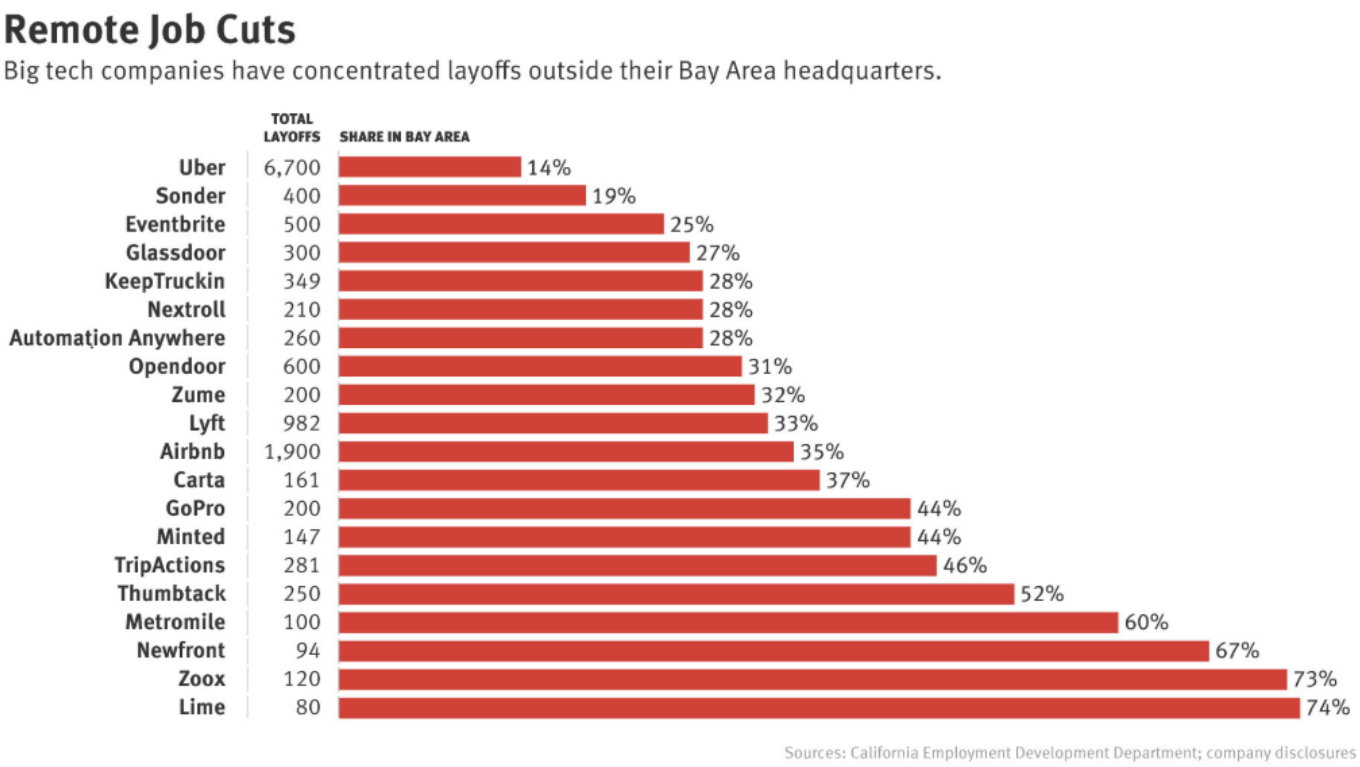
It's all about relationships

Throughout the process, remember that you've chosen to partner with this CVC because you think he/she will bring unique value to your company, as well as new capital. Negotiations should be a pathway to a strong relationship that avoids pitfalls, not a stressful battle over terms.

Choosing a sophisticated CVC who is in the game for the right reasons and has every incentive to see your company win is the most effective way to ensure that the deal gets done on terms that are right for your company, and sets you up to grow a strong business.

Where Are Most Tech Layoffs? Not Silicon Valley

By Cory Weinberg



Some of San Francisco's most well-known tech firms have cut deep into their staffs in recent months. But much of the pain is being felt outside the Bay Area.

An analysis of public filings from 20 tech firms based in the region, including Uber, Lyft and Airbnb, show that three-quarters of employees laid off worked outside the region, typically in satellite offices around the world or in lower-cost locations like Portland, Ore., and Nashville, Tenn.

The data suggest most tech firms are holding on to many well-paid software engineers, product managers and designers, who often work in the companies' Bay Area headquarters, while paring the ranks of sales, customer service and operations workers in satellite offices.

In some cases, companies closed certain back offices altogether. Uber shut or consolidated 45 offices globally, but closed just one of the seven it has in the Bay Area.

Uber had about one-third of its employees in the Bay Area as of early 2019, making it the fifth-largest employer in the city, according to research by the San Francisco Business Times. But just 14% of its 6,700 total layoffs this month were in the Bay Area. An Uber spokesman pointed to a recent company statement that it had kept a slight majority of its workforce outside the U.S. as of March.

"Managing multiple locations is harder and more expensive than managing one location," said Vinayak Ranade, founder and CEO of Drafted, a Boston-based startup that develops recruiting software for tech firms. "There is

location overhead cost, plus the people cost. If you can get rid of a location as well as the people, it saves you more money."

Airbnb also has been looking at closing some of its offices around the world to save on real estate costs, a person close to the company said. The company hasn't announced any closures yet. Airbnb made substantial staff reductions in Portland, where it housed many of its customer service staff, and in Montreal, where it had a high-end vacation rental business that it has decided to scale back.

Just 35% of the company's 1,900 layoffs this month were in San Francisco, according to its public filing. Airbnb had a majority of its employees based in the Bay Area last year, a person familiar with the matter said. An Airbnb spokesman confirmed the figures.

The Information analyzed filings tech firms made with the California Employment Development Department. Under California law, companies with 75 or more employees are required to issue a notice if they lay off 50 or more employees. We compared that number with the total number of layoffs tech companies announced across all their offices.

The analysis is consistent with previous conclusions about how corporations adjust their workforce during economic downturns. In 2009, researchers Jed Kolko and David Neumark published findings in the Journal of Urban Economics indicating that amid broader shocks on employment growth, jobs were very stable at companies' headquarters if they had branches in other cities. Their research was based on a database that included all U.S. businesses between 1989 and 2006.

The layoffs in outlying offices are occurring even as other big tech companies announce plans to allow some or all employees to work remotely. While some firms say they expect to have at least some office space for remote workers who want to interact with colleagues in person, many of these dispersed employees are likely to work from home.

Tech companies that have opened offices outside major coastal cities have generally based sales and administrative staff there, said Colin Yasukochi, executive director of the Tech Insights Center at real estate brokerage CBRE. "It's quite expensive to maintain those teams in the Bay Area."

He said firms have typically hired software engineers in the Bay Area if they are based there. Those employees have largely been spared. "They seemingly haven't hit that point," Yasukochi said. "Hopefully they won't."

Lyft, which made one-third of its cuts in the Bay Area, also laid off a substantial number of people from its customer service hub in Nashville, according to state filings. Lyft confirmed the figures.

Several smaller San Francisco–based tech firms appeared to lay off significantly more staff from their satellite offices that handle sales or customer service. Opendoor, a home-buying startup, told state regulators it laid off 80 people in San Francisco and 145 people in Phoenix, where it housed customer service staff. It had started moving more employees to Phoenix last year to lower costs.

Eventbrite laid off more employees from its Nashville sales-focused office than from its San Francisco headquarters. Sonder, a short-term rental startup, laid off more people in its Denver office than in San Francisco, according to state filings.

Some tech companies, especially those with offices in Europe, have bucked the trend, focusing their layoffs in the Bay Area. TripActions, a Palo Alto–based firm, laid off around 130 people in its two Bay Area offices, but aid from the Dutch government allowed the company to avoid making cuts in its large satellite office in Amsterdam. Smaller firms

such as autonomous vehicle startup Zoox and insurance startup Metromile, which tend to have fewer locations, also concentrated nearly all their recent layoffs in San Francisco.

Ranade said it might be more difficult for people laid off from satellite offices to find new jobs quickly because there are more job opportunities in cities that are typically tech headquarters, such as San Francisco, Boston, Seattle, New York and Austin, Texas. In 2018, those big cities expanded their already outsize share of tech job postings compared with other regions in the U.S., according to Indeed.

The Information's analysis could be underestimating the proportion of employees laid off in the Bay Area because the state doesn't require firms to disclose the number of contract workers they let go. Some companies might have included those employees in their public disclosures about the total number of layoffs, without sharing them with California regulators.

The analysis also only focuses on some of the largest layoffs in tech, as firms with more modest cuts aren't required to notify state governments.

Venture capital found its footing in biotech. Then came the virus

There's been no better time for venture firms to invest in drug startups than the past several years. But when a virus upended the world, it raised new questions about what types of investors and investments would succeed moving forward.

By Jacob Bell

Amir Nashat has spent nearly two decades building biotechnology companies. The first he worked on, Alnylam Pharmaceuticals, pioneered a new way to make genetic medicine. He's since helped advise and nurture at least 16 others, several of which were acquired for hundreds of millions of dollars.

Despite this track record, Nashat, a partner at the venture firm Polaris Partners, says most of his career in venture capital took place under "really crappy circumstances" that made it challenging to invest in young drug companies. Only in the last five or so years did things really start to change.

It was during this period that public markets came to love young biotechs, buying into record stock offerings. Large drugmakers, starved for innovation, also turned to them for their next drugs. This created a "hyper-compressed, hyper-intense environment," according to Nashat, where venture firms had much clearer and quicker paths to earn returns on their investments. For venture capitalists, there had never been a better time to invest in drug startups and, coming into 2020, many expected another big year.

Their predictions were quickly upended by the spread of the new coronavirus, which has infected millions and brought the global economy to a halt. In the past, economic downturns shaped how venture firms fund and incubate drug companies. Now, a pandemic threatens to do the same.

BioPharma Dive spoke with half a dozen venture capitalists who grow drug companies, as well as legal and financial advisors who work with healthcare venture firms. Almost all said the spread of the new coronavirus is affecting to some degree how they manage existing investments or think about new ones.

"It used to be that we had a lot of chaos, but the rest of the world was predictable," said Noubar Afeyan, CEO of Flagship Pioneering, the biotech incubator which founded coronavirus vaccine developer Moderna along with more than 25 other companies. "Now, we have chaos and the rest of the world has chaos, and so there are some adjustments being done."

As venture capitalists assess the damage caused by the pandemic, they appear to be treading lightly — financial data provider Pitchbook found biopharma venture deals are down roughly 16% compared to last year. Some firms told BioPharma Dive that, in the current environment, they'd be apprehensive to invest in certain kinds of drug companies.

Even small adjustments could have a lasting impact on the drug industry, given the vital role venture firms play in it. Many biotechs wouldn't exist without venture money and support, making these investors a powerful force over the drugs that could become available in the future.

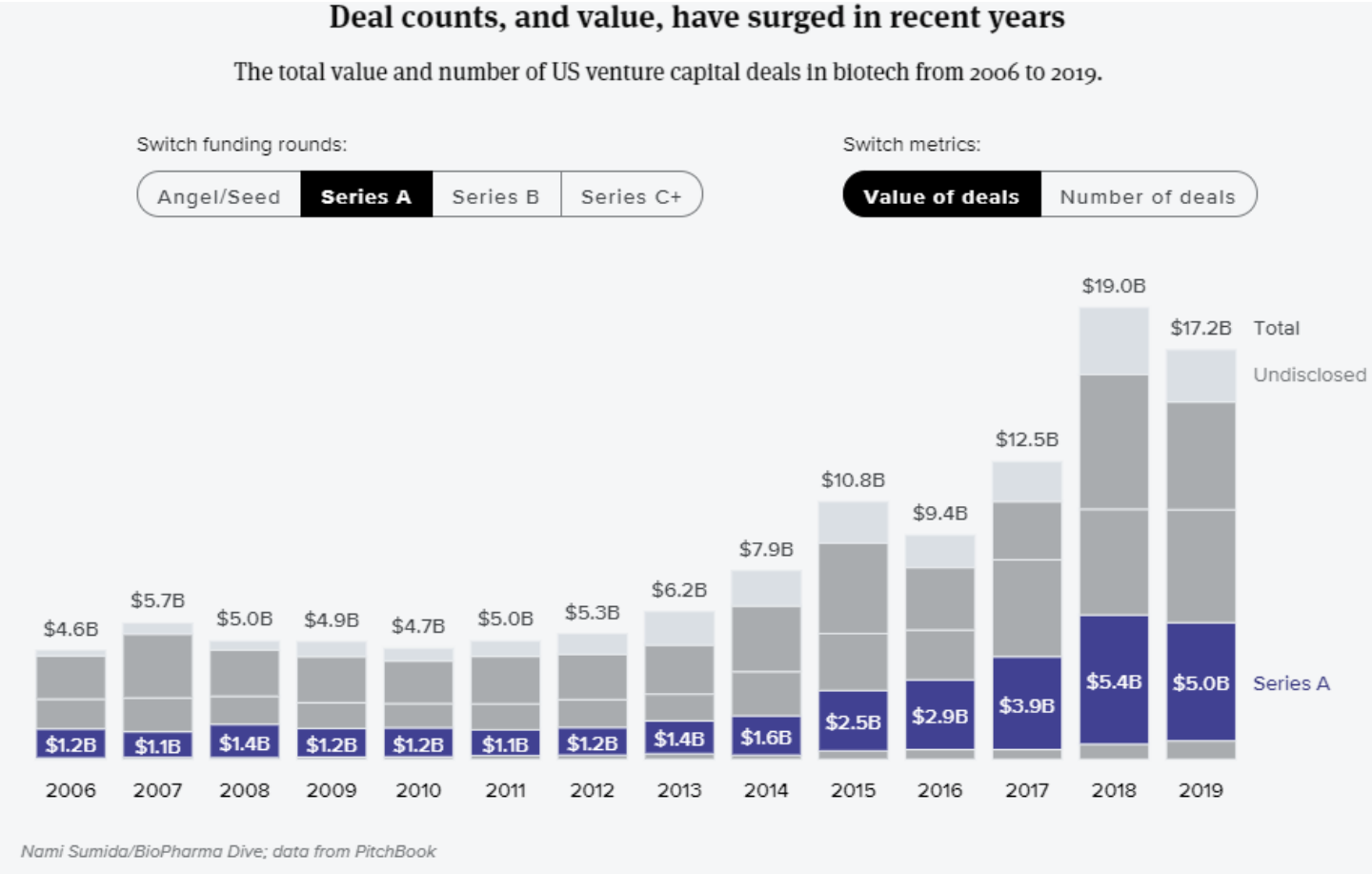
Money harder to find?

After the recession in the early 2000s, scientific breakthroughs led to a surge in biotech investments, many of which would ultimately disappoint. When the financial crisis hit in 2008, healthcare-focused venture firms found it extremely difficult to raise money from their investors, who viewed biotech as a risky bet.

Their attitude didn't start to change until about 2013, by which time the recession was over and advances in drug research had made biotech more attractive to a wider group of investors and potential buyers. Biopharma acquisitions and initial public offerings, typically the two main ways venture firms receive returns, would hit record highs in the following years, giving these firms and their backers the confidence to keep putting in money.

Indeed, since 2013 there's been an annual uptick in the number of funding deals venture firms are doing, with almost every year having about 70 more than the one prior, according to Pitchbook. By 2019, the deal count had hit 941.

The collective value of these deals, which range from small angel investments to the larger funding rounds that follow, has grown too. In four of the last five years it surpassed $10 billion.



The favorable conditions also made it so that venture firms could go back to their investors for more money. Polaris Partners, 5AM Ventures, Third Rock Ventures and Versant Ventures, among others, each secured hundreds of millions of dollars across 2018 and 2019, while Flagship, Arch Venture Partners and venBio closed new funds this spring worth almost $3 billion combined.

Deerfield, a type of investor known as a "crossover" because it invests in both private and publicly traded companies, also just completed raising $840 million to put into healthcare companies.

While money has been plentiful, the economic disruption caused by the coronavirus raises doubts about whether that will continue.

Bob Nelsen, managing director at Arch, said he'd be surprised if any new, first-time funds can raise cash at all this

year. Firms with existing networks of investor relationships may be able to pull off follow-on funds, he added, but they'd likely take longer to complete.

If a slowdown persists, young biotechs could find it difficult to close their next rounds of financing. Already, the pace of biopharma venture deals appears to be lagging, as Pitchbook counted 228 deals between early February and mid-May this year, down from the 271 seen in a similar time frame in 2019.

One top concern is that crossover investors, who often come in later and supply a substantial amount of the funding that props up a company until it goes public, will back away from biotech startups. Without those investors, early-stage venture backers might have to dig deeper in their pockets to push their companies forward.

"It can take $1 billion to get a drug to market," said Kristopher Brown, a partner in the life sciences group at law firm Goodwin. "There are few venture capitalists who can afford to fund that."

Nelsen predicts some crossover investors will take a break from biotech startups and focus on public stocks that are now cheaper because of a turbulent market. But Jon Norris, a managing director at Silicon Valley Bank who works on deals with healthcare venture firms, isn't so sure.

Biotech stocks have held up relatively well this year compared to the rest of the market, which Norris said bodes well for continued crossover interest. What's more, the number of biotechs that have gone public this year — 14 as of May 26 — is just a tick down from the 17 IPOs completed by the same date in 2019.

"It just means to me that people continue to see this sector as one that's worthy of investing," Norris said. "If you see good returns, people are not going to be quick to exit the market."

Still, much is unknown about how the pandemic will further unfold.

For drug companies, the impact of social distancing and its ripple effects on the economy are expected to be more dramatic in the second and third quarters. In a possibly foreboding sign, industry bellwethers Merck & Co. and Johnson & Johnson have lowered their revenue forecasts for the year by billions of dollars.

"I do worry about the delays that are inherent to having this whole economy come to a stop and hospital systems being overwhelmed," Norris said. "To me, that's a big deal over the next quarter."

'Safer' bets

In the meantime, venture firms need to put the money they've already raised to work.

Early-stage investors who spoke to BioPharma Dive said their core strategies are still intact in spite of the coronavirus. Flagship and Arch prefer companies with technology platforms that, in theory, can give rise to multiple drugs. Polaris, as it has in the past, works its close relationships with academic institutions to find new startup opportunities. Atlas Venture remains fairly agnostic, while San Francisco-based venBio looks for companies on track to hit a meaningful milestone in the next three to five years.

And yet, the pandemic does weigh on their thinking.

To attract new investors, development partners and potential acquirers, biotech startups need to hit goals like moving a drug into and through human testing. But they've found a new obstacle in the coronavirus. By late May, nearly 100 drug companies of all sizes had reported impacts to their clinical trials related to the pandemic.

"There could be significant dollars lost and significantly extended timelines" for biotechs on the verge of, or already in, clinical testing, said James Flynn, managing partner at Deerfield.

As such, some firms are investing more selectively. Aaron Royston, a managing partner at venBio, said his team will be "very cautious" when putting money into any drug company that's close to starting an important trial or launching a new product.

Funding also might be harder to come by for biotechs built around a single drug program, as there's not much cushioning if that program runs into complications.

"Companies that are purely based on single assets with a clinical readout are in deep shit," Nelsen said.

By contrast, companies at the earliest stages of research may benefit. Investors assume that, by the time these companies reach human trials, some of the challenges and uncertainties surrounding the coronavirus will have been ironed out.

Royston, for instance, said he has little apprehension investing in biotechs that will be working on early research for the next 12 to 18 months.

"Preclinical investment is almost a safe place to hide while everybody else is on the later-stage side, trying to figure out how to deal with delays in clinical trials," SVB's Norris said.

For now, venture firms say they've been more frequently checking in with companies that could face setbacks because of the disruption and, if needed, helping devise plans to conserve cash.

"At the end of the day, data is the currency of how we value our progress," said Atlas Venture partner Bruce Booth. "So, as long as the biotech has enough capital to get it through those data collections and can get out from some of those R&D delays, then I think we'll be in an OK place coming out of this crisis."

Clues from the past

In responding to the disruption brought by the pandemic, venture capitalists may revisit approaches honed after the last big economic downturn in 2008.

Then, a dried up IPO market alongside difficulties raising money led some venture firms to leave life sciences investing altogether. Others doubled down on their existing strategies or adopted new ways to build companies.

Versant, for example, was known to start companies with a prearranged buyer in place. Atlas gave some companies, like Nimbus Therapeutics, a limited liability structure that made it easier to sell individual drugs to buyers, though more complicated to go public. Such tools are "less critical now than they were during that challenging period" because biotechs can still conduct IPOs, Booth says.

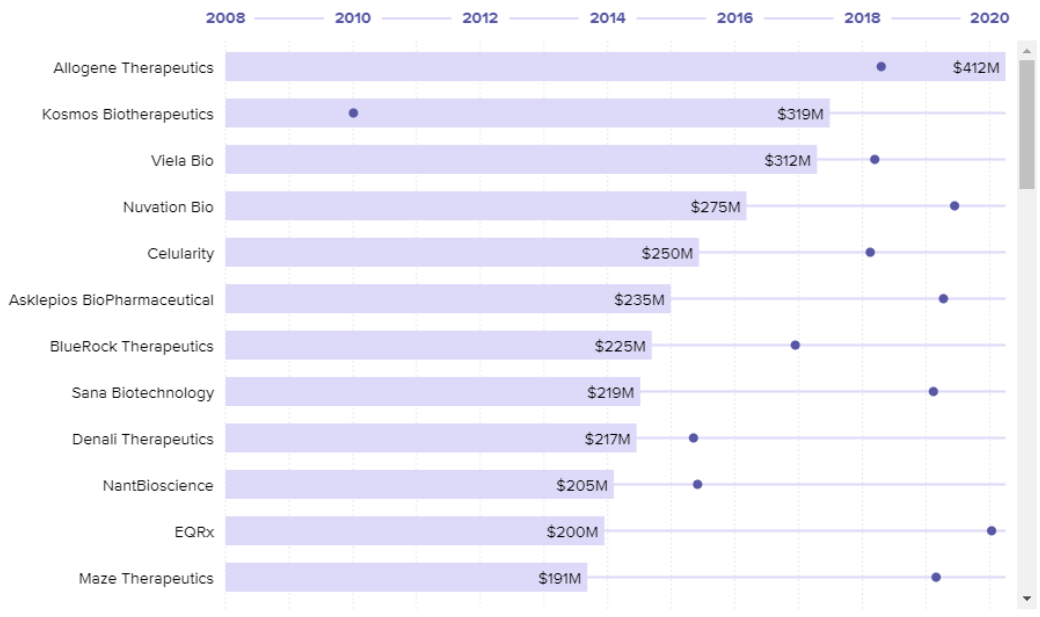
At Polaris, hard economic times reinforced the firm's trust in a type of group investing called syndicates, which can spread risk between firms. Flagship, on the other hand, backed away from forming biotechs with other investors because the process felt too restrictive.

"What we found was that, when people were traumatized through financing risks and through uncertainty, a syndicate was only as strong as its weakest link," Afeyan said. "In other words, if you had five investors sitting around a board table, the weakest one was the one that got to decide what you did."

Flagship has since shifted resources to focus almost exclusively on creating startups in its own labs. And it isn't alone. Firms such as Third Rock have become known for an intensely hands-on approach, incubating companies and ultimately owning significant stakes when those biotechs go public.

Another popular strategy has been to stagger, or tranche, investments to limit risk. Typically, this means firms give smaller chunks of cash early on and larger chunks later, once a startup has provided more evidence that its medicines might pan out.

Top Series A biopharma deals for U.S. venture capital



Nami Sumida/BioPharma Dive; data from PitchBook

The top 50 U.S. Series A deals in pharma and biotech from 2006 through the first quarter of 2020. Each bar represents the deal value. Each circle marks when the deal occurred.

And yet, despite the unprecedented challenges posed by the pandemic, venBio and others appear optimistic that a 2008-like shakeout isn't coming, and that they won't have to rely on unorthodox strategies to navigate the future. Royston's view on 2020 opportunities

hasn't changed; Nelsen doesn't foresee the pandemic preventing Arch from investing right now; and Flagship is still on track to spin around 10 projects into full companies over the next year and a half, Afeyan said.

There's a key difference this time around, several firms and advisors said, and that's the money which has so far stayed readily available to healthcare investors. Cowen Healthcare Investments just last week finished raising nearly half a billion dollars, adding to the string of recent hauls from other firms.

"We've seen these things come and go, and frankly we've done some of our best companies in the down cycles," Nelsen said.

A pandemic, however, isn't just another down cycle.

Past downturns didn't threaten to overwhelm the healthcare system, as the outbreak of the coronavirus has. Hundreds of thousands of Americans have been sickened by coronavirus infections. And for millions of people with diseases other than COVID-19, how they seek and receive care changed overnight.

The widespread shutdown of businesses across the country, meanwhile, has created economic hardship not seen since the Great Depression, and it's unlikely a stop-and-start reopening will quickly heal those wounds.

"No one fully can comprehend, even in a world as smart as the biotech scientific world, the trajectory and the impact of the current situation," said Amy Schulman, a managing partner at Polaris.

Whether the pandemic persists into next year or lingers much longer, venture capitalists do acknowledge it will have profound effects on society and, by extension, the drug industry.

Nashat envisions that "new kinds of entrepreneurs" will rise amid the chaos, while others will be "scared off." Nelsen predicts big changes in how healthcare is delivered, which will "shock" the system and create new opportunities.

That means investors will need to adapt too.

"It would be incredible, to me," Afeyan said, "if people just forgot this and resumed their old normal."

Moats Before (Gross) Margins

Gross margins have become a shorthand metric for business quality, but they are not the sole factor when it comes to long-term value and defensibility, argue Alex Immerman and David George. Value comes from defensibility, and defensibility comes from moats. Moats provide a path to business value that founders would be remiss not to take. Alex and David walk through four moats that can lead to long-term business value, and the metrics.

By David George and Alex Immerman

In 2019, long before the outbreak of COVID-19, many lower gross margin tech companies were not being well-received by the public markets, and an excessive spotlight was cast by many on company gross margins. In the present moment, that attention has only grown for both public and private companies. We've observed a bifurcation in the market of "haves" and "have nots": those companies that have high gross margins are worthy of investor attention, but those that do not are quickly dismissed.

Of course, the focus on gross margins is understandable. A high gross margin is a preferred business feature. Higher gross margins allow for more percentage points of revenue to be spent on growth and product development. Higher gross margins also tend to translate to higher cash flow margin, and in a world where "how much runway do you have" has become a (if not, the) preeminent question, cash is paramount. For these reasons, high gross margin companies typically have higher revenue multiples than their low gross margin counterparts.

But we risk losing sight of what truly drives business value. Yes, gross margins are important. But over-rotating on gross margins is myopic because business quality is driven by more than margins.

Business quality is about defensibility. Defensibility comes from moats. And while high gross margins are often a reflection of moats, they are not a moat in and of themselves. And when faced with a low gross margin business, you need to focus even more on moats: without those extra points of revenue to invest in sales & marketing strategies or research & development, you need other ways to generate cash flow over time.

The markets will show you that companies with low gross margins can still be highly cash flow generative and highly defensible, and thus highly valuable. One of the highest valued companies in a major exchange, Apple, has a 38% gross margin, roughly half of that for many software businesses! In fact, many of the most valuable companies have low gross margins (as shown by Capital IQ, as of May 27, 2020): from Walmart and Home Depot to Disney and Netflix to Nike and Starbucks to Raytheon and Lockheed Martin. We believe the next generation of iconic companies like these will be more tech-enabled, but still likely have gross margins that are well below those seen in traditional software.

In the current crisis, many companies are (rightfully) focused on survival, but as we look toward the future, it's critical to think about what your moat is or will be. For all entrepreneurs (but especially those building a low gross margins business), here are four examples of moats, as well as some metrics we look for that demonstrate the presence of that moat.

Economies of scale

Economies of scale refers to a cost advantage resulting from increased production. One of the most prominent examples in tech is Amazon's distribution network, but they're not the only one. For example, the scale of Carvana's refurbishment network enables the company to care for vehicles at a lower cost than competitors.

The simplest question for whether economies of scale are achieved is: are your per unit costs defensibly lower than your competitors'? It's super-rare for early and growth stage startups to achieve such scale; assuming yours are not, the next question is: are your per unit costs improving while not degrading your unit economics? For example, you

could push paid advertising to lead to high volume and scale benefits, but that paid advertising may be so excessive that your unit economics become unprofitable.

Another sign of emerging economies of scale is if your business has a clear pathway to negotiating power over your suppliers and/or buyers. Again, Amazon is the classic example, but another interesting possibility is Spotify. Historically, music labels have commanded certain economics from streaming services, but if Spotify's existing large user base continues to gain share, the negotiation could flip, allowing Spotify to achieve meaningfully differentiated economics relative to the competition.

Meaningfully differentiated technology

Most companies believe they have differentiated technology, and many do. Features, integrations, reportability … the list goes on. But when entrepreneurs look to distinguish their technology enough to make it a true moat, they should be focused on differentiating their product and service in a way that matters. Doing so enables companies to charge more ("premium" pricing) and spend less on sales & marketing (the product "sells itself"). Moreover, customer lock-in can be higher because there is a perceived switching cost of moving to an inferior tech solution.

There's no one clear metric that indicates this moat across all cases, but we tend to see it pop up in a few ways. One example is if your company has intellectual property (e.g. patents) that can protect your advantage for many years to come. In the absence of IP, the clearest measure of differentiated technology is pricing power. Are customers willing to pay a higher price for your product than others? If so, you are likely selling a differentiated offering.

Another way we get at this question is talking to customers. If asked, do your customers claim no one else can match your offering today, and that they would be willing to pay a higher price? Do they say that no one else on the market has the capacity to continue building the way you do? Government officials select Anduril because its sensor fusion and machine vision platform is unlike the offerings of other defense contractors who are also unlikely to be able to recruit and retain talent capable of building similar technology in the coming years.

Network effects

It's no secret that we at a16z love network effects, especially when it comes to marketplaces. Network effects happen when a product or service becomes more valuable to its users as more people use it, creating a flywheel effect on growth. Despite having low gross margins, many public company internet marketplaces, such as Lyft and Uber, have leveraged network effects to drive organic growth, increase switching costs, and build scaled businesses.

We have published a lot about the metrics for and common leading indicators of network effects (to start, try here, here, and here), but there are a few rules of thumb for determining if you have network effects. One is measuring engagement: does engagement (e.g., DAU/MAU) improve as the number of users grows? Another way is to look at monetization: are you experiencing organic growth in wallet share for supply and demand? Across the many grocery and restaurant delivery startups, we've observed higher consumer engagement and dollar retention in denser markets. Ideally, for companies exhibiting network effects, we see increasing returns to engagement (e.g., revenue grows exponentially relative to time within a single metro).

Direct brand power

One way to combat having fewer percentage points of revenue to spend on strategies like outbound sales and paid marketing is to have built a killer brand. A strong brand commands word-of-mouth referrals, a cult following, and direct traffic. Those with LaCroix, Hint Water and increasingly Bevi in their office know that word spreads fast, and soon every office kitchen must have them in stock.

Building a brand takes time and focus (and money!), but it's ultimately valuable and can pay off well into the future. How do you know if you have a powerful brand? One metric we look for is increasing organic and direct traffic: do you have an increasing percentage of your traffic and revenue coming from organic or direct channels (vs. paid) over

time? Leveraging unpaid channels can help ensure you're not overly dependent on more expensive customer acquisition channels (i.e., are you beholden to Google and Facebook?).

Another metric we look at is decreasing customer acquisition costs (CAC): is your cost to acquire each customer falling or staying flat? Combined with growing organic traffic, flat to down paid CAC translates to declining blended CAC. While it is common for CAC to go up in the earlier days of a startup, as you build a strong brand that drives word-of-mouth, we look for CAC to come back down after you achieve product-market fit.

[For a more in-depth discussion of the nuances of organic traffic and CAC, check out this podcast (with transcript) with our colleagues Jeff Jordan, Andrew Chen, and Sonal Chokshi on user acquisition and growth.]

These four examples are far from the definitive list of moats, but they hopefully serve as a healthy reminder how startups can build enduring businesses, even without high gross margins. Still, the reality remains that if you don't have high gross margins, you'll often need two or more of these moats to become a highly valued company with meaningful cash flow.

Ultimately, there is no one path to building a defensible and valuable company. Though some ways, like having high gross margins, might be easier than others, we work with founders every day who are forging the right path for their company.

Wearable Vitamin C Sensor Could Help Track Users' Nutritional Intake

Written by AZoSensors

A team at the University of California San Diego has developed a wearable, non invasive Vitamin C sensor that could provide a new, highly personalized option for users to track their daily nutritional intake and dietary adherence. The study was published in the May 18, 2020 issue of ACS Sensors.

"Wearable sensors have traditionally been focused on their use in tracking physical activity, or for monitoring disease pathologies, like in diabetes," said first-author Juliane Sempionatto, a PhD Candidate in nanoengineering in Joseph Wang's lab at the UC San Diego Jacobs School of Engineering. "This is the first demonstration of using an enzyme-based approach to track changes in the level of a necessary vitamin, and opens a new frontier in the wearable device arena."

"Wearable sensors have rarely been considered for precision nutrition," said Joseph Wang, a professor of nanoengineering and director of the Center of Wearable Sensors at UC San Diego.

Why vitamin C is important
Vitamin C is an essential dietary component, as it cannot be synthesized by the human body and must be obtained through our food or via vitamin supplements. The vitamin is important for supporting immune health and collagen production, a vital player in wound healing, as well as improving iron absorption from plant-based foods. Ongoing research is examining whether or not the vitamin's role as an antioxidant might support its use in treating diseases like cancer and heart disease.

Most pressingly, the vitamin is being studied in several clinical trials for its potential in supporting recovery from COVID-19, the disease caused by the novel SARS-CoV-2 virus. A handful of past studies have linked high doses of vitamin C, alongside other treatments, to reduced mortality rates in patients with sepsis and, in one study, acute respiratory distress syndrome (ARDS) - both common conditions seen in serious cases where patients with COVID-19 require intensive care and intubation.

If vitamin C does help patients recover from the disease, such a wearable sensor might aid doctors and recovering patients in tracking their vitamin C levels during treatment and recovery, providing an opportunity for healthcare providers to precisely tune vitamin supplementation to match a patient's needs.

The wearable device
The new wearable device consists of an adhesive patch that can be applied to a user's skin, containing a system to stimulate sweating and an electrode sensor designed to quickly detect vitamin C levels in sweat. To do so, the device includes flexible electrodes containing the enzyme ascorbate oxidase. When vitamin C is present, the enzyme converts it to dehydroascrobic acid and the resulting consumption of oxygen generates a current that is measured by the device.

In vitro testing and testing in four human subjects who had consumed vitamin C supplements and vitamin C-containing fruit juices showed that the device was highly sensitive to detecting changes in the levels and dynamics of the vitamin when tracked across two hours. The researchers also tested the electrode detector's ability to detect temporal vitamin C changes in tears and saliva, demonstrating its cross-functionality. Differences observed in the vitamin C dynamics across different human subjects indicates that the device has promise for personal nutrition applications.

"Ultimately, this sort of device would be valuable for supporting behavioral changes around diet and nutrition," said Sempionatto. "A user could track not just vitamin C, but other nutrients - a multivitamin patch, if you will. This is a field that will keep growing fast." The UC San Diego team is closely collaborating with a major global nutrition company DSM towards the use of wearable sensors for personal nutrition.

"Despite the rapid development of wearable biosensors, the potential of these devices to guide personalized nutrition has not yet been reported," said Wang. "I hope that the new epidermal patch will facilitate the use of wearable sensors for non-invasive nutrition status assessments and tracking of nutrient uptake toward detecting and correcting nutritional deficiencies, assessing adherence to vitamin intake, and supporting dietary behavior change."

With the pressing need to develop new treatments for COVID-19, the team is also looking for ways to quickly get this technology into a clinical setting, in the event that vitamin C does prove to be a helpful treatment for the disease.

As hospitals and other healthcare facilities deal with current COVID-19 patients and prepare for future cases, the need for a reliable, strong, and effective wireless networks is more apparent than ever.

By Anil Gupta

The network must be designed for high availability, night and day, year-round. At a minimum, this means including enough APs to support high usage with no dead zones. It might also mean utilizing secondary sources such as Bluetooth Low Energy (BLE) beacons to support RTLS used to track mobile workstations, medical providers, and patients. Opt for a centralized design with a single network infrastructure to improve performance and uptime. The goal is a design that affords better access to clinical data whenever it's needed—think less hierarchical and more flattened.

Facilities can consider where it makes sense to integrate wired technology into the network design to free up wireless capacity for wireless-only devices. For example, patient rooms can have wired televisions and analog phones, and reception desks can use wired computers.

Finally, design the network with future flexibility in mind. Building in 30%-40% excess capacity gives the network room to grow over the next few years. As thousands of wireless medical devices hit the market every year, this ensures the network is prepared to handle an evolving RF environment.

Bringing Order to the Wi-Fi Ecosystem

Organization is the watchword for networks supporting such a vast array of uses and users. When an existing building is to be outfitted with multiple, physically separate networks, plan to consolidate into one infrastructure if possible. Working with a centralized network operations system simplifies Wi-Fi network management by improving visibility.

While it's common practice to segment wired networks via virtual LANs (VLANs), the whole concept falls apart when it comes to wireless networks. On wireless LANs (WLANs), multicast and broadcast traffic are treated equally and can become the cause of extraneous airtime utilization. Most Wi-Fi networks will send multicast/broadcast traffic at the lowest data rates to guarantee delivery to the farthest clients, thus leading to higher airtime utilization.

Devote special attention to limiting the amount of such traffic. For example, use smaller subnets, increase multicast data rates, use multicast DNS (mDNS) gateways, enable dynamic multicast optimization methods, and so on. The solution(s) can vary depending on your WLAN vendor.

Security and Privacy

Security is a critical part of any healthcare network design, especially with so many ransomware attacks targeting hospitals and bring-your-own-device (BYOD) policies allowing even more personal devices on the network. Integrate security into network infrastructure with network access controls and an intrusion detection and prevention (IDP) solution to monitor access and ensure that only authorized users are on the network.

Separate networks and bandwidth limits should be utilized to provide security and ensure strong performance for medical devices first and foremost. More often than not, three networks will be sufficient for a facility's needs, but some facilities may choose to implement four:

- SSID 1: Secured with WPA2 (or the newer WPA3), this network is for facility employees only. It must ensure that all patient-confidential information is protected, following security regulations such as HIPAA and PCI.
- SSID 2: This is the guest network for patients and visitors, which may also be secured with a password.
- SSID 3: This is a "catch-all" network for hospital devices that may not support advanced security protocols such as WPA2; many IoT devices will fall into this category.
- SSID 4: Although not essential, this network may be used specifically for Voice over Wi-Fi (VoWi-Fi). If facilities decide to implement SSID 4, it must be as securely encrypted as SSID 1, while keeping in mind the security protocols supported by the VoWi-Fi devices.

Maintaining a Network—Working Easier, Not Harder

As challenging as healthcare network design can be, the need to maintain an optimized network day and night over decades only compounds the challenges. To make this process easier, facilities can work with an AI-based management solution that provides 100% visibility, proactive insights and alerts, and remote access.

Healthcare facilities provide a challenging RF environment. There are many connected hallways, shielded radiology departments, and sometimes several connected smaller buildings and centers, each of which may have switches, routers, and APs from different vendors. Achieving constant and complete visibility into this environment, including the thousands of supported client devices, is a critical first step in maintaining a reliable network.

An AI-based solution that provides a centralized control platform for capturing and processing analytics gives IT a detailed look into the entire ecosystem from one user interface. Depending on the solution, it might identify every connected device, backend and frontend infrastructure, and nearby networks. With these in-depth analytics, IT can determine exactly what the network is tasked with supporting, how each device and application behaves under normal and high-stress conditions, and how the network is affected when new devices and applications are connected.

Not only does complete visibility make it easier to monitor network health and performance, it also supports IT in the quick discovery and resolution of network issues, as well as future capacity planning.

In healthcare settings, any network downtime or disruption must be avoided. The network must be available 99.999% of the time. The best way to ensure that availability is with automated, proactive alerts.

With complete visibility, AI solutions can determine healthy, baseline network behavior. If this behavior changes for any reason, the solution can alert IT with specifics such as the root cause of the change and actionable insights. This supports IT in quickly resolving the issue before it affects users, greatly improving the mean-time-to-resolution (MTTR).

Included in this management capability are network tests and historical analytics. Historical analytics are useful both in the short and long terms. They provide observational insights into network usage and growth over days, weeks, and months; and key analytics for capacity planning. Historical analytics are a key element in efforts to maintain an optimized network into the future.

Scheduled, consistent network tests are an effective means of monitoring a network in real time and to receive instant notification of any issues. With thousands of devices and applications to monitor, as well as other business-critical responsibilities, IT often lacks the bandwidth to run tests manually. IT staff should be supported with an automated solution that simulates the end-user experience, provides in-depth analytics, and frees up IT resources for other tasks.

In a time when travel is difficult or impossible, remote access is a mission-critical capability. Even when travel is easy, remote access reduces the MTTR and makes it possible to deliver faster troubleshooting to even small, remote facilities.

As healthcare facilities often operate 24/7, it can be difficult to determine the best time to plan scheduled maintenance, let alone address issues that can arise at any time of the day or night. The more opportunities that IT teams have to access the network remotely, the easier it can be to keep the entire network running smoothly.

Network Optimization

While the wired network is important to maintain back-end connectivity, the end users (healthcare providers, staff, and patients) are mostly on-the-go. They rely more on the wireless network to get their jobs done. Hence, the wireless network is the backbone of a healthcare facility. Users depend on the wireless network for life-saving resources as well as for updated care management.

Increased mobility, real-time alerts, and improved care coordination are only a few of the benefits that result from having an optimized wireless network. Focus on an integrated network design and AI-based maintenance plan that will support patient care now and into the future.

China could be leaning toward 5G in mmWave spectrum

By Mike Dano

Chinese researchers are growing increasingly interested in the operation of 5G in millimeter wave (mmWave) spectrum, a development that could portend an eventual rollout of 5G in that spectrum in the world's most populous country.

That development would undoubtedly supercharge the global mmWave industry, which has so far been relegated to a small handful of the world's 5G countries. It could also have significant implications for some companies in the US wireless industry, which have made significant investments into the development of mmWave 5G technologies.

"I've seen this uptick in interest in mmWave spectrum" among Chinese researchers, said Sarah Yost with National Instruments. The company develops testing products and technologies for a variety of engineering projects, including wireless networks. And Yost works in NI's research design and prototyping team, where she's involved in wireless research.

As a routine part of her job, Yost said she fields requests for research on a variety of topics, and she said she's noted a significant increase in interest from China in 5G in mmWave spectrum, as well as in beamforming, 5G in nonterrestrial networks, and communications above 100GHz (spectrum many believe will eventually house 6G).

Yost isn't the only one who expects China to move forward with 5G deployments in mmWave spectrum. Qualcomm's Ignacio Contraras said he expects China to consider commercial 5G deployments in mmWave spectrum in 2021 or later. That would represent a significant development for chipmaker Qualcomm, which has invested a significant amount of attention into silicon for mmWave 5G products.

Indeed, Contraras pointed out that Qualcomm recently tested 5G mmWave connections with Chinese vendor ZTE in the country.

The Chinese behemoth

Chinese wireless network operators are just a few months into their initial 5G launches, but they are already collectively reporting fully 65 million 5G subscribers. While that's a relatively small portion of the 1.4 billion people who live in China, it's far more than the 4 million 5G customers collectively counted by South Korean wireless network operators. US operators have not reported their 5G customer metrics, but they're likely dwarfed by their Chinese and South Korean counterparts.

Chinese officials have allocated mostly midband spectrum (2.6GHz, 3.5GHz and 4.8GHz) to the country's four 5G wireless providers. Such spectrum has been described as "Goldilocks" spectrum because it toes the line between supporting both broad geographic coverage and speedy connections.

And that's noteworthy considering US officials have been criticized for focusing initial 5G efforts on operations in mmWave spectrum. Verizon, T-Mobile and AT&T have all embarked on 5G deployments in mmWave spectrum, but are working to expand their 5G offerings into other spectrum bands. Unlike 5G in midband and lowband spectrum, 5G in highband, mmWave spectrum can't cover wide geographic areas. However, it can support blazing fast speeds.

mmWave economies of scale

The US, by all accounts, is leading in the rollout of mmWave 5G. But it's not alone. Qualcomm's Contraras said that operators in Japan are deploying mmWave 5G, and that operators in Russia, South Korea, Australia and elsewhere are also moving forward with their own mmWave deployments.

According to the Global mobile Suppliers Association (GSA), there were a total of 200 5G devices announced in January 2020, and a third of those support at least one mmWave spectrum band.

Thus, a Chinese move into 5G in mmWave spectrum could have significant repercussions for the global wireless industry. Chinese purchase orders would likely dwarf the purchase orders from virtually every other country in the world, thereby helping to spur mmWave innovation and lower equipment costs. After all, China's three top operators are on pace to erect fully half a million 5G basestations this year alone.

"The expected socio-economic impact of allocating mmWave spectrum for 5G networks in China is significant," wrote GSMA, the global wireless industry's main trade group, in a recent policy paper. The association urged Chinese policy makers to quickly allocate mmWave spectrum in China to operators and enterprises, without charging initial spectrum license fees.

Doing so, the group argued, would create an economic benefit in the country totaling $104 billion by 2034. The GSMA said mmWave spectrum is ideal for 5G deployments in dense urban areas, manufacturing facilities and transportation operations, among other locations.

SVB study: Industry 4.0 advances continue, but manufacturing jobs may be at risk

Provided by RobotReport

Silicon Valley Bank, which has helped fund more than 30,000 startups, yesterday released a report on "The Future of Robotics: An Inside View on Innovation in Robotics." It described trends in production, business models, and the adoption of robotics reflecting the increasing maturity of Industry 4.0. The report also addressed concerns about automation displacing jobs and public-policy reactions.

Overall, the free Silicon Valley Bank (SVB) report (download PDF) was cautiously optimistic about the prospects for industrial automation. It cited rising U.S. productivity, maturing technologies and suppliers supporting a variety of applications, and a steady climb for robotics deployments, particularly in Asia. The report also discussed the value of the robotics-as-a-service (RaaS) business model, in which automation becomes a recurring operating expense (OpEx) rather than a capital expenditure (CapEx).

SVB notes causes for concern

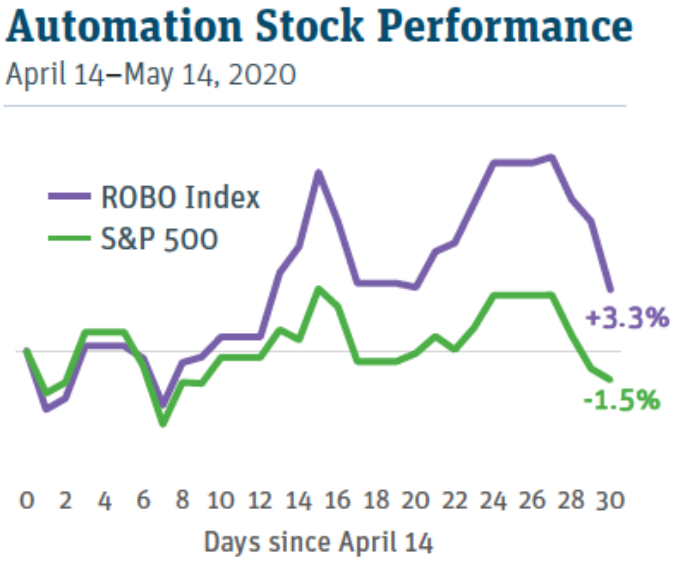
However, Santa Clara, Calif.-based SVB also observed that fewer but larger venture capital deals are being made. It described the potential for job displacement among less-educated workers, as well as policy proposals such as robot taxes and universal basic income (UBI).

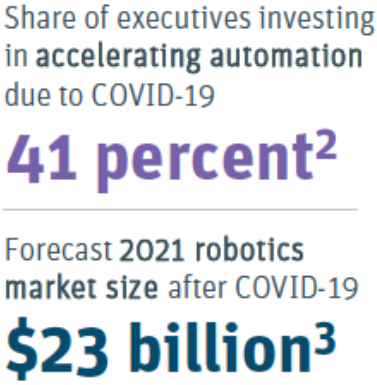
"Recessions tend to reduce employment, and some jobs don't come back," said the report, which said that the COVID-19 crisis could accelerate economic shifts. "This trend is glaring for U.S. manufacturing in the prior two downturns, as businesses reconsidered their supply chains and looked to move production offshore or to automate. The pandemic's effect on global supply chains has made the offshoring option problematic, increasing the likelihood that this cycle will see an increase in investment in automation."

Discussing report details

Austin Badger, director of frontier tech at SVB and co-author of the report, replied to the following questions from The Robot Report:

According to "The Future of Robotics," automation stock performance has not increased overall by much, even though almost half of executives expect to invest in robotics. Is this then a longer-term trend?





Footnotes: 2. Based on Ernst & Young survey results, released 3/30/2020, 3. Based on ABI Research study relased 4/2/2020. Source: SVB

Badger: The focus of this insight is indeed the long term, but 4% relative performance versus the S&P [Standard & Poor's index] during a bear market is certainly something to write home about. The dates shown cover a tumultuous time in the markets, as lockdowns persisted and the economy braced for recession.

It's also highlighting the acceleration of a trend already in process. Actions that may have taken years are now occurring in months. Outsize performance is not to be expected in most categories, with the exception of some isolated segments such as remote work tech and some healthcare-related stocks.

With the Fourth Industrial Revolution upon us, what industries will automation affect most? Is it mainly manufacturing?

Badger: Industrial automation — manufacturing, construction, supply chain-related, and agriculture — are still the areas for which robotics is most relevant. These segments have seen the largest, most successful companies and the most notable exits. However, we do expect Industry 4.0 to coincide with new growth in the consumer and service segments, with some key examples being **food tech** and frontier robotics companies.

The SVB report describes the increasing number of robots in China as "impressive" but "not tremendous." What does that mean for robotics suppliers and users? Will other nations — such as the U.S. — pick up the slack?

Badger: The "not tremendous" comment alludes to the fact that 18% CAGR [compound annual growth rate] is a five-year doubling rate – likely too slow to support a massive industrial robotics industry if all firms are focusing on satisfying new demand.

Further, this growth is expected to halve over the next four years. Our take is that robotics suppliers will have an opportunity to build robots that replace the existing stock, as opposed to increasing the existing stock. This dramatically increases the TAM [total addressable market] in discussion. Consider that industrial robotics has been around for decades; thus, it is plausible that many robots on factory floors need an update.

You mention emerging "category leaders" in robotics investments — can you give some examples? With fewer but bigger deals, what does this mean for innovation?

Badger: A climbing median deal size indicates that companies are maturing. As this occurs, we have seen specific segments become represented by a small handful of leading startups. For instance, Bossa Nova Robotics, 6 River Systems, Fabric, and a couple others are leading startups in industrial/supply chain.

As for innovation, this is an interesting problem. A strong early-stage environment encourages innovation by presenting competitive risk to established later-stage firms who want to avoid being usurped.

However, recent research at the NBER [National Bureau of Economic Research] showed that early-stage innovation is highly pro-cyclical – that is to say that recessions badly deplete innovation among early-stage companies – while later-stage innovation is more stable. Thus, more concentration at the late stage might make for more stable innovation in robotics in the coming years.

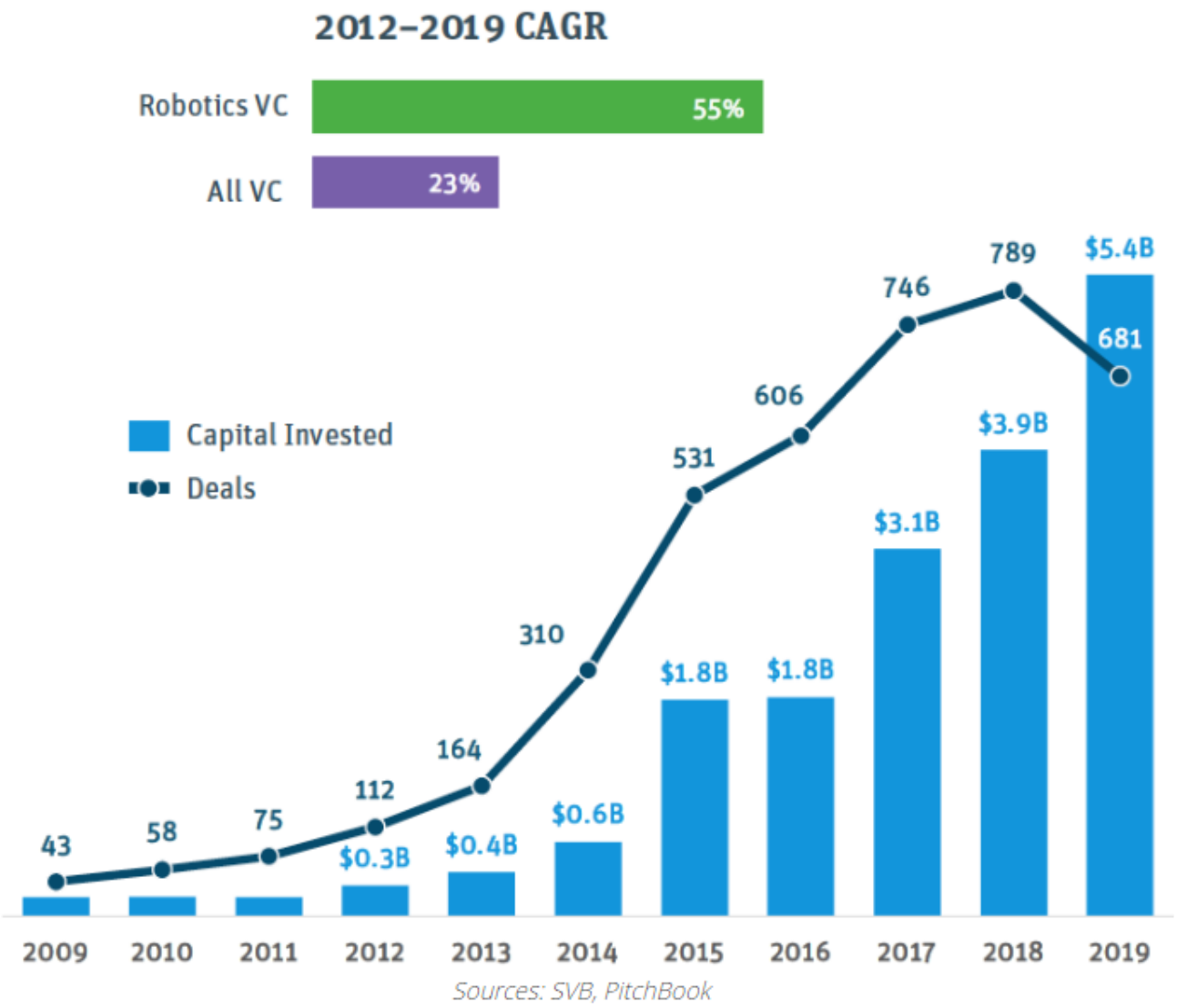
Also, it's worth noting the late-stage stabilization occurs in all maturing markets, and has also been present in our recent data of overall VC investment.

The U.S. and China are leaders in venture capital investment. While China leads in robotics use, is the U.S. mainly exporting robots?

Badger: While data on orders for American-made robots is not public, we do know that China is by far the largest end user of industrial robots, with the U.S. market less than one-third as large.

One benefit of industrial automation, however, is its ability to enable production reshoring by achieving cost parity with cheaper labor abroad. This is another trend that could be accelerated by COVID-19 and could lead to rapid growth of the U.S. share of end users.

Global VC Investment in Robotics and Related Hardware



The SVB report discusses maximizing revenue per robot versus diversification — is this about commoditization, risk, or economies of scale?

Badger: Risk, specifically risk of a single contract cancellation causing a substantial drop in revenue.

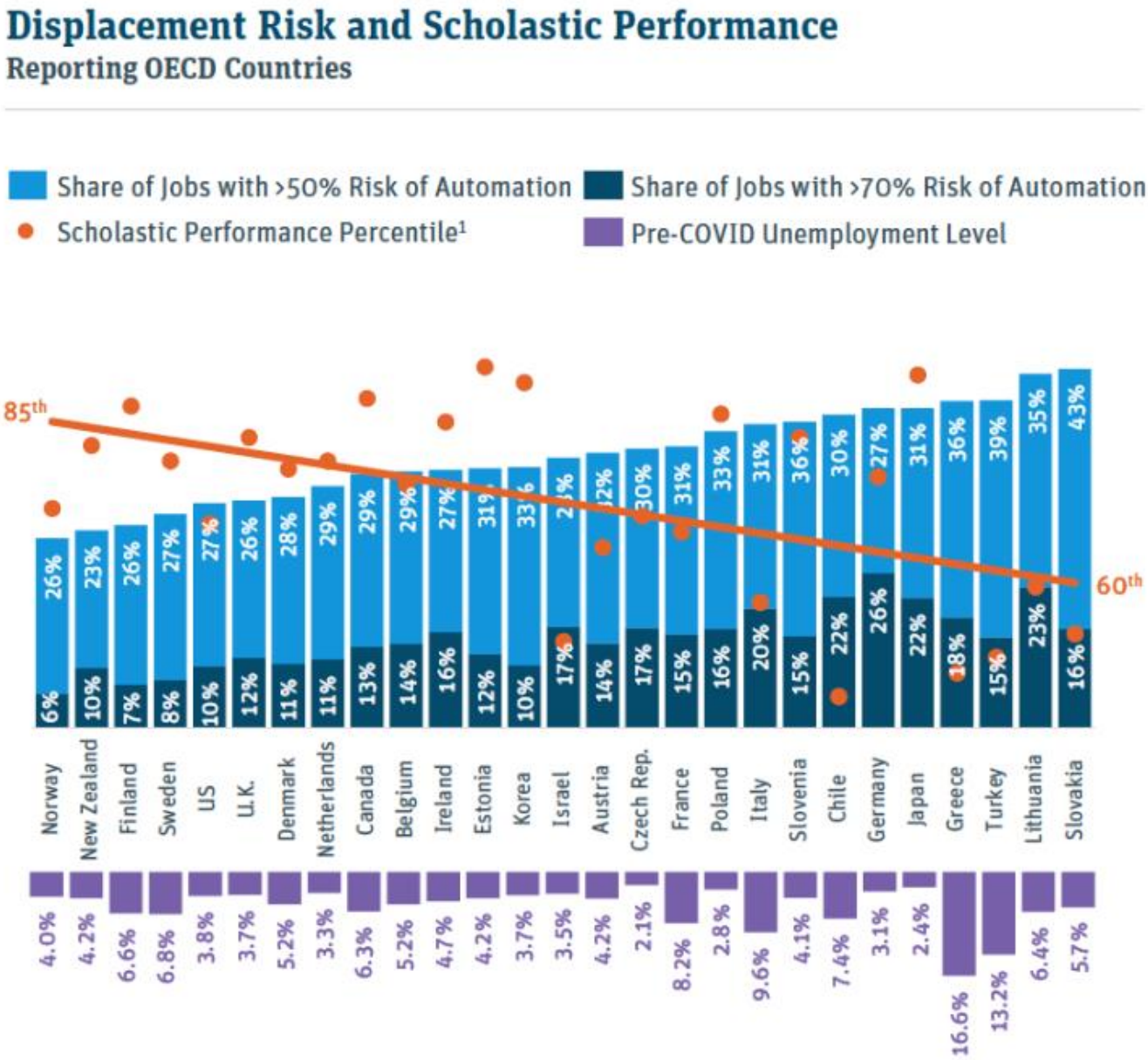
You mention several major acquisitions, mostly around mobile robots in logistics and agriculture. Does this reflect maturity of the platforms or the readiness of each vertical for automation?

Badger: We interpret it as a reflection of large incumbents' appraisal of later-stage robotics startups as competitive risks, as well as a confirmation of their innovative quality – essentially, their tech is worth the multi-hundred-million acquisition costs.

One chart in the report shows the decline in U.S. manufacturing productivity and employment — is it because of too much automation, or too little?

Badger: The chart shows that productivity and employment are inversely correlated – when productivity has gone up, employment has gone down. This is not a commentary on too much or too little automation. Generally, automation increases productivity. Many techno-optimists have assumed that this will naturally increase unemployment. In manufacturing, this has not been the case.

Where does the metric "Share of jobs with >50% or 70% risk of automation" come from? Aren't low-skill jobs already vulnerable to offshore outsourcing?



Notes: 1) Measured by mean cumulative Programme for International Student Assessment (PISA) score. Percentiles based on all countries participating in the PISA assessment program, not just those shown.
Source: OECD, SVB

Badger: The automation risk data comes from the OECD [Organisation for Economic Co-operation and Development, which] characterized employment categories as more or less susceptible based on metrics like high or

low skills, as you suggest. It is true that many low-skill jobs have already been offshored, but offshoring is not feasible for others, such as truck drivers.

The SVB report mentions the concept of how the introduction of automated teller machines (ATMs) did not initially lead to fewer bank jobs. Since both employment and automation have risen in the past few years, at least until the COVID-19 crisis, what's the actual correlation between them?

Badger: In the case of the ATM, you have had continued growth in the automating technology — ATMs — but a decline in employment. We don't have a general take on the relationship between automation and employment, but wanted to present a counterpoint to the ATM argument, which cites that the growth of ATMs did not reverse, but actually increased bank teller employment – this has ceased to be the case since the Great Financial Crisis.

Proponents such as Microsoft co-founder Bill Gates and presidential candidate Andrew Yang have proposed robot taxes and UBI in reaction to a growing wealth gap. How much of the current gap in the U.S. is attributable to automation or to other causes, such as tax policies?

Badger: The determinants of inequality are outside the scope of our research for this report, but there are strong arguments for both of the causes you mention.

Facebook AI Research applies Transformer architecture to streamline object detection models

By Khari Johnson

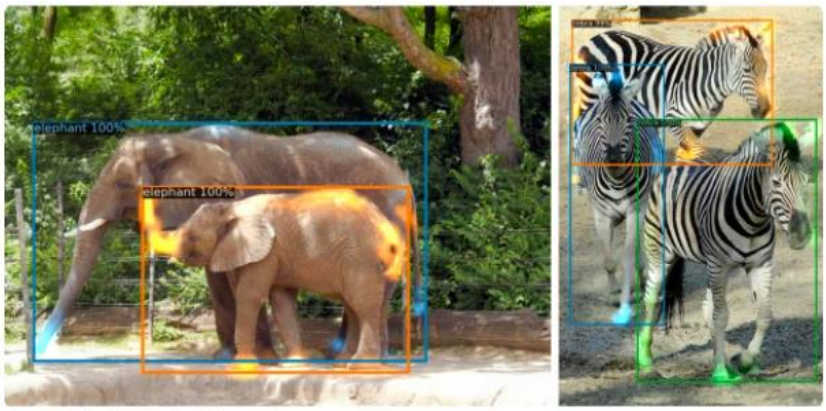


Image Credit: Facebook AI Research

A team of 6 members of Facebook AI Research (FAIR) tapped the popular Transformer neural network architecture to create end-to-end object detection AI, an approach they claim streamlines the creation of object detection models and reduces the need for handcrafted components. Named Detection Transformer, aka DETR, the model can recognize objects in an image in a single pass all at once.

DETR is the first object detection framework to successfully integrate the Transformer architecture as a central building block in the detection pipeline, FAIR said in a blog post. The authors added that Transformers could revolutionize computer vision as it did natural language processing in recent years, or bridge gaps between NLP and computer vision.

"DETR directly predicts (in parallel) the final set of detections by combining a common CNN with a Transformer architecture," reads a FAIR paper published Wednesday alongside the open source release of DETR. "The new model is conceptually simple and does not require a specialized library, unlike many other modern detectors."

Created by Google researchers in 2017, the Transformer network architecture was initially intended as a way to improve machine translation, but has grown to become a cornerstone of machine learning for making some of the most popular pretrained state-of-the-art language models, such as Google's BERT, Facebook's RoBERTa, and many others. In conversation with VentureBeat, Google AI chief Jeff Dean and other AI luminaries declared Transformer-based language models a major trend in 2019 they expect to continue in 2020.

Transformers use attention functions instead of a recurrent neural network to predict what comes next in a sequence. When applied to object detection, Transformer is able to cut out steps to building a model, such as the need to create spatial anchors and customized layers.

DETR achieves results comparable to Faster R-CNN, an object detection model created primarily by Microsoft Research that's earned nearly 10,000 citations since it was introduced in 2015, according to arXiv. The DETR researchers ran experiments using the COCO object detection data set as well as others related to panoptic segmentation, the kind of object detection that paints regions of an image instead of with a bounding box.

One major issue the authors say they encountered: DETR works better on large objects than small objects. "Current detectors required several years of improvements to cope with similar issues, and we expect future work to successfully address them for DETR," the authors wrote.

DETR is the latest Facebook AI initiative that looks to a language model solution to solve a computer vision challenge. Earlier this month, Facebook introduced the Hateful Meme data set and challenge to champion the creation of multimodal AI capable of recognizing when an image and accompanying text in a meme violates Facebook policy. In related news, earlier this week, the Wall Street Journal reported that an internal investigation concluded in 2018 that Facebook's recommendation algorithms "exploit the human brain's attraction to divisiveness," but executives largely ignored the analysis.

Big tech companies are adopting a new security model called confidential computing to protect data while it's in use

By Fahmida Y Rashid

A handful of major technology companies are going all in on a new security model they're calling confidential computing in an effort to better protect data in all its forms.

The three pillars of data security involve protecting data at rest, in transit, and in use. Protecting data at rest means using methods such as encryption or tokenization so that even if data is copied from a server or database, a thief can't access the information. Protecting data in transit means making sure unauthorized parties can't see information as it moves between servers and applications. There are well-established ways to provide both kinds of protection.

Protecting data while in use, though, is especially tough because applications need to have data in the clear—not encrypted or otherwise protected—in order to compute. But that means malware can dump the contents of memory to steal information. It doesn't really matter if the data was encrypted on a server's hard drive if it's stolen while exposed in memory.

Proponents of confidential computing hope to change that. "We're trying to evangelize there are actually practical solutions" to protect data while it's in use, said Dave Thaler, a software architect from Microsoft and chair of the Confidential Computing Consortium's Technical Advisory Council.

The consortium, launched last August under the Linux Foundation, aims to define standards for confidential computing and support the development and adoption of open-source tools. Members include technology heavyweights such as Alibaba, AMD, Arm, Facebook, Fortanix, Google, Huawei, IBM (through its subsidiary Red Hat), Intel, Microsoft, Oracle, Swisscom, Tencent, and Vmware. Several already have confidential computing products and services for sale.

Confidential computing uses hardware-based techniques to isolate data, specific functions, or an entire application from the operating system, hypervisor or virtual machine manager, and other privileged processes. Data is stored in the trusted execution environment (TEE), where it's impossible to view the data or operations performed on it from outside, even with a debugger. The TEE ensures that only authorized code can access the data. If the code is altered or tampered with, the TEE denies the operation.

Many organizations have declined to migrate some of their most sensitive applications to the cloud because of concerns about potential data exposure. Confidential computing makes it possible for different organizations to combine data sets for analysis without accessing each other's data, said Seth Knox, vice president of marketing at Fortanix and the outreach chair for the Confidential Computing Consortium. For example, a retailer and credit card company could cross-check customer and transaction data for potential fraud without giving the other party access to the original data.

Confidential computing may have other benefits unrelated to security. An image-processing application, for example, could store files in the TEE instead of sending a video stream to the cloud, saving bandwidth and reducing latency. The application may even divide up such tasks on the processor level, with the main CPU handling most of the processing, but relying on a TEE on the network interface card for sensitive computations.

Such techniques can also protect algorithms. A machine-learning algorithm, or an analytics application such as a stock trading platform, can live inside the TEE. "You don't want me to know what stocks you're trading, and I don't want you to know the algorithm," said Martin Reynolds, a technology analyst at Gartner. "In this case, you wouldn't get my code, and I wouldn't get your data."

Confidential computing requires extensive collaboration between hardware and software vendors so that applications and data can work with TEEs. Most confidential computing performed today runs on Intel servers (like the Xeon line) with Intel Software Guard Extension (SGX), which isolates specific application code and data to run in private regions of memory. However, recent security research has shown that Intel SGX can be vulnerable to side-channel and timing attacks.

Fortunately, TEEs aren't available only in Intel hardware. OP-TEE is a TEE for nonsecure Linux Kernels running on Arm Cortex-A cores. Microsoft's Virtual Secure Mode is a software-based TEE implemented by Hyper-V (the hypervisor for Windows systems) in Windows 10 and Windows Server 2016.

The Confidential Computing Consortium currently supports a handful of open-source projects, including the Intel SGX SDK for Linux, Microsoft's Open Enclave SDK, and Red Hat's Enarx. Projects don't have to be accepted by the consortium to be considered confidential computing: For example, Google's Asylo is similar to Enarx, and Microsoft Azure's confidential computing services support both Intel SGX and Microsoft's Virtual Secure Mode.

Hardware-based TEEs can supplement other security techniques, Thaler said, including homomorphic encryption and secure element chips such as the Trusted Platform Module. "You can combine these technologies because they are not necessarily competing," he said. "Are you looking at the cloud or looking at the edge? You can pick which techniques to use."

This article appears in the June 2020 print issue as "The Rise of Confidential Computing."

Who's Really Hiring in Tech Right Now

By Kate Clark, Amir Efrati, Alex Heath and Kevin McLaughlin

Tech workers are facing a job market that seemed unthinkable six months ago. They're getting fired over Zoom, whipsawed by phantom job listings and finding that aggressive recruiters have suddenly gone quiet.

Yet certain tech companies are scouting for and hiring employees. These include large companies like Facebook and Amazon, midsize public firms such as Pinterest and ServiceNow, and smaller startups such as design software maker Figma. Several self-driving car companies, including a Hyundai-affiliated joint venture, are flush with new capital that will allow them to recruit specialized engineers.

Some tech companies have sidestepped the pressure to cut costs. After Facebook's revenue growth slowed in the first quarter, ad sales started to stabilize in April. In the past few weeks, Facebook has released a slew of new products, including a shopping hub. It now says it plans to hire up to 10,000 people for product and engineering roles this year.

Hiring for teams working on commerce and video features has been "supercharged in recent weeks and months," Miranda Kalinowski, **Facebook**'s global head of recruiting, said in a recent interview.

For cloud computing providers like **Amazon Web Services**, as well as companies whose products help with remote work, such as **Slack** and **Tandem**, shelter-in-place mandates have boosted business. They're also finding the downturn has made it easier to recruit.

"The fight for great candidates in places like San Francisco and Toronto has lessened a little bit," said Jennifer Tejada, CEO of 700-person **PagerDuty**, which sells a cloud-based service to help IT teams respond to problems like site outages. It plans to hire more than 50 new employees, including developers, data scientists and sales professionals, this fiscal quarter. It's open to having staff work remotely.

"I've said to a number of other CEOs, 'If you're going through layoffs, send your people our way,'" she said. Here are other tech companies that are hiring, according to executives and other company representatives interviewed by The Information staff.

Cloud, SAAS and Enterprise
The shift of companies to working from home during the Covid-19 pandemic is translating into increased sales and hiring plans for some providers of software as a service.

ServiceNow's shares have vaulted more than 30% this year. Remote-work mandates have prompted more companies to replace manual business processes, such as fielding support calls from customers, with ServiceNow's software, which handles these tasks automatically. In April, the Santa Clara, Calif.–based company announced it would not lay off any of its 11,000 employees this year, and also pledged to hire 1,000 new employees in the U.S. by year's end.

"The push toward digital transformation was important before Covid-19, and it's more important now," said Pat Wadors, the company's chief talent officer. Its open positions include about 600 product and engineering roles and 360 salespeople, Wadors said.

Twilio, which sells software for video and call center applications, has over 350 open positions, about 40% of which are engineering focused, said Christy Lake, chief people officer, in an emailed statement. Shares of the San Francisco–based company have doubled since the beginning of the year.

Slack currently has 183 open positions listed on its website, about one-third of which are engineering roles, said Robby Kwok, senior vice president of people. It has kept its hiring plans steady during the pandemic. "Part of the reason is that we have seen a surge in demand from customers who need help in becoming more distributed," Kwok said.

Zoom, whose videoconferencing service has been widely using while people shelter in place, is hiring "at a healthy rate" right now across all departments, according to a person with direct knowledge. Zoom currently has 119 open positions listed on its website, about one-third of which are engineering roles. A spokesperson declined to comment, citing the company's quiet period ahead earnings.

Atlassian, **Okta**, **Box** and **Dropbox** are also actively hiring new staff, according to company spokespeople.
As more companies permanently shift to remote work, startups like **Tandem** are also looking for new talent. Tandem graduated from the Y Combinator startup accelerator last year and raised $7.5 million from Andreessen Horowitz to build the digital office of the future. Now it's looking for four engineers to add to its eight-person team to build products, including a video communication tool, CEO Rajiv Ayyangar told The Information.

Larger startups in the space are recruiting, too. These include **Automattic**, the company behind the blogging tool WordPress. Automattic was already operating remotely and is backed by nearly $600 million in venture capital funding, according to PitchBook. A spokesperson for the company said it was hiring for 30 positions, a majority of them in engineering, marketing or business development.

GitLab, a $2.75 billion (valuation) maker of software for developers, is hiring across 40-plus roles, says a spokesperson.

Consumer Tech
Big Internet companies that were avid recruiters for tech talent have in most cases cooled their hiring plans following the coronavirus shutdowns. One big exception is **Amazon**. The company is hiring for more than 25,000 corporate roles, in addition to its hiring plans for its fulfillment centers, according to a person with knowledge of its plans.

On Amazon's jobs website, roughly a third of the company's available corporate jobs are in software development, the most common category of open positions. The next biggest categories are solutions architects and a group identified as sales, advertising and account management.

These openings include positions at Amazon Web Services, the dominant cloud infrastructure provider. AWS "is continuing to hire at a rapid pace as our cloud computing services continue to be in demand during this critical time," said Jay Shankar, vice president of global talent acquisition, in an emailed statement.

Things are different over at Google, which is "significantly" slowing down its hiring after parent Alphabet increased head count nearly 19% in the first quarter over the number a year ago. Twitter, meanwhile, has told staffers it has slowed hiring except for key areas of the company, like its monetization efforts. Both companies have talked about a drop in ad sales in March.

Other consumer tech companies are weathering the downturn well enough to keep hiring plans afloat.

Pinterest said it's hiring for approximately 70 positions, mostly in engineering and products, with a focus on areas including machine learning, data science, shopping and ad relevance. The San Francisco company currently has 2,300 employees.
TikTok, which just hired a senior Disney executive as its CEO, lists more than 200 jobs on its website. "We continue to build out our presence in the U.S. in offices throughout the country, including [Los Angeles], Mountain View, Austin, New York and at least half a dozen other cities," a spokesperson said.

China's **Tencent**, owner of WeChat, is also hiring in the U.S. to support gaming, entertainment, partnerships and cloud services, a spokesperson said.

Canva, which sells a Web-based app for easily making graphics, is seeking 100 new employees in engineering, product management, operations and customer support. **Figma**, another design software company that just raised $50 million in new funding, is looking to hire 24 employees, a spokesperson said.

Also expanding head count is **Unity**, a gaming company backed with about $700 million in VC funding. Valued at $6 billion last year, the company said it has 410 open roles across its engineering, sales, human resources, marketing, IT, user experience and security teams.

Self-Driving Car Companies
After a decadelong hiring boom, the autonomous vehicle industry is retrenching through layoffs. Still, many companies in the field told The Information they are hiring.

Alphabet's **Waymo**, which already has been on a hiring binge and has the second-biggest robotaxi team by head count (1,500 people), wants to fill hundreds of additional positions across engineering, product, operations and business teams, mainly in the U.S., a spokeswoman says.

Hyundai and automotive component manufacturer **Aptiv** formed a joint venture in March that just received $2 billion in funding. The venture is looking for 210 new employees, mostly engineers, in Pittsburgh and Boston, which would bring its total head count to 1,000, a spokeswoman says.

Tesla's Autopilot, a driver assistance system that appears to generate enough revenue to support the cost of further development for the electric carmaker, is hiring for at least a few full-time software and hardware engineering positions. These include some for the machine learning team headed by well-known deep-learning researcher Andrej Karpathy, according to a recent recruit.

Argo AI, a self-driving car developer currently majority owned by Ford, will receive $1.6 billion in capital from its investors, which will soon include Volkswagen. The company, which currently has more than 800 employees, is trying to fill dozens of engineering positions in Palo Alto, Calif.; Pittsburgh; Detroit; and a town in New Jersey close to New York, according to a company spokesman.

These plans contrast with some recent cutbacks. In the U.S., about 500 people were recently laid off at companies including General Motors–controlled Cruise, Uber, Lyft and several startups, such as Zoox, which has been looking for a buyer.

Startups that raised funds in the past year or so are also hiring. These include **Aurora Innovation** (which among other roles is looking for a senior vice president of engineering), **Gatik** (which wants to double its staff to 50 in the next 12 months), **Phantom AI**, **Embark** and **Voyage**.

Some are cutting senior executive salaries at the same time. Embark CEO Alex Rodrigues says he and his co-founder each took a 50% pay cut in order to make up for the fact that the company's backup truck drivers, who help test its prototypes, were idled due to shelter-in-place orders.

Voyage, which is developing fully automated vehicles for retirement communities and towns, also temporarily cut the pay of its seven most-senior employees and founders by 20% in an effort to make sure its cash lasts through at least the end of next year, CEO Oliver Cameron said.
"It felt like the circumstances called for hunkering down for winter," Cameron said.

The Takeway

** Amazon and Facebook are among the big Internet companies accelerating hiring plans*
** Demand for remote-work services has boosted recruiting plans at ServiceNow, Twilio and other cloud companies*
** Self-driving car startups are using new cash injections to hire*

The secret to trustworthy data strategy

By Daniel Wu, Eugene Kolker, Leandro DalleMule, Barbara Cohn, Carlos Rivero

Shortly after its use exploded in the post-office world of COVID-19, Zoom was banned by a variety of private and public actors, including SpaceX and the government of Taiwan. Critics allege its data strategy, particularly its privacy and security measures, were insufficiently robust, especially putting vulnerable populations, like children, at risk. NYC's Department of Education, for instance, mandated teachers switch to alternative platforms like Microsoft Teams.

This isn't a problem specific to **Zoom** . Other technology giants, from Alphabet, Apple to Facebook, have struggled with these strategic data issues, despite wielding armies of lawyers and data engineers, and have overcome them. To remedy this, data leaders cannot stop at identifying how to improve their revenue-generating functions with data, what the former Chief Data Officer of AIG (one of our co-authors) calls "offensive" data strategy. Data leaders also protect, fight for, and empower their key partners, like users and employees, or promote "defensive" data strategy. Data offense and defense are core to trustworthy data-driven products.

While these data issues apply to most organizations, highly-regulated innovators in industries with large social impact (the "third wave") must pay special attention. As Steve Case and the World Economic Forum articulate, the next phase of innovation will center on industries that merge the digital and the physical worlds, affecting the most intimate aspects of our lives. As a result, companies that balance insight and trust well, Boston Consulting group predicts, will be the new winners.

Drawing from our work across the public, corporate, and startup worlds, we identify a few "insight killers" — then identify the trustworthy alternative. While trustworthy data strategy should involve end users and other groups outside the company as discussed here, the lessons below focus on the complexities of partnering within organizations, which deserve attention in their own right.

Insight-killer #1: "Data strategy adds no value to my life."
From the beginning of a data project, a trustworthy data leader asks, "Who are our partners and what prevents them from achieving their goals?" In other words: listen. This question can help identify the unmet needs of the 46% of surveyed technology and business teams who found their data groups have little value to offer them.

Putting this to action is the data leader of one highly-regulated AI health startup — Cognoa — who listened to tensions between its defensive and offensive data functions. Cognoa's Chief AI Officer identified how healthcare data laws, like the Health Insurance Portability and Accountability Act, resulted in friction between his key partners: compliance officers and machine learning engineers. Compliance officers needed to protect end users' privacy while data and machine learning engineers wanted faster access to data.

To meet these multifaceted goals, Cognoa first scoped down its solution by prioritizing its highest-risk databases. It then connected all of those databases using a single access-and-control layer.

This redesign satisfied its compliance officers because Cognoa's engineers could then only access health data based on strict policy rules informed by healthcare data regulations. Furthermore, since these rules could be configured and transparently explained without code, it bridged communication gaps between its data and compliance roles. Its engineers were also elated because they no longer had to wait as long to receive privacy-protected copies.

Because its data leader started by listening to the struggles of its two key partners, Cognoa met both its defensive and offensive goals.

Insight-killer #2: "Data strategy is too slow."
Trustworthy data leaders should consider which action provides the most value, adjusting for speed and risk. Prioritization helps address the critique posed by 62% of surveyed technology and business teams, which found their data groups work too slowly.'

Consider the prioritization strategy of one high-growth legaltech startup to advance both data defense and offense. Data strategists at this legaltech startup initially placed comprehensive risk mitigation above project speed and benefit. For instance, they tried to tackle dozens of data analytics projects and identify all possible risks in one go. The burdens on its partners were immense, who needed to source a number of data projects, stalling the project. Furthermore, new iterations were delayed due to the scale and complexity of the projects involved.

However, when the startup built off one pre-existing, validated customer analytics data project, the project moved forward. It did what agile product expert Matt LeMay calls "scouting and scaling." Neither a new project had to be sourced nor did new data had to be collected. Instead, marketing and customer success leaders got excited about combining their existing datasets with product metrics data already in the existing data project. The project owner sought to prioritize customer needs and product features better, furthering data offense and customer-centricity.

Yet to meet defensive goals, data strategists could not give anyone access to sensitive customer information. To address this legal risk without making the project too unwieldy, the strategists started with a scoped data policy that only controlled a few datasets, which reduced both the complexity and risk of the project. In particular, the policy allowed internal analysts to access data automatically when they met predefined access rules relating to their function and when they limited their use of data to the less-risky purpose of internal customer analytics. This was faster than an alternative proposal where analysts would have to request access to the data and receive manual approval. After the startup validated the utility of this policy, its no-code architecture could allow it to improve and scale the policy to more datasets, without significant technical and governance staffing.

Ultimately, prioritizing one project allowed the legaltech startup to advance not just privacy, a core defensive goal, but also an understanding of customer needs, a core offensive goal.

Insight-killer #3: "Data strategy makes my workflow more difficult."
Finally, trustworthy data leaders should consider what their partners enjoy and hate about their current workflow. 46% of technology and business teams find their data groups too difficult to work with. When data strategy becomes unbearably difficult, other teams will circumvent these rules to do their work, multiplying risks to customers and organizations.

To deal with problems like these, HotelTonight developed a data workflow to help multiple partners collaborate better, furthering both defensive and offensive goals. HotelTonight's Chief Data and Strategy Officer diagnosed that the company's data strategy was hampered by "the same problem you have in product" — diverse functional partners with different opinions about what should be prioritized. While this diversity of thought is core to offensive data strategies like product innovation, without appropriate management, misalignment leads to shifting priorities, confused workflows, wasted resources— and distrust. For the data team, this distrust ultimately meant that its internal partners "questioned its [data's] accuracy, a core component of data defense.

To address these issues, HotelTonight's chief data officer developed a workflow that would make partners' lives easier, not harder. First, she ensured one person owned the data product and process, fostering clear accountability to drive improvements. With a clear line of ownership in place, the data strategy team then sharply defined goals and metrics, fashioning shared vocabulary around offensive metrics like "revenue" and "website visit." Armed with accountability and a north star, she built a workflow that brought in partners at the right time to use their time effectively. The first priority was accuracy; the quality assurance team would now validate the quality of the data as it was ingested. Next, her team developed workflows to prioritize new issue backlogs and loop in teams responsible for technical solutions and user needs.

Her work paid off. Now, even if internal partners may not like the data, "no one" asks her team if the data is accurate.

Ultimately, by diagnosing problems in its data workflow, HotelTonight's chief data strategist improved accuracy, a key defensive issue, and an understanding of how to advance offensive goals like revenue.

Unfortunately, only 23% of companies commit resources to adoption-oriented workflow testing and learning like HotelTonight's, which McKinsey found is common to 90% of successful data programs. The best data strategies learn and evolve.

Ultimately, move fast and uplift your employees and customers.
At its heart, a successful data strategy requires organizational change. Leaders can accelerate change by drawing from the stories and emotions of their employees and customers.

Take the experience of Dr. Reddy's, one pharmaceutical company, to become more innovative and patient-centered. The CEO started by listening to the stories of diverse employees across the company, from janitorial staff to scientists. His questions asked what mattered most to them. Synthesizing these stories, the CEO developed a new motto: "Good health can't wait."

A new brand identity based on this motto unified the CEO's efforts to bolster data-driven innovations serving Dr. Reddy's customers. The company prioritized projects that would lead to quick wins, so that employees could sense how they were serving their patients and improving their health. This service "gives meaning to work, conjures individual emotion, and incites collective action," argues IDEO's managing director Bryan Walker and Stanford Business Professor Sarah Soule.

Moving forward, third-wave innovators can also anchor their data strategies to a mission that serves others, drawn from their own employee and customer stories. Whether they are improving the highly-regulated fields of healthcare, finance, or housing, these innovators can use data strategies that protect, fight for, and empower critical, but easily-forgotten, stakeholders, like users and workers.

To guide how leaders can apply these lessons to their initiatives, request access to the data strategy template here. This template helps leaders identify key problems, sharpen them, and identify methods to create cross-functional support for trustworthy, yet customer-centric data strategy.

Moving forward, data leaders must learn from Zoom — and not become victims of their own successes.
Zoom's quick response to pause the development of new features and instead prioritize privacy and security issues illustrated agile data leadership.

To avoid common data insight killers, leaders can ensure their strategies identify key needs, prioritize, make their partners' workflows better — and ultimately serve customers.
Don't move fast and break things.

DoD to invest $2.7 million in spectrum-sharing research

By Kelly Hill

At a 5G testbed in Salt Lake City, DoD funds will support advanced spectrum-sharing research

In the wake of DARPA's three-year Spectrum Collaboration Grand Challenge, the Department of Defense is continuing its investment in advanced spectrum-sharing technologies with a new $2.7 million project that will include live tests in a 5G New Radio network in Salt Lake City, to demonstrate how two mobile operators could operate in Citizens Broadband Radio Service spectrum simultaneously, while sharing existing CBRS spectrum tiers.

Zylinium Research, one of the top three teams from the final SC2 challenge (which was held at last October's Mobile World Congress event in Los Angeles), has been tapped to bring its artificial intelligence-powered decision engine to Salt Lake City's 5G NR testbed under the umbrella of the Platform for Advanced Wireless Research (PAWR) Project Office.

"When we started the PAWR program to develop and deploy four city-scale wireless testbeds across the country, it was with the intention of creating shared infrastructure to enable new research into advanced communications network technologies," said Joe Kochan, principal investigator and project director for the PAWR Project Office, in a statement. "We're gratified to be able to support the DOD's mission today to further network performance with greater spectrum sharing capabilities in the transition to 5G and beyond."

In Salt Lake City, the Platform for Open Wireless Data-driven Research — or POWDER — has been built with $17.5 million in funding to cover 2.3 square miles of the University of Utah campus, 1.2 square miles of downtown Salt Lake and a two-mile corridor connecting the two locations. Those locations potentially will reach up to 40,000 people.

At the virtual 5GX Connect event yesterday (May 28, 2020), Thyagarajan Nandagopal, deputy division director for the Division of Computing and Communications Foundation of the National Science Foundation, said that after the conclusion of the SC2 grand challenge, conversations started immediately on how to take the concepts from SC2 and put them into action in a real network, rather than an emulated one.

He said that when the testbeds were conceived in 2017, the input from industry was that, while they were investing in many 5G testbeds, they were focused on specific deployment use cases — but the possibilities of 5G were "so vast" that "they wouldn't be able to customize test beds to meet every design challenge that 5G networks would be conceived for." The four PAWR testbeds were designed to be used as proof-of-concept testing for unique aspects of 5G. The POWDER outdoor testbed in Salt Lake City, Utah is focused on how to meaningfully increase efficiency and creative use of the often-crowded airwaves below about 6-7 GHz. In New York City, another testbed is looking at the use of millimeter wave spectrum and beyond it, into even higher frequencies that are likely to be used in 6G (which has not yet been standardized). In Raleigh, North Carolina, a third testbed will be used to explore automotive and mobility-related technologies such as connected drones and autonomous vehicles. A fourth testbed is still in the awards process, but it will focus on rural broadband applications.

Existing networks, Nandagopal explained, are governed by extensive, manual human processes: human understanding of how signals travel, manual configuration for allocation of bandwidth, traffic prioritization and so on. The very way that spectrum is allocated — by auction, usually to a single license holder who may or may not utilize it at all times — is a very static and human process. Nandagopal said that some research has shown that 4G networks have around 5,000 parameters that have to be set and optimized by humans. If artificial intelligence can take over even some of those parameters, he added, there's evidence that networks could gain 30-40% in efficiency.

The Spectrum Collaboration Challenge sought to turn those paradigms on their head and hand over control of spectrum utilization to AI-driven, software-defined radios. Now, the DoD funding will take that initial work and build on it by bringing it into a live network.

CBRS is already a three-tiered spectrum-sharing framework, but the new project will explore how to share on a more granular level within the established tiers. The new project proposes "a new overlay capability in the CBRS band for 5G networks," which has been dubbed the "Zylinium Spectrum Exchange (ZSE)." This is not a Spectrum Access System, or a SAS replacement, but a more granular coordination system meant to act within the rules of the existing three tiers. The ZSE "coordinates spectrum usage at the scale of 5G resource blocks that are 180 kHz by 1 ms," according to PAWR, and is meant to "allow more spectrum sharing within these tiers, creating greater spectral efficiency while minimizing interference."

The ZSE was initially tested using the Colosseum, the enormous radio frequency emulation playground that was used for SC2 and brought to MWC Los Angeles last year. Zylinium's work in the near-term on ZSE will take place using the Colosseum, which now lives at Northeastern University, and the testing will move to the POWDER outdoor testbed later this year, after the necessary 5G-NR software stack has been completed.

PAWR said that the development of that software profile will also benefit other researchers, because once the profile is finalized, it will enable other researchers will be able to remotely set up a 5G network on the testbed and use it to conduct research "under real world conditions."

The latest embedded software technology moves hardware into an almost magical realm

By Adam Benzion

Aluminum and iconography are no longer enough for a product to get noticed in the marketplace. Today, great products need to be useful and deliver an almost magical experience, something that becomes an extension of life. Tiny Machine Learning (TinyML) is the latest embedded software technology that moves hardware into that almost magical realm, where machines can automatically learn and grow through use, like a primitive human brain.

Until now building machine learning (ML) algorithms for hardware meant complex mathematical modes based on sample data, known as "training data," in order to make predictions or decisions without being explicitly programmed to do so. And if this sounds complex and expensive to build, it is. On top of that, traditionally ML-related tasks were translated to the cloud, creating latency, consuming scarce power and putting machines at the mercy of connection speeds. Combined, these constraints made computing at the edge slower, more expensive and less predictable.

But thanks to recent advances, companies are turning to TinyML as the latest trend in building product intelligence. Arduino, the company best known for open-source hardware is making TinyML available for millions of developers. Together with Edge Impulse, they are turning the ubiquitous Arduino board into a powerful embedded ML platform, like the Arduino Nano 33 BLE Sense and other 32-bit boards. With this partnership you can run powerful learning models based on artificial neural networks (ANN) reaching and sampling tiny sensors along with low-powered microcontrollers.

Over the past year great strides were made in making deep learning models smaller, faster and runnable on embedded hardware through projects like TensorFlow Lite for Microcontrollers, uTensor and Arm's CMSIS-NN. But building a quality dataset, extracting the right features, training and deploying these models is still complicated. TinyML was the missing link between edge hardware and device intelligence now coming to fruition.

Tiny devices with not-so-tiny brains
The implications of TinyML accessibility are very important in today's world. For example, a typical drug development trial takes about five years as there are potentially millions of design decisions that need to be made en route to FDA approval. Using the power of TinyML and hardware, not animals, for testing models can speed up the process and take just 12 months.

Another example of this game-changing technology in terms of building neural networks is the ability to fix problems and create new solutions for things we couldn't dream of doing before. For example, TinyML can listen to beehives and detect anomalies and distress caused by things as small as wasps. A tiny sensor can trigger an alert based on a sound model that identifies a hive under attack, allowing farmers to secure and assist the hive in real time.

Why TinyML matters IRL
The huge need for inexpensive, easily deployable solutions for COVID-19 and other viruses is present for all of us and early detection of symptoms could have an immediate impact on millions of lives around the world. Today, using TinyML and a simple Arduino board, you can detect and be alerted to unusual coughing as a first defense mechanism for COVID-19 containment. In a recent showcase, Edge Impulse and Arduino published a project that had the power and simplicity of running TinyML on an Arduino Nano BLE Sense that could detect the presence of specific coughing

sounds in real-time audio, including a dataset of coughing and background noise samples. It could then apply a highly optimized TinyML model to build a cough detection system that runs in under 20 KB of RAM on the Nano BLE Sense. The project and the dataset were originally started by Kartik Thakore to help in the COVID-19 effort and was made available as an open-source repository on Hackster.io.

This same approach applies to many other embedded audio pattern matching applications. For example, childcare, elderly care, safety and machine monitoring.

TinyML is going to be everywhere

With 250 billion microcontrollers in the world today, and growing by 30 billion annually, TinyML is the best technology for performing on-device data analytics for vision, audio, motion and more. TinyML gives small devices the ability to make smart decisions without needing to send data to the cloud. Unlike the general ML monsters used by data scientists, TinyML models are small enough to fit into any environment — and that's why they will be everywhere.

The accessibility of TinyML for software developers and engineers is another key factor as to why this technology will be so pervasive. For example, software developers who want to build embedded systems using ML can build a model by tapping their iPhone as the edge device, using its sensors to capture the data. All you need to do in order to build your first model is sign into the data acquisition tab on Edge Impulse Studio, select your phone as the edge device, choose the accelerometer sensor, for example, and then click "Start sampling" while moving your phone up and down to generate the data and see it in a graph. It is that easy.

Take it from another interesting company, Syntiant, who have figured that low power, less cloud and better results rely on their new embedded hardware technology in a tiny form factor. This Silicon Valley startup is building a new processor for deep learning, dramatically different from traditional computing methods. By focusing on memory access and parallel processing, their Neural Decision Processors operate at efficiency levels that are orders of magnitude higher than any other technology. The company claims its processors can make devices approximately 200x more efficient by providing 20x the throughput over current low-power MCU solutions, and subsequently, enabling larger networks at significantly lower power. Be it Edge Impulse or Syntiant, the end result is the same – a better user and developer experience, otherwise known as "Wow" and "How did it do that?"

Back in the 1970s, there were predictions that by 2020 there would be generalized AI by now. We are not there with artificial intelligence, but the progress in solving concrete problems with ML has been amazing. Soon, embedded systems trained by TinyML will be everywhere you are, and will progressively get smaller, running at an extremely low power, measured in mW or even uW. It's becoming so popular that over 100 of the top leading technology companies, from Google to Microsoft, are adopting TinyML as the wave of the future.

Today and going forward, billions of tiny devices will act as an extension of our brains, feelings and emotions as a natural extension of everyday life. And with that, TinyML will impact every industry: retail, healthcare, transportation, wellness, agriculture, fitness and manufacturing.

Many people are finding it difficult to concentrate during the pandemic. Productivity experts have some tips and tricks for how to remain focused at work.

By Emily Dreyfuss

It is hard to concentrate in the middle of a pandemic. Even for people fortunate enough to be employed and working in a safe environment, distractions—painful, ceaseless—are everywhere. "It's just harder to do anything when you're stressed out, worrying the world's going to end," said Jaime Teevan, Microsoft's chief scientist for experiences and devices, who researches productivity.

But the work must go on, and for many companies, there is more work to do than ever, sometimes with smaller workforces in the wake of layoffs. So how to cope? After more than two months of sheltering in place, tech leaders and productivity experts have landed on some concrete steps people can take to harness their attention span, minimize distractions and not burn out while trying to function during the pandemic.

Don't Give In to Doom
Research shows that negative emotions narrow the ability to focus, but positive emotions can broaden it. When people feel good, they are more creative, thoughtful, adaptable and efficient. They can plan ahead.

It isn't easy to feel good during a pandemic, but it is possible to limit exposure to upsetting information. That's what Grace Marshall, a productivity ninja who works with corporate clients and author of the book "How to Be Really Productive," calls "being really mindful of the diet we feed our minds."

Brian Murphy, CEO of cybersecurity company ReliaQuest, embraces that approach. "I'm a big believer that how you think impacts how you feel, and how you feel impacts how you perform," he said. For years, Murphy has employed a mindset coach to teach ReliaQuest employees to notice what information they consume and how it makes them feel. As a result, Murphy said, employees are more productive, and the coaching has left everyone better able to handle the pandemic.

Understand Your Rhythms
People only have a few hours a day of "proactive" attention, according to Marshall. Those are the two or three hours when they are most creative and able to generate ideas. After that, most people have a few hours of what she calls active attention. This phase is a step down the creativity ladder, but still a time when people can thoughtfully catch up on email, tick tasks off a to-do list, or take calls and participate in videoconferences.

For many people, proactive attention peaks in the morning. When that's the case, Marshall says, resist the temptation to answer email as soon as the workday starts if it means squandering big-idea time.

She also suggests making a to-do list at the end of the day to know what to start with the next morning.

Embrace Microproductivity
One of the biggest impediments to productivity is how difficult it can be to get back into proactive flow, or even active attention, after getting derailed.

One trick for easing the transition back into a big project is what Teevan calls microproductivity, the act of breaking down your bigger tasks into smaller ones that can be completed individually.

“One of the challenges that I find is if I’m blocking out my calendar, and I say this is going to be work time, and if I turn off all my notifications, I actually still don’t do the big task that I’ve set aside for myself,” Teevan said, because starting on a large project feels hard. But if that project is broken down into small chunks, it is much more manageable to get going. And once you’re going, it’s easier to stay with it. “Having your attention somewhere is easy,” Teevan explained. “Transitioning your attention is hard.”

Microproductivity is especially suited for our current predicament, she said, while our attention is so fragmented.

Teevan first hit upon the idea when she was experiencing her own distracting circumstances. About 10 years ago, she was finishing her computer science Ph.D. at the Massachusetts Institute of Technology, working on artificial intelligence, while also raising four boys under the age of 4. Three were in diapers.

“I was doing research around how people get tasks done. And meanwhile, I was not getting anything done because it was impossible,” she said. All she had were snippets of free time before a baby would wake up. “And so I thought it would be really cool if I could use these micro moments and little scraps of time and have them add up to something that was a bigger task.”

Schedule Everything

Ara Katz, co-CEO of Los Angeles–based biotech Seed, schedules her breaks. Katz and her husband are a “two-startup household,” as she puts it, “so that requires some serious production on a daily basis.” Katz and her team put their lunches, as well as their yoga time, on their calendars. She and her husband finalize the family schedules on Sunday night. Their son’s preschool lessons go on the calendar, too. This sends the message from the top that it is OK to have a life and to work around it.

Cue Your Work Brain

Even after taking steps to maximize productivity, the constant strain of work and household demands, especially during this monumentally stressful time, can easily lead to burnout. One way to address it is to unblur the lines between home and work.

When Hunter Walk, partner at seed-stage venture firm Homebrew, is done working, he now closes his computer and puts it away, after his 8-year-old daughter pointed out that when the computer was out he had a tendency to keep working. “I started to think how in any profession, there’s this ritual of taking out your tools and then putting your tools back. And that suggests the start and end of something.”

Teevan has a bell on the door handle of her home office. It rings in the morning when she starts work, and in the evening when she closes the door for the night. This sound is a cue for herself, and her whole family, that her workday has begun and ended.

5G breaks from proprietary systems, embraces open source RANs

By Darrin Vallis

The days of a proprietary radio-access network are vanishing as carriers look for disaggregated systems, increasing flexibility while reducing cost.

Even though 5G has standards and is in deployment, it's very much still undergoing change. One such place where 5G is changing from its initial concept is in the space between the wireless aspect and the wired network that carries the bits. Because 5G must support several overall use cases, the need has arisen for a flexible architecture on the front end, just after the radio, known as the radio-access network (RAN).

Wireless carriers need a transport technology with greater complexity and significantly more hardware and software that they needed with LTE networks. Carriers need networks and network components easy and economical to deploy, have high reliability, and minimize power consumption. This need to control expenses has led to an industry-wide shift from 4G's dedicated hardware and proprietary software to open software stacks installed on open and commercial-off-the-shelf (COTS) hardware platforms.

4G's proprietary components

You can think of wireless networks in terms of the core and the RAN. The core encompasses the backbone plus metro and regional networks (Figure 1). The core aggregates data at the edge of the RAN, which transfers the aggregated data to the radio tower. Early networks used fixed switches and routers to direct data. The goal more recently has been to develop software defined networks (SDNs) that can be dynamically reconfigured to address changes in demand.

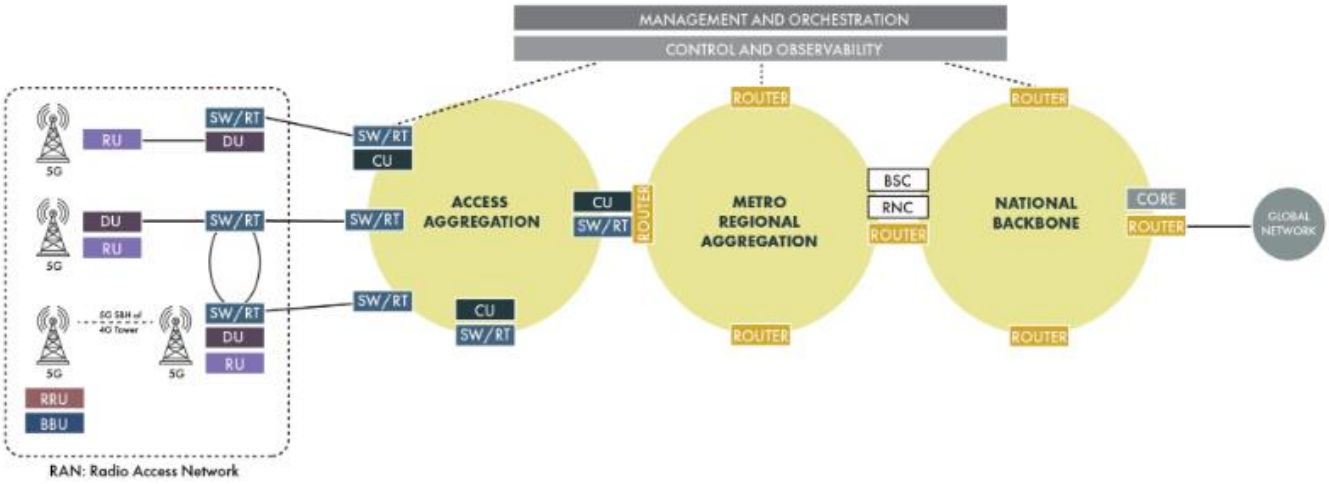


Figure 1. A wireless network consists of a radio-access network connected to an aggregation network and to a network core.

4G networks operate over the frequency band from 1 GHz to 4 GHz, using large-frame towers with fixed cell sizes. Each tower is equipped a baseband unit (BBU) that aggregates data from the core and communicates it to a tower's remote radio unit (RRU).

4G was largely implemented with custom hardware running proprietary software stacks. When a carrier chose an equipment vendor, it became a long-term commitment. That approach was tolerable for 4G networks but given 5G and the drive for lower total cost of ownership, carriers have begun developing open-source solutions. 5G's goal is interchangeable COTS ARM or x86 servers running open-source software stacks.

5G is different

The 5G network is substantially different from 4G LTE, beginning with frequency band. 5G picks up where 4G leaves off, spanning the spectrum from 6 GHz to 300 GHz. Higher frequencies support significantly smaller cell sizes, enabling 5G cells to provide highly localized coverage in locations such as neighborhoods, manufacturing plants, or even within houses and other structures.

5G disaggregates the 4G BBU into a radio unit (RU), distributed unit (DU), and centralized unit (CU) (Figure 2). Decoupling these functions brings carriers flexibility because they can co-locate the RU, DU, and CU or deploy them in different locations as needed. A network requiring the lowest possible edge latency may, for example, locate the RU, CU and DU together at the edge. This will maximize performance for far-edge-connected user applications. Unfortunately, such a configuration means that each tower includes environmentally controlled enclosures. Multiple RUs may be serviced by one DU, lowering network costs while providing adequate performance where longer latencies are acceptable. Carriers may deploy a mixture of architectures to target different markets and geographies.

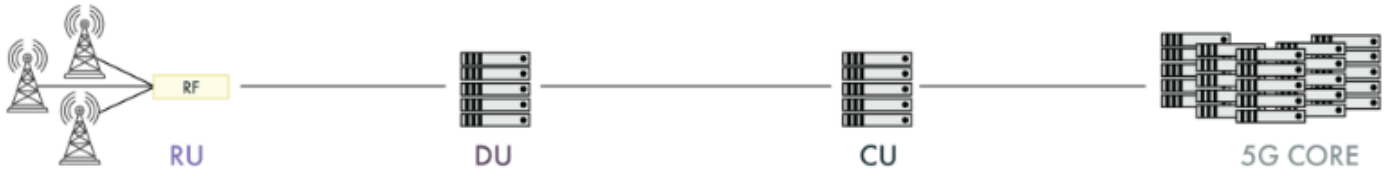


Figure 2. In a 5G network, the BBU can be dis-aggregated into radio unit (RU), distribution unit (DU), and centralized unit (CU).

Figure 3 shows a deeper view of 5G network hardware and interconnections.

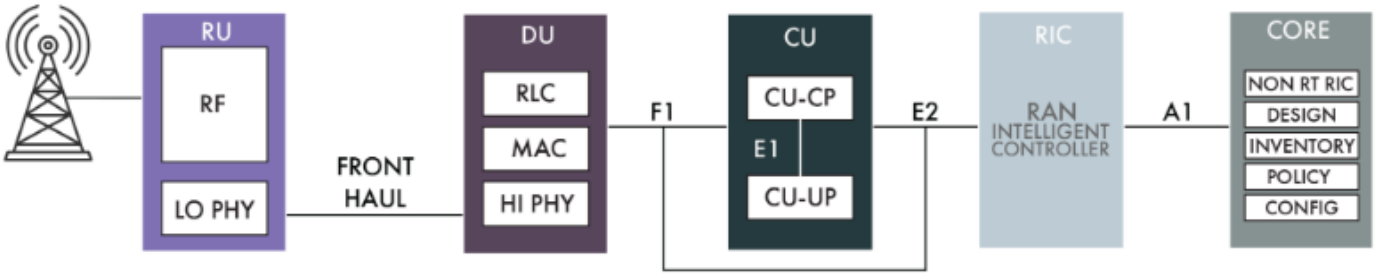


Figure 3. 5G networks split the baseband unit into an RU, DU, and CU.

The 5G RU consists of an RF transmitter and a LO PHY block, typically implemented as an FPGA or ASIC optimized for packet management. It operates at wireline speed and can deliver latencies of less than 1 ms. The RU connects to the DU in what's known as the fronthaul between the LO PHY and HI PHY.

The DU manages radio packet transmissions to and from the RU over the fronthaul link. The primary components of the DU are the radio link controller (RLC), the media access controller (MAC), and the HI PHY. The MAC incorporates software that communicates with the RLC and a hardware module that communicates with the PHY. It can incorporate hardware accelerators such as GPUs or FPGAs and can operate with a latency of less than 5 ms. The DU is connected to the CU over an F1 mid-haul interface. A DU COTS implementation would consist of a server chassis with hardware acceleration PCIe cards and an open-source MAC/RLC stack.

The CU consists of a control plane (CP) and a user plane (UP). The configuration mimics that of LTE, making it easier to integrate a 5G network with a 4G LTE network. Plus, it provides flexibility for unique 5G RAN configurations. The CP and the UP connect in the CU box as part of the CU. They can operate with latencies of around 10 ms.

The RAN Intelligent Controller (RIC) sits upstream from the CU. This function virtualizes the radio network into a series of functions accessible by upstream core controllers.

The shift toward open

The RU, DU, and CU include all of the functions and interfaces necessary for a software-defined network, or virtual RAN (vRAN). The network orchestration and automation layer at the core does, however, need software to manage the process. LTE networks manage this task through proprietary hardware and software. Cost constraints in 5G has inspired carriers for look for a standardized, open-source option that leverages COTS hardware. In response, four key open-source initiatives have emerged: the Akraino Edge Stack, the O-RAN Alliance, the Open Networking Automation Platform (ONAP), and the Open Computing Project (OCP).

The Akraino Edge Stack

Launched in 2018 and now part of the LF Edge Initiative, the Akraino Edge Stack focuses on developing open software stacks for the network edge. The organization emphasizes modular design, which enables reuse of software components. Known as Akraino blueprints, the stacks serve various subsets of the edge cloud infrastructure, including enterprise edge, over-the-top edge, provider edge, and carrier edge. When installed on "bare-metal" servers, the blueprints convert the machines into application-specific appliances.

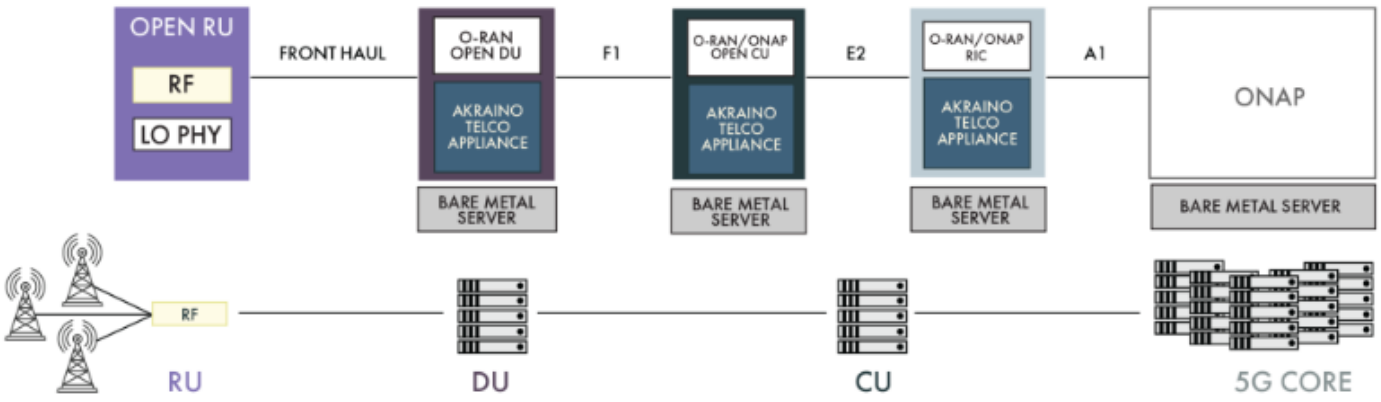
Akraino has multiple carrier blueprints in development as it works to create 5G telco appliances that speed RAN deployment. The group recently released the Akraino radio-edge cloud (REC) blueprint, which provides an essential component for the management and orchestration and automation layer to interface with the vRAN.

Running on a Linux CentOS distribution, the REC works with management and monitoring software containerized and managed with Kubernetes. The stack virtualizes a bare-metal server so that it can be abstracted as a software service. These APIs can be called by the overlying control layer, enabling it to interact with the data plane at the network layer.

The O-RAN Alliance

The O-RAN Alliance is dedicated to the realization of an open, intelligent RAN. The alliance is developing open virtualized network elements such as an open DU and open CU. As with Akraino, the focus is on building modular reference designs that are both reusable and standardized. The approach not only speeds integration and deployment, it lets developers skip writing code blocks for common functions, freeing them to spend time innovating.

The O-RAN effort is closely tied to the development of the Akraino blueprints. The idea is that the Akraino blueprints abstract the hardware layer and then the O-RAN/ONAP software stacks run on top of that and interface with the APIs (Figure 4).



One of the key software developments tackled by O-RAN is the RAN intelligent controller (RIC). The RIC provides an interface between the RAN controller at the 5G core and the access network, enabling policy-driven closed-loop automation. The RIC is the interface piece that converts the RU, DU, and CU into the vRAN, delivering faster, more agile services deployment and programmability.

The RIC is co-located with the CU. It is connected to the orchestration and automation stack at the core by backhaul and connected to the CU and the DU by midhaul. It will run atop the Akraino REC blueprint, which is optimized to minimize latency between the RIC and the DU/CU (Figure 5). The Akraino REC is integrated with the regional controller at the core edge to provide fully automated deployment of the REC to edge sites.

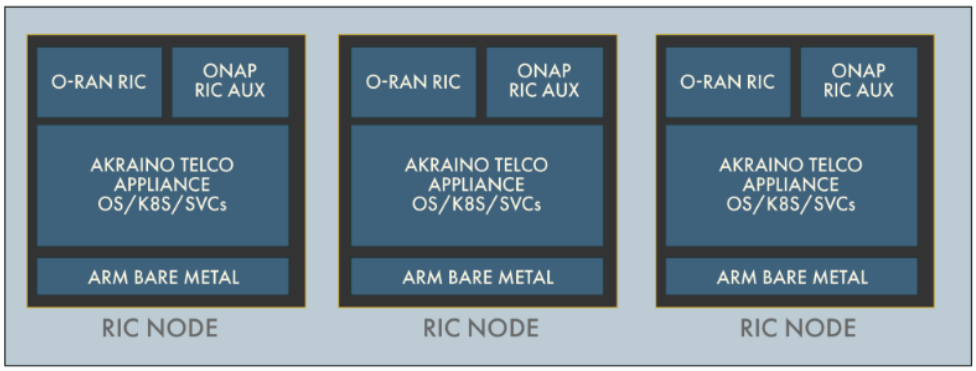


Figure 5. The O-RAN's RAN Intelligent Controller (RIC) can be implemented with the Akraino Radio Edge Cloud (REC) Blueprint.

The Open Networking Automation Platform (ONAP)

The 5G network is expected to support a variety of applications with dramatically different requirements. A mobile device streaming video can tolerate higher latencies but may be highly mobile. Smart factories don't move but demand the lowest possible latency. Automated vehicles present the dual challenges of ultrahigh reliability and ultralow latency. Other variables include bandwidth and cost. Effectively serving these diverse applications requires the ability to virtualize the network so that it can act as a collection of network slices, each of which can be dynamically reconfigured to provide the quality of service required by each application.

The building blocks discussed so far provide a means to create network slices, but they need a top-level control fabric at the core to orchestrate and manage services. The Open Networking Automation Platform (ONAP), an open-source networking project hosted by the Linux Foundation, was established to address this need.

ONAP is critical for 5G deployment. It supports orchestration, automation, and end-to-end lifecycle management of network services. It is highly complex and computationally intensive; running just one instance of ONAP requires 140 cores and 140 GB of RAM. ONAP interfaces with the RAN as shown in Figure 6.

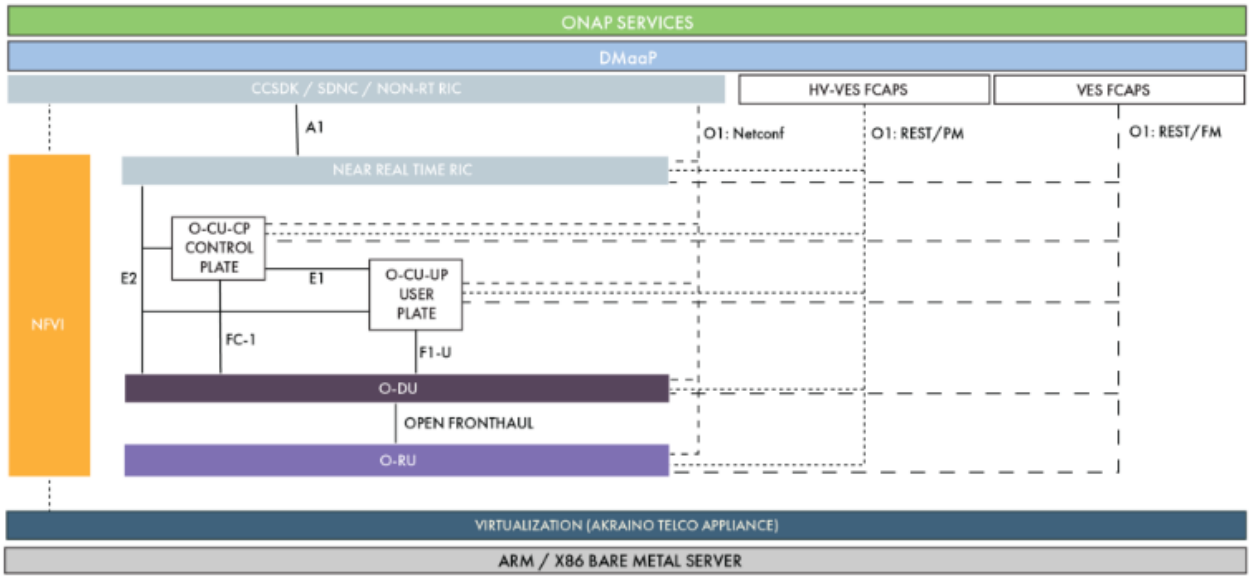


Figure 6. Software services and interfaces form the 5G network core.

The Open Compute Project

Creating interoperability in the networking world is required to standardize form factors and interfaces. The Open Compute Project (OCP) was launched to establish hardware specifications to achieve this standardization. One of the specifications to come out of the OCP is the openEDGE chassis (Figure 7). Its shallow form factor, low power requirements, and processing density are optimized for telco and edge applications.

Figure 7. The openEDGE chassis design is based on Open Compute Project standards. Its shallow form factor, low power requirements, and processing density are optimized for telco and edge applications

5G promises enormous performance improvements that could fundamentally change global communications. It provides telco operators the opportunity to create new markets and consumer services. To succeed in 5G, carriers need improved network equipment with flexibility, low total cost of ownership and fast time to market. Open 5G hardware and software enables these goals.

A version of this article originally appeared as a white paper "Understanding 5G Transport Networks."

Gaussin and Total developing 1st full electric aircraft refueler transporter; Saft batteries

Engineering company Gaussin and energy major Total are jointly developing the first full electric aircraft refueler transporter (ART FULL ELEC). Planned for the Airbus industrial site in Toulouse, this prototype will be capable of towing two fuel tankers, with a fuel capacity of 30 tons each. Delivery is expected at the end of 2020.

Electric Aircraft Refueler Transporter, equipped with two 30-ton fuel tanks (artist rendering – courtesy of Gaussin)

This partnership between Gaussin and Total will be drawing on the 40 years of know-how of Saft (a subsidiary of Total) in designing and producing batteries for electric & hybrid commercial and industrial vehicles. Saft will provide the lithium-ion batteries for this future fleet.

The batteries will be entirely developed and manufactured at Saft's facilities in Nersac and Bordeaux in the Nouvelle-Aquitaine region of France.

This first firm order will enable Gaussin to expand its offering on the electric vehicles market and Total to provide a solution adapted to the refueling business. It also paves the way for the development of a fleet of innovative vehicles, specifically dedicated to aviation.

Total is one of the world's biggest suppliers of aviation fuel, in France, in Europe and Africa. Total supplies 280 airlines in 300 airports around the world.

Gaussin designs, assembles and sells products and services in the transport and logistics field. Its know-how encompasses cargo and passenger transport, autonomous technologies allowing for self-driving solutions such as Automotive Guided Vehicles, and the integration of all types of batteries, particularly electric and hydrogen fuel cells.

With more than 50,000 vehicles worldwide, Gaussin enjoys a strong reputation in four fast-expanding markets: port terminals, airports, logistics and people mobility.

The group has formed strategic partnerships with major global players in order to accelerate its market penetration: Siemens Logistics in the airport field, Bolloré Ports and ST Engineering in ports, UPS in logistics and Bluebus for people mobility.

Global Venture Funding Through The Pandemic, Late-Stage Stays Strong

By Gene Teare

To understand the impact of the pandemic on global venture funding, we took a look at comparative trends for the first four months of each year from 2016 through to 2020.

The impact to technology companies was immediate, with transportation (Uber, Lyft), logistics (KeepTruckin), travel (Airbnb, OYO), real estate (Compass, Opendoor), marketing (Branch), retail (Rent the Runway, The RealReal), finance (Monzo, Metromile), media (Politico, Quartz, TheSkimm), and recruiting (Glassdoor, ZipRecruiter) all letting staff go as the business environment has changed directly or indirectly due to social distancing.

The practicalities of investing have also changed for venture firms; investing in companies without meeting face to face to develop a rapport is now the new way of doing business.

While this is a clarifying time for startups, it still provides opportunities for investors who have raised unprecedented funds in the last two years. The numbers bear this out, as we are not noticing a substantial downturn in funding yet.

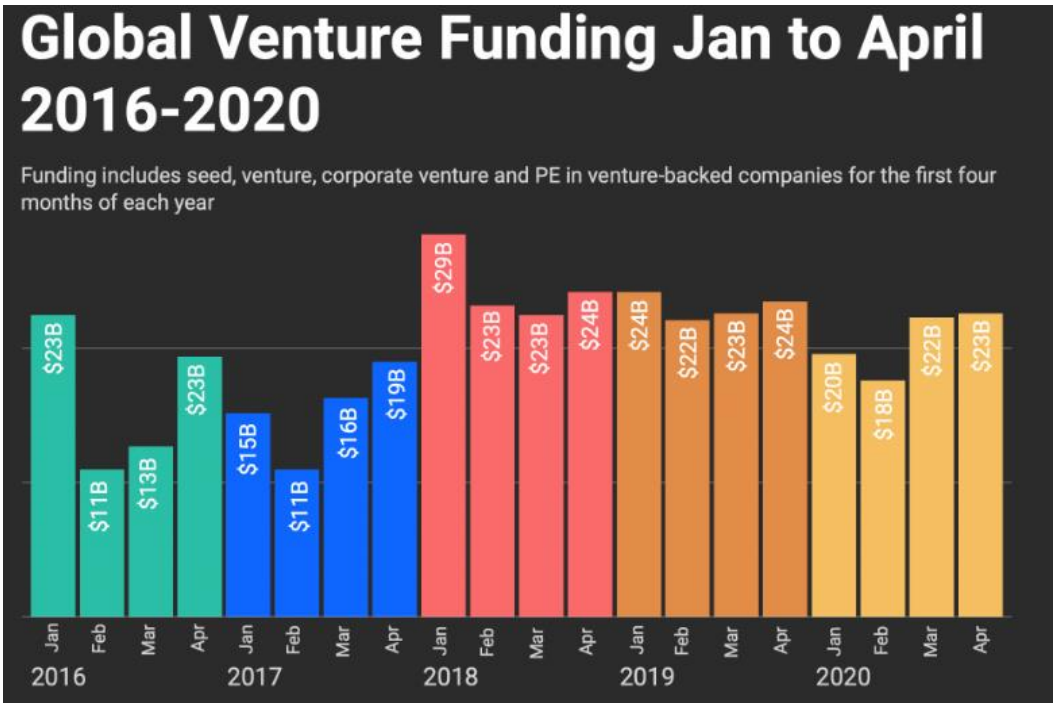
Global funding in the first four months of 2020 is down by 11 percent compared to the first four months of last year. It is worth noting, however, that this percentage may decline somewhat over time as data for the most recent months will cause numbers to rise, relative to the same timeframe in 2019.

And if you think January and February activity mirror that in March and April, you would be wrong. In the timeframe where social distancing took hold during March and April in most parts of the globe, funding increased by as much as $2 billion to $5 billion per month over the first two months of the year.

January through April highlights

- 2018 was an all-time high for global funding from January to April at $99 billion.
- January through April 2019 tracked at $93 billion.
- In 2020 we hit $82 billion in the same four-month timeframe.

For this study we include seed, venture, corporate venture and private equity rounds in venture-backed companies. See glossary of funding stages right.

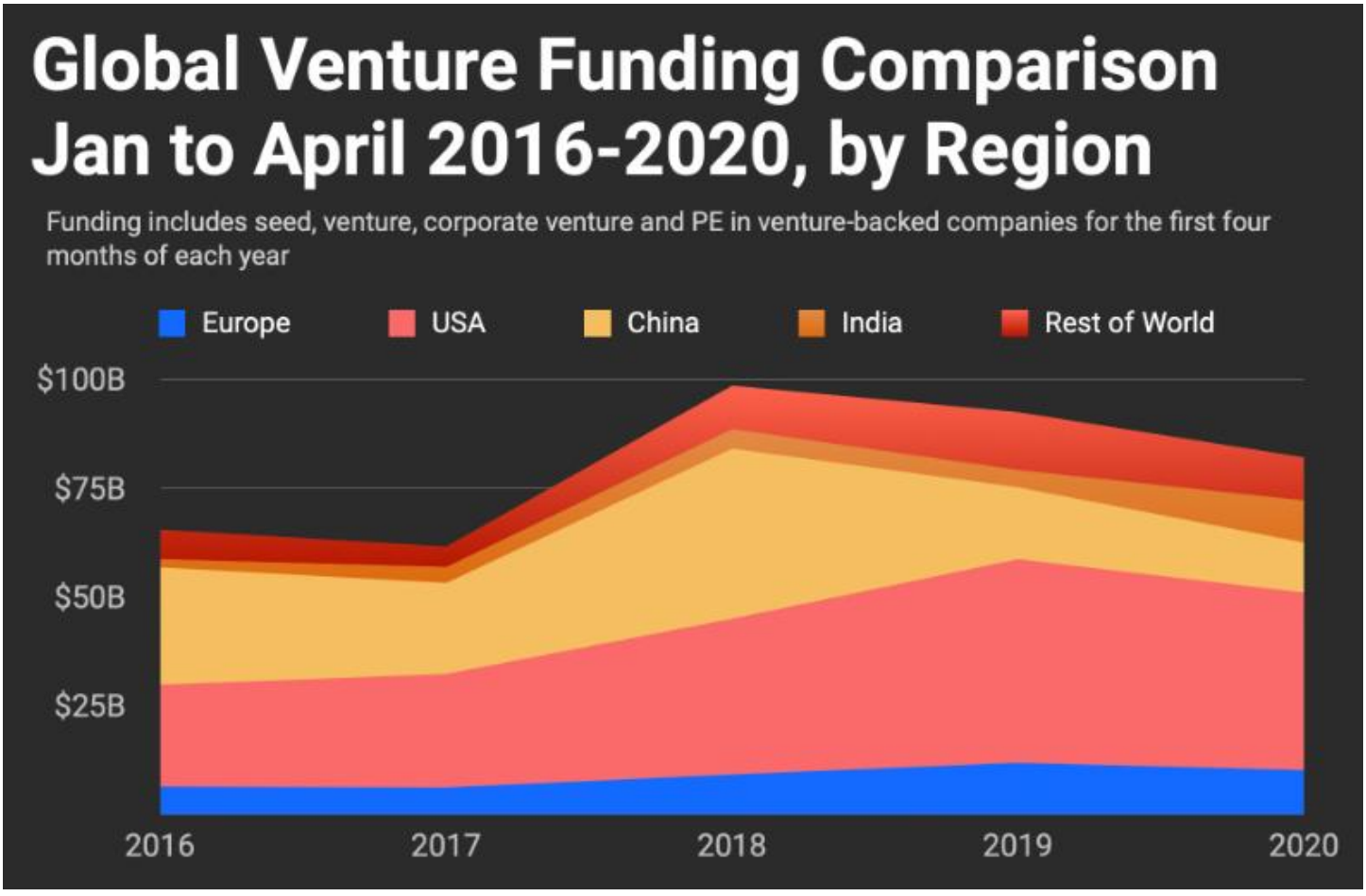


Huge regional differences
China contracted quite substantially in the first four months of the year, down 30 percent for 2020 and down 58 percent for 2019, when comparing year over year. The downward trend in funding in China, however, predated the crisis.

The U.S. and Europe show figures that are down by 13 percent when comparing 2020 to 2019. Both regions grew during the 2019 four-month time frame, over 2018's growth.

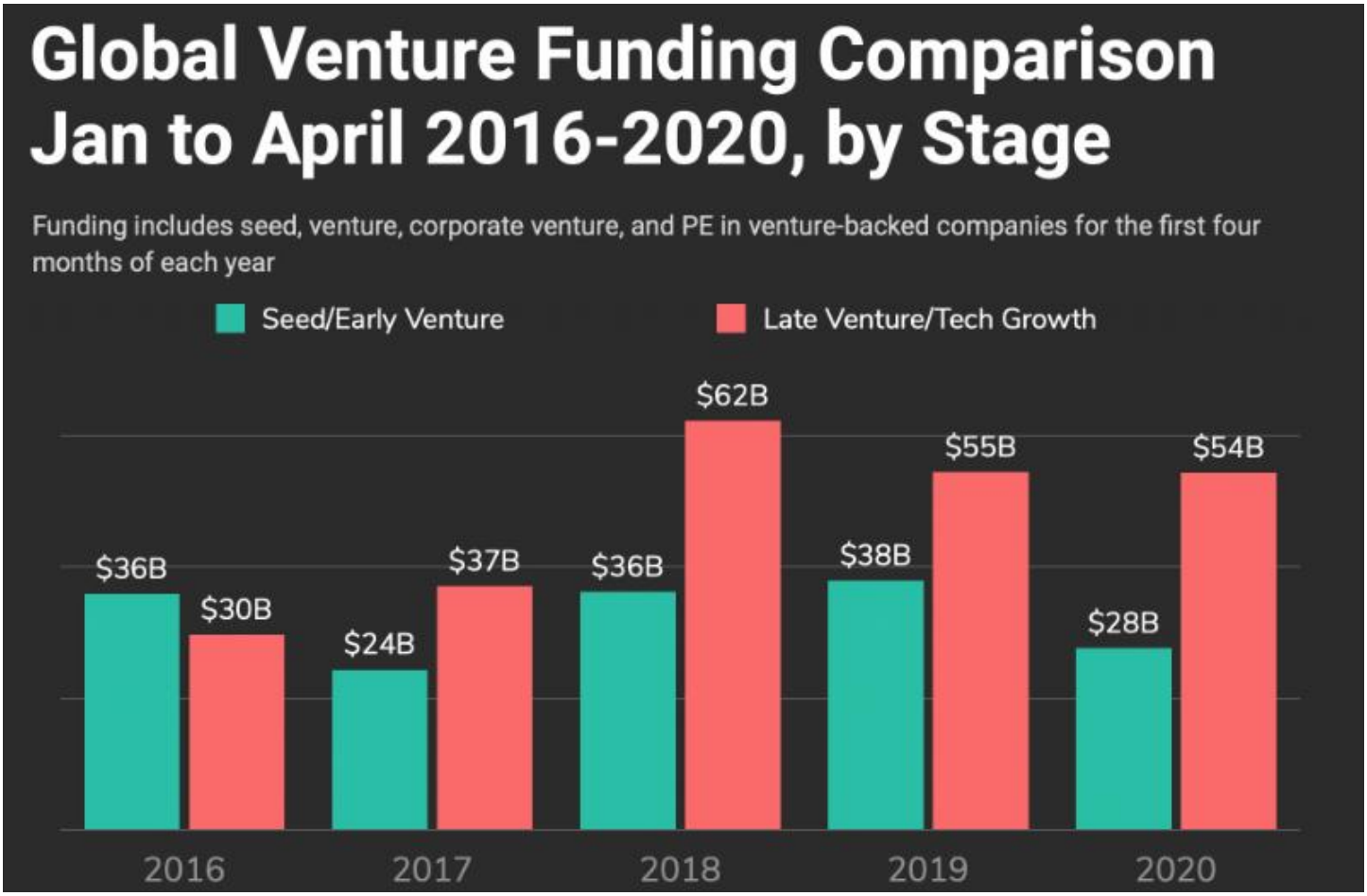
India saw the greatest increase for this time period; growing from $4 billion in 2019 to $9.7 billion in 2020. However, the increase is attributed to an investment in Reliance Jio in which Facebook gained a 10 percent stake.

The rest of the world was growing its share of venture in 2018 and 2019, but is down 26 percent year over year for 2020. Leading countries include Singapore, Indonesia, Israel, Canada, Australia, and Brazil. Of these, Indonesia, Brazil and Australia experienced the highest growth year over year in the first four months of 2020.



Late-stage stays strong
Seed funding is down 32 percent and early-stage funding down 26 percent for the four-month period. Given that seed has the largest data lag, however, we fully expect it to recover. For early-stage funding, we see a bigger pullback as the larger Series A and B rounds are announced in news cycles.

Late-stage venture rounds, plus technology growth, is stable year over year for this four-month timeframe at $54 billion with a greater share of overall dollars coming in at 66 percent versus 59 percent in 2019. Late-stage peaked in 2018 due to funding expansion in China, followed by a contraction in 2019.



For context, the 2008 financial crisis
In the 2008 financial crisis, seed as a newer investment class kept growing. The funding environment shifted dramatically for Series A, B and C rounds in 2009, down year over year by 40 percent, 41 percent and 46 percent, respectively. Funding levels took a couple of years to recover.

The pandemic is having a very different impact on venture funding this time around in contrast to 2008. Some leading technology stocks including Facebook, Netflix, Google, Amazon, Apple and Zoom, are performing well compared to a year ago despite the global crisis.

There is a growing awareness that leading technology companies emerge stronger given the trend of moving everything online.

Smartphones and cloud services are close to 15 years in adoption, with the additive spurt of shelter-in-place requirements locking us to our screens for friendship, entertainment, education, work, finances, health and shopping. In our recently published Opportunity Index we look at the sectors we believe will see renewed investor interest through the pandemic.

Glossary of funding terms
For reporting purposes, Crunchbase aggregates its funding data into "stages," reflecting the different phases of private company development. Rounds are classified by stage according to the following sets of rules.

- Seed-stage are composed of seed, pre-seed and angel rounds. Crunchbase also includes venture rounds of
- unknown series, equity crowdfunding rounds, transactions of undisclosed type, and convertible notes below $3 million or less.

- Early-stage consists of Series A and Series B rounds, as well as other round types. Crunchbase includes venture rounds of unknown series, transactions of undisclosed type, and convertible notes totaling above $3 million and $15 million.
- Late-stage consists of Series C, Series D, Series E and later-lettered venture rounds following the "Series [Letter]" naming convention. Also included are venture rounds of unknown series, transactions of undisclosed type and convertible notes above $15 million.
- Technology growth is a private-equity round raised by a company that has previously raised a "venture" round. (So, basically, any round from the previously defined stages.)

High-Accuracy DAQ System Supports Sensors with Different Output Signals

To address today's high-precision requirements, this solution combines a high-impedance input and programmable gain, and meets drift, offset, SNR, and linearity needs.

By Thomas Brand

Today's data-acquisition (DAQ) systems are a central element to more than just industrial applications. They're usually used for sensor-based measurements of temperature, flow, fill level, pressure, and other physical quantities, which are then converted to high-resolution digital information and communicated further for processing via software. Such systems require increasingly more precision. As a result, developers often wind up struggling to unite properties that have negative impacts to the system, such as signal noise and drift with requirements for high conversion and transmission rates.

High input impedances are typically required to directly connect different sensor types with correspondingly different analog signal outputs. In addition, the inputs should be able to buffer, amplify, and adjust levels of input signals. Or they also must be capable of generating differential signals to cover the complete voltage range of the analog-to-digital converter (ADC) inputs and simultaneously meet their common-mode voltage requirements. However, the original measurement signal should remain as undistorted as possible.

The input stage is, thus, one of the decisive factors for determining the overall accuracy of data-acquisition systems. Programmable-gain instrumentation amplifiers (PGIAs) are typically used for this purpose, which is how gain is usually adjusted via external resistors; the outputs are directly coupled to the inputs of a downstream ADC.

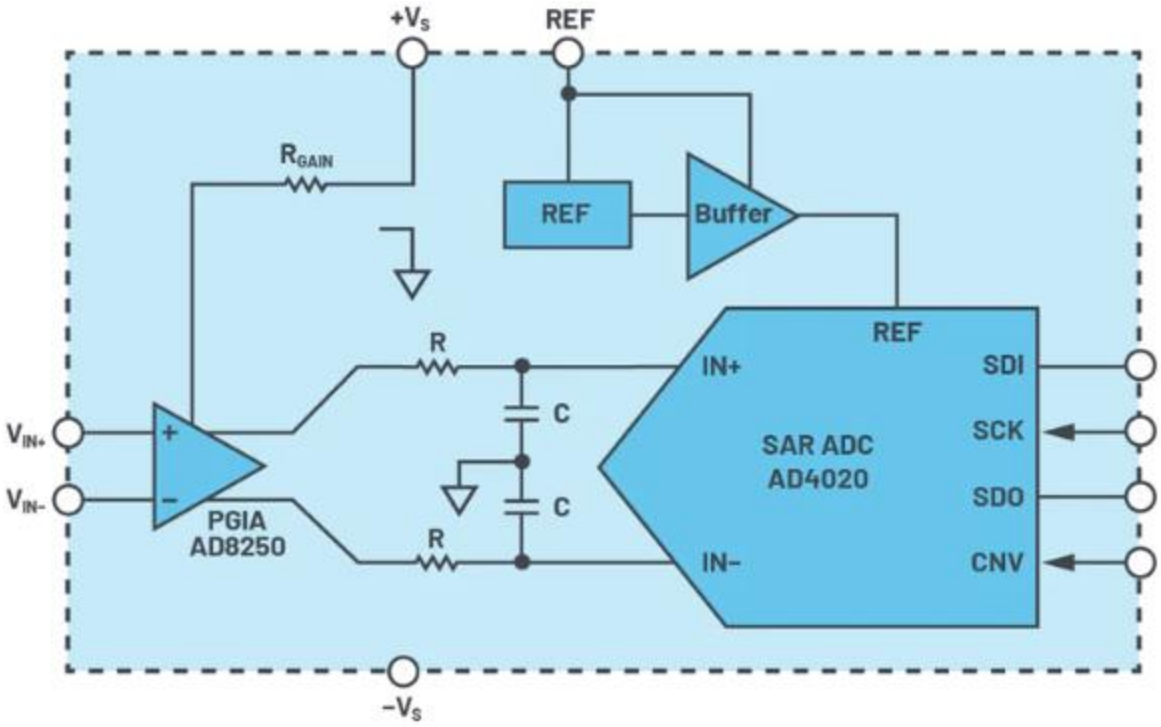
PGIAs are commonly equipped with single-ended outputs and hence can't be used to drive fully differential successive-approximation-register (SAR) ADCs directly. Therefore, an additional signal-conditioning or driver stage is needed. However, the additional driver stage affects the performance of the overall DAQ system because further error components can be introduced through it. Good performance is achievable with the right selection of components (see figure).

The figure shows a simplified circuit for a DAQ system that contains a reference voltage source and a reference buffer with integrated power supply, as well as a PGIA and an AD4020 SAR ADC. The differential outputs of the PGIA consist of discrete standard components for digitally programmable gain. It features an input impedance in the gigaohm range, a common-mode rejection ratio of over 92 dB, low output noise, and low distortion. This makes it suitable for direct control of the SAR ADC without loss of performance.

The PGIA drives the AD4020, a 20-bit, 1.8 MS/s, low-power SAR ADC. The AD4020 has a number of other functions that can be used to reduce the complexity of the complete signal chain and increase channel density without detracting from performance. Additional functions include, for example, a high-impedance mode for reducing nonlinear input currents coupled with a long detection phase for direct connection of the PGIA with a simple RC filter in between.

The high sampling rate of the AD4020 enables precise acquisition of high-frequency signals up to several hundred kilohertz. It also allows for decimation so that the dynamic range can be expanded for the precise detection of low voltage signals. Moreover, the demands on the antialiasing filter can be reduced.

The SPI interface, which is compatible with different logic levels (1.8, 2.5, 3, and 5 V), can be programmed in many ways and offers both read and write functions.



Illustrated is a simplified block diagram of a precise data-acquisition system.

With the components shown in the figure, the circuit offers a good linearity (INL) of typically ±2 ppm, low offset and gain drifts (±3.5 ppm/°C and ±6 ppm/°C, respectively), and a good noise power of over –115 dB, all at the full conversion rate and over the entire gain range. The circuit enables both bipolar and unipolar single-ended or fully differential input signals up to ±10 V for gains of 1 to 10. An overview of the input voltage range as a function of gain is given in the table below.

Input Signal (V)	Gain
Differential	
±1	G = 5
±2.5	G = 2
±5	G = 1
Single-Ended	
±1	G = 10
±2	G = 5
±5	G = 2
±10	G = 1

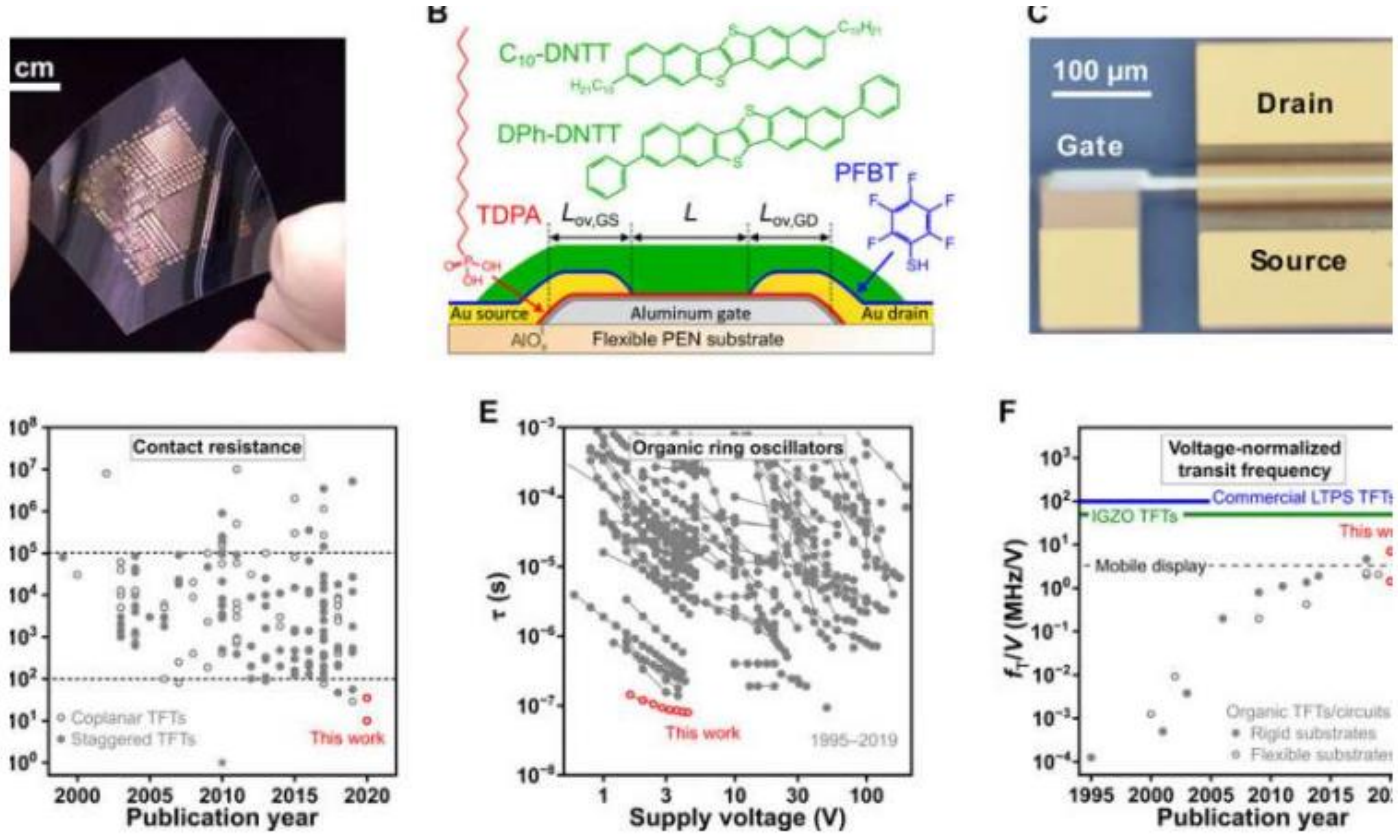
The circuit also offers calibration options for larger PGIA ranges. This function offers precise ratiometric performance and simplifies the system design by already containing options for signal buffering, amplification and

attenuation, common-mode level shifting, and various other functions for overcoming the challenges in analog signal processing.

With the high-impedance input and the programmable gain, a wide variety of sensors with unipolar, bipolar, differential, and single-ended outputs can be connected. In addition, drift, offset, linearity, signal-to-noise ratio, and common-mode rejection requirements can be met. In turn, it's possible to realize a high-precision DAQ system for applications with extremely high-accuracy requirements.

Flexible low-voltage high-frequency organic thin-film transistors

By Thamarasee Jeewandara



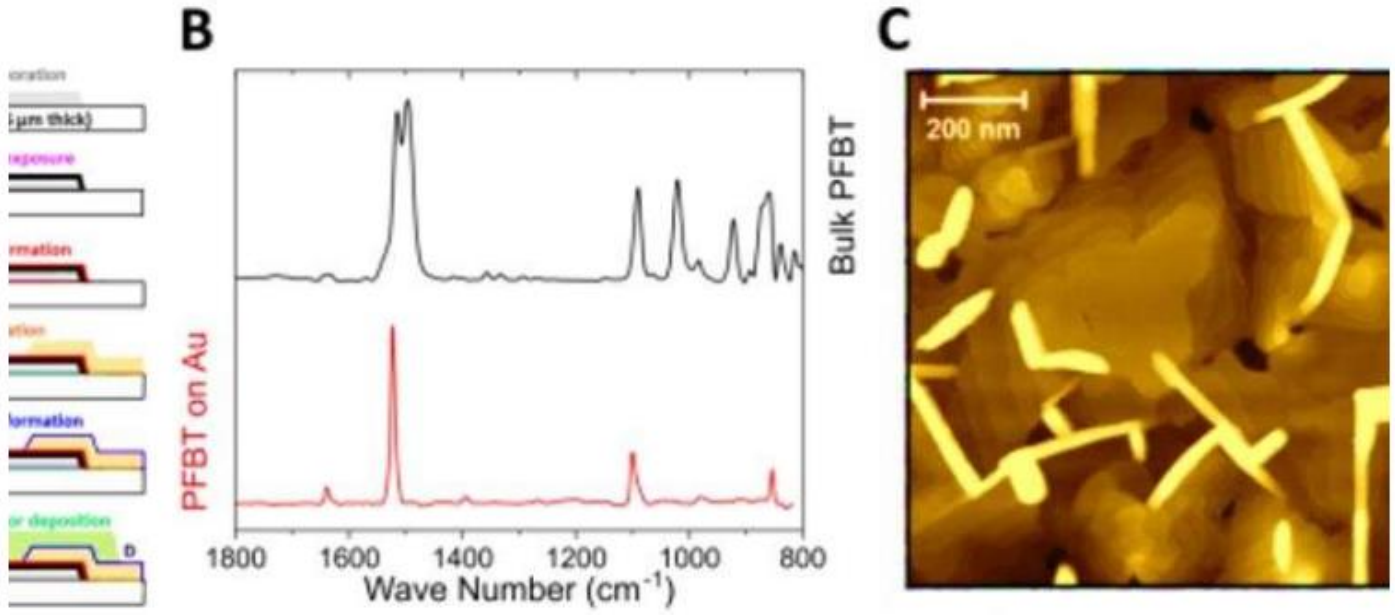
Flexible organic transistors with small contact resistance and high-frequency performance. (A) Photograph of organic TFTs and circuits fabricated at a maximum process temperature of 100°C on a flexible, transparent PEN substrate. (B) Schematic cross section of the TFTs and chemical structures of the organic materials used in their fabrication: n-tetradecylphosphonic acid (TDPA) used for the self-assembled monolayer (SAM) in the hybrid aluminum oxide/SAM gate dielectric, PFBT used to treat the gold source and drain contacts to reduce the contact resistance and the small-molecule organic semiconductors DPh-DNTT and C10-DNTT. (C) Photograph of a TFT having a channel length of 8 µm, a total gate-to-contact overlap of 4 µm, and a channel width of 200 µm. (D) Literature overview of the width-normalized contact resistance (RCW) in organic TFTs. The dotted lines at 102 and 105 Ω·cm indicate the typical range of contact resistances reported for organic TFTs. (E) Literature overview of the signal propagation delay per stage (τ) of organic TFT–based ring oscillators as a function of supply voltage. (F) Literature overview of the highest voltage-normalized transit frequencies (fT/V) of organic TFTs fabricated on rigid and flexible substrates. The solid horizontal lines indicate the voltage-normalized transit frequencies of LTPS TFTs used in smartphone displays and of state-of-the-art low-temperature–processed IGZO TFTs; the dashed line indicates approximately the minimum requirement for mobile displays (3 MHz V−1). Photo credit: James W. Borchert, Max Planck Institute for Solid State Research. Credit: Science Advances, doi: 10.1126/sciadv.aaz5156.

Electronic applications on unconventional substrates that require low-temperature processing methods have primarily driven the development of organic thin-film transistors (TFTs) in the past few decades. Such applications primarily require high-frequency switching (rate at which an electronic switch performs its function) or amplification at low operating voltages. However, most organic-TFT technologies show limited dynamic performance unless researchers apply high operating voltages to overcome their high contact resistances and large parasitic

capacitances, i.e. a capacitance that exists between parts of electronic components or a circuit due to their proximity to each other. In this work, James W. Borchert and a team of interdisciplinary researchers in nanoscience, chemistry, quantum science and solid state research in Germany and Italy, presented low-voltage organic TFTs. The devices recorded static and dynamic performances including contact resistances as small as 10 Ω·cm, on/off current ratios as large as 1010 and transit frequencies as high as 21 MHz. The inverted coplanar TFT structure developed in this work can be readily adapted to industry-standard lithographic techniques.

Flexible electronics are presently a $20-billion-per-year industry driven by recent trends of active-matrix organic light-emitting diode (AMOLED) smartphone displays on polyimide substrates. Among the many challenges associated with the transition, scientists must reduce the process of the thin-film transistor (TFT) technology via low temperature polycrystalline silicon (LTPS), to make it compatible with polyimide substrates, while retaining the characteristics of TFT. In this work, Borchert et al. showed the capabilities of a previously reported method to develop low-voltage organic TFTs with low contact resistance for enhanced static and dynamic performance.

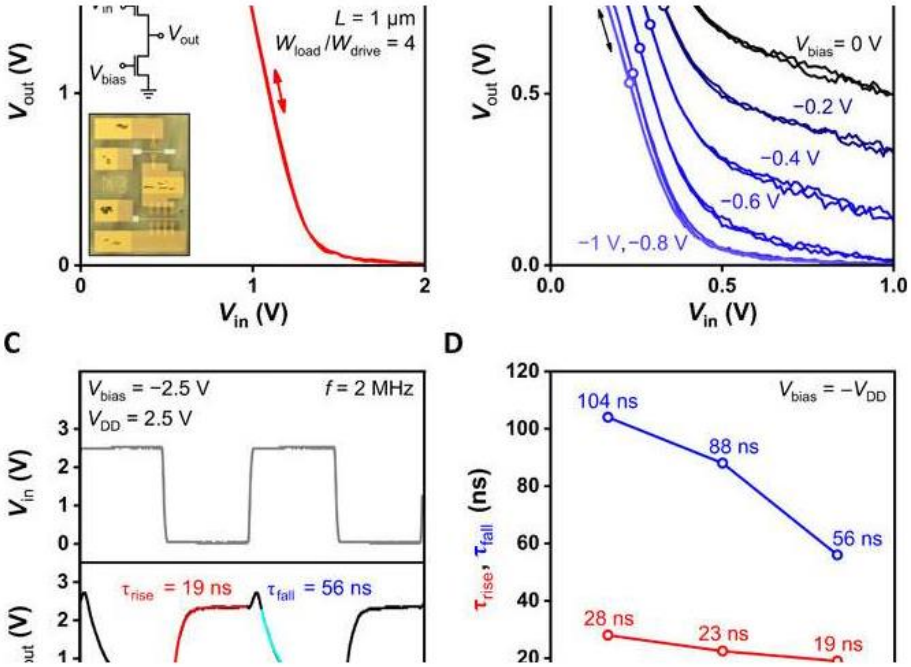
They fabricated the TFTs and circuits on flexible polyethylene naphthalate (PEN) sheets with high-resolution silicon stencil marks to pattern all device layers. The team combined the low contact resistance with a small channel length and small gate-to-contact overlaps to obtain record static and dynamic performances. They measured the dynamic performances of individual TFTs operating in the saturation regime using a two-port network analysis (an electrical network with two terminals connected to external circuits). Borchert et al. then measured the channel-length dependence of the transit frequency and determined a width-normalized contact resistance of 10 ± 2 Ω·cm. The experimental characteristics represented important proof-of-concepts to develop low-power flexible circuits based on organic TFTs for use in flexible AMOLED displays.



Device fabrication process and materials characterization. (A) Schematic process flow for the fabrication of bottom-gate bottom-contact (inverted coplanar) organic TFTs. All metal and semiconductor layers are deposited by thermal evaporation or sublimation in vacuum and patterned using high-resolution silicon stencil masks. (B) Infrared reflection absorption spectroscopy (IRRAS) analysis of bulk pentafluorobenzenethiol (PFBT, black) and of a chemisorbed monolayer of PFBT on a gold surface (red). (C) AFM height scan of a thin film of the organic semiconductor DPh-DNTT deposited onto a hybrid AlOx/SAM gate dielectric on a flexible PEN substrate. Credit: Science Advances, doi: 10.1126/sciadv.aaz5156

The team engineered small molecule organic semiconductors as the active layer of TFTs, on flexible polymer substrates with a channel length of 8 µm, a gate-to-contact overlap of 4 µm and a channel width of 200 µm. They

determined the transfer and output characteristics of TFTs based on diverse semiconductors that constituted the device. The experimental results were similar to previous studies and confirmed good reproducibility of the fabrication process. During the experiments, the scientists used two types of semiconductor materials abbreviated DPh-DNTT and C_{10}-DNTT to form thermally stable thin film transistors (TFTs). They then observed the static and dynamic circuit characteristics using an inverter composed of DPh-DNTT based TFTs and an 11-stage ring oscillator based on C_{10}-DNTT based TFTs. The dimensions were identical in both circuits and maintained a similar biased-load design.



Static and dynamic inverter characteristics. (A) Static transfer characteristics of an inverter based on two DPh-DNTT TFTs in a biased-load circuit design fabricated on a flexible PEN substrate for a supply voltage (VDD) of 2 V and bias voltage (Vbias) of −1 V. The TFTs have a channel length (L) of 1 µm and a total gate-to-contact overlap of 4 µm. The insets show the circuit diagram and a photograph of the inverter. Photo credit: James W. Borchert, Max Planck Institute for Solid State Research. (B) Static transfer characteristics of the same inverter for bias voltages ranging from −1 to 0 V. The open circles indicate the trip voltage. (C) Dynamic characteristics of the inverter in response to a square-wave input signal with a frequency of 2 MHz, a duty cycle of 50%, and an amplitude of 2.5 V. Characteristic rise and fall time constants of the switching delays (τrise, τfall) were determined by fitting simple exponential functions to the measured output waveform. (D) Rise and fall time constants measured for supply voltages (VDD) of 1.5, 2.0, and 2.5 V. The amplitude of the square-wave input signal was identical to the supply voltage, and Vbias = −VDD for each measurement. Credit: Science Advances, doi: 10.1126/sciadv.aaz5156

To understand the dynamic performance of the inverter, Borchert et al. applied a square-wave input signal with a frequency of 2 MHz and an amplitude of 1.5, 2.0 or 2.5 V. They detected the smallest time constants (19 and 56 nanoseconds—ns) for a supply voltage of 2.5 V and then summarized the results from the 11-stage ring oscillator. The team photographed the 11-stage ring oscillator circuit using scanning electron microscopy and measured its output signal. The signal-propagation delay in the setup was the smallest value reported to date (143 ns for a supply voltage of 1.6 V and 79 ns for a supply voltage of 4.4 V) at a supply voltage less than 50 V.

The team obtained more detailed information of the dynamic properties of individual TFTs using a two-port network analysis. Using scattering-parameter (S-parameter) measurements the team studied the high-frequency characteristics of organic TFTs. Based on the method, they performed detailed dynamic characterizations of thin film transistors and observed the area-normalized gate-drain capacitance to be constant with the frequency in all measurements. The scientists determined the transit frequencies and noted their dependence on the channel length to thereby extract the contact resistance and intrinsic channel mobility.

Parasitic fringe capacitance effects in the field-effect transistors could also arise when the semiconductor layer extended beyond the edges of the device. The team therefore reduced the gate-to-source overlap, while maintaining the total gate-to-contact overlap and the channel length constant to obtain a smaller total gate capacitance and a higher transit frequency. By optimizing the dimensions of the TFT, the scientists obtained a transit frequency of 21 MHz as the highest value reported to date for an organic transistor made on a flexible substrate. The

results demonstrated the possibility of building organic TFTs on flexible substrates with static and dynamic performance for high-frequency mobile electronic applications. The results of the work approached those of industry-standard low temperature polycrystalline silicon TFTs, while using a TFT architecture that complied with existing industry-standard fabrication processes.

More information: James W. Borchert et al. Flexible low-voltage high-frequency organic thin-film transistors, *Science Advances* (2020). DOI: 10.1126/sciadv.aaz5156

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Journal information: Science Advances , Nature Electronics , Nature Materials

The best investment every digital brand can make during the COVID-19 pandemic

By Steve Tan

Intuitively, stores that sell online should be making a killing during the COVID-19 pandemic. After all, everyone is stuck at home — and understandably more willing to shop online instead of at a traditional retailer to avoid putting themselves and others at medical risk. But the truth is, most smaller online stores have seen better days.

The primary challenge is that smaller shops often don't have the logistics networks that companies like Amazon do. Consequently, they're seeing substantially delayed delivery timelines, especially if they ship internationally. Customers obviously aren't thrilled about that reality. And in many cases, they're requesting refunds at a staggering rate.

I saw this play out firsthand in April. At that point, my stores were down 20% or in some cases even 30% in revenue. Needless to say, my team was freaking out. But there's one thing we did that helped us increase our revenue over 200% since the pandemic, decrease refund requests and even strengthen our existing customer relationships.

We implemented a 24-hour live chat in all of our stores. Here's why it worked for us and why every digital brand should be doing it too.

Avoid the common 'unreachability' frustration

When I started my first online store in 2006, challenges that bogged my team down often meant that my team's first priority became resolving those challenges so that we could serve our customers faster. But admittedly, when these challenges came up, it became more difficult to balance communicating with our customers and resolving the issues that prevented us from fulfilling their orders quickly.

While we always knew something needed to change, the real wakeup call was in 2015, when we pushed so many ads we ended up being overwhelmed by over 7,000 support tickets. At that point, we just didn't have the customer support backend to get back to everyone quickly and personally. In my experience, hundreds if not thousands of small online stores face this challenge at some scale or another, especially during the COVID-19 pandemic.

Now, with 14 years of experience under my belt, I can wholeheartedly say that the end customer should never be left in the dark about what's happening. Every online store should be letting their customers know if there's a hiccup in the supply chain, even if it means they'll request a refund or won't buy from you in the first place.

That's why having 24-hour live chat first sounded like a double-edged sword to us but ended up being a wonderful decision. Especially during the COVID-19 pandemic, we wanted to make sure that our website visitors were aware before they bought that their products would see a delivery delay. By having these expectations clear in the first place we were able to build trust with new customers and keep our loyal clientele in the loop through more intimate channels like email.

Decrease refund rates and build mutual empathy at the same time

Maybe the most frustrating part of the buying process is making a purchase, not being satisfied, and having to return the product. For online stores during COVID-19, the refund rates appear to be primarily driven by delayed delivery timelines. I've seen a lot of stores try to avoid being transparent about this fact (e.g., put it in fine print on the checkout page) and truly pay the price later — both in revenue and in relationships.

By implementing a live support chat that runs 24 hours a day, there is a guarantee that your website visitors, wherever they reside, are able to ask questions prior to their purchase. Doing so has actually allowed us to make

refund rates even lower than what they were before the COVID-19 pandemic hit, despite the longer delivery timelines.

An example that stands out to me is a furious message from a customer: "I want a refund. I've been waiting so long." It was totally understandable — a disruption for a supplier we work with caused a huge shipment delay on our end.

But having that quick live chat support (as opposed to emailing the customer back) allowed us to explain the circumstances and salvage that sale by checking our systems and letting our customer know that indeed her product was already in transit.

That example really just scratches the surface but gives a good idea of how powerful live chat can be — especially at scale.

Substantially increase repeat purchase rate
Speaking of establishing mutual understanding between a team and its customers, this is really a piece that a lot of brands are missing during this crisis. I've seen a lot of short-sighted decisions meant to help companies make a quick buck (e.g., not allowing software credits to roll over past a certain date), but a time like this is a great opportunity to play the long game.

Customers don't just forget about the companies that treated them well — and when budgets pick back up post-crisis, they'll be more likely to return to the vendors who gave them a good experience. And this is the case for both consumer and enterprise customers.

Live chat support is a great way to handle these relationships. While many decision-makers may be reluctant to send an email to a generic inbox, figuring that their email will never be looked at, live support can help brands handle FAQs and individual edge cases at ease and with speed.

Crunching the numbers: Why the strategy is an investment, not a cost
While you might think implementing 24-hour live chat support would cost a lot of money, that's actually not the case. It's truly an investment. Here's what the numbers look like at my stores.

We use Zendesk for our live chat software, which costs $30 per agent per month. The actual customer support cost per agent is $600-$700 per month. Each of our stores needs three agents, each of whom cover one 8-hour shift per day.

Our live chat support has helped my stores reduce the refund rate (which is typically 5%) by approximately 25%; our average ticket size is $80 and we do approximately 1,000 orders per day.

So our 24-hour live chat support system is actually helping us save close to $36,000 a month with only about $2,000 invested. And that massive return on investment doesn't even include a boost in conversion rates or the intangible benefits of building better relationships with our customers.

3 bearish takes on the current edtech boom

By Natasha Mascarenhas

Edtech is booming, but a short while ago, many companies in the category were struggling to break through as mainstream offerings. Now, it seems like everyone is clamoring to get into the next seed-stage startup that has the phrase "remote learning" on its About page.

And so begins the normal cycle that occurs when a sector gets overheated — boom, bust and a reckoning. While we're still in the early days of edtech's revitalization, it isn't a gold mine all around the world. Today, in the spirit of balance and history, I'll present three bearish takes I've heard on edtech's future.

Quizlet's CEO Matthew Glotzbach says that when students go back to school, the technology that "sticks" during this time of massive experimentation might not be bountiful.

"I think the dividing line there will be there are companies that have been around, that are a little more entrenched, and have good financial runway and can probably survive this cycle," he said. "They have credibility and will probably get picked [by schools]." The newer companies, he said, might get stuck with adoption because they are at a high degree of risk, and might be giving out free licenses beyond their financial runway right now.

"They're spending all their resources and money meeting near-term demand and it's not clear in the short-term what will translate into revenue dollars."

Jan Lynn-Matern, founder and partner at Emerge Education, a European firm, recognizes edtech's waves of popularity. Years ago, Lynn-Matern said the sector heated up because of the MOOCs (massive open online courses) like Coursera, but then lost popularity soon after.

It has not forced the education-focused investor to change much.

"To be honest, we're not like over-reacting in either direction," he said. "We are going with exactly the pace we were going at pre-crisis, and we are being very considerate about where we put money."

"We are not funding tutoring companies or homeschooling companies just because they have become more popular over the last four weeks," he said. "We have core theses on what we think is fundamentally going to happen over the next 10 years."

This comment stuck out for me because it sounded almost like a subtweet: Homeschooling startup Primer recently raised money. Flashcard companies like Quizlet have raised, and tutoring businesses like Juni Learning have also been seeing unprecedented inbound from investors.

These existing, yet nascent categories that Lynn-Matern is hinting at include challenger online universities, vocational schools and up-skilling opportunities.

Now that we know that the next wave of edtech companies might struggle, and high-competition sectors are risky bets, there's one more trend I want to call out: the cliché that it is hard to sell B2B in edtech.

Monetization in edtech has always been a challenge, particularly when companies are selling to businesses instead of directly to consumers. This is largely because schools don't have a lot of extra money sitting around and budgets

are tight. Throw in a once-in-a-lifetime pandemic and reduced spending at the state and local level, and school districts may not be ordering thousands of VR goggles for their students when doors reopen.

However, as lockdowns extend, schools — particularly higher-ed — need new ways to get on the radar of incoming students. If you look at some recent customer-growth metrics of B2B companies, proof is there that budgets are changing.

Toronto-based ApplyBoard, which connects international students to opportunities abroad, raised $75 million earlier this month at a $1.5 billion post-money valuation. The company had a 200% month-over-month surge of new schools signing up for its service. On the complete other end of the spectrum, EdSights raised $1.6 million in new funding after doubling the customers it had taken a year to secure in just one month. The company sells a chatbot that checks in on students and connects them to resources at universities, and charges per student.

While edtech has stepped up in the past few months to connect millions to studies, it doesn't mean a spray-and-pray approach is what the entire category needs from a startup generation to investment perspective. The boom will only last for so long, but when students return to campuses, only the strong will avoid the bust.

Cisco acquires ThousandEyes for $1 billion to expand its portfolio of cloud-based software and bolster its cloud offerings

Cisco has acquired network intelligence startup ThousandEyes in a deal reportedly valued at around $1 billion. In a Thursday announcement, the tech giant said the acquisition of the San Francisco-based ThousandEyes would enable the combined companies to provide customers with an end-to-end view into the digital delivery of applications and services.

As part of the acquisition agreement, Cisco said ThousandEyes CEO and co-founder Mohit Lad will take on the role of GM of ThousandEyes, and Co-Founder, CTO Ricardo Oliveira will continue to drive ThousandEyes product vision and innovation strategy.

Before the announcement, ThousandEyes, which had previously raised $110 million in venture funding, helps businesses to see, understand, and improve the experience for every user and every application over any network. The startup also provides tools to help IT teams determine what's braking or slowing down apps and websites. Prior to this acquisition, Cisco bought Duo Security in 2018 for $2.35 billion to shore up its capabilities in the authentication space.

Founded in 2010 by Mohit Lad and Ricardo Oliveira, ThousandEyes cloud platform offers unmatched vantage points throughout the global Internet and provides immediate visibility into experience for every user and application over any network, so companies can deliver superior digital experiences, modernize their enterprise WAN, and successfully migrate to the cloud. ThousandEyes is central to the global operations of the world's largest and fastest growing brands, including Comcast, eBay, HP, 100+ of the Global 2000, 60+ of the Fortune 500, 5 of the 6 top US banks, and 20 of the 25 top SaaS companies.

By bringing together Cisco's strength in network and application performance with ThousandEyes' visibility into the Internet, customers will now have an end-to-end view into the digital delivery of applications and services over the Internet, allowing them to pinpoint deficiencies and improve network and application performance across enterprise and cloud networks. This acquisition will also empower enterprises to accelerate their digital transformation, no matter where they are in their journey, by delivering comprehensive visibility into applications and services delivered to customers and employees.

"I'm excited to welcome the ThousandEyes team to Cisco," said Todd Nightingale, senior vice president and general manager, Cisco Enterprise Networking and Cloud. "The combination of Cisco and ThousandEyes will enable deeper and broader visibility to pin-point deficiencies and improve the network and application performance across all networks. This will give customers end-to-end visibility when accessing cloud applications, and Internet Intelligence will improve networking reliability and the overall application experience."

Cisco will incorporate ThousandEyes' capabilities across Cisco's core Enterprise Networking and Cloud, and AppDynamics portfolios to enhance visibility across the enterprise, internet and the cloud. The acquisition is expected to close before the end of Cisco's Q1 FY'21. ThousandEyes will join Cisco's newly-formed Networking Services business unit, reporting to Todd Nightingale.