

CB DIGEST FOR TECHNOLOGY

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Amazon re-joins the trillion-dollar club after blowout earnings report. Amazon previously reached a trillion-dollar market capitalization in 2018 but got kicked out of the trillion-dollar club. Now, the eCommerce giant has rejoined the [trillion-dollar club](#) after reporting blowout earnings for its fourth quarter on Thursday. Shares of Amazon hit a new all-time intraday high Friday, climbing more than 9.2% in early trading. The surge propelled Amazon's market cap to hit roughly \$1.02 trillion at the open. The four-company trillion club includes other tech giants including Apple, Microsoft and Alphabet.

Connected cars are a 'key component' of AT&T's IoT strategy

AT&T has 32 million connected cars operating on its network, as well as 5 million fleet vehicles. At this week's Washington Auto Show, Jeff Stewart, AVP for global public policy at AT&T Services, called connected vehicles "a key growth area" for the carrier, which he said has been adding vehicle connections at a rate around 1.5 million in recent quarters.

European Privacy Breach Fines Hit 114 Million Euros

Regulators in Europe have imposed 114 million euros (\$126 million) in fines for privacy breaches since the European Union's General Data Protection Regulation came into effect in mid-2018, Reuters reported, citing a report by a law firm examining the fines. The largest fine, of 50 million euros, was imposed by France on Google. The Netherlands, Britain and Germany had the highest number of notifications under the law. Britain has proposed the largest fine—\$239 million—but it has yet to be levied against the parent company of British Airways.

New Digital Media Venture Targets Women and Politics

A group of veteran journalists and media financiers announced the launch of The 19th, a non-profit journalism venture that will cover women and politics. Founded by Emily Ramshaw and Amanda Zamora, former leaders at the Texas Tribune, the outlet is backed by Kathryn Murdoch, climate activist and philanthropist, philanthropist Craig Newmark, Laurene Powell Job's Emerson Collective, and many others. (I am also a small supporter.) The 19th, which aims to be non-partisan, is wading into a treacherous but important topic: how policy, especially that being debated by the presidential candidates, affects women.

Its business model will also be closely watched as many digital news startups have struggled. As a non-profit, it will accept individual and corporate donations and host events. The playbook has worked well for the Tribune, which is widely respected. It will officially launch this summer and will publish on the website of the Washington Post until then.

Peter Thiel-backed mobile bank N26 says it's luring deposits from US heavyweights like Chase and Citibank.

German mobile bank [N26](#) said its planning to lure deposits from US Wall Street giants like Chase and Citibank. The bank said it has attracted 250,000 users in the United States, where it claims new customers are shifting funds from established giants like Chase Bank and Citibank. The fintech startup, which is backed by Silicon Valley venture capitalist Peter Thiel, was launched in 2013 to offer mobile banking solutions to customers in the European Union through its subsidiary. The startup expanded to the U.S. in July 2019.

Sony Opens Automotive Design Center in Oslo, Norway

Johannes Solhusvik becomes the Head of Automotive Design Centre at Sony Europe B.V. In the past, Johannes used to be BU-CTO of Aptina's Automotive and Industrial Business Unit. Later, he was Omnivision's GM of Europe Design Center located in Norway. Now, one can expect a big boost of Sony automotive image sensor business in Europe.

Apple generated \$56 billion in iPhone sales in just 3 months. Apple's iPhone strength is back. Yesterday, Apple reported iPhone revenue of \$56 billion for its fiscal first quarter, exceeding analysts' estimates, proving that the new

iPhone 11 is off to a strong start. iPhone revenue for the quarter rose 8% from a year earlier and climbed from the fourth quarter when Apple generated \$33.36 billion in iPhone sales. Analysts were expecting revenue for the devices to come in at \$51.62 billion in the first quarter. Notwithstanding, Apple is gradually turning its focus toward other areas of its business like wearables and services, amid broader stagnation in the smartphone market.

mmWave auction completes its clock phase, raising \$7.56 billion

Bidding has closed in the first phase of the Federal Communications Commission's millimeter wave spectrum auction, with the bid total at more than \$7.56 billion.

Since December 10, 35 bidders have been vying for the licenses. After 104 rounds of the clock phase, prices settled for 14,142 spectrum licenses, and just two licenses are still held by the FCC.

Now that the clock phase is complete, the auction moves into an assignment phase for specific blocks of spectrum. During the clock phase, bidders set their sights on either the MN or P licenses in each of 416 geographic Partial Economic Areas that make up the U.S. The MN licenses consist of 24 100-MHz license blocks in the 37 (37.6-38.6 GHz) and 39 GHz frequency ranges, and the P licenses are ten 100-MHz licenses in the 47 GHz frequency range of 47.2-48.2 GHz.

Facebook lost more than \$50 billion in market value after reporting a 51% rise in expenses compared with its total in 2018. What's a \$50 billion loss to Facebook? The stock of Facebook [reportedly fell much as 8% as the market opened](#) erasing more than \$50 billion from the social media giant's market cap. The decline comes after Facebook reported a 51% rise in expenses compared with its total in 2018. The expenses were largely related to the company's privacy and security improvements. That coincides with a drop in the company's operating margin, which fell from 45% in 2018 to 34% in 2019.

GameRefinery acquires Reflection.io, a U.K. startup that provides market insight for app developers.

[GameRefinery](#), a mobile game insight and analytics startup, today announced it has acquired another market insight platform, Reflection.io. The terms of the deal were not disclosed. As part of the acquisition agreement, Reflection.io's capabilities will be into the GameRefinery portal over the coming months. The current Reflection's platform will remain fully operational and accessible to existing customers at [Reflection.io](#). Founded in 2013, Reflection.io provides market insight for app developers. The startup has worked with an impressive list of customers including Square Enix, Miniclip, Sky, BBC, Wooga, Endemol and Sega.

Banks Can Invest in VC Funds Again, Says Fed

The Federal Reserve has approved a proposal to allow banks to invest their own capital in venture capital funds.

Since 2014, banks have been prohibited from taking stakes in VC funds as part of the Volcker Rule, a federal regulation crafted in the aftermath of the 2008 financial crisis. The policy also limited banks ability to invest in hedge funds and private equity funds.

Intended to protect bank customers, the Volker Rule has prevented capital from flowing in to venture funds and startups. Critics say that prevented economic development and limited banks' ability to profit from investment opportunities. Backers of the rule argued that it kept those bank customers isolated from high-risk ventures where big losses are possible. Prior to 2014, banks were limited partners in many small regional ventures funds.

The changes to the Volker Rule are likely to bring an influx of capital to the VC market where there is already no shortage of cash. More importantly, banks experimenting with riskier asset classes could spell trouble for bank customers.

Qorvo Announces Two Acquisitions: Decawave and Custom MMIC. During its earnings call yesterday (1/30/20), Qorvo announced it will pay some \$500 million to acquire two companies: Decawave, a technology play in ultra-wideband (UWB) for mobile applications, and Custom MMIC, a complementary addition to its defense segment.

Qorvo CFO Mark Murphy said more than three-quarters of the \$500 million will be for Decawave, the remainder for Custom MMIC. The deals, which were signed during the current quarter, are expected to close in February. Qorvo will pay for them with cash.

General Motors (GM) to invest \$2.2 billion at Detroit factory to make electric trucks, SUVs. Under intense competition and pressure from Tesla, GM is boosting its investment in electric trucks and SUVs. The No.1 U.S. automaker announced Monday that it will invest \$2.2 billion in its Detroit-Hamtramck assembly plant to build electric trucks and sport utility vehicles, a move that would create 2,200 jobs. GM said its first electric truck will be a pickup, whose production will begin late next year and will be followed by a self-driving vehicle, Cruise Origin.

Gravyty closes \$21 million in funding to accelerate growth. [Gravyty](#), a Boston, MA-based provider of fundraiser enablement solutions powered by artificial intelligence (AI), raised \$21m in funding to continue its growth in the social good sector which includes higher education institutions, nonprofits, healthcare organizations and hospitals. The investment was led by K1 Investment Management.

Microsoft invests in U.K.-based startup SuperAwesome as demands for Internet safety for kids intensify. [SuperAwesome](#), a U.K.-based startup that offers Internet safety tools for kids, today announced it has received new investment from Microsoft's corporate venture fund M12. The total amount of funding was not disclosed. SuperAwesome, which currently has touchpoints reaching 500 million children globally, provides a platform for companies to offer advertising, video and communities that are safe for children, as well as parental consent options. Its global customers include LEGO, NBC Universal, Hasbro and Mattel, which have to adhere to new digital privacy laws such as COPPA in the US, GDPR-K in Europe and CCPA in California.

Iguazio Raises \$24M to Accelerate Growth and Global Penetration of its Data Science Platform. [Iguazio](#) (* [Chambiz DF 16 June 18](#)), an Israeli tech startup and a provider of data science platform for real time machine learning applications, today announced that it has raised \$24M of funding. The round was led by INCapital Ventures, with participation from existing and new investors, including Pitango, Verizon Ventures, Magma Venture Partners, Samsung SDS, Kensington Capital Partners, Plaza Ventures and Silverton Capital Ventures. The funds will be used by Iguazio to accelerate its growth and expand the reach of its data science platform to new global markets.

Visa led \$80 million investment in Currencycloud, the payments startup behind fintech apps Monzo and Revolut. [Currencycloud](#), a U.K.-based payments startup which sells payment software for banks and fintech firms to process their international transactions, has closed \$80 million in a funding round co-led by SAP's venture arm Sapphire and Visa. Currently operates in Europe and North America, the company will use funding proceeds to expand into Asia. Though not as well-known as consumer-focused peers like Monzo and Revolut, Currencycloud provides some of the crucial underlying "plumbing" in the background for these apps to operate. They take care of all the intricacies and regulatory hurdles involved with cross-border payments, giving their customers the tools to globalize their business. Founded in 2012 by Mike Laven, Nigel Verdon, Richard Arundel, and Stephen Lemon, Currencycloud powers cross-border payments for a number of popular finance apps. Currencycloud is a global payments platform built on smart technology that takes the complexity out of moving money.

Fintech startup AlphaCredit to raise \$125 million from SoftBank-led group. [AlphaCredit](#), a Mexico-based fintech startup and one of the fastest growing technology-enabled financial platforms in Latin America, announced today

it has signed an equity round for up to \$125 million led by SoftBank's Latin America Fund. The Series B round was also joined by other leading international venture capital funds along with a group of its existing investors. The equity infusion will allow AlphaCredit to continue its expansion and leverage the competitive advantages of its proven and profitable business model. Co-founded in 2010 by Co-CEOs Augusto Álvarez and José Luis Orozco, AlphaCredit provides consumer loans and financial solutions for consumers and SMEs in Mexico and Colombia through innovative solutions and cutting-edge technology.

GLS Capital raises \$345M for its inaugural fund to finance commercial and intellectual property litigation. [GLS Capital](#), a private investment firm founded by trio of industry veterans, today (1/27/2020) announced the closing of \$345 million fundraising for its inaugural litigation finance fund, GLS Capital Partners Fund I, LP. The Fund's diverse institutional investor base includes global financial institutions, endowments, foundations and family offices. Founded in 2018 by David Spiegel and his co-founders, Adam Gill and Jamison Lynch, the Chicago, IL-based GLS Capital is one of the world's largest private investment firms focused on legal and regulatory risk. The firm provides bespoke financial solutions to meet the unique needs of each investment opportunity.

Deep tech startup Lynq Technologies raises \$6M seed funding to accelerate growth and technology expansion. [Lynq Technologies](#), a Brooklyn, New York-based deep-tech startup that connects people and devices across miles without infrastructure, has closed \$6 million seed round today. Based in Brooklyn, Lynq uses its decentralized, private and flexible network protocol to change how low-bandwidth data is transmitted. Backers include ff Venture Capital, Sony Innovation Fund, Chetrit Ventures, and Plus Eight Equity Partners. The funding follows successful presale campaign on the IndieGogo that reached over \$1.7 million for the company's premiere device, which is now commercially available.

Roambee closes \$15.2 million in Series B funding. [Roambee](#), a Santa Clara, California-based on-demand shipment and asset monitoring platform company, raised \$15.2m in additional Series B funding to expand operations and accelerate sales globally. The round was led by Anchor Group and Comcraft, with participation from Intuitive Ventures, Jebson & Jessen, Telkomsel and Anant Singhania. Led by Sanjay Sharma, CEO, Roambee provides an on-demand shipment and asset monitoring platform to companies in manufacturing, logistics, transportation, finance, pharmaceutical and automotive industries. Its sensor logistics platform uses IoT sensors to collect data, artificial intelligence (AI) to deliver insights and foresights and robotic process automation (RPA) to automate operations within the enterprise.

ServiceNow acquires tech startup Passage AI to advance its deep learning AI capabilities. [ServiceNow](#) today announced it has signed an agreement to acquire [Passage AI](#), a Mountain View, Calif.-based conversational AI platform company. The total amount of the deal was not disclosed. The transaction will advance ServiceNow's deep learning AI capabilities and will accelerate its vision of supporting all major languages across the company's Now Platform and products, including ServiceNow Virtual Agent, Service Portal, Workspaces and emerging interfaces. Founded in 2016 by CEO Ravi N. Raj, CTO Madhu Mathihalli and CTO Mitul Tiwari, Passage AI's conversational AI platform is built on deep learning models that can be trained to understand text in all major languages.

Justworks lands \$50 million in Series E funding to accelerate growth. [Justworks](#), a New York City-based HR tech startup, has closed \$50 million in Series E funding to continue to expand operations and its business reach. The round, which brings the total funding to \$143 million, was led by Union Square Ventures and existing investor FirstMark Capital, with participation from Bain Capital Ventures, Index Ventures, Redpoint Ventures, Spark Capital, and Thrive Capital. Founded in 2012 by Isaac Oates, CEO, Justworks provides a platform to start, run and grow a business. By leveraging a technology-enabled version of the Professional Employer Organization (PEO) model, Justwork provides a platform for small and medium-sized companies with under 200 employees to get access to big-company benefits, health and wellness providers, payroll, HR tools and compliance support.

Fintech startup Joust launches a new banking app for freelancers and self employed workers. [Joust](#) announced the launch of a new banking app for freelancers & self employed workers. The new app has a modern, intuitive re-design, and a slate of new, consumer-driven features — with additional features releasing throughout 2020. Based on customer feedback, these new features include an analytical dashboard, Joust Visa debit card management, invoice creation/payments, and more. Joust will continue to release a host of new app features throughout 2020. In addition to these new features, the Joust app will continue to boast its invoice-guaranteeing product, PayArmour™, which funds unpaid client invoices, and its FDIC-insured bank account combined with a merchant account. Founded in 2017 by Lamine Zarrad and George Kurtyka, Joust is the nation's first all-inclusive banking platform for independent professionals. It serves freelancers, contractors, and self-employed workers in all 50 states.

AppOmni scores \$10M Series A to prevent SaaS data leaks through continuous monitoring and alerting. [AppOmni](#) announced it has raised \$10 million in Series A funding to accelerate sales and marketing operations, and bolster the startup's product development teams at both their corporate headquarters in San Francisco and their Innovation Center in Carbondale, Colorado. The round, which brings the company's total financing to \$13 million to date, was led by ClearSky. New investor Inner Loop Capital also participated in the round, joining existing investors Costanoa Ventures, Silicon Valley Data Capital, and Twilio's COO George Hu. Founded in 2018 by Brendan O'Connor, AppOmni empowers organizations to easily secure, manage, and monitor applications in the public cloud. Unlike traditional security and management tools, AppOmni deeply understands SaaS applications and cloud platforms, and operates on the authorization and data-access layers.

Securiti.ai scores \$50M Series B to modernize data governance

Securiti.ai, a San Jose startup, is working to bring a modern twist to data governance and security. Today the company announced a \$50 million Series B led by General Catalyst, with participation from Mayfield. The company, which only launched in 2019, reports it has already raised \$81 million. What is attracting all of this investment in such a short period of time is that the company is going after a problem that is an increasing pain point for companies all over the world because of a growing body of data privacy regulation like GDPR and CCPA. These laws are forcing companies to understand the data they have, and find ways to be able to pull that data into a single view, and, if needed, respond to customer wishes to remove or redact some of it. It's a hard problem to solve with customer data spread across multiple applications, and often shared with third parties and partners.

Company CEO and founder Rehan Jalil says the goal of his startup is to provide an operations platform for customer data, an area he has coined PrivacyOps, with the goal of helping companies give customers more control over their data, as laws increasingly require.

Coding Bootcamp Galvanize Agrees to \$165 Million Acquisition

A wave of consolidation in the education technology market appears set to continue this year. K12 Inc., a publicly-traded education company, has agreed to acquire Galvanize, a provider of coding bootcamps and co-working spaces across eight locations in the U.S., for \$165 million in cash, according to an email addressed to Galvanize shareholders that was viewed by The Information. The email, sent earlier this week by Galvanize CEO Harsh Patel, said the companies intend to close the deal and announce it publicly on Monday.

Concentric emerges from stealth with \$7.5 million to stop threat and protect sensitive enterprise data with AI. [Concentric](#), a tech startup solving one of the most pressing data security challenges facing the modern enterprise of identifying and securing business-critical data within unstructured data, has come out of stealth with \$7.5 million in funding to stop the threat of unprotected and overshared business-critical data. Backers include Clear Ventures, Engineering Capital, Homebrew and Core Ventures. Concentric also announced the availability of a new approach to the most significant security challenge facing the enterprise today – business-critical unstructured data, stored on-premises or in the cloud, that is impossible to identify and protect manually.

Kenyan on-demand logistics startup Sendy raises \$20M Series B round backed by Toyota, others. [Sendy](#), a Kenyan on-demand logistics startup that allows customers to order courier services over their mobile phones, today

announced it has raised a \$20 million Series B led by Atlantica Ventures, with participation from Toyota Tsusho Corporation, a trade and investment arm of Japanese automotive company Toyota. Sendy is a delivery partner for moving packages in Kenya. Sendy provides a mobile app and web platform that enables individuals and small businesses to connect with Drivers and request on-demand or scheduled package delivery services anytime, any day, 24/7. Its app links delivery drivers with customers, is embarking on a second round of fundraising to expand in East Africa. Founded in 2014 by Don Okoth, Evanson Biwott, Malaika Judd, and Meshack Alloys, Sendy offers on-demand door-to-door package delivery services in Nairobi, Kenya.

SOCi scores \$15M Series C funding to grow its reputation management platform. [SOCi](#), a San Diego, California-based social and reputation management platform for multi-location businesses, has closed a \$15m Series C funding round to continue to build out its platform to allow enterprise partners to manage all of their local digital channels and assets that are core to their localized marketing presence in a single platform. The round was co-led by Vertical Venture Partners, Grayhawk Capital, and Ankona Capital with participation from Blossom Street Ventures. The company, which has raised roughly \$35m since its inception in 2012.

Self-storage marketplace startup Neighbor.com closes \$10 million Series A led by Andreessen

Horowitz. [Neighbor.com](#), an Utah-based tech startup disrupting the self-storage marketplace, has closed a \$10 million Series A funding round led by Silicon Valley venture capital firm Andreessen Horowitz. Other investors in this round include Nate Bosshard, former partner at Khosla Ventures and co-founder of Tonal, as well as Ryan Graves, Uber's first CEO. In conjunction with the funding, Neighbor.com also announced that Jeff Jordan, managing partner at Andreessen Horowitz and former eBay, PayPal and OpenTable executive who currently sits on the boards of Airbnb, Instacart, Lime and Pinterest, will join its Board of Directors.

Aquant closes \$30M in Series B funding for its service intelligence and AI platform. [Aquant](#), a NYC-based provider of a service intelligence platform, has raised \$30 million Series B funding round to drive continuous innovation of its AI platform, accelerate global expansion, and grow its engineering, client services, and go-to-market teams. The round, which brought total funding to \$40 million, was led by Insight Partners with participation from existing investors including Lightspeed Venture Partners, Angular Ventures, and Silverttech Ventures. Co-founded by Shahar Chen, CEO and co-founder, and COO and co-founder, Aquant provides an artificial intelligence technology platform that captures the knowledge of subject matter experts before they leave, by unlocking insights from clients' data silos (e.g., CRMs and ERP systems), analyzing the free-text of customer comments and field technician notes, and validating findings with top performers.

1Huddle raises \$5M Series A to reinvent the 'Future Of Work' through mobile gamification. 1Huddle, a tech startup that helps organizations onboard new hires, announced it has raised \$5 million in Series A funding to increase staffing, accelerate growth, and meet heightened global demand for its product. The round was led by Tribeca Venture Partners alongside Humbition, NRD Capital and Newark Venture Partners. Founded in 2015 by Sam Caucci, the New York-based 1Huddle is a workforce tech startup company that onboards, upskills and fires up employees through the use of science-backed quick-burst mobile games.

Lily AI Closes \$12.5 Million Series A Funding. [Lily AI](#) (**Chambiz DF 17 Feb 17*), a Mountain View, California-based deep learning startup focused on enabling brands to convert customers through emotionally tailored recommendations, raised \$12.5m in Series A funding to expand operations and its development efforts. The round was led by Canaan Partners, with participation from NEA, Unshackled and Fernbrook Capital. Co-founded in 2015 by Purva Gupta and Sowmiya Chocka Narayanan, Lily AI combines deep product tagging with deep, real-time psychographic analysis to determine the active state of mind of each shopper. The startup helps brands and retailers to understand individual customer's emotional context, auto-tag products with a rich set of attributes.

SoftBank leads \$250 million Series D funding in drug delivery startup Alto Pharmacy, now valued at over \$1 billion. Silicon Valley-based drug delivery startup Alto Pharmacy (formerly known as ScriptDash) has closed a total of around \$250 million in funding to move beyond its delivery roots and offer doctors and clinics a technology platform to fill prescriptions. The new round, which was led by SoftBank's Vision Fund II was joined by existing investors

including Greenoaks Capital and Jackson Square Ventures also participated in the Series D round, according to a report from Reuters, citing two people familiar with the development. The latest round now values the company at over \$1 billion. To date, Alto has far raised a total of over \$350 million in funding.

Gabi Secures \$27 Million in Series B Funding. [Gabi](#), a San Francisco, California-based home and auto insurance startup, has closed \$27 million in Series B funding to expand operations and business reach. The round was led by Mubadala Capital with participation from Canvas Ventures, Northwestern Mutual Future Ventures, Correlation Ventures, Securian Ventures, A.Capital Ventures, Project A, CMFG Ventures, Burst Capital, and AngelList. Co-founded in 2016 by Hanno Fichtner, Krzysztof Kujawa, Vincenz Klemm, and Pawel Olszewski, Gabi provides a proprietary quoting flow platform that allows people to connect existing auto or home insurance account or upload a PDF of policy.

By Fraser Tenant

Burgeoning trend or a flash in the pan? Whatever the sentiment, the value of impact investing is an issue that has generated considerable coverage and discussion in recent years.

Defined by the Global Impact Investing Network (GIIN) as “investments made by companies, organisations or funds with the intention to generate positive, measurable social and environmental impact along with a financial return”, impact investments can be made in both emerging and developed markets – targeting a range of returns from below market to market rate, depending on investors’ strategic goals.

The GIIN’s ‘2019 Annual Impact Investor Survey’ – which features the views of organisations with impact investments worth approximately \$239bn – highlights five key findings it suggests “demonstrates the increasing scale and maturity of the impact investing industry”. First, the market is diverse. Second, the impact investment industry continues to grow and mature. Third, impact measurement and management is central to investors’ goals and practices. Fourth, overwhelmingly, impact investors report performance in line with both financial and impact expectations. Finally, impact investors indicate commitment to developing the industry.

“Impact investing enables investors to achieve financial returns according to their risk and return preferences, invest in alignment with their values, and contribute to social and environmental solutions,” says Sapna Shah, managing director at the GIIN. “Impact investing also allows investors to differentiate themselves competitively and provides a path to cater to growing client demand for aligning business with personal values. Investors from around the world and in every segment of the financial industry are entering this market – from large pensions to banks, foundations, family offices and smaller, impact-focused fund managers.”

Moreover, in impact investing parlance, there are two types of impact investors: ‘finance first’ and ‘impact first’. “Depending on whether impact or finance is the main motivation, investors will select projects with different returns – both financial and in terms of impact,” explains Diane-Laure Arjaliès, assistant professor, managerial accounting and control, general management and sustainability at Ivey Business School. “Impact investing addresses a need that was not previously fulfilled – whether at issuer or investor level. It is the financing of projects that trigger positive change and generate financial returns.”

In the experience of Lucinda Gregory, investment research and guidance manager at The Share Centre, the majority of these projects “provide capital to address the world’s most pressing challenges in sectors such as conservation, renewable energy, sustainable agriculture, microfinance, and affordable and accessible basic services, including healthcare, housing and education”.

The GIIN’s 2019 ‘Sizing the Impact Investing Market’ report estimates that over 1340 organisations manage \$502bn in impact investing assets (predicted to reach \$1 trillion by 2020). Yet, while pervasive and maturing, for Rehana Nathoo, founder and chief executive of Spectrum Impact, the growth of the market is a less fascinating trend compared to the diversity of impact investing investors. “In 2010, when some of the first surveying began, investors largely consisted of one or two development financial institutions using a mix of capital to help seed the market,” she recalls. “Today, investors are active across investor type and asset class, and the increase in number of deals, year over year, demonstrates that investors are finding a pipeline of opportunities to meet their financial and impact targets.

“Investors’ goals depend greatly on the change they want to see,” she continues. “Impact investing, at its core, is not a new ‘way of investing’. It is a new purpose of investing. It is behaviour change. It works with the traditional

markets to be more intentional, explicit and future-oriented when we think about utilising investment for a dual purpose. Just like in traditional investing, impact investments require a similar consideration of trade-offs across risk, return and liquidity. They also add ‘impact’ to that important calculation.

Instruments

Private debt, private equity, public equity and real assets are among the most popular instruments for making impact investments. Furthermore, an impact investment instrument should meet both general partner (GP) and portfolio company financing needs, have a clear process for its deployment and imply a strategy for ultimate exit.

“Any kind of financial product that aims to make an impact alongside financial returns could potentially be adopted for impact investing,” says Ms Arjaliès. “Of course, such instruments must aim to produce value in the real economy – not nurture speculative behaviours. Derivatives, for instance, would be difficult to use for impact investing. For now, most impact investing vehicles take the form of impact bonds or venture capital type of funds in the form of equity holding, convertible debt or debt. But there are currently many initiatives that might expand the type of instruments currently in use, for instance conservation impact bonds that use blended finance models.”

“As the industry and its investor portfolios scale and mature, the general consensus is that ever-increasing numbers of investors will turn to the impact investing market in the years to come as a way of generating value beyond solely return on investment (ROI).”

Indeed, investors have been demonstrating an increasing appetite for bonds issued to fund sustainable projects. “Green bonds are fixed interest instruments which exclusively assign proceeds to finance projects in sectors such as energy efficiency or water management, while social impact bonds (SIBs) invest in listed bonds issued by organisations that support key social themes, including employment and housing,” observes Ms Gregory.

One such bond, available later this year, is the Rhino Impact Bond (RIB) – the world’s first financial instrument working toward the conservation of a species at the risk of extinction. “The RIB will transfer the risk of funding conservation from donors to impact investors by linking conservation performance to financial performance and looks to boost the black rhino population by 10 percent globally,” explains Ms Gregory. “This is an exciting innovation that will surely grab the attention of investors.”

In the view of Ms Nathoo, the choice of investment instrument very much depends on the asset class, with some impact investors suggesting that impact investing is its own asset class. “We disagree,” she says. “The typology of ‘asset class’ – and its alignment with traditional investment classification – is very important to maintain. Asset class connotes an acceptable level of risk, return and – most importantly – liquidity based on investment type. Impact investments range in those considerations.

“You can have something risky and something that is not,” she continues. “Something that is liquid and something that is not. We believe that you can find impact investments in almost every asset class. A decision on the right investment tool to pursue should, firstly, be a decision on the right asset classes to engage in. What we are really asking is for investors to be clear about their risk, return and liquidity preferences. Once that is made clear, there are impact investment tools to meet all of those needs.”

Challenges

The challenges associated with impact investing are numerous – from getting the balance right between delivering a strong return to investors and ensuring the community or issue the investors are attempting to resolve receives adequate funding to establishing a viable mechanism for measuring success. At the same time, investors also need to remember that impact investments perform like other investments and may not achieve their targeted returns.

Among the challenges respondents to the GIIN's 2019 survey noted were: (i) appropriate capital across the risk/return spectrum; (ii) suitable exit options; (iii) sophistication of impact measurement and management practice; (iv) high-quality investment opportunities (fund or direct) with track record; (v) common understanding of definition and segmentation of impact investing market; (vi) government support for the market; (vii) data on investment products and opportunities; (ix) professionals with relevant skill sets; and (x) research on market activity, trends, performance and practice.

“There has been an increase in demand for transparency and measurement – both to understand how investments are performing as well as their intended, and unintended, consequences,” says Ms Nathoo. “Impact investing is not much different. In its 13-year history, the industry has also needed to evolve, greatly, to be more inclusive, more accessible and more transparent. Though the size of the market and number of players suggests that the trend is still on the rise, a commitment to better measurement and transparency suggests that we are reconnecting to the rigour needed to differentiate this investing from other types.

“The biggest challenge, as well as opportunity, is that of standardising measurement,” she continues. “Much of the criticism in impact investing is about the inability to measure. That is incorrect. Frameworks exist that continue to sophisticate measuring the impact – both outputs and outcomes – of investment activity. But without standardised use of those frameworks and an ability to compare performance, we are not saying much in terms of best practice. That is a real opportunity to build transparency into a set of investment practices that do not often exist elsewhere in private markets.”

Another issue is the potential for companies to ‘greenwash’. “Impact investing is privy to the same concerns over ‘greenwashing’ that other responsible investing strategies have been facing recently,” notes Ms Gregory. “The wish to capitalise on the growing demand for responsible products has seen some organisations promote products falsely. Standardisation within the industry of what constitutes a socially responsible investment (SRI), environmental, social and governance (ESG) or impact product would be a huge help to the retail investor, but it is not a straightforward task.”

Despite the challenges, there is confidence that solutions are within the grasp of investors. “The industry is still growing, and experienced practitioners are actively working to generate solutions to these challenges,” says Ms Shah. “For those new to the industry, do not start from scratch where work has been done before you. There are many resources available, including research, tools and existing systems that can help investors articulate their impact strategies, and measure and manage their impact performance against their objectives.”

Outlook

As the industry and its investor portfolios scale and mature, the general consensus is that ever-increasing numbers of investors will turn to the impact investing market in the years to come as a way of generating value beyond solely return on investment (ROI) considerations.

“Previously, responsible investing was seen by many in the industry as a niche strategy,” says Ms Gregory. “However, in recent years, we have seen a significant shift in investor interest. Investors are recognising that new ideas are required in order to address some of the largest societal and environmental challenges facing mankind, and because of this impact investing is gaining traction. Demographics such as millennials require more than just the superficial return of investments and want to align their profits with their principles.”

In Ms Shah's view, demand for impact investing will only increase over time, with investors becoming more sophisticated in their practice. “We see more and more signs that public expectation on the very role of the financial markets in society is changing, and with this a greater demand for options to invest according to one's values. For example, research shows that younger generations demonstrate a greater interest than their predecessors in aligning all aspects of their lives with their values.

“As these generations begin to inherit and achieve their own personal wealth, investment options will have to adapt to these interests,” she continues. “We have also seen business leaders across the globe recognising the business significance of investing with social and environmental considerations. The traditional view of the investment industry is falling short of where the world is headed, and financial services firms that want to be successful in future markets need to make an investment in these capabilities today.”

Equally optimistic as to an increase in impact investing is Ms Arjaliès, not only because it makes economic sense to invest in projects that have a positive outcome on society, but also because financial returns are difficult to extract in conventional products. “As the world is moving to passive investing and the number of companies publicly listed decreases, investors will have to search for value in places that have been neglected so far,” she says.

While questions remain regarding the impact, benchmarking of investment products and financial viability of projects, impact investing is generally viewed as a burgeoning growth area – a win-win scenario for those companies that possess a positive social, environmental and financial outlook.

Israel-based tech startup Iguazio scores \$24M to accelerate growth and expand global penetration of its data science platform



The demand for AI applications is on the rise. According to Gartner, AI augmentation alone will create \$2.9 trillion of business value in 2021. However, there are still many challenges in deploying AI solutions in an effective and scalable way. An estimated 87% of data science models which have shown great promise in the lab never make it to production. This is due to the challenges of transforming a great AI model, which is functional in lab conditions, to a fully operational AI application that can deliver business impact at scale and in real time.

Enter Iguazio, a Tel Aviv, Israel-based tech startup and a provider of a data science platform that accelerates the development and deployment of AI applications, enabling data scientists to focus on delivering better, more accurate and more powerful solutions instead of spending most of their time on infrastructure. Iguazio solves this problem and brings data science to life for enterprises worldwide.

Today (1/27/20), Iguazio(* [Chambiz DF 16 June 18](#)) announced it has closed \$24 million of funding to accelerate growth and expand the reach of its data science platform to new global markets. The round was led by INCapital Ventures, with participation from existing and new investors, including Pitango, Verizon Ventures, Magma Venture Partners, Samsung SDS, Kensington Capital Partners, Plaza Ventures and Silverton Capital Ventures.

Iguazio was founded in 2014 by Asaf Somekh, Orit Nissan-Messing, Yaron Haviv, and Yaron Segev. The startup provides a data science platform to automate machine learning pipelines. The Iguazio Data Science Platform enables enterprises to develop, deploy and manage AI applications at scale. With Iguazio, companies can run AI projects in real time, deploy them anywhere; multi-cloud, on-prem or edge, and bring to life their most ambitious data-driven strategies.

The Iguazio data science platform helps data scientists create real-time AI applications while working within the familiar machine learning stack they know and love. The platform has been deployed by enterprises spanning a variety of verticals, including financial services and telecommunications. It is being used for a multitude of real-time use cases, such as self-healing networks, ride-hailing optimization, logistics optimization, and real-time recommendations. By way of example, Iguazio announced today that Payoneer, the global digital payment platform, has deployed the platform to predict and prevent fraud with real-time machine learning.

“Iguazio’s unique technology facilitates the data science creation process from start to finish, enabling enterprises to deploy AI applications that create real business impact,” said Tom Kennedy, Chairman of Kensington Capital Partners. “With the opportunities we are seeing for machine learning technology and the global success stories emerging from this high-tech nation, Iguazio represents a great first investment for Kensington in an Israeli company.”

“This is a pivotal time for AI. Our platform helps data scientists push the limits of their real-time AI applications and see their impact in real business environments,” said Asaf Somekh, co-founder and CEO of Iguazio. “With support from INCapital, Kensington Capital Partners, and our other investors, we are ready to expand our international team and reach our ambitious goals.”

By Justin Pierce Berutich at Euclid Transactional, LLC.

To what extent are transaction parties showing greater awareness and understanding of potential tax risks in the M&A process, and the importance of managing them?

Managing tax risks has always been of great importance to M&A transaction parties, whether as a result of the potential deal structure or a historic tax position taken by the target company. An adverse tax ruling has the ability to be catastrophic by either eliminating a buyer's perceived value proposition for an investment or by creating a large liability for an exiting seller. As a result, transaction parties spend a great deal of resources planning, structuring and diligencing potential tax pitfalls associated with their potential M&A transactions and their potential targets. In the past, there were three main options for managing an identified tax risk. First, buyers would be forced to self-insure. Second, sellers would be subject to a large indemnity or would be required to tie up sales proceeds in an escrow. Third, the deal would fall apart. More recently, however, taxpayers have found that leveraging tax insurance is a better and more efficient means of insulating themselves from the impact of an adverse tax ruling.

Could you outline some of the common types of M&A-related tax risks that typically surface?

The most common types of M&A risks are typically related to deal structure, or the prior restructuring of a target company, and include tax-free reorganisations, restructurings and spin-offs. However, tax implications are global, complex and ever-changing. For example, taxpayers and their advisers are still working to determine the implications associated with the Tax Cuts and Jobs Act (TCJA), which instituted the transition tax, global intangible low-taxed income (GILTI), foreign-derived intangible income (FDII), and the base erosion and anti-abuse tax (BEAT). The uncertainty associated with the TCJA has led to many related M&A tax risks. The acquisition of an S-Corp., and any related 338(h)(10) election, often leads to tax risks as a result of the historic operations of the S-Corp. and whether those operations created an S-Corp. foot-fault – ineligible shareholders, second class of stock, disproportionate distributions and late elections – inadvertently terminating the S-Corp. status and creating entity-level tax. M&A transaction parties also frequently come across tax risks associated with whether a distribution is considered debt or equity, the classification of income as ordinary or capital, whether there are indirect transfer tax implications, and the impact, if any, of Section 382 limiting NOLs and Section 409A.

As one way to help manage these risks, could you provide an overview of tax liability insurance and the benefits it can provide?

Tax insurance has proven to be a very efficient tool for transaction parties to manage the risk associated with an identified, supportable tax position not qualifying for its intended tax treatment. Even the strongest tax opinions acknowledge that the tax position is not free from doubt. Private letter rulings are not always available or can take a significant amount of time and energy to procure. Tax risks, by their very nature, can linger for prolonged periods of time. As a result, identified risks often lead to tense negotiations that have the potential to force the parties to walk away from the deal. Tax insurance is a cost and time efficient product that enables the parties to transfer the risk associated with an identified tax position to an insurer. It saves buyers from having to self-insure the entire risk or engage in tense negotiations to procure an indemnity, and when indemnities do arise, sellers can insulate themselves from an indemnity claim via tax insurance. Generally, tax insurance provides the insured with coverage for the taxes owed if the position does not receive the intended treatment, any associated interest and penalties, and the costs associated with defending the position, as well as a 'gross-up' to cover any income taxes assessed on the receipt of the insurance proceeds.

What trends are you seeing in terms of policy coverage, terms and pricing, as well as claims processing?

The tax insurance market has certainly become more competitive in recent years. One positive result of this shift is that tax insurance policies have become much more cost-effective. Additionally, in most cases the individuals underwriting tax risks are former tax and M&A attorneys or advisers, who thoughtfully consider the tax risk and,

when necessitated by the risk, can offer longer policy periods and creative coverage terms. This experience, along with growing familiarity with the product, also helps drive better terms. At the end of the day, we view ourselves as a partner with the insured working together to craft the best – and often a very innovative – approach to the identified issues. Given this partnership mentality and the nature of the identified, supportable tax risk, the claims process is not contentious as the insurer and the insured are both advocating for the same tax treatment.

In your experience, what considerations should acquirers make when assessing the options available for tax liability insurance? How should they go about choosing the right policy for their particular situation?

An acquirer needs to look both internally and externally when determining the best option to address a tax risk. Internally, the acquirer needs to consider several things. First, it should determine how much of the risk it is willing to bear – even if its adviser has provided a tax opinion on the issue, as opinions are not a guarantee of success. Second, the acquirer needs to think about its ability to transfer the risk to the seller, but also about how attempting to transfer the risk will impact negotiations, especially in a competitive process. Third, no matter how remote, it must weigh how an adverse resolution of the tax issue would impact its acquisition – adverse resolutions often result in significant financial implications. Finally, the acquirer will want to consider if it has the ability and the time required to obtain a private letter ruling. Externally, the acquirer will want to determine whether the seller is creditworthy enough post-sale to stand behind any indemnity, the ability to lock-up sale proceeds in an escrow for an extended period of time, and how either a request for an indemnity or an escrow may impact the deal. If an acquirer does not want to bear the entire risk and does not have the leverage to push the risk entirely onto a creditworthy seller, then insuring the tax risk may be an excellent option. Representations and warranties insurance (RWI) is designed to cover unknown risks resulting in a breach of a specific representation in the transaction agreement. By their nature, identified, material tax risks are excluded from RWI policies. On the other hand, tax insurance is an efficient means to transfer the risk associated with the identified, material tax risk and is often used in connection with RWI insurance to provide broader overall coverage.

Could you provide an insight into insurers' underwriting process for tax liability insurance, and related timescales? What information do underwriters typically require, both initially and during the formal underwriting?

After receiving a submission requesting tax insurance coverage from one of the specialised, experienced tax insurance brokers, the underwriter researches the issue and cross-references it against the position presented by the taxpayer and its advisers. While an opinion from an adviser is not always necessary, so analysis of the tax issue is generally required and will certainly expedite the submission review process. When timing is not imperative, the underwriter generally has a week to share its non-binding terms with the broker. The broker aggregates all terms submitted by potential markets and works with the client to select the market most attractive to it. Once formally selected by the client, the underwriter will perform additional analysis of the tax issue, request additional supporting documents and, more often than not, engage outside counsel to assist in the underwriting process. During the formal underwriting process, the underwriter also works with, and through, the broker to negotiate a bespoke policy specifically tailored to address the tax risk at hand. The formal underwriting process normally takes a week or two, but when time is a determinative factor, the entire process can be expedited. In some circumstances – for example when a transaction is at risk – the entire process can be completed in 48 hours.

Going forward, do you expect to see increasing appetite and rising demand for tax liability insurance?

Tax insurance is a practical, efficient tool to address identified, supportable tax positions. When tax insurance is utilised, transaction parties are no longer required to expend their valuable time and resources to acquire private letter rulings nor engage in tense, protracted negotiations for seller indemnities or escrows. The tax insurance market will continue to grow as more taxpayers come to understand its benefits. As the market grows, its ability to insure these complicated risks will increase and, assuming responsible underwriting, the cost to do so will remain attractive.

By Luke Dormehl

Google famously laid out its mission as organizing “the world’s information [to] make it universally accessible and useful.” The search giant’s algorithms kneaded the web’s doughy data and metadata until it no longer resembled the lumpy experience of using the internet in the bad old days of Yahoo and Ask Jeeves, but rather a new streamlined, smoother surfing experience built for maximum effectiveness. Today hosting 5.6 billion searches per day, Google has been overwhelmingly successful at its job.

Now Alphabet, the parent company to which Google is but one part, wants to do the same thing with drone deliveries. But in a real-world of, well, brick and mortar buildings, weather systems, and FAA regulations, can its drone delivery subsidiary Wing hope to be as transformative as Google was in the world of search?

In short, can it succeed at making drone deliveries both universally accessible and useful?

A drone delivery system that works



Unlike most Google stories, Wing begins with a failure parable. Kind of. In 2012, the team behind Wing (it grew out of X Development, Alphabet’s “seriously-we-can-do-that-now?” moonshot initiative) showed off their initial prototype vertical landing and takeoff vehicle. This was capable not only of flying from one location to another, but also of hovering and winching packages up and down from the ground using a retractable

tether. Wing immediately aimed for the most headline-grabbing, life-altering use-case possible: delivering defibrillators to people having heart attacks. As Apple is currently finding with the heart-rate tracking feature on the Apple Watch, few technology demonstrations generate more positive headlines than ones that involve saving lives. But it wasn’t to be.

“In the process of [exploring this idea] we realized that the drone technology wasn’t yet far enough along to be used as a reliable deliverer for that kind of urgent use-case,” Alexa Dennett, who heads up marketing and communications for Wing, told Digital Trends. “We spent the next seven-plus years, through today, trying to build an energy efficient, fast, reliable, and safe drone delivery system [that works].”

Here in 2020, companies promising drone deliveries is a whole lot like sex in high school. Everyone says they’re doing it, but hardly anyone actually is. Lots of readers will be familiar with proclamations like Jeff Bezos’ announcement of Amazon Prime Air, the one-click dream of achieving autonomous drone-based Amazon deliveries to customers within 30 minutes of ordering. But more than six years after Bezos showed off the concept during an episode of 60 Minutes, Amazon deliveries remain frustratingly grounded. Wing, meanwhile, is surging forward — or, rather, upward. So long as you live in one of several select locations, that is.

“We’ve done over 80,000 flights with our current iteration of drone,” Dennett continued. “We’ve done that across three continents, with operations in Australia, Finland, and the U.S.”

Wing is currently operating in Australia's cities of Canberra and Logan; Helsinki in Finland; and, in the United States, in the 21,000-person town of Christiansburg, Virginia. By partnering with assorted other businesses, it's carried out proof-of-concept deliveries for everything from [donuts](#) and [artisanal cheeses](#) to [Walgreens groceries](#) and [FedEx packages](#).



The most exciting development of all, however, is one that, on paper, sounds like little more than fine print: Wing has received an Expanded Air Carrier Certificate from the Federal Aviation Administration (FAA). “We’re the first drone company in the United States to be a certified air carrier,” Dennett explained. “That means that we’re able to take money in return for providing our services because we’ve demonstrated such a level of safety.”

Bringing it to the masses

Alongside the ability to fly legally beyond the drone operator’s line of sight, this suddenly makes autonomous drone deliveries seem a lot more viable. This doesn’t just benefit Wing, either. It also makes the technology available to a whole lot more customers; ones that don’t necessarily have the resources of a Silicon Valley tech giant to consider implementing their own drone delivery systems.

“What I see as the most unique and differentiating thing about our drone is that really what we’re trying to do is empower everyone to access drone delivery,” Dennett said. “What I mean by that is that we’re building a system that allows drones to pick up and deliver to anywhere. The awesome thing is that, let’s say you’re a local coffee store, you could potentially work with Wing to have your coffee delivered to customers who would normally not walk past your store.”

From the perspective of a Wing partner, the idea is theoretically straightforward. You partner with the company, a bit like an independent developer hitching its wagon to Apple’s App Store star. Customers then get to order your products, you pack up the boxes when an order comes in, head outside to wait for Wing’s drone to whisk off your products, and Wing takes care of the rest. For a fee, of course.

“When that button is pushed [by a customer], our merchants are told ‘put [the item] in a box,’” Dennett said. “Our drone is then given instructions to take off. The route is planned by our unmanned traffic management system to be the safest, most efficient route. The package is loaded on by the merchant, and the drone flies completely autonomously to the person who has ordered it. The drone then hovers at about seven meters above the ground. It lowers a string, unhooks the package, winds up the string, and flies away to its charge pad to get ready for its next order.”

As simple as that, right? “[X Development]’s mission is to basically create businesses that will have an impact on hundreds of millions of people,” Dennett explained. “But will also, as a corollary, have the potential to generate large returns. From Wing’s perspective, we believe that we fall into that bucket.”

Delivering the undeliverable

The smart play — and the reason why drone deliveries are so exciting for companies — is because it makes it possible to deliver things that have never been delivered. For years, companies have delivered large items to customers. A new fridge or couch is a big-ticket item that's impractical to transport on your own, and probably isn't needed right this instant. Since then, the bar for the kind of things we'll order for delivery has lowered as the speed of transportation has increased. Six weeks' wait for a couch is acceptable. Six weeks' wait for your fresh groceries is less so. One or two days for a book from Amazon is probably easier than driving downtown, parking, and going to a bookstore. One or two days' wait for a cup of coffee is wildly impractical.

“In Australia, we've got a coffee provider called Kickstart Espresso,” said Dennett. “We've got an ice cream company called Pure Gelato. Both of those industries are, historically... you're not going to deliver ice cream by a car, right? Because it's melted by the time it's delivered. And you're not going to deliver an espresso-based coffee by car because it's going to be lukewarm by the time it reaches the customer. But thanks to Wing, people can get deliveries to their door in a handful of minutes. That means ice cream that's still frozen on a hot day when it's delivered to your yard. Same with coffee, which is still piping hot. For these kind of businesses, drones are facilitating a whole new type of delivery that's a new way of serving their customers.”

To put it another way, Wing — and drone delivery companies like it — hope to make deliverable whole new categories of goods that wouldn't previously have been. Dennett would not share the exact price point at which it makes sense for a company to offer drone delivery (does ice cream by drone make sense or does it smack of dot-com bubble insanity?). However, she is confident that Wing's business model is built with scalability in mind.

“You don't need to have a delivery driver who then gets stuck in traffic,” she said. “It's a point-to-point system flying in the sky where there is no traffic. We're very confident that it will be significantly more cost effective for businesses to use this delivery service.”

Where we're going...

There are challenges, of course. As noted, plenty of other companies are jumping into the drone delivery space. There are also ground-based delivery services like Starship Technologies, which offer sidewalk-based delivery bots that aim to achieve much the same thing.

Elsewhere, questions remain about things like the level of noise pollution drone deliveries will create. During Wing's operations in Canberra, one complaint described the noise of its delivery drones as being like “a chain saw gone ballistic.” (Dennett said that Wing has made changes to its propellor and blade design, which has resulted in a “perceptible halving of the sound.”) Then there's all the regulatory bodies, which will need to be convinced that drones are safe and efficient before they are given unanimous approval to operate everywhere.

But Wing, and others like it, have one big ace in the hole: our current method of transportation is, frankly, kind of broken. “There [has] to be a better way to transport things,” Dennett said. “Roads are incredibly congested. It seems absurd that you carry a two-pound package in a 2,000 pound car, with the carbon emissions associated with that kind of transportation.”

Drones, with their cavalier disregard for anything as mundane as ordinary streets, offer one sci-fi-sounding solution. As Dr. Emmett Brown tells Marty McFly at the end of *Back to the Future*, “Roads? Where we're going, we don't need roads.”

Nicole Raimundo envisions a day when streaming video will be as routine a part of emergency response as stretchers and defibrillators.

Raimundo, who is the chief information officer for the town of Cary, North Carolina, believes high-quality live streams will redefine the way responders, caregivers and law enforcement authorities manage crises. Police departments across a region will be able to assess an emergency and dispatch officers accordingly. Doctors and nurses will diagnose injuries via high-definition video before patients reach the emergency room. Traffic control systems will automatically adjust stoplights and re-route traffic to speed emergency vehicles on their way.

“Imagine if you could string applications together so response happens all at once,” said Raimundo, who is leading efforts to implement such capabilities for Cary’s “smart cities” project.

The technology to enable these scenarios is theoretically in place today – but you wouldn’t want to depend on it. As anyone who has ever made a video call over a cellular network knows, fuzz-outs, freezes and dropped connections are par for the course. It’s the price we pay for sharing bandwidth with others, which is how wireless networks have always operated.

All that may be about to change, however — and 2020 could be the turning point. A trio of new technologies is set to redefine wireless networking. That, in turn, could change the way enterprises think about how they build applications, manage data, distribute computing resources and even deploy robots and factory floor machinery.

Computing on the edge

It’s called “edge computing,” and the infrastructure to make it real is about to hit the market. The timing couldn’t be better. International Data Corp. projects that the world will create 163 zettabytes of data annually by 2025, about 10 times as much as in 2016. The research firm also expects that a quarter of that data will be created in real time, with “internet of things” devices contributing 95% of that volume.

Processing and storing such large volumes of data in a centralized cloud or data center is impractical. That means more decisions need to move closer to the sensors, video cameras, cash registers, hygrometers and hundreds of other devices that create data. The emerging wireless protocols to make that distributed intelligence feasible – 5G, Wi-Fi 6 and Citizens Broadband Radio Service — are finally here.

The big question: Will complexity, security and management issues stall new edge models before they get off the ground?

There’s a lot at stake for a wide swath of the technology industry, ranging from cloud computing providers to traditional networking providers and telecommunications giants. Edge computing’s distributed nature is at odds with the centralized processing model that cloud giants such as Amazon Web Services Inc. and Microsoft Corp. have ridden to success, and they’re wasting no time in responding.

At the same time, networking providers such as Cisco Systems Inc. and Juniper Networks Inc. see the opportunity to embed themselves more firmly into their customers’ information technology infrastructure. Wireless carriers and colocation providers are hunting new opportunities to help enterprises construct sprawling new edge “fabrics.” Virtualization and systems management vendors such as VMware Inc. and IBM Corp. will compete to tie it all together, as will a host of startups.

These issues will be top of mind for many people at industry conferences in coming weeks, from Cisco Live in Barcelona this week to Mobile World Congress next month, also in Barcelona, and Internet of Things World in April in Santa Clara, California. But they're also likely to dominate conversations throughout the tech industry all year.

That's because many people expect edge computing will prompt a massive rethinking of enterprise IT infrastructure. "I believe we're right smack in the middle of a big rip with forces pulling for both centralization and decentralization," said Vince Kellen, CIO at the University of California at San Diego. Cloud will continue to be the preferred destination for aggregation and analysis, but what the networks will look like that feed data to the cloud is anybody's guess.

Wireless at wire speed

By now just about everyone has heard of 5G, the new international standard for communication over digital cellular networks, but most people don't understand why it's such a big deal. There's good reason for confusion. There are three different versions of the protocol – low-band, mid-band and high-band – and they're all incompatible with each other. Low-band networks offer only marginal speed improvements over current 4G speeds and will be the first to reach consumer handsets.



Packet's Smith foresees wireless applications with "zero latency and nearly unlimited bandwidth." Photo: Packet

The real excitement is over high-band 5G, which operates in the spectrum between 20 gigahertz and 100 gigahertz, a range that has never been used for consumer applications. Not only do high-frequency bands enable blistering speed but 5G brings with it the ability to slice signals into multiple virtualized and independent logical networks that run on the same physical network infrastructure.

Each slice can have different characteristics and can be reserved for specific uses or organizations, providing guaranteed performance and extremely low latency. Network slicing does away with bandwidth sharing, which is the principal cause of unpredictable performance on today's cellular networks.

"If you're FedEx and you need cellular bandwidth today, you have to share it with people streaming videos," said Zac Smith, chief executive of Packet Host Inc., developer of a bare-metal cloud platform. With 5G, in contrast, "whenever you're near a radio you have guaranteed spectrum that isn't shared," he said. "Now you can run applications with zero latency and nearly unlimited bandwidth."

And the connection can be very fast, up to 10 gigabits per second. That makes 5G a potential wireless alternative to Ethernet cabling, a fact that could liberate millions of machines from their hard-wired tethers.

The challenge with high-band 5G is that signals at those frequencies don't travel very far and are easily blocked by walls and trees. To get the full benefit of speed and low latency, micro-cell stations need to be positioned as little as 500 feet from each other, making network buildouts both time-consuming and expensive. It's expected that for the foreseeable future public cellular data networks will use a combination of all three types of 5G bands, along with their 4G and 3G predecessors, depending on the usage scenario.

Commercial deployments of 5G networks began last year and about 50 trials are in place, according to Chris Pearson, president of 5G Americas, a trade association of telecommunications service providers and manufacturers. "But you'll see a steep ramp up in 2020," said Pearson, who's leading two sessions on 5G futures at the Internet of Things World conference in April. "We're expecting more than 1 billion connections worldwide by the end of the year."

Wi-Fi that works

The second technology that's set to make an impact this year is Wi-Fi 6, the latest version of the wireless protocol typically used within buildings or geographically bounded shared spaces. Although the standard has yet to be formally ratified, devices that are compatible with the draft standard have been available for months and are expected to fall sharply in price over the next year.

Wi-Fi 6 delivers a modest performance boost over the current standard but has a couple of new features that enterprises will appreciate. Like 5G, Wi-Fi 6 implements its own form of network slicing, enabling signals to be dedicated to certain endpoints. Bandwidth sharing is the bugaboo that has frustrated network architects for years, limiting Wi-Fi's use in settings where reliability and speed are critical. "Wi-Fi is currently completely unusable for any application requiring guaranteed access and performance," said Packet's Smith.

The new standard also raises the threshold on the number of devices that can be addressed simultaneously by a Wi-Fi access point. When combined with bandwidth slicing, that greatly improves reliability. "It is much more effective at handling densely populated areas" than its predecessors, said Bob Laliberte, an analyst at Enterprise Strategy Group Inc.

Finally, a feature called "Wake on Wireless LAN" permits devices on the network to be awoken when needed rather than connected all the time, a feature that can greatly improve the battery life of sensors and other endpoint devices. Currently, endpoints must constantly broadcast their status over the network, even if updates are only needed occasionally. "Wi-Fi 6 is a game changer from a battery life perspective," said Kilton Hopkins, CEO of Edgeworx Inc., an edge computing software company.

The third significant new wireless standard, Citizens Broadband Radio Service, is also the least well-known. CBRS, which is unrelated to the lightly regulated Citizens Band voice service that was popular with truckers during the 1970s and 1980s, covers a swath of unlicensed spectrum that was originally developed for use by the U.S. Department of Defense and cleared for commercial use last fall. Like Wi-Fi, CBRS is intended for geographically bounded areas such as university campuses and sports arena.

It has greater capacity, speed and range than Wi-Fi. But perhaps more important, CBRS can be used as a carrier medium for 5G, meaning enterprises can run their own 5G networks without licensing commercial spectrum. That has never been possible before. Commercial CBRS deployments have been slowed by regulatory red tape but are expected to begin in earnest this year.

Taken together, the new standards should enable organizations to build micro-networks without having to deal with the bottleneck of cell towers and shared signals. They can essentially become mini-cloud providers, delivering most services locally and only sending data selectively to a central cloud.

That has cloud providers scrambling to respond. Although public cloud's rapid growth has so far provided plenty of riches to go around, edge computing could be a potent challenger to the centralized computing model ushered back in by the cloud.

1 + 1 = 3

The potential is particularly compelling when technologies are combined. For example, Hopkins said Wi-Fi 6's Wake on Wireless LAN can lead to dramatically lower power consumption that enables more intelligence to be housed in sensors and remote devices. That, in turn, allows more application logic to be delegated to those devices.

Similarly, the speed and bandwidth of 5G networks will enable many devices that currently require hard-wired Ethernet connections to unplug. Companies that are embracing these technologies "are not looking replace Wi-Fi; they're looking to replace wiring," said Ozer Dondurmacioglu, vice president of marketing at Celona Inc., a company that builds enterprise applications based upon 5G.



Celona's Dondurmacioglu: Next-generation wireless adopters "are not looking replace Wi-Fi; they're looking to replace wiring." Photo: Celona

Features such as bandwidth slicing and reserved bandwidth are also challenging decades-old assumptions about network architecture. "Years ago, everything was built on a hub-and-spoke model," said Joe Wojtal, chief technology officer of the global service provider division at World Wide Technology Inc., a provider of technology and supply chain services for enterprises. "With public cloud and edge computing becoming more prevalent, there are really no more borders to these networks."

"With 3G and 4G the network was a big pie, and the quality of service between the app and mobile device was determined on a best-effort basis," said Ken Zhang, CEO of Global Elmeast, an IT consulting firm focused on intelligent networks. "It's now possible for enterprises to build their own dedicated 5G networks within a given geographic region with as few as 10-20 base stations."

Sitting atop this new infrastructure is software-defined networking, a catch-all term for the management layer that orchestrates devices and services. SDN enables services to be provisioned and managed flexibly from a central administration point. Networks can be set up, changed, segmented and shut down without touching physical devices.

Arizona State University is going all in on SDN, 5G, Wi-Fi 6 and CBRS in a complete overhaul of its campus network that it expects will deliver high speed and guaranteed performance across thousands of devices.

"We're looking at virtual networks, software-defined orchestration and automation across multiple domains with the ability to provision performance, latency, privacy and security for each customer," said James McCabe, an ASU enterprise network architect who previously designed networks for the National Aeronautics and Space Administration.

ASU's new network will enable the university to disperse processing now done on central hubs local processors and even intelligent devices themselves. "We have the ability to sensor the environment as well as the transmission," McCabe said. For example, intelligent cameras will be able to interpret video signals instead of just capturing them, empowering campus police to detect a crowd while it's forming or identify people who are overheating on a hot summer day.

The new network will enable the university to become, in effect, both a cloud service provider and a telecommunications carrier. ASU has already deployed branded version of applications like WhatsApp and Zoom videoconferencing on a campus-wide basis rather than from a public cloud. It can mine usage data to better understand how those applications are being applied.

It can also apportion dedicated slices of its network for such uses as emergency response, fleet management and scientific experimentation. "For the first time we're virtualizing the network and taking advantage of a sliceable software platform," said CIO Lev Gonick. "It's simplified operational overhead dramatically."

ASU is also extending its network for use by nearby innovation zones where businesses set up shop and collaborate with the university. "Leveraging our network rather than commercial networks can add up to significant cost savings for those towns," Gonick said.



Arizona State University CIO Gonick: "It's simplified operational overhead immensely." Photo: ASU

SDN also permits operators to expose network services through application program interfaces, a capability that particularly piques the interest of people in the public sector like the Town of Cary's Raimundo. "Current IoT solutions tend to be very singular," she said, "but we're talking about new ecosystems that pull in all this data into one place and look at it holistically."

That could be used to furnish a consistent user experience to visitors driving through the town as well as aid in region-wide emergency response. Cary is working with the nearby town of Apex as well as the North Carolina capital city of Raleigh on a coordinated approach to storm water sensors so that towns that are experiencing flooding can alert their downstream neighbors to prepare.

The goal is for video cameras to sense an oncoming flood and trigger alerts that automatically shut down affected roads and redirect traffic. Such a network can be built by federating local networks through APIs. "A lot of the benefit will be thinking in a regional approach across a larger community," Raimundo said.

Campus networks that combine technologies like CPRS, Wi-Fi 6 and 5G can empower enterprises to become, in effect, providers of their own small clouds. That would permit the owner of a football stadium to set up a private 5G network exclusively for fans in the stands and provide value-added content such as virtual reality replays and interactive gaming for a fee or as a ticket sales incentive. Essentially the stadium owner becomes a content delivery network and a carrier without paying any of the overhead to external services.

"Right now people in the stands are using an LTE server, but there's no reason the stadium can't become the network provider," said Packet's Smith.

Given the complexity of highly distributed networks, enterprises are likely to lean heavily on technology providers to make edge computing real.

"We have multifaceted complexity and the management overhead is enormous," said Russell Kaurlo, CIO at Clemson University, which is investigating a network overhaul using CBRS, 5G and Wi-Fi 6. He's leaning on technology providers to make the network as simple for the university to operate as the cable modem in a consumer's home. "I can control it but I don't own it," he said. "Do I really want to be in the carrier business?"

Client/server 2.0?

Despite the promise of next-generation networks, many CIOs remain skeptical. In an informal year-end survey of IT leaders by The Wall Street Journal, they labeled 5G as one of the most overhyped technologies of the previous year.

Their attitude no doubt reflects a certain battle weariness but may also be shaped by the belief that these technologies are simply faster versions of what they already have, said Edgeworx's Hopkins. "If they think 5G is just an upgrade in bandwidth, then of course it's not a revolution," he said. "They need to understand that this is about entirely new models of connectivity and consumption."

Some experts have drawn an analogy to the introduction of electricity and manufacturing plants in the 1920s. Prior to that, most factories used a system of serpentine leather belts connected to a central power source like a steam engine or water wheel to drive equipment on the factory floor. Decisions about where to locate machinery were influenced as much by the need for proximity to the power source as by operational efficiency. Electrification enabled factory owners overhaul their assembly lines, putting machinery where it made the most sense and enabling huge gains in manufacturing productivity.

Next-generation networks have the same disruptive potential, many experts believe. Initial use cases are likely to include real-time couponing in retail settings, fleets of autonomous vehicles and modular robots in manufacturing and warehouse environments, said ESG's Laliberte. "The IT pendulum is clearly swinging back to distributed environments and technologies that enable organizations to more effectively connect those environments," he said.



UCSD's Kellen sees "a big rip with forces pulling for both centralization and decentralization." Photo: UCSD

But complexity could throw a wrench into the works. IT veterans have been down the distributed intelligence path before. In the early 1990s a concept called client/server captured the imagination of the industry organizations with promises of breaking centralized mainframe computing into networks of servers and PCs.

Client/server was supposed to be cheaper and more flexible than centralized computing, but it never lived up to expectations, in large part because of administrative complexity and security concerns. Could edge computing end up being client/server 2.0? Some people say it's a possibility.

"The size and scale of this stuff runs the risk of collapsing the value proposition," said Rob High, an IBM fellow and chief technology officer for IBM Watson. "If we don't solve the problem of making administration ubiquitous, easy and cheap, then the weight of the scale could supersede the value it delivers."

World Wide Technology's Wojtal agreed. "Nobody is going to pay more and deal with more complexity if they're not seeing the payback," he said.

Others say the scenarios are too different to compare. For one thing, client/server was conceived in the days before the commercial internet provided a consistent transport layer. It also relied heavily on Windows personal computers, which could barely even multitask at the time. In contrast, new edge architectures are intended to distribute processing and logic across a diverse and fluid network of computers and other devices.

Client/server was also framed as an alternative to corporate mainframes. Thanks to the rise of cloud computing, no one is casting aspersions on centralized processing anymore. Rather, the cloud is seen as an essential destination in the value chain with intelligent devices taking on more of the tasks of sifting data at the edge.

"It is all about how deploying the minimal amount of infrastructure to perform the analysis required, ensuring that all data is then sent to a centralized data lake, ocean or cloud of your choice," said ESG's Laliberte. "Enterprises shouldn't look at this as a case of one versus the other but rather how can these technologies work together seamlessly."

That vision of a flat, peer-to-peer network rekindles memories of grid computing, another 1990s phenomenon that never quite lived up to the hype. Grid is a distributed processing architecture in which many computers tackle a complex problem in parallel. It's still popular in scientific and high-performance computing today environments today, and edge computing networks could rekindle interest in other areas.

Last fall UCSD partnered with the University of Wisconsin to apply more than 51,000 rented graphics processing units bound together in a grid to the task of analyzing ice crystals deep below the Antarctic surface. The experiment demonstrated how grid architectures could amass computing power on a temporary basis to attack big problems. "We're now seeing forms of grid computing becoming very feasible," said CIO Kellen.

Competitive scrum

The vendor land grab has already begun, led by the cloud platform providers. The on-premises cloud operating stacks that the top three providers are pushing – AWS' Outposts, Microsoft's Azure Stack and Google's Anthos – all serve as base stations that can be used to orchestrate customers' edge deployments in the future.

Last December AWS announced Wavelength, a service that makes its cloud compute and storage resources available at the edge of 5G networks, along with a partnership with Verizon Communications Inc. that it said is the

first of many telecom alliances. AWS has also started rolling out Local Zones, which are small satellite data centers intended for latency-sensitive applications. “People are going to want to eliminate several or all of those hops and find a way to have the compute and the storage much more local to where the 5G is and then an experience that wraps that together,” CEO Andy Jassy told SiliconANGLE.

Microsoft teamed up with AT&T Corp. on an alliance to deliver Azure cloud services from edge locations on AT&T’s 5G network. The company announced a broad series of edge-focused initiatives at its Build developer conference last spring and has a version of its Azure cloud specifically for deployment on IoT devices.

Google has so far staked its strategy on the Kubernetes container orchestrator that was developed on its campus. It’s considered a key technology for making cloud-native applications run on edge devices.

Some people say cloud providers have the most to lose to edge networking, although few executives are losing sleep at the moment given the industry’s rapid growth. Nevertheless, a core principle of edge computing is to reduce reliance on central services over the long term.

Cloud providers “absolutely are threatened” by the edge, said Hopkins. “Microsoft and AWS don’t make money by helping people keep data inside their buildings. The more they keep it there, the less incentive there is to use the cloud.”

Telecommunication providers, on the other hand, could benefit from helping customers set up their own micro networks and even delivering cloudlike computing and data services at the local level. “The service providers have a bit of a leg up on the public cloud providers because they have facilities that connect directly to enterprise customers,” said World Wide Technologies’ Wojtal.

Edge computing could also spark a resurgence of interest in colocation, a decades-old business that has a knack for reinventing itself. Originally conceived as leased data center space, colocation providers now serve an important role as low-cost networking hubs for companies that want to exchange data with each other. They could find new relevance as nexus points for geographically confined 5G networks.

Not least, traditional networking companies such as Cisco are hoping their strength in data centers and corporate networks along with newly developed and acquired 5G and other edge technologies can help them remain a mainstay in enterprises as they rethink their networks.

Building the next generation of networks will take time and CIOs who don’t want to be on the bleeding edge are best advised to wait, experts say. “Get educated on the technologies and ensure key architects and team members are educated as well,” advised ESG’s Laliberte. Then proceed incrementally. “For example, it probably makes sense for organizations to migrate to Wi-Fi 6 during a normal technology refresh, even though there may not be many compatible devices available today,” he said.

By moving methodically, upgrading incrementally and relying on technology providers to do the heavy lifting, enterprises will eventually arrive at a network of unprecedented speed, adaptability and dependability. Even for video phone calls.

By Ingrid Fadelli

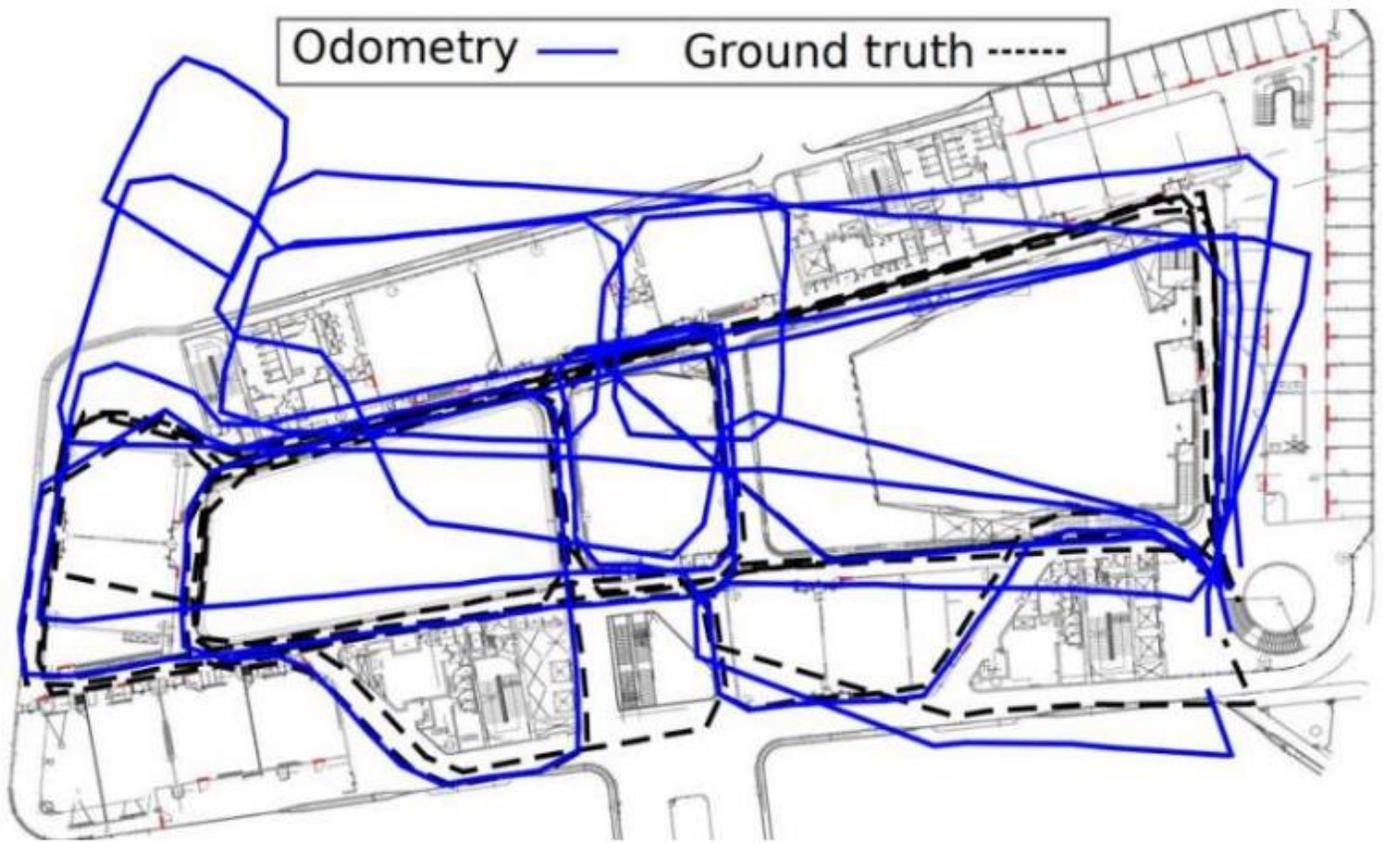


Figure showing how ground truth approaches compare to odometry techniques

In recent years, research teams worldwide have developed new methods for simultaneous localization and mapping (SLAM). These techniques can be used to construct or update maps of a given environment in real time, while simultaneously tracking an artificial agent or robot's location within these maps.

Most existing SLAM approaches rely heavily on the use of range-based or vision-based sensors, both to sense the environment and a robot's movements. These sensors, however, can be very expensive and typically require significant computational power to operate properly.

Aware of these limitations, researchers at the Singapore University of Technology and Design, Southwest University of Science and Technology, the University of Moratuwa and Nanyang Technological University have recently developed a new technique for collaborative SLAM that does not rely on range-based or vision-based sensors. This technique, presented in a paper prepublished on arXiv, could enable more effective robot navigation within unknown indoor environments at a cost significantly lower than that of most previously proposed methods.

"We aimed to utilize low cost and low computational sensor as a replacement for range-based or visual-based sensors," Chau Yuen, one of the researchers who carried out the study, told TechXplore. "Since modern buildings typically have Wi-Fi network coverage, our goal is to utilize such freely available information to perform SLAM."

To exploit radio features that are readily available in most urban environments, the researchers developed an approach for collaborative simultaneous localization and radio fingerprint mapping called C-SLAM-RF. Their technique works by crowdsensing Wi-Fi measurements in large indoor environments and then using these measurements to generate maps or locate artificial agents.

"Our goal is to generate a radio map of the environment with the least human effort possible by leveraging in-built sensing capabilities of commonly used smart phones," Yuen explained.

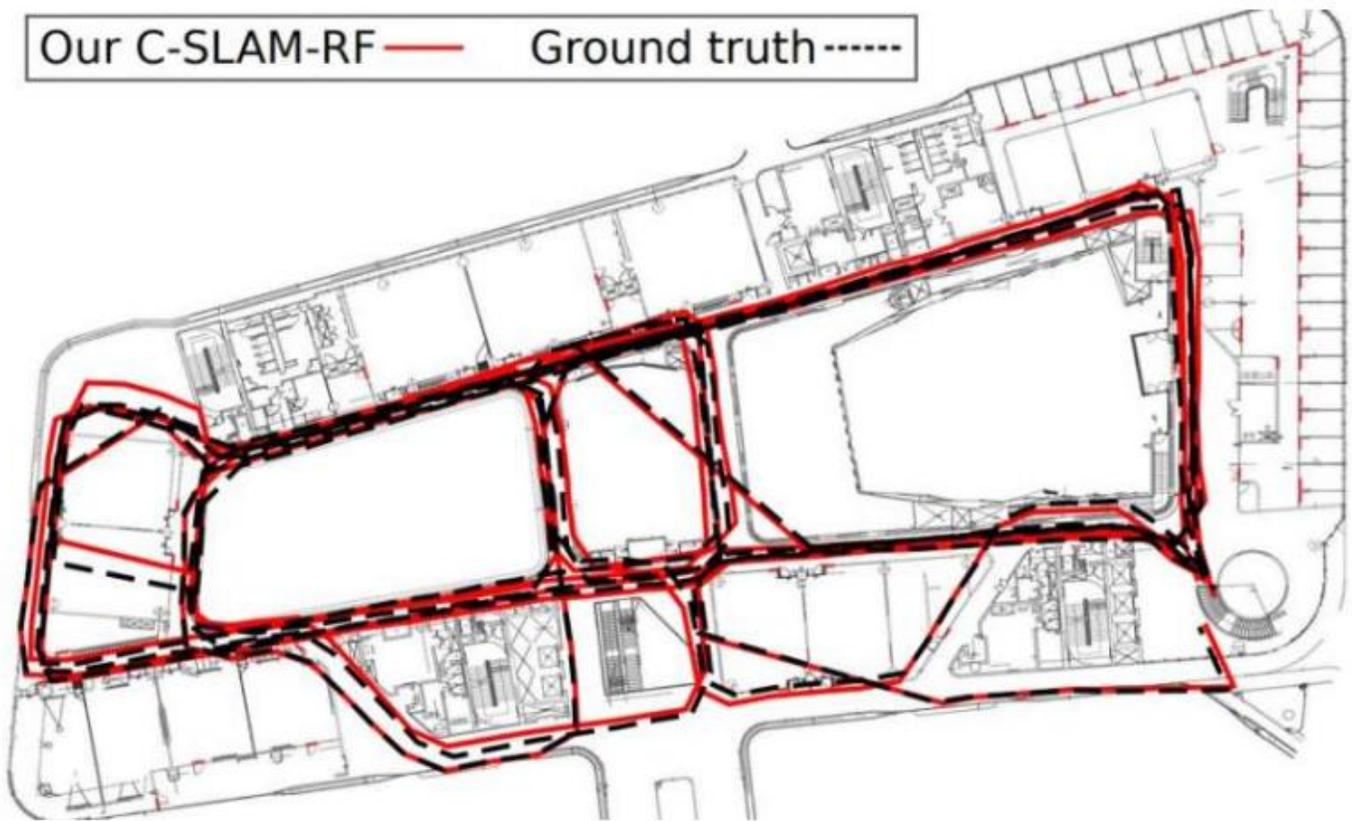


Figure showing how estimated path approaches compare with the SLAM technique developed by the researchers.

The system developed by Yuen and his colleagues receives information about the strength of the signal coming from pre-existing Wi-Fi access points spread around a given environment, as well as from pedestrian dead reckoning (PDR) processes (i.e., calculations of someone's current position) derived from a smart phone. It then uses these signals to build a map of the environment without requiring prior knowledge of the environment or the distribution of the access points within it. The C-SLAM-RF tool devised by the researchers can also determine whether the robot has returned to a previously visited location, known as "loop closure," by assessing the similarity between different signals' radio fingerprints.

"Existing SLAM approaches often use dedicated devices, for example, visual cameras or range-based LIDAR sensors, to measure the similarity of observations by scan matching or feature matching, which are computationally expensive," U-Xuan Tan, another researcher involved in the study, told TechXplore. "Our solution exploits the

possibility to perform localization and mapping with low-cost, ubiquitous IoT devices like smartphones, due to growing popularity of Wi-Fi wireless networks."

Yuen, Tan and their colleagues tested their technique in an indoor environment with an area of 130 meters x 70 meters. Their results were highly promising, as their system's performance exceeded that of several other existing techniques for SLAM, often by a considerable margin.

"We evaluated our approach in a large scale environment and a positioning accuracy of 0.6 meters is achieved without any prior knowledge of the environment," Ran Liu, another researcher involved in the study, told TechXplore. "This accuracy outperforms state-of-the-art fingerprinting-based localization approach, which requires a tedious survey of the environment. The computational time required by our approach is insignificant when compared to the range-based or visual SLAM."

In the future, the approach for collaborative SLAM devised by this team of researchers could help to enhance robot navigation in unknown environments. In addition, the fact that it does not require the use of expensive sensors and relies on existing Wi-Fi hotspots makes it a more feasible solution for large-scale implementations.

"We would now like to explore the possibility of fusing different radio signals, for example cellular signal, to improve the positioning accuracy," Yong Liang Guan, another researcher involved in the study, told TechXplor. "Another plan is to use the produced radio map for the purpose of localization. A combination with other sensors for example laser range finders to accelerate and improve the mapping in large scale environment will be also one of our future research."

By Steve Crowe



If you are a roboticist, chances are you have always wanted to tinker with any of Boston Dynamics' robots. The Softbank-owned company trying to make those dreams come true by making its Spot SDK publicly available on GitHub. This will allow developers to build custom applications that enable Spot to do useful tasks across a variety of industries.

But there is a catch. Developers who want to actually test their code will need to become part of the Spot Early Adopters Program and lease the quadruped. Prior to the open-source code on GitHub, only developers in the program had access to the SDK. Boston Dynamics shared the following examples of what can be done with the Spot SDK:

- Creating VR-based controls for Spot
- Automating registration of laser-scanning
- Connecting Spot's data to cloud work order services
- Using edge computing to help Spot semantically understand its environment

“Spot's early adopters have had robots in hand and on-site for a few months now, and we're seeing an early adopter community come together to build solutions on the platform,” said Boston Dynamics VP of Business Development Michael Perry. “There's no better way to facilitate getting customers the tools they need to create exciting new applications for the robot than connecting the already vibrant and creative community already leveraging Spot.”

Boston Dynamics started leasing Spot in September 2019, marketing the quadruped as a tool for construction, oil & gas, public safety and entertainment applications. SpotWalk is a good example of how Spot can be used as a platform. The SpotWalk app, built by HoloBuilder, enables the Spot robot to autonomously walk job sites and capture 360° images to record the progress of a construction project over time. This process allows for quality and accuracy control, giving contractors, trade partners, and owners a digital record.

```
61 # Now, we are ready to power on the robot. This call will block until the power
62 # is on. Commands would fail if this did not happen. We can also check that the ro
63 # powered at any point.
64 robot.logger.info("Powering on robot... This may take a several seconds.")
65 robot.power_on(timeout_sec=20)
66 assert robot.is_powered_on(), "Robot power on failed."
67 robot.logger.info("Robot powered on.")
68
69 # Tell the robot to stand up. The command service is used to issue commands to a r
70 # The set of valid commands for a robot depends on hardware configuration. See
71 # SpotCommandHelper for more detailed examples on command building. The robot
72 # command service requires timesync between the robot and the client.
73 robot.logger.info("Commanding robot to stand..")
74 command_client = robot.ensure_client(RobotCommandClient.default_service_name)
75 blocking_stand(command_client, timeout_sec=10)
76 robot.logger.info("Robot standing.")
77
78 # Capture an image.
79 # Spot has five sensors around the body. Each sensor consists of a stereo pair and
80 # fisheye camera. The list_image_sources RPC gives a list of image sources which a
81 # available to the API client. Images are captured via calls to the get_image RPC.
82 # Images can be requested from multiple image sources in one call.
83 image_client = robot.ensure_client(ImageClient.default_service_name)
84 sources = image_client.list_image_sources()
85 source_name = sources[0].name
86 image_response = image_client.get_image_from_sources([source_name])
87 _maybe_display_image(image_response[0].shot.image)
88
```

Sample code from the Spot SDK. / Credit: Boston Dynamic

To foster its development community, Boston Dynamics also announced its first user conference, Actuate. The invite-only event will take place May 12-13, 2020 in Boston, bringing together Spot sensor providers, software developers, and users for presentations, hands-on workshops, and networking.

Marc Raibert steps down as Boston Dynamics CEO

Boston Dynamics has been more focused on real-world applications ever since it was acquired by SoftBank in mid-2017 from Google. In another sign of its commercialization efforts, Boston Dynamics Founder Marc Raibert has stepped down as CEO, a transition TechCrunch reports happened in October 2019. Raibert spun off the company from the MIT in 1992. Raibert is now Chairman and Founder of the company. He reportedly will continue to help it develop research robots. Robert Playter, who has been with Boston Dynamics since 1994, is now CEO.

“I just had my 70th birthday,” Raibert told TechCrunch. “So I’ve been thinking about this for about a year that we needed a succession plan and I had been working on it during that time, talking to SoftBank, making sure they were cool with the idea, and making sure I was cool with the idea.”

Playter told TechCrunch, “I’ve been the organizational guy for a long time. I basically hired most of the people in the company and growing us aggressively is a big challenge right now. Over the past year, bringing on new people into our executive leadership team has been a primary goal, as well as feeding an insatiable appetite for our technical teams to grow in order to meet the goals we’ve set for them. Which includes not only advancing the state of the art of robotics but actually making some of our robots into products and delivering them and supporting them and changing the organization to do so.”

In other signs of commercialization efforts, Boston Dynamics released a video of its reimagined Handle robot in March 2019. Handle is now described as a “mobile manipulation robot designed for logistics. Handle autonomously performs mixed SKU pallet building and depalletizing after initialization and localizing against the pallets.” Handle had two arms when it was introduced in 2017, but now it only has one arm to lift and move boxes thanks to a suction gripper.

Also early in 2019, Boston Dynamics acquired Kinema Systems, a Menlo Park, Calif.-based startup that uses vision sensors and deep learning to help robots manipulate boxes. Financial details of the acquisition were not disclosed.

Boston Dynamics was one of The Robot Report’s companies to watch in 2019. It doesn’t appear that will change this year as 2020 is crucial for Boston Dynamics.

By Junko Yoshida

Auto makers are adding functions that all depend on connectivity. A plenty of companies also offer car-to-cloud platforms. Bear in mind, though, anyone who claims to have an “end-to-end” solution doesn’t.

Vehicles are getting connected. That’s a good thing. But they are getting connected in haphazard and slapdash ways, and that’s not good at all. Each car has multiple connectivity needs and, to date, car makers tend to satisfy each need by adding another, different connection. The electronics industry is eager to provide consolidated connectivity solutions, but most major automobile companies remain dedicated to developing proprietary technologies, which means auto makers and their suppliers are figuratively reinventing the wheel on a constant basis.

What follows is an overview of the connectivity requirements by the automobile industry. We then compare several solutions offered by some of the more prominent vendors in the electronics industry.

Why connect?

In-vehicle infotainment systems and telematics units have become top priority for over-the-air (OTA) software updates. Carmakers plan to add new apps and services — ranging from car-sharing to detecting fuel levels — without redesigning the car. A flood of audio and video streaming media — via Wi-Fi, 4G and 5G — is washing over vehicles.

Cybersecurity demands OTA. When there’s a hack, nothing is more important to car OEMs than the agility to send software patches — stat. For software-rich vehicles, OTA is their BFF. Because there is no such thing as bug-free software, vehicles must be prepared to correct software errors.

The next frontier of OTA updates is happening in the whole car. Carmakers need to be able to target not just TCUs (telematics control units) but also the various ECUs, developed by different chip vendors, installed in each vehicle. These ECUs are tasked to control various parts of a vehicle, ranging from engine control to air bags and seat adjustments.

Connectivity must go two ways. Besides the ability to send software patches, carmakers must be able to extract information from vehicles. In the era of highly automated vehicles, massive sensory data generated by cameras, radars and lidars needs to be aggregated, processed, stored and sent to the cloud for AI training. Possibly in a consistent format.

Last but not least, data collected by connected vehicles must be analyzed.

In short, connected cars cover a lot of ground. Connectivity empowers the automotive industry to develop and add new apps and services. Connectivity supports road safety, sends cybersecurity fixes, and advances machine learning. “Car-to-cloud” connected vehicles are a huge market. Every tech supplier, OEM, tier one and tier two is chipping away at it.

Painting a rosy future for connected vehicles is easy. More difficult is figuring out which connectivity solutions are doing what. Bear in mind that no one has gotten all the connectivity pieces down. Anyone who claims to have an “end-to-end” solution doesn’t.

Tower of Babel

At issue is not a lack of building blocks to design connected vehicles. The real concern is that carmakers — as they have done for decades — continue to develop proprietary solutions designed for one but exclude the rest of the industry.

Players in the connected vehicle field — car OEMs, tier ones and tier twos — are building a “Tower of Babel,” observed Mark Singer, director of marketing at Excelfore. An OTA software update solution offered by one company, or designed for one model, for example, does not necessarily talk to another model even within the same company.

Three driving forces for connectivity

The lay of land for connected vehicles is complex. There are, however, three key forces driving vehicles to connect to the cloud.

First is the emergence of “software-defined” vehicles. “Cars are becoming software,” said Raj Kanaya, general manager of automotive and chief marketing officer at Aeris.

Second, 5G and the “infinite scalability of the Internet,” as Harman calls it, are making carmakers rethink how to deliver features and content to a vehicle. Tim Van Goethem, vice president, advanced mobility solutions at Harman, sees the promise of 5G and the Internet enabling car OEMs to “keep adding new features to a vehicle throughout its entire life cycle.”

Third, “data is reshaping the autonomous vehicle (AV) value chain.” Massive data collected for AV applications is making the cloud “an essential building block,” as Danny Kim, partner and director at VSI Labs noted in his company’s technology brief.

Against this backdrop, we will examine who’s who in the connected vehicle market, while breaking down who’s addressing which segments of the car-to-cloud conundrum.

Qualcomm’s Car-to-Cloud Platform

Qualcomm launched its Car-to-Cloud Platform this month at CES.

If you are naïve enough to believe that the vehicle of the future is “a smartphone on wheels,” you might conclude that Qualcomm leading the car-to-cloud revolution is a no-brainer. Hold that thought.



When EE Times asked Qualcomm which parts of the connected vehicle market its Car-to-Cloud Platform is designed to address, Nimish Shrivastava, senior director of product management, gave a

measured response. Qualcomm's immediate mission is to enable carmakers to boost their vehicle's connectivity performance from 4G to 5G without car OEMs having to change the hardware.

Shrivastava said Qualcomm's Car-to-Cloud Platform has two key features. One is something called "Soft SKU." The other is security directly built into connectivity chips. Soft SKU lets field-upgradeable chips "securely support new functionality as performance requirements increase or new features become available." It ensures a smooth transition from 4G to 5G and enables "regional customization and feature upgrades tailored for specific product segments," according to Qualcomm. By leveraging its capabilities, OEMs can customize a single SKU for multiple tiers and markets. That, in the end, will help automakers save costs associated with dedicated investments in multiple SKUs, Qualcomm claimed.

Qualcomm's Car-to-Cloud platform also gives carmakers a flexible way to provision data usage. Shrivastava explained that it's probably not okay for carmakers to charge consumers for the data usage in OTA updates, for example. Connected car vendors should offer different billing systems, while providing plans to bundle data, services and new user experiences in a flexible manner, said Shrivastava.

Too little too late?

Incumbents of the connected vehicle business see Qualcomm's entry in the crowded connected vehicle market as "too little, too late." Greg Basich, associate director of automotive practice at Strategy Analytics, pointed out Qualcomm's inexperience in managing the lifecycle of a vehicle. Qualcomm also lacks knowledge of ECUs supplied by different chip vendors and designed into different vehicles. Supporting Qualcomm's own chip in its own Car-to-Cloud platform is one thing. Presenting itself as a serious car-to-cloud panacea for the whole industry is entirely another. "Qualcomm's car-to-cloud service must be decoupled with Qualcomm's own chip," Basich said.

Shrivastava acknowledged the need for Qualcomm's platform to support other chips in the future. But for now, Qualcomm sees its mission in filling certain gaps it has found in current telematics solutions. Soft SKU will be important for Qualcomm, because all major OEMs are scrambling to make their connected vehicles "future proof." With Soft SKU's ability to activate new features – as needed – at device level, Qualcomm will add "life-time value" to their chips deployed in connected cars, Shrivastava said.

Given the complexity of vehicle architecture, the automotive industry can't simply re-purpose OTA update technology originally invented for mobile phones. That mobile OTA technology cannot update, for example, brake systems, because it lacks the means to extract the necessary delta from a variety of ECUs, whose resources — memory and processing power — are severely constrained.

Nonetheless, Shrivastava insisted that Qualcomm knows something about "bringing different players together" in the "ecosystem." Qualcomm hopes to replicate in the automotive ecosystem its own success in bringing network operators, content owners and software developers together to enable advancements in features and content of smartphones.

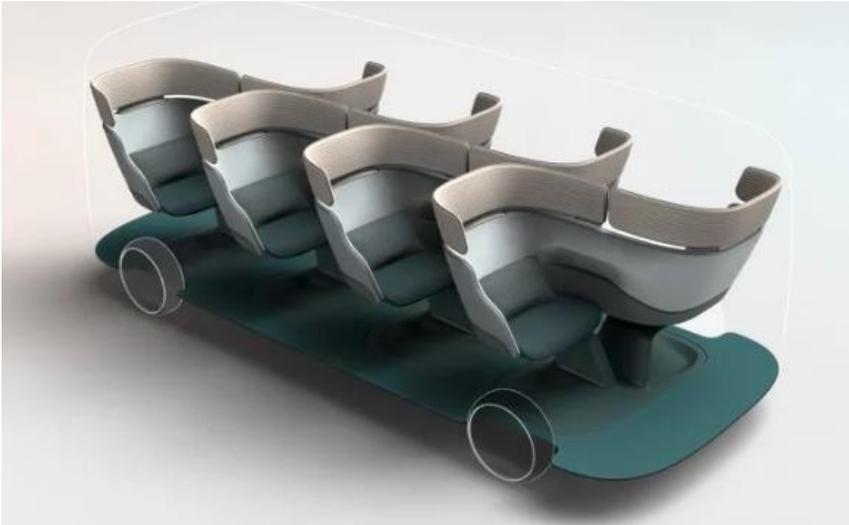
VW-Aeris joint venture

Earlier this week, Volkswagen Group of America announced the formation of a joint venture, called Ventic LLC, with Aeris.

The new JV grew out of a relationship VW had with Aeris. In 2017, the two companies worked together to develop "an IoT platform" to support the embedded connectivity module in cars, a VW spokesperson explained. The JV's work will include "OTA updates to the embedded connectivity module," she added.

The perfect ride-share vehicle is here. Now who will build it?

By Mark Wilson



It's midnight, and you're deciding between an Uber and an Uber Pool to get home. The plain Uber is more money, and it's worse for the environment. But the shared ride means you'll be sitting shoulder to shoulder with a (fellow?) drunk who at best smells like Blue Curaçao and at worst pukes it on you.

There has to be a better way, and you're looking right at it. Designed by the U.K. design studio Layer, Joyn is a conceptual, ride-sharing platform that's explicitly designed to be shared. The vehicle, which would be autonomous, features eight S-shaped seats, which break the car into two

rows that face different ways. The headrests double as privacy screens. And so even though you're packed into a vehicle with seven strangers, you can still have your own personal space. The app would assign you an empty seat automatically.



“This whole share economy thing is idyllic and, I think, the future,” says Benjamin Hubert, founder and creative director of Layer. “But sitting so close to people that you don’t know in a city . . . when you don’t even talk to your neighbors, the comfort level of doing that would be a difficult trade-off.”

There are plenty of public places where we're packed in but manage to keep some measure of privacy: railways and airplanes (especially premium-class tickets). Hubert's team was inspired by business-class seating, adding not just barriers for space but a pocket where you might even work if you wanted, complete with a tray table.

The quality of this idea is self-evident, especially when you compare Joyn to the latest in autonomous vehicle design. Think about Origin from GM. It's a similarly sized box-on-wheels, built to seat six with an almost opulent seating arrangement built for socializing. Concepts have teased designs like Origin for years, but they assume people will want to socialize or collaborate on work when, in fact, most commuters want to tune the rest of the world out.



In any case, Joyn is just an idea, but everything about it looks perfectly feasible. (The biggest remaining consideration is what the outer shell of the vehicle would be. Would it have four double doors, or a full eight doors so everyone has their own entrance to the vehicle?) Let this be a lesson to GM, Tesla, Uber, Lyft, or any other company considering the autonomous ride-share business: They could do a lot worse than take some notes from Joyn.

By Kevin McLaughlin

Google is working on a mobile application for businesses that brings together the functions of several standalone apps the company already offers, including Gmail and its online storage service Drive. The move could help it compete more effectively with application suites from Microsoft and others, according to two people who have used the application and three people briefed about it.

The new mobile app, which is currently being tested internally at Google, also includes Hangouts Meet, Google's video conferencing app and Hangouts Chat, a real-time message app, according to the people. Thomas Kurian, the CEO of Google's cloud unit, discussed the new app at a conference held in mid-January for the unit's salespeople and business partners, according to two of the people. The new app is expected to be part of G Suite, the collection of online productivity software that is overseen by the cloud unit, known as Google Cloud.

The new application could provide Google a new tool in its efforts to win share in the giant market for workplace communications and productivity apps. The biggest player in that business is Microsoft with its Office 365 suite of apps. A part of that suite is Microsoft Teams, which combines a number of functions in a single app, including workplace chat, videoconferencing, internet telephony and productivity offerings.



A spokesperson for Google Cloud declined to comment.

It couldn't be learned whether and how the new app will affect Google's current lineup of standalone communications apps. For years, Google has had one of the more confusing collections of communications apps in the tech industry, many with overlapping functions. It killed one of its mobile email clients, Inbox, along with a WhatsApp-like messaging service called Allo. The company has announced plans to end its classic Hangouts app and transition its users to two new apps, Hangouts Meet and Hangouts Chat, by June.

The new app could represent a new approach to winning business customers at Google Cloud. Kurian, who took over leadership of the unit last January after a long stint at Oracle, has made it his mission to attract Fortune 500 companies in specific industries to its services. Bundling several communications apps together could make it easier for corporate technology departments to manage the apps used by employees, by reducing the number of separate Google apps they have to keep tabs on.

The new app can also be used to open Google's Calendar app, though users need to download that app separately, said one person briefed on it.

The unified mobile app is part of Google Cloud's efforts to make G Suite more appealing to businesses at a time when Microsoft is aggressively pitching Teams to Fortune 500 companies, while younger workplace collaboration companies like Slack and Zoom are also making inroads. While many consumers also use G Suite, a person directly familiar with the matter said the G Suite team is almost exclusively working on products with enterprise customers in mind.

Google Cloud bolstered its leadership in October by hiring Javier Soltero, a Microsoft executive who previously oversaw the Cortana digital assistant and Office productivity applications, as vice president and general manager of G Suite.

By Mark Davies@ King & Spalding LLP

On the heels of an extraordinarily busy year for M&A activity in 2018, 2019 offered both opportunities for celebration, as well as some causes for concern for market participants. Complex forces are currently converging to create an economic environment that remains difficult to navigate. Many commentators have expressed concerns about an impending downturn in the global economy, and some are forecasting a dry spell for accretive M&A in the year ahead. With that said, chief executive and board appetites for major, transformative deals do not appear to be slowing any time soon, and stock markets remain buoyant. Whether 2020 will be another great year for M&A dealmaking or whether it will usher in the recession that some believe to be overdue, we are confident only that M&A transactions will become harder to close in the year ahead.

Several major M&A transactions incurred meaningful obstacles to closing in 2019. Recent data from Gartner, Inc. has suggested that the number of days elapsed between the signing and closing of M&A deals has increased over 30 percent since 2010. We do not expect this trend to abate in 2020. M&A deals are taking longer to proceed from announcement to completion, and dealmakers and their clients should seek to understand why. This article will review some of the major reasons why we believe that closing M&A deals will continue to be a much more difficult exercise than in years prior. We will conclude with a few thoughts on how dealmakers should react to this phenomenon and steps that can be taken to prepare accordingly.

Regulatory environments have made transaction approvals more difficult to obtain

First, the regulatory environment for obtaining transaction approvals has become more complex. Acquirers are being forced to work harder than ever to fulfil approval-related closing conditions on a timely basis, and regulators are not afraid to withhold their approvals of deals for as long as it takes until they are satisfied as to the merits of the transactions at hand. Five years ago, a chief concern among advisers in strategic M&A deals was how long it might take to clear a Hart-Scott-Rodino Act ‘second request’, but it was still generally expected that almost all of these deals would still make it to the closing table. Today, transformative horizontal and vertical combinations are increasingly being litigated and aggressively investigated by regulators, and a higher number of parties are walking away from the table with only unsuccessful deals to show for their efforts. This is one of the reasons why the average reverse break fee in an M&A deal has ticked up to 7.3 percent of transaction equity value in October 2019, up from 5 percent over the previous 12 months, according to Deal Point Data.

Perhaps echoing sentiments that may underlie the larger global debate about rising global economic inequality, antitrust regulators appear to have become increasingly sceptical of large market leaders that are consolidating their dominant positions and growing revenues through M&A. US antitrust oversight of M&A transactions is approaching a local zenith, where we continue to witness a clampdown on business combinations and a muscular approach to M&A oversight that was not anticipated from the ‘pro-business’ Trump administration. Overtures from the campaign trail aside, the Trump administration’s Department of Justice (DOJ) has been unexpectedly active in reviewing, scrutinising and now even aggressively litigating against various transactions. On the heels of a regulation-laden Obama administration that pushed heavy regulatory overlays upon American corporations, many hoped that president Trump would bring a welcome respite from governmental scrutiny. There is no doubt that the president places significant emphasis on the performance of the US stock market, but he has hardly been the rubber stamp for M&A dealmaking that many anticipated. The president exhibited immediate scepticism of big deals after taking office, starting with a string of tweets against the AT&T/Time Warner merger, which could only be closed over two years later. Most recently, a post-closing action by the DOJ unwound a consummated \$5bn aviation fuel M&A deal between Parker-Hannifin and CLARCOR that had already been closed over six months previously, and that had complied with the mandatory waiting period imposed by the Hart-Scott-Rodino Act. Dealmakers must not only be concerned with federal regulatory approvals of their deals, as individual state attorneys general are also voicing

public concern about the potential negative effects of deals on consumers, as is currently being witnessed in the Sprint/T-Mobile transaction.

European regulators have been similarly aggressive in the policing of deals and the enforcement of European Commission (EC) merger control rules. In February 2019, the EC blocked Siemens' proposed takeover of Alston, citing pricing concerns and reduction in innovation. ThyssenKrupp's tie-up with Tata Steel was also rejected, which would have created a joint venture between the second and third largest producers of flat carbon steel in the European economic area. In an expansion of its authority, the EC has announced a proposal to introduce 'interim measures' to apply remedies to harmful business combination activity in situations where its full investigation has not been completed. European deal regulators argue that these types of new tools, which are largely injunctive in nature and can be deployed quickly to require companies to either act or refrain from acting in specified manners, are necessary to confront acceleration in industries like technology and software.

And antitrust is not the only regulatory framework that threatens to hamstring the closing process in 2020. President Trump's administration has long been deeply protective of US industrial competitiveness, and the latest measure taken in this regard has been the expansion of authority granted to the Committee on Foreign Investment in the United States (CFIUS). In August 2018, the president signed into law the Foreign Investment Risk Review Modernisation Act of 2018, which expanded the types of investments and transactions subject to review by CFIUS on national security grounds. Just a few months ago, CFIUS published new proposed rules that can bring 'non-controlling' minority investments, as well as certain transactions involving US real estate, under the jurisdiction of CFIUS.

The types of deals that are likely to draw CFIUS's focus are expanding in scope. In its early stages, CFIUS was adopted to police foreign investment in the military and aerospace and defence sectors, but CFIUS has recently adopted 'critical technology' and 'critical infrastructure' into its lexicon for determining where it will focus. Those terms have yet to be conclusively fleshed out into exhaustive lists of the types of investments they cover. As part of the Foreign Investment Risk Review Modernization Act's FIRRMA's pilot programme, as many as 27 key industries were identified as comprising 'critical technology' and 'critical infrastructure', but, as currently styled, CFIUS's investigative authority is not strictly limited to those 27 key industries and can include other applications that have not yet been enumerated.

Institutional investors are increasingly demanding to be heard

Beyond just regulation, other market forces pose challenges to completing M&A transactions. Major shareholders have become keenly aware of the power they wield in shaping and approving M&A deals. These shareholders have exhibited a willingness to participate and be included in the dealmaking process and to understand the thesis for a given deal before announcement. Shareholder activism has remained a key driver of M&A activity over the last few years, and other types of investors, including active managers, are resorting to activist-like tactics, including public campaigns and statements for or against certain deals, to make their voice heard.

As has been well documented, index investing and the capital flowing out of actively managed mutual funds and into the hands of low-fee index fund managers has empowered passive investors like Vanguard, BlackRock and State Street to place a renewed and sharper focus on corporate governance and purpose. The popularity and performance of these types of exchange-traded investment products has, in turn, placed pressure on more expensive fund products offered by active managers such as T. Rowe Price, Neuberger Berman and Wellington to demonstrate greater value and to show customer-investors who have a choice why they should select an investment with a higher fee. Being openly vocal about their beliefs on whether a given deal will create shareholder value, or whether current corporate leadership is optimal for the company, is a departure from these active managers' previous trend of watching idly by and remaining largely silent as deals were announced.

Where active fund managers question the motivation or the thesis underlying a given deal, they are becoming more apt at speaking up in protest. Actively managed funds, once they articulate a distaste for a deal, can find friends in

shareholder activists and other persuasive equity investors that have been described as hunting in ‘wolf packs’. This powerful constituency, comprised of many disparate individual actors, that sways the fate of M&A transactions has been nicknamed the ‘shareholder electoral college’. While the goals of actively managed funds are not necessarily to agitate for a higher price, or better terms, as would a traditional greenmailer of yore, active managers today generally yearn for increased engagement with the board and to understand how a given deal supports the larger strategy of the company that has been previously communicated to them. The \$74bn Bristol-Meyers-Squibb acquisition of Celgene was a highlight among 2019 deals, but not only because it was a mammoth merger in size or scale. Wellington Management, an active manager, that owned about 8 percent of Bristol-Meyers-Squibb prior to the deal’s announcement, wasted little time in publicly expressing its disfavour of the transaction in a one-paragraph press release issued six weeks prior to the Bristol-Meyers-Squibb shareholder meeting. This moment was said to mark an unprecedented intervention in the M&A evaluation process by an institutional equity holder. Hedge fund Starboard Value later also expressed similar concerns at that deal’s prospects for value creation. After further engagement by Bristol-Meyers-Squibb with Institutional Shareholder Services and proxy adviser Glass Lewis, both of those proxy firms eventually expressed support for the deal, which closed on 20 November 2019 after finally receiving US Federal Trade Commission (FTC) approval.

In March 2019, shareholder Paulson & Co. sent a public letter to Newmont Mining Corporation expressing that Paulson did not support its planned acquisition of Goldcorp as initially structured. Newmont Mining subdued Paulson’s concerns by promising a special dividend to its investors if the Goldcorp deal received shareholder approval. We expect to continue to see fund managers like Neuberger Berman, Fidelity and T. Rowe Price, names that never would have been thought to intervene or initiate in proxy battles just five years ago, continue to vie for enhanced engagement and to exert considerable influence over the strategy and direction of any company in which they are invested.

These situations reveal a complicated dynamic where important stakeholders must be identified and thoughtfully and strategically engaged by companies and their advisers on the road to deal creation. These types of holders are another key constituency whose opinion and influence can no longer be overlooked. It requires meaningful time and effort that must be devoted to yet another workstream on a parallel timeline to negotiations with the counterparty. It requires special expertise, beyond the investment bank or average law firm to navigate these waters and ensure that an impending transaction is not met with an unwelcome surprise from an important constituent after announcement. Where those surprises happen, the path to closing becomes even more unpredictable and difficult to tread, and even when a deal does close, it is becoming apparent that enduring peril for incumbent corporate leadership does not end there.

What to do about it?

Recognising today’s headline regulatory considerations and other potential event-driven impediments that can hang up a proposed deal is a sound first step in adequately preparing. With respect to mitigating the obstacles to closing deals in today’s M&A market, we recommend that buyers and sellers, in addition to equipping themselves with top-flight advisers, place enhanced emphasis on communication and deal strategy.

With threats to deal completion consistently evolving around new regulations and potentially aggravating market forces, the experience of an advisory team that understands and is at the forefront of these issues can turn into an enduring competitive advantage. Sharp bankers and M&A drafters are, of course, a must-have for any transaction to stay on course, but it is equally important to employ a deep bench of subject matter experts with demonstrated first-hand experience with the entities who may decide the fate of a transaction. The supply of advisers who have boots-on-the-ground experience, working with governance professionals at fund managers, the DOJ or the FTC for example, that can predict the inquiries that may arise and chart a course for navigation that can save valuable time and expense, is not ubiquitous in the market. It is, however, worth seeking out.

Communication and articulation of a deal and its narrative, why it makes sense over other strategic alternatives, including remaining an independent standalone company, is going to be paramount to successful dealmaking in

2020 and beyond. Well-rounded advisory teams, and deep discussion among them, can assist in developing that narrative. From a regulatory perspective, early engagement with economists and market consultants empowers corporate leaders to develop a story, and data, around the deal that can be expressed, and defended, as and when it becomes subject to scrutiny. Understanding concerns around novel antitrust situations, such as data sharing, ‘informational’ monopolies and horizontal combinations involving technology giants, is critical to developing a cohesive and defensible story underpinning the decision to do a deal. With respect to mitigating the impact of an adverse intervention by a well-known shareholder, it is no longer enough for boards and executives to look only at the legal risks in a traditional manner. Best-in-class advisers are using cutting-edge monitoring tools and techniques to track shareholder ownership and to triangulate it against emergent shareholders’ past practices and tendencies. They deploy deep relationships with personnel from related institutions, who know the personalities of those who are making voting decisions at important funds and governance institutions, and they draw on backgrounds in governance, investor relations, crisis management and strategic communications. This process is iterative and bespoke, it must be continuously conducted in real time and it leverages diverse professional skillsets beyond those provided only in law schools. The strategies needed to successfully and persuasively interface with the ‘shareholder electoral college’, comprised of significant equity institutions and their portfolio managers and research analysts who may be studying a proposed deal, is in equal parts an exercise in financial analysis and investor relations as it is in clearly understanding fiduciary duties and the legal regimes applicable to directors and managers. This process requires great foresight and often must look several moves ahead to develop the record needed to justify why a given deal is appropriate at a given time.

Availing oneself of uncommon advisory expertise and establishing these channels of communication to deliver purposeful messaging to the market can make or break a deal in today’s resilient, but increasingly fragile, M&A environment for big players. Deals will still be able to be found in the year ahead, although we expect they will become even tougher to wrangle across the finish line. While they may seem daunting, the heightened stakes present opportunities for those companies that are prepared to continue to leverage M&A to build sustainable lasting organisations and deliver value to stakeholders.

By Kurt Schlosser

The man being treated for what was initially the first known case of coronavirus in the United States is being cared for in a specially designed room at Providence Regional Medical Center in Everett, Wash., and a robot is aiding in the process.

According to reports in The Guardian, CNN and the Everett Herald newspaper, the man in his 30s is a Snohomish County resident who had traveled recently to Wuhan, China, where the virus originated. He was transported to the hospital north of Seattle by ambulance and was in a protective gurney, called an Isopod before being placed in a protective room.

Inside the room, the man has been tended to by a robot, equipped with a stethoscope which takes his vitals and allows doctors to communicate with him through a large screen, according to Dr. George Diaz, chief of the infectious disease division at the hospital.

“The nursing staff in the room move the robot around so we can see the patient in the screen, talk to him,” Diaz told CNN. The use of the robot minimizes exposure of medical staff to the infected man.

The two-bed isolated area is reportedly away from other units at the hospital and has a separate air filter, according to the Herald. It was set up about five years ago during the Ebola crisis, and this is the first time it’s been used in a real-life scenario.

Meanwhile, at Fred Hutchinson Cancer Research Center in Seattle, more specialists are lending their expertise in tracking the evolution of the virus in real time.

Dr. Trevor Bedford, an associate member of the Vaccine and Infectious Diseases Division at Fred Hutch, uses powerful computers and complex statistical methods to study the rapid spread and evolution of viruses. He and colleagues have created visuals of a phylogenetic tree and map tracking the evolution of SARS-like betacoronaviruses, including samples from the current outbreak.

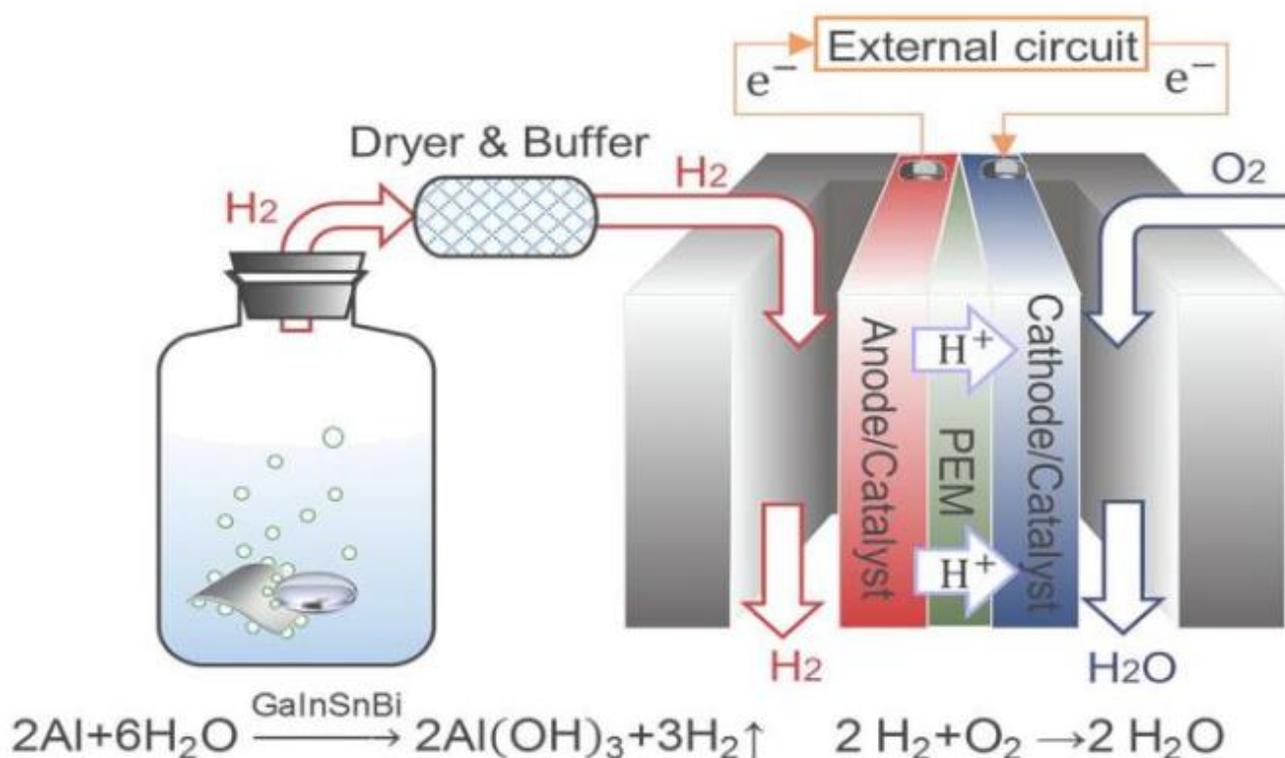
Bedford collaborates with colleagues globally to track evolutionary changes in infectious diseases. Previous projects (which can all be found on the open-source website, nextstrain) have followed Ebola, MERS, influenza and Zika, to name a few.

The coronavirus epidemic is growing, according to figures in The New York Times’ ongoing live updates on the subject. The death toll in China has climbed above 80 and 110 people in the U.S. are being evaluated.



An InTouch Vici telehealth machine like the one treating a patient in Everett, Wash.

By American Institute of Physics



A schematic diagram demonstrating the combination of a hydrogen extraction system and a PEMFC for power supply.

Since the Industrial Revolution, the environmental impacts of energy have posed a concern. Recently, this has driven researchers to search for viable options for clean and renewable energy sources.

Due to its affordability and environmental friendliness, hydrogen is a feasible alternative to fossil fuels for energy applications. However, due to its low density, hydrogen is difficult to transport efficiently, and many on-board hydrogen generation methods are slow and energy intensive.

Researchers from the Chinese Academy of Sciences, Beijing and Tsinghua University, Beijing investigate real-time, on-demand hydrogen generation for use in fuel cells, which are a quiet and clean form of energy. They describe their results in the *Journal of Renewable and Sustainable Energy*.

The researchers used an alloy—a combination of metals—of gallium, indium, tin and bismuth to generate hydrogen. When the alloy meets an aluminum plate immersed in water, hydrogen is produced. This hydrogen is connected to a proton exchange membrane fuel cell, a type of fuel cell where chemical energy is converted into electrical energy.

"Compared with traditional power generation methods, PEMFC inherits a higher conversion efficiency," said author Jing Liu, a professor at the Chinese Academy of Sciences and Tsinghua University. "It could start rapidly and run quietly. Moreover, a key benefit to this process is that the only product it generates is water, making it environmentally friendly."

They found the addition of bismuth to the alloy has a large effect on hydrogen generation. Compared to an alloy of gallium, indium and tin, the alloy including bismuth leads to a more stable and durable hydrogen generation reaction. However, it is important to be able to recycle the alloy in order to further reduce cost and environmental impact.

"There are various problems in existing methods for post-reaction mixture separation," Liu said. "An acid or alkaline solution can dissolve aluminum hydroxide but also causes corrosion and pollution problems."

Other byproduct removal methods are difficult and inefficient, and the problem of heat dissipation in the hydrogen reaction process also needs to be optimized. Once these difficulties are resolved, this technology can be used for applications from transportation to portable devices.

"The merit of this method is that it could realize real-time and on-demand hydrogen production," said Liu. "It may offer a possibility for a green and sustainable energy era."

More information: Instant hydrogen production using Ga-In-Sn-Bi alloy-activated Al-water reaction for hydrogen fuel cells, *Journal of Renewable and Sustainable Energy* (2020). DOI: [10.1063/1.5124371](https://doi.org/10.1063/1.5124371)

Journal information: [Journal of Renewable and Sustainable Energy](#)

By Michelle Hampson

A proposed crowd-sourcing technique could mean that hardware for 5G networks hitches a ride on cars



In an outdoor experiment, wireless data throughput—from a server to radio units installed on cars and then to wireless handsets—is measured using an IEEE 802.11ac/ad wireless local-area network acting as a stand-in for 5G signals

Business districts may be bustling in the daytime, but they can often be near-deserted in the evenings. These fluctuations in population density pose a challenge to the emergence of 5G networks, which will require more hardware than ever before to relay massive amounts of data. Here's the rub: To ensure reliable service, mobile networks must either invest in and deploy many more hardware units—or find ways to let the hardware move with the crowds.

One group of researchers is proposing a creative solution: installing small radio units on cars and crowdsourcing the task of data transmission when the vehicles are not in use. That approach relies on the fact that more cars tend to be parked in highly populated areas.

The most common network model that service providers are considering for 5G networks involves C-RAN architecture. Central units coordinate the transmission of data; the data is disseminated through distribution units and is further processed and transmitted by fleets of radio units. Those units convert the information to usable formats for mobile users.

Some researchers have explored deploying radio units on moving vehicles such as city buses which run along defined routes. But it has proven difficult to successfully transmit data via moving targets.

In a study published 20 January in IEEE Access, a Japanese research team showed that harnessing radio units on parked cars results in efficient data transmission, all while keeping radio units close to where people are. The team proposed a crowd-sourcing approach, in combination with a monetary or non-monetary incentive, which could be used to get drivers to participate.

With their approach, radio units are charged via the car battery and can be activated when the car is parked. When a crowd-sourced radio unit is available, it establishes a wireless mobile front-haul link with a neighboring distribution unit and starts working to transmit data to nearby phones.

In a series of simulations, the researchers compared the effectiveness of their approach to that of a traditional fleet of stationary radio units. The results show that 100 radio units installed on nearby parked cars that complement 200 stationary units (or 300 radio units total) can deliver data better than 400 uniformly dispersed stationary radio units. Thus, its possible to get better data throughput with fewer radio units that have the added benefit of almost always being where network users happen to be.

The researchers also confirmed the efficacy of this approach through experiments. “The improvement of throughput by locating and activating a radio unit near users was far higher than expected,” says Yu Nakayama, a member of the research team who is a professor at Tokyo University of Agriculture and Technology. “This result implies the effectiveness of adaptively locating and activating radio units based on the distribution of mobile users,” adds Yu.

The group is interested in exploring the commercialization of this technique. “We believe that it is a promising solution for the future mobile networks beyond 5G,” Yu says.

Emulating racing aircraft yielded the most energy-dense aviation battery pack yet

By Prachi Patel



Dozens of electric general aviation projects are underway around the world, not counting the urban air taxis that dominate the electric propulsion R&D scene. The first all-electric commercial aircraft, a seaplane intended for short flights, completed a 15-minute test flight in

December.

Shortly after, luxury icon Rolls Royce unveiled what it hopes will be the world's fastest electric aircraft. The current speed record for that type of plane is 335 kilometers per hour (210 mph). The new one-seater craft, slated to fly this spring, will top out at 480 km/h (300 mph). It should also be able to fly from London to Paris, about 320 km (200 miles), on a single charge.

That's thanks to "the world's most energy-dense flying battery pack," according to Rolls Royce. The aircraft has three batteries powering three motors that will deliver 750kW to spin the propellers. Each 72 kilowatt-hour battery pack weighs 450kg and has 6,000 densely packed lithium-ion cells.

Getting all this power on board wasn't easy, says Matheu Parr, project manager for the ACCEL project, short for Accelerating the Electrification of Flight. Careful thought and engineering went into each step, right from selecting the type of battery cell. Lithium-ion cells come in many forms, including pouches as well as prismatic and cylindrical cells. Cylindrical ones turn out to be best for holding a lot of energy and discharging it quickly at high power, he says.

Next came the critical task of assembling the cells into a pack. Rolls Royce's partner, Electroflight, a startup specializing in aviation batteries, began that effort by analyzing innovations in the relatively new all-electric auto-racing space.

"Really, the challenge for electric aviation is one of packaging," Parr says. "So we've looked at how Formula E [air racing] tackles packaging and then taken it a step further." By using lightweight materials—and only the bare minimum of those—the Formula E teams manage to cut their planes' packaging-to-battery cell weight ratio in half compared with the amount of battery packaging an electric car has to carry around for each kilogram of battery cell.

The high-power, closely packed cells get pretty hot. So, designing an advanced active-cooling system was important. Instead of the air-cooling used in car batteries, Rolls Royce engineers chose a liquid-cooling system. All the cells directly contact a cooling plate through which a water-and-glycol mixture is piped.

Finally, the engineers built in safety features such as an ultra-strong outside case and continual monitoring of each battery's temperature and voltage. Should something go wrong with one of the batteries, it would automatically be shut off. Better still, the airplane can land even if two of its three batteries are turned off.

The ACCEL battery comes out to a specific energy of 165 watt-hours per kilogram, which puts it on par with the battery pack powering the Tesla Model 3. That's still a long way from the 500 Wh/kg needed to compete with traditional jet-propulsion aircraft for commercial flights (aviation batteries are not expected to store that much energy per unit mass until 2030). For now, Rolls Royce and others believe all-electric propulsion will power smaller aircraft while larger planes will have hybrid fuel-electric systems. The company has teamed up with Airbus and Siemens to develop a hybrid airplane.

With its high-speed racing aircraft, Rolls Royce wants to pioneer the transition to the "third age of aviation, from propeller aircraft to jet aircraft to electric," says Parr. The project will also provide know-how that will shape future designs. "We're learning an awful lot that we want to see packed into a future aircraft. Innovations in the battery and system integration, packaging and management will all help us shape any future electric product, be it all-electric or hybrid."

A RUN FOR THE RECORD BOOKS →

Electrifying Flight

In 2020, Rolls-Royce will make history when its first fully electric aircraft takes to the skies over Wales. Funded by the UK government, the "Accelerating the Electrification of Flight" project (ACCEL) is an effort to build, test, and commercialise a specially designed aircraft powered entirely by megawatts. Rolls-Royce and its partners, Electroflight and YASA, intend the single-passenger aircraft to break a series of speed, performance, and development records. ACCEL's overarching mission is to develop the requisite technology and supply chain knowledge to spur development of future aircraft concepts and establish the UK as a global leader in all-electric aviation. Here's a look at ACCEL's key features.

Propeller
Three electrically powered blades spin at 2,400 RPM

Inverter
The generator will run at 700 RPM, coupled to a 10:1 gearbox to output an electric fan output

Active Thermal Management System
Cooling pumps

Auxiliary Systems
ACCEL's avionics bay houses the engine hardware, including the engine system unit (ESU), power distribution unit (PDU), and flight sensors

Airframe
The power plant uses air flow to generate lift

Batteries
With 165 Wh/kg, ACCEL's battery pack is designed for safety and weight reduction. The pack is designed to be able to land even if two of its three batteries are turned off.

Powertrain
Rolls-Royce Powerplant world-class expertise in power plant design and testing, ACCEL's all-electric powertrain is the key to achieving 300+ mph, efficiency and manoeuvrability. The comparison aircraft has a top speed of 200 mph.

Motors
For the record attempt, ACCEL will use three 700W high-speed electric motors built by the British electric motor company YASA. Combined, the power plant motors will deliver more than 200 horsepower to the propeller at lower RPM than a conventional propeller, which means increased cooling and less noise.

Project name	ACCEL
Max power	750 kW
Top speed	300+ MPH
Range	200 miles
Development	24 months
Collaborators	

Controls
This all-electric motor features a suite of digital control systems, providing the pilot of the information required for the safety and security.

Imagery by Skyline

Source: Marla Keene @ AX Control Inc.

The use of robotics in manufacturing and industrial settings continues to advance, expand, and evolve at a rapid pace. According to one McKinsey study, the market for industrial robotics has increased by double digits each year since 2012, and will continue this growth at least through 2021. Main drivers include a desire to improve quality and increase productivity while decreasing costs, as well as to increase safety for employees while responding to a lack of available skilled workers. The decreasing prices and improving capabilities of industrial robots have a positive effect, too. Here are some trends to watch in 2020 and beyond.

Collaborative Robots

Also known as cobots, collaborative robots are designed so they can work safely alongside human workers without the need for safety barriers. Typically these robots are designed with advanced sensors and software that allow them to detect and adapt to any human intrusion into their workspace, which allow cobots to avoid their human coworkers by stopping their motion automatically if necessary.

Collaborative robots are utilized for monotonous, tedious, or repetitive duties, leaving employees available for more value-added tasks. McKinsey estimates significant growth in this area of robotics, with shipped units increasing from 10,000-20,000 in 2017 to an estimated demand of 100,000 in 2020.

IIoT

It's been just over two decades since we began discussing the "Industrial Internet of Things." In those two decades IIoT has become firmly established and is still rapidly expanding. Now the declining cost of sensor technology that connects robotics and machinery to analytics software is helping to drive an expanded integration of technology. More connectivity tends to increase production line precision, flexibility, and efficiency through machine visibility, data analytics, and better predictive maintenance.

Industry 4.0

As more robotics on the factory floor are connected via sensors and their data analysed, manufacturers can move to a higher level of understanding of their production and supply chain. This deeper understanding of the value chain helps maintain a competitive edge in a global market through the power of lean initiatives, downtime reduction, and an investment in equipment efficiency.

While early adopters of Industry 4.0 have seen significant increases in productivity combined with as much as a 30% decrease in maintenance costs, not everyone is yet on board with Industry 4.0 adoption. In fact, according to one BDO study, the manufacturing industry is significantly behind industries like healthcare, financial, and retail in the number of businesses implementing a strong digital transformation strategy.

Moving into Smaller Markets

While introducing robotics to an existing plant can be expensive (robotics and their peripherals are often upwards of \$100,000), they are no longer reserved for big companies. Small and mid-sized manufacturers are now exploring how robotics can improve their production, often using local development initiatives like New York state's Buffalo Billion operated by non-profit engineering company EWI as Buffalo Manufacturing Works. This program helps manufacturers understand how to identify, develop, and implement a plan for adding robotic technology into their existing operation and how they can best benefit from the addition of this kind of change.

Small and mid-size manufacturers discover multiple advantages to this type of investment, including improving the safety of their facility, increased quality control, and higher customer satisfaction due to faster and more efficient production.

The robotics manufacturing sector has been growing steadily for decades. This will be a key trend for many years, one with the possibility to change the future of manufacturing in many different and unexpected ways.

By John Edward

Hybrid cloud environments can deliver an array of benefits, but in many enterprises, they're becoming increasingly complex and difficult to manage. To cope, adopters typically turn to some type of management software. What soon becomes apparent, however, is that hybrid cloud management tools can be as complex and confounding as the environments they're designed to support.

A hybrid cloud typically includes a mix of computing, storage and other services. The environment is formed by a combination of on-premises infrastructure resources, private cloud services, and one or more public cloud offerings, such as Amazon Web Services (AWS) or Microsoft Azure, as well as orchestration among the various platforms.

Any organization contemplating a hybrid cloud deployment should begin building a transition framework at the earliest possible stage. "The biggest decision is what data and which applications should be on-premises due to the sensitivity of data, and what goes into the cloud," says Umesh Padval, a partner at venture capital firm [Thomvest Ventures](#).

Numerous other issues also need to be sorted out at the start, including the ultimate destination of lower priority, yet still critical, data and applications. Will they be kept on premises forever or migrated at some point into the cloud? With applications and data scattered, security is another major concern. Operational factors and costs also need to be addressed at the very beginning. "Your email application may run great in your data center, but may operate differently in the cloud," Padval notes.

Hybrid cloud tools immature yet evolving

A complex hybrid cloud requires constant oversight as well as a way to intuitively and effectively manage an array of operations, including network performance, workload management, security and cost control. Not surprisingly, given the large number of management tasks needed to run an efficient and reliable hybrid cloud environment, adopters can select from a rapidly growing array of management tools.

"There's a dizzying array of options from vendors, and it can be difficult to sort through them all," says R. Leigh Henning, principal network architect for data center operator Markley Group. "Vendors don't always do the best job at making their differentiators clear, and a lot of time and effort is wasted as a result of this confusion. Companies are getting bogged down in an opaque field of choices."

The current hybrid cloud management market is both immature and evolving, declares Paul Miller, vice president of hybrid cloud at Hewlett Packard Enterprise. Vendors are still getting a handle on the types of management tools their customers need. "Offerings are limited and may not be supported across all public, on-premises and edges," Miller adds.

Perhaps the biggest challenge to hybrid cloud management is that the technology adds new, complex and frequently discordant layers to operations management. "Many solutions have compatibility restrictions on the components they can manage, locking your management platform into a vendor or group of vendors, which may or may not align with your current or future system architecture," warns George Burns III, senior consultant of cloud operations for IT professional services firm SPR.

A lack of standardized APIs, which in turn results in a shortage of standardized management tools, presents another adoption challenge. "The lack of standardized tools increases operational complexity through the creation of multiple incongruent tools; this leads to vendor lock-in and, in some cases, gross inefficiencies in terms of resource

utilization," explains Vipin Jain, CTO of Pensando, a software-defined services platform developer. "To make it worse, these kinds of problems are typically 'solved' by adding another layer of software, which further increases complexity, reduces debuggability, and results in suboptimal use of features and resources."

Meanwhile, using standardized open-source tools can be an effective starting point to safeguard against compatibility issues. "Cloud Native Computing Foundation (CNCF) tools, such as Kubernetes and Prometheus, are good examples," Jain says. "Open-source tools from HashiCorp, such as Vault, Vagrant, Packer, and Terraform, [provide] a good normalization layer for multi-cloud and hybrid cloud deployments, but they are by no means sufficient," he notes. Ideally, the leading public cloud vendors would all agree on a standardized set of APIs that the rest of the industry could then follow. "Standardization can be a moving target, but it's critical from an efficiency and customer satisfaction perspective," Jain says.

Developers writing API configurations, as well as developers using API configurations, form a symbiotic relationship that should be mutually maintained, Burns advises. "Hardware vendors need to be open about changes and enhancements coming to their products and how that will affect their APIs," he explains. "Equally, management platform developers need to be mindful of changes to hardware platform APIs, [and] regularly participate in testing releases and provide adequate feedback to the vendor about results and functionality."

Prioritize management requirements; expect gaps

Even when everything works right, there are often gaps remaining between intended and actual management functionality. "In an ideal world, developers would have the perfect lab environments that would allow them to successfully test each product implementation, allowing functionality to be seamless across upgrades," Burns observes. "Unfortunately, we can't expect everything to function perfectly and cannot forgo [on-site] testing."

When selecting a hybrid cloud management platform, it's important to not only be aware of its documented limitations, but also to know that nothing is certain until it's tested in its user's own hybrid cloud environment, Burns advises. "Gaps will exist, but it's ultimately your responsibility to fully identify and verify those gaps in your own environment," he says.

Further muddling the situation is the fact that many management tool packages are designed to supply multiple functions, which can make product selection difficult and confusing. "To simplify, customers need to consider which features are most important to them based on their use cases and can show a quick return on investment, mapping to their specific cloud journey," Miller explains.

Real-world experience with hybrid cloud management

Despite management challenges, most hybrid cloud adopters find a way to get their environment to function effectively, reliably and securely.

Gavin Burris, senior project leader, research computing, at the Wharton School of the University of Pennsylvania, appreciates the flexibility a hybrid cloud provides. "We have a small cluster ... that's generally available to all the faculty and PhD students," he notes. The school's hybrid environment supports a fair share prioritization scheme, which ensures that all users have access to the resources they need to support their work. "When they need more, they're able to request their own dedicated job queue that's run in the cloud," he says.

Burris, who uses Univa management products, says that having a management tool that allows fast and easy changes is perfect for individuals who like to maintain firm control over their hybrid environment. "I like to do things with scripting and automation, so to be able to go in and write my own rules and policies and build my own cluster with these management tools is really what I'm looking for," he explains.

James McGibney, senior director of cybersecurity and compliance at Rosendin Electric, an electrical contractor headquartered in San Jose, Calif., relies on a hybrid cloud to support a variety of essential operations.

"Approximately two years ago we embarked on our journey from an on-premises disaster recovery, quality assurance and production environment to a cloud migration encompassing hundreds of terabytes of data," he says. McGibney relies on a management console provided by AWS and VMWare. The tool meets his current needs, but like many hybrid cloud administrators, he's keeping a close eye on industry developments. "We're currently investigating [other] options, just to see what's out there," he says. Yet he doesn't expect to make any changes in the short term. "We're happy with the tools currently provided by AWS and VMware."

Sharpen network skills for hybrid cloud

Selecting a hybrid cloud management platform is not as simple as purchasing software and spinning up some VMs to run it. "During implementation, ensure that you have selected the proper product owners and engineers, and then determine what, if any, additional education or credentials they will need to effectively deploy and maintain the platform," Burns suggests. "Fully define your architecture, ensure buy-in from your staff, work with them to identify education gaps and create a solid operational plan for going forward."

Most hybrid cloud management tasks focus on configuration and access control operations, which tend to be both complex and challenging to implement. "At the same time, the beauty of the cloud is its ability to automate," says Mike Lamberg vice president and CISO at ION Group and its Openlink unit, which provides risk management, operations and finance software. Yet deploying a high level of automation also requires new skills and developers who can expertly handle the demands of virtual software-defined infrastructures as well as traditional environments. "We can't assume that because teams can build applications in physical data centers that these skills will translate as they move to the cloud; new skills are required for success," Lamberg notes.

Hybrid cloud management requires a new team mindset. "IT networking staff literally need to unlearn what they know about physical networks and connectivity and recognize that the moving of packets and data is now handled by a forwarding software configuration, not by physical routers or switches," Lamberg says. "You can't take what you did in building and supporting physical data centers and just apply it to the cloud—it simply doesn't work."

In the big picture, transitioning to a hybrid cloud environment can solve many problems, yet it can also create some new obstacles if not properly implemented and managed. "Don't rush into any decision without considering all the points of impact that you can identify," Burns advises. "Make sure that you understand the breadth of a hybrid infrastructure and how it will be used to address business needs."

Apple Ends AI Startup's Work on 'Project Maven' After Acquisition

By Nick Wingfield and Ashley Gold

Big technology companies like Microsoft, Amazon and Google have jockeyed to secure lucrative contracts supplying their products and services to the military. Apple, though, has shown less interest in the market. And when it recently bought a startup that was working on a controversial Pentagon project, Apple ended that company's work on the project, The Information has learned.

The startup, a maker of artificial intelligence software called Xnor.AI, had been involved in Project Maven, an effort by the U.S. Department of Defense to use AI software to analyze imagery captured by military drones. Apple acquired Xnor.ai recently and decided to terminate the work, a person familiar with the matter said. Google's participation in Project Maven sparked protests from thousands of its employees, prompting it to withdraw from the project.

Tech companies for many years have sold software, computers and other products to various branches of the military. But lately, as big tech companies have begun to pursue larger, multiyear contracts with the military, intelligence agencies and law enforcement groups, workers in the industry have begun to protest the deals.

The military has taken an especially keen interest in using AI to help it on battlefields and in other settings. In 2018, the Defense Department formed an organization called the Joint Artificial Intelligence Center to accelerate AI adoption for everything from health record analysis to warfare.

Until Apple acquired it, Xnor.ai was a little-known Seattle startup that had spun out of the Allen Institute for Artificial Intelligence, a research lab formed by Microsoft co-founder Paul Allen, who died in 2018. Xnor.ai made machine-learning algorithms that could run on low-powered devices instead of relying on connectivity to the cloud.

That technology could be especially useful on devices like drones, which sometimes operate with unreliable, intermittent network connections. According to the person familiar with the matter, Xnor.ai worked on Project Maven in conjunction with another startup, Clarifai, which has publicly spoken about its work on the Pentagon effort. Clarifai executives didn't respond to requests for comment.

But Xnor.ai's technology could also be used inside consumer electronics devices for applications like image recognition. Its software could fit in with Apple's broader effort to run AI algorithms locally on devices rather than in the cloud, a practice that raises privacy concerns.

An Apple spokesperson reiterated a statement confirming the acquisition of Xnor.ai, which the tech news site GeekWire first reported earlier this month. GeekWire stated that Apple paid around \$200 million for the startup, a figure confirmed by a person with knowledge of the deal.

"Apple buys smaller technology companies from time to time, and we generally do not discuss our purpose or plans," the Apple spokesperson said.

A Defense Department spokesperson declined to comment.

As one of the more consumer-focused big tech companies, Apple hasn't shown much interest in building a sizable military contracting business. But it hasn't shunned such relationships entirely. In 2008, it acquired PA Semi, a semiconductor startup that eventually formed the basis for a large organization that now builds custom chips for iPhones, AirPods and other Apple devices.

Military Deals

A sampling of work big technology companies are doing with the military

Microsoft	Recently won a \$10 billion deal to provide cloud computing services to the Pentagon and a \$479 million deal to supply its HoloLens AR headset to the U.S. Army. The Defense Department paid Microsoft nearly \$50 million from 2018 to today, a large chunk of it for contracts on information technology, telecom and computer systems, according to a government database.
Google	Pulled out of controversial 'Project Maven' at Defense Department after employee protests. Google Cloud still has projects with the Department of Defense and the U.S. Air Force, according to a spokesman.
Amazon	Also bid on the \$10 billion Pentagon cloud contract, and is protesting the awarding of the deal to Microsoft. Has \$600 million cloud computing contract with CIA. The Defense Department spent about \$220,000 on AWS from 2018 to 2019.
Facebook	Facebook has sold various products to government agencies, but doesn't appear to have current military contracts, according to a government database.
Apple	A number of government agencies frequently purchase equipment from Apple, but the company doesn't appear to have active military contracts, according to a government database.

Source: The Information reporting, USASpending.gov

Prior to the acquisition, though, PA Semi had begun supplying chips to makers of military equipment. Apple, under pressure from the Pentagon, continued to supply chips to those equipment makers, The New York Times reported in 2008.

Some of Apple's big competitors have shown much more enthusiasm for doing military work, painting their efforts in patriotic terms. Even Google, which withdrew from Project Maven, has reportedly sought to woo Pentagon officials, Bloomberg reported in November.

Microsoft, meanwhile, appears to be pursuing military deals more avidly than some of its rivals, having just been awarded a \$10 billion cloud computing contract by the Pentagon (Amazon, another bidder on the contract, has sued to prevent work on the project from proceeding). As the debate over whether tech companies should work with the military began to escalate, Microsoft president Brad Smith wrote a blog post in October 2018 acknowledging that the use of AI in warfare requires new ethical and policy discussions.

However, Smith said that Microsoft wouldn't stop working with the Defense Department. "First, we believe that the people who defend our country need and deserve our support," he wrote. "And second, to withdraw from this market is to reduce our opportunity to engage in the public debate about how new technologies can best be used in a responsible way. We are not going to withdraw from the future."

A massive neural network connects cameras, a robot arm, and a suction gripper in Covariant's logistics system

By Evan Ackerman @ IEEE Spectrum

Two years ago, we wrote about an AI startup from UC Berkeley and OpenAI called Embodied Intelligence, founded by robot laundry-folding expert Pieter Abbeel. What exactly Embodied was going to do wasn't entirely clear, and honestly, it seemed like Embodied itself didn't really know—they talked about “building technology that enables existing robot hardware to handle a much wider range of tasks where existing solutions break down,” and gave some examples of how that might be applied (including in manufacturing and logistics), but nothing more concrete.

Since then, a few things have happened. Thing one is that Embodied is now Covariant.ai. Thing two is that Covariant.ai spent almost a year talking with literally hundreds of different companies about how smarter robots could potentially make a difference for them. These companies represent sectors that include electronics manufacturing, car manufacturing, textiles, bio labs, construction, farming, hotels, elder care—“pretty much anything you could think about where maybe a robot could be helpful,” Pieter Abbeel tells us. “Over time, it became clear to us that manufacturing and logistics are the two spaces where there's most demand now, and logistics especially is just hurting really hard for more automation.” And the really hard part of logistics is what Covariant decided to tackle.

There's already a huge amount of automation in logistics, but as Abbeel explains, in warehouses there are two separate categories that need automation: “The things that people do with their legs and the things that people do with their hands.” The leg automation has largely been taken care of over the last five or 10 years through a mixture of conveyor systems, mobile retrieval systems, Kiva-like mobile shelving, and other mobile robots. “The pressure now is on the hand part,” Abbeel says. “It's about how to be more efficient with things that are done in warehouses with human hands.”

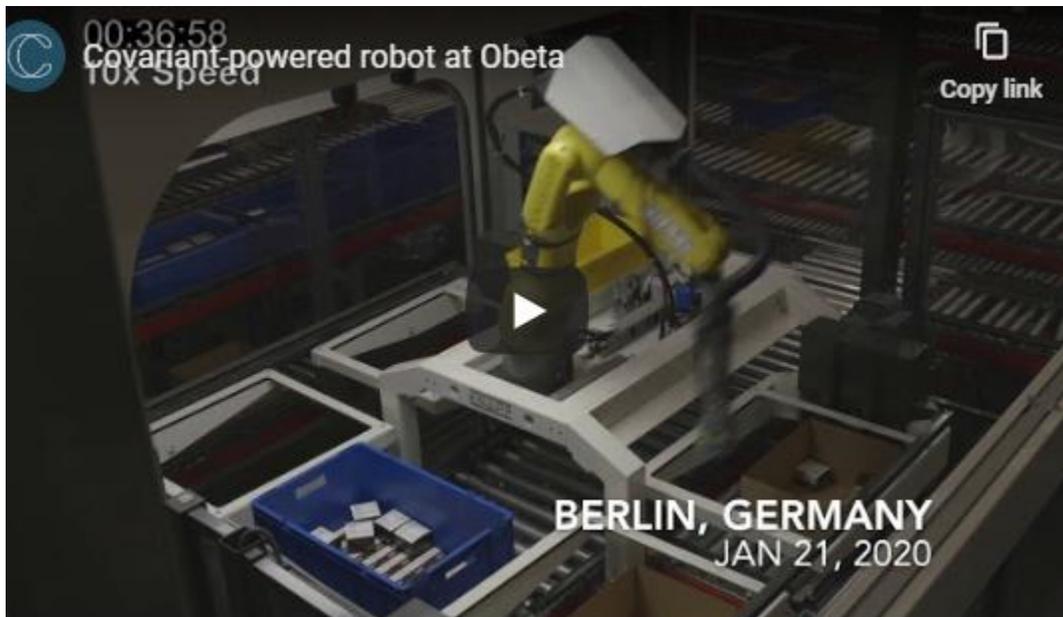
A huge chunk of human-hand tasks in warehouses comes down to picking. That is, taking products out of one box and putting them into another box. In the logistics industry, the boxes are usually called totes, and each individual kind of product is referred to by its stock keeping unit number, or SKU. Big warehouses can have anywhere from thousands to millions of SKUs, which poses an enormous challenge to automated systems. As a result, most existing automated picking systems in warehouses are fairly limited. Either they're specifically designed to pick a particular class of things, or they have to be trained to recognize more or less every individual thing you want them to pick. Obviously, in warehouses with millions of different SKUs, traditional methods of recognizing or modeling specific objects is not only impractical in the short term, but would also be virtually impossible to scale.

This is why humans are still used in picking—we have the ability to generalize. We can look at an object and understand how to pick it up because we have a lifetime of experience with object recognition and manipulation. We're incredibly good at it, and robots aren't. “From the very beginning, our vision was to ultimately work on very general robotic manipulation tasks,” says Abbeel. “The way automation's going to expand is going to be robots that are capable of seeing what's around them, adapting to what's around them, and learning things on the fly.”

Covariant is tackling this with relatively simple hardware, including an off-the-shelf industrial arm (which can be just about any arm), a suction gripper (more on that later), and a straightforward 2D camera system that doesn't rely on lasers or pattern projection or anything like that. What couples the vision system to the suction gripper is one single (and very, very large) neural network, which is what helps Covariant to be cost effective for customers. “We can't have specialized networks,” says Abbeel. “It has to be a single network able to handle any kind of SKU, any kind of picking station. In terms of being able to understand what's happening and what's the right thing to do, that's all

unified. We call it Covariant Brain, and it's obviously not a human brain, but it's the same notion that a single neural network can do it all."

We can talk about the challenges of putting picking robots in warehouses all day, but the reason why Covariant is making this announcement now is because their system has been up and running reliably and cost effectively in a real warehouse in Germany for the last four months.



This video is showing Covariant's robotic picking system operating (for over an hour at 10x speed) in a warehouse that handles logistics for a company called Obeta, which overnights orders of electrical supplies to electricians in Germany. The robot's job is to pick items from bulk storage totes, and add them to individual order boxes for shipping. The warehouse is managed by an automated logistics company called KNAPP, which is Covariant's first partner. "We were searching a long time for the right partner," says Peter Puchwein, vice president of innovation at KNAPP. "We looked at every solution out there. Covariant is the only one that's ready for real production." He explains that Covariant's AI is able to detect glossy, shiny, and reflective products, including products in plastic bags. "The product range is nearly unlimited, and the robotic picking station has the same or better performance than humans."

The key to being able to pick such a wide range of products so reliably, explains Abbeel, is being able to generalize. "Our system generalizes to items it's never seen before. Being able to look at a scene and understand how to interact with individual items in a tote, including items it's never seen before—humans can do this, and that's essentially generalized intelligence," he says. "This generalized understanding of what's in a bin is really key to success. That's the difference between a traditional system where you would catalog everything ahead of time and try to recognize everything in the catalog, versus fast-moving warehouses where you have many SKUs and they're always changing. That's the core of the intelligence that we're building."

To be sure, the details on how Covariant's technology work are still vague, but we tried to extract some more specifics from Abbeel, particularly about the machine learning components. Here's the rest of our conversation with him:

IEEE Spectrum: How was your system trained initially?

Pieter Abbeel: We would get a lot of data on what kind of SKUs our customer has, get similar SKUs in our headquarters, and just train, train, train on those SKUs. But it's not just a matter of getting more data. Actually, often there's a clear limit on a neural net where it's saturating. Like, we give it more data and more data, but it's not doing any better, so

clearly the neural net doesn't have the capacity to learn about these new missing pieces. And then the question is, what can we do to re-architect it to learn about this aspect or that aspect that it's clearly missing out on?

You've done a lot of work on [sim2real](#) transfer—did you end up using a bajillion simulated arms in this training, or did you have to rely on real-world training?

We found that you need to use both. You need to work both in simulation and the real world to get things to work. And as you're continually trying to improve your system, you need a whole different kind of testing: You need traditional software unit tests, but you also need to run things in simulation, you need to run it on a real robot, and you need to also be able to test it in the actual facility. It's a lot more levels of testing when you're dealing with real physical systems, and those tests require a lot of time and effort to put in place because you may think you're improving something, but you have to make sure that it's actually being improved.

What happens if you need to train your system for a totally new class of items?

The first thing we do is we just put new things in front of our robot and see what happens, and often it'll just work. Our system has few-shot adaptation, meaning that on-the-fly, without us doing anything, when it doesn't succeed it'll update its understanding of the scene and try some new things. That makes it a lot more robust in many ways, because if anything noisy or weird happens, or there's something a little bit new but not that new, you might do a second or third attempt and try some new things.

But of course, there are going to be scenarios where the SKU set is so different from anything it's been trained on so far that some things are not going to work, and we'll have to just collect a bunch of new data—what does the robot need to understand about these types of SKUs, how to approach them, how to pick them up. We can use imitation learning, or the robot can try on its own, because with suction, it's actually not too hard to detect if a robot succeeds or fails. You can get a reward signal for reinforcement learning. But you don't want to just use RL, because RL is notorious for taking a long time, so we bootstrap it off some imitation and then from there, RL can complete everything.

Why did you choose a suction gripper?

What's currently deployed is the suction gripper, because we knew it was going to do the job in this deployment, but if you think about it from a technological point of view, we also actually have a single neural net that uses different grippers. I can't say exactly how it's done, but at a high level, your robot is going to take an action based on visual input, but also based on the gripper that's attached to it, and you can also represent a gripper visually in some way, like a pattern of where the suction cups are. And so, we can condition a single neural network on both what it sees and the end-effector it has available. This makes it possible to hot-swap grippers if you want to. You lose some time, so you don't want to swap too often, but you could swap between a suction gripper and a parallel gripper, because the same neural network can use different gripping strategies.

And I would say this is a very common thread in everything we do. We really wanted to be a single, general system that can share all its learnings across different modalities, whether it's SKUs, end of arm tools, different bins you pick from, or other things that might be different. The expertise should all be sharable.

“People often say neural networks are just black boxes and if you're doing something new you have to start from scratch. That's not really true . . . Their strength comes from the fact that you can train end-to-end, you can train from input to the desired output”

—Pieter Abbeel, *Covariant.ai*

And one single neural net is versatile enough for this?

People often say neural networks are just black boxes and if you're doing something new you have to start from scratch. That's not really true. I don't think what's important about neural nets is that they're black boxes—that's not really where their strength comes from. Their strength comes from the fact that you can train end-to-end, you can train from input to the desired output. And you can put modular things in there, like neural nets that are an architecture that's well suited to visual information, versus end-effector information, and then they can merge their information loads to come to a conclusion. And the beauty is that you can train it all together, no problem.

When your system fails at a pick, what are the consequences?

Here's where things get very interesting. You think about bringing AI into the physical world—AI has been very successful already in the digital world, but the digital world is much more forgiving. There's a long tail of scenarios that you could encounter in the real world and you haven't trained against them, or you haven't hardcoded against them. And that's what makes it so hard and why you need really good generalization including few-shot adaptation and so forth.

Now let's say you want a system to create value. For a robot in a warehouse, does it need to be 100 percent successful? No, it doesn't. If, say, it takes a few attempts to pick something, that's just a slowdown. It's really the overall successful picks per hour that matter, not how often you have to try to get those picks. And so if periodically it has to try twice, it's really the picking rate that's affected, not the success rate that's affected. A true failure is one where human intervention is needed.

With true failures, where after repeated attempts the robot just can't pick an item, we'll get notified by that and we can then train on it, and the next day it might work, but at that moment it doesn't work. And even if a robotic deployment works 90 percent of the time, that's not good enough. A human picking station can range from 300 to 2000 picks per hour. 2000 is really rare and is peak pick for a very short amount of time, so if we look at the bottom of that range, 300 picks per hour, if we're succeeding 90 percent, that means 30 failures per hour. Wow, that's bad. At 30 fails per hour, fixing those up by a human probably takes more than an hour's worth of work. So what you've done now is you've created more work than you save, so 90 percent is definitely a no go.

At 99 percent that's 3 failures per hour. If it usually takes a couple of minutes for a human to fix, at that point, a human could oversee 10 stations easily, and that's where all of a sudden we're creating value. Or a human could do another job, and just keep an eye on the station and jump in for a moment to make sure it keeps running. If you had a 1000 per hour station, you'd need closer to 99.9 percent to get there and so forth, but that's essentially the calculus we've been doing.

And that's what you realize how any extra nine you want to get is so much more challenging than the previous nine you've already achieved.

There are other companies that are developing using similar approaches to picking—industrial arms, vision systems, suction grippers, neural networks. What makes Covariant's system work better?

I think it's a combination of things. First of all, we want to bring to bear any kind of learning—imitation learning, supervised learning, reinforcement learning, all the different kinds of learning you can. And you also want to be smart about how you collect data—what data you collect, what processes you have in place to get the data that you need to improve the system. Then related to that, sometimes it's not



Photo: Elena Zhukova

Covariant co-founders (left to right): Tianhao Zhang, Rocky Duan, Peter Chen, and Pieter Abbeel.

just a matter of data anymore, it's a matter of, you need to re-architect your neural net. A lot of deep learning progress is made that way, where you come up with new architectures and the new architecture allows you to learn something that otherwise would maybe not be possible to learn. I mean, it's really all of those things brought together that are giving the results that we're seeing. So it's not really like any one that can be singled out as "this is the thing."

Also, it's just a really hard problem. If you look at the amount of AI research that was needed to make this work... We started with four people, and we have 40 people now. About half of us are AI researchers, we have some world-leading AI researchers, and I think that's what's made the difference. I mean, I know that's what's made the difference.

So it's not like you've developed some sort of crazy new technology or something?

There's no hardware trick. And we're not doing, I don't know, fuzzy logic or something else out of left field all of a sudden. It's really about the AI stuff that processes everything—underneath it all is a gigantic neural network.

Okay, then how the heck are you actually making this work?

If you have an extremely uniquely qualified team and you've picked the right problem to work on, you can do something that is quite out there compared to what has otherwise been possible. In academic research, people write a paper, and everybody else catches up the moment the paper comes out. We've not been doing that—so far we haven't shared the details of what we actually did to make our system work, because right now we have a technology advantage. I think there will be a day when we will be sharing some of these things, but it's not going to be anytime soon.

It probably won't surprise you that Covariant has been able to lock down plenty of funding (US \$27 million so far), but what's more interesting is some of the individual investors who are now involved with Covariant, which include Geoff Hinton, Fei-Fei Li, Yann LeCun, Raquel Urtasun, Anca Dragan, Michael I. Jordan, Vlad Mnih, Daniela Rus, Dawn Song, and Jeff Dean.

While we're expecting to see more deployments of Covariant's software in picking applications, it's also worth mentioning that their press release is much more general about how their AI could be used:

The Covariant Brain [is] universal AI for robots that can be applied to any use case or customer environment. Covariant robots learn general abilities such as robust 3D perception, physical affordances of objects, few-shot learning and real-time motion planning, which enables them to quickly learn to manipulate objects without being told what to do.

Today, [our] robots are all in logistics, but there is nothing in our architecture that limits it to logistics. In the future we look forward to further building out the Covariant Brain to power ever more robots in industrial-scale settings, including manufacturing, agriculture, hospitality, commercial kitchens and eventually, people's homes.

Fundamentally, Covariant is attempting to connect sensing with manipulation using a neural network in a way that can potentially be applied to almost anything. Logistics is the obvious first application, since the value there is huge, and even though the ability to generalize is important, there are still plenty of robot-friendly constraints on the task and the environment as well as safe and low-impact ways to fail. As to whether this technology will effectively translate into the kinds of semi-structured and unstructured environments that have historically posed such a challenge for general purpose manipulation (notably, people's homes)—as much as we love speculating, it's probably too early even for that.

What we can say for certain is that Covariant's approach looks promising both in its present implementation and its future potential, and we're excited to see where they take it from here.

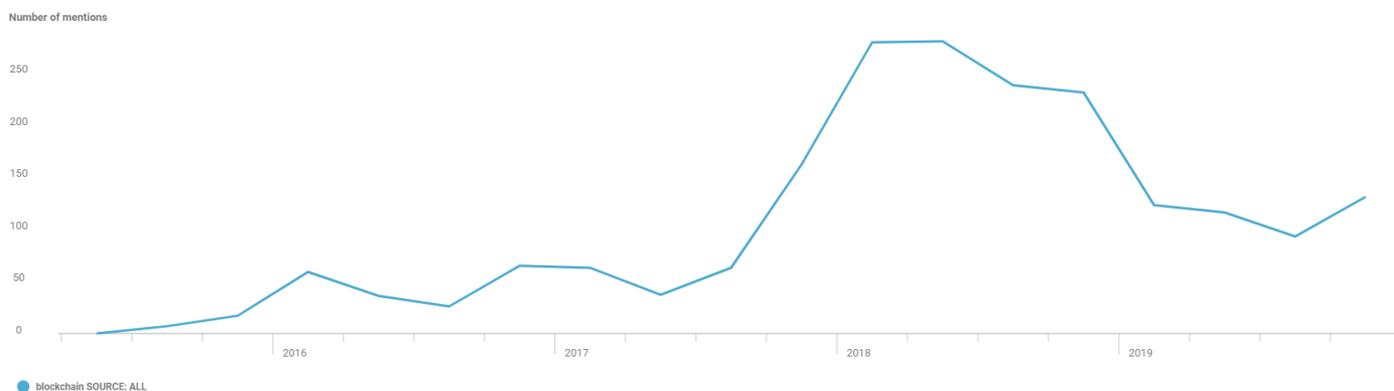
Investment To Blockchain Startups Slips In 2019

Despite a drop in total funding dollars, investment activity in the fourth quarter of 2019 points towards pockets of opportunities for blockchain technology in enterprise applications.

Sourced by CBInsights

Total equity funding to the space, which is one measure of investor enthusiasm, fell over 30% in 2019. Mentions of the technology in public company earnings transcripts also dropped off.

█ Mentions in Earnings Calls



One of the reasons for this slip is that many products are still trying to find product market fit.

Entrepreneurs have pitched applications for blockchain technology ranging from supply chain tracking to financial asset settlement, but the only one that has found adoption at any significant scale so far is cryptocurrency creation and trading. Bitcoin still dominates in that area, representing over 65% of the cryptocurrency market's total value.

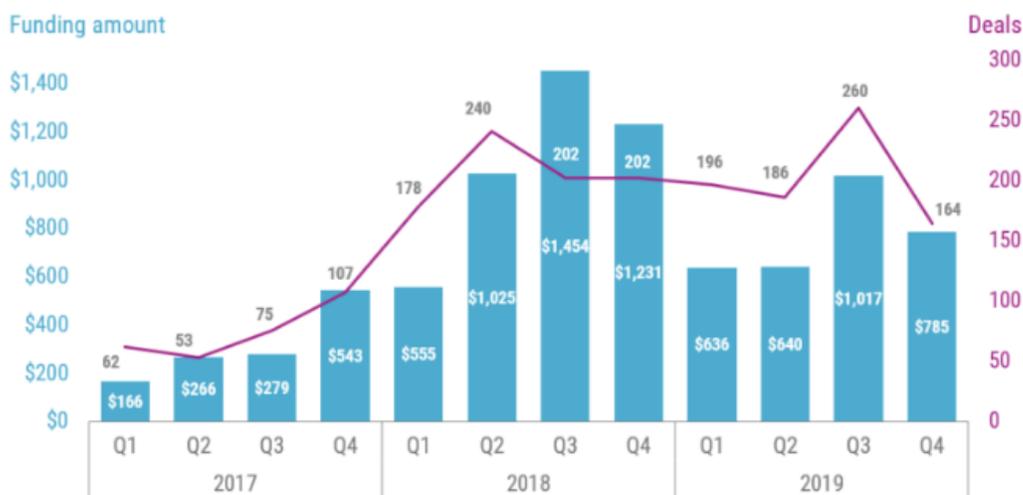
Still, investor activity shows there are pockets of potential in the blockchain sector worth tracking. Using CB Insights data, we analyze investment trends across the space from Q4 2019.

FOURTH QUARTER FUNDING DOWN SHARPLY FROM A YEAR AGO

Overall, dollar funding in 2019 was down 28% from 2018's peak of \$4.3B, while deal activity remained relatively flat.

█ Q4 funding to blockchain cos declines year-over-year

All funding values shown in \$M



Source: cbinsights.com

CBINSIGHTS

Companies like Bitmain (cryptocurrency mining hardware) and Coinbase (cryptocurrency exchange) were the top two fundraisers in 2018, demonstrating investors' focus on public cryptocurrencies. The companies raised \$400M and \$321M, respectively, both contributing to 2018's spike.

In Q4'19, companies in the blockchain space raised \$785M across 164 deals, representing a 36% decline from Q4'18. Though lower than 2018 numbers by a stretch, the quarter still outperformed Q1 and Q2 in 2019, with investor interest pointing specifically towards enterprise applications.

Enterprise payments network Ripple raised the highest amount of funding in the quarter — a \$200M Series C round from SBI Group, Tetragon Financial Group, and Route 66 Ventures, which valued the company at \$10B. Ripple stated the financing would go towards additional hiring, adding overseas offices, and improving balance sheet flexibility.

The company has continued to market its RippleNet payments platform as a disruptive technology to the cross-border payments market and the correspondent banking system that banks use to transfer funds.



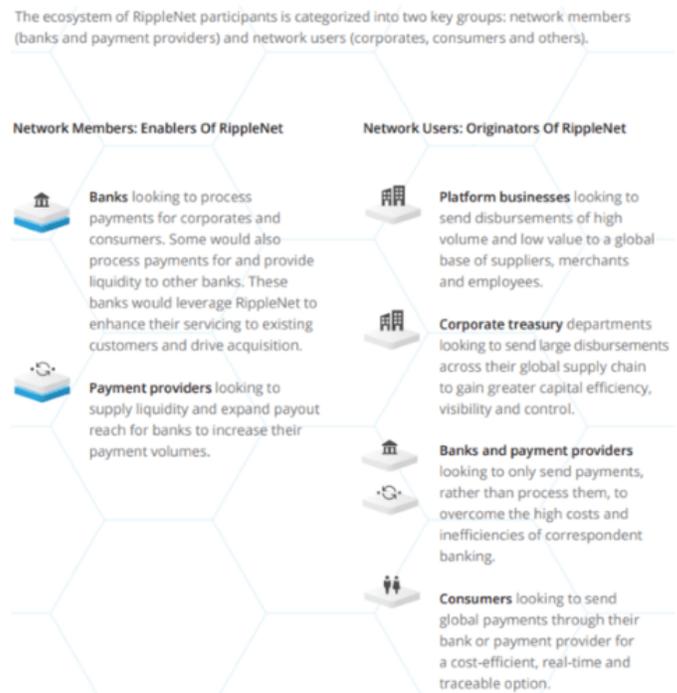
Funding
\$293.90M

Valuation
\$10.00B

Ripple is an Internet protocol that interconnects all the world's disparate financial systems to power the secure transfer of funds in any currency in real time. Ripple provides a frictionless experience to send money globally using the power of blockchain.

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LARGEST FUNDING ROUNDS POINT TO ENTERPRISE APPLICATIONS FOCUS

Following Ripple's mega-round, 3 of the next 4 largest blockchain deals of the quarter went to companies looking to streamline business processes (the exception being Layer1).

Figure Technologies raised \$103M to continue growing its blockchain-based platform Provenance, through which the company provides home equity loans with approval times as fast as 5 minutes.

Digital Asset raised \$35M to fund developer community initiatives supporting its Digital Asset Modeling Language (DAML) used for faster financial asset settlement and to expand the technology's applications.

Lastly, PeerNova raised \$31M for market expansion and product development. The company's technology helps financial institutions manage their data workflows more efficiently.

Top rounds to blockchain companies, Q4'19

Company	Deal Date	Amount	Funding Round	Total Funding	Description
 Figure Technologies	11/05/2019	\$103.00M	Series C	\$1,218.00M	Figure Technologies is a financial technology company leveraging blockchain, AI, and analytics to deliver home equity release solutions and other products that help improve the financial lives of customers.
 Ripple	12/20/2019	\$200.00M	Series C	\$293.90M	Ripple is an Internet protocol that interconnects all the world's disparate financial systems to power the secure transfer of funds in any currency in real time. Ripple provides a frictionless experience to send money globally using blockchain technology.
 Digital Asset Holdings	12/11/2019	\$35.00M	Series C	\$142.12M	Digital Asset provides tools that use distributed ledgers to track and settle both digital and mainstream financial assets in a cryptographically secure environment. The company's platform is ...
 PeerNova	10/22/2019	\$31.00M	Series C	\$68.82M	PeerNova provides peer to peer applications and platforms for the digital currency and e-commerce markets. The company offers high performance hardware and software solutions at the lowest OpEx and CapEx.
 Layer One	10/15/2019	\$50.00M	Series A	\$52.10M	Layer1 is a crypto asset investment and infrastructure platform based in San Francisco, CA. Layer1 takes concentrated bets on promising blockchain protocols and builds critical technology to support their global impact. Layer1 invests in crypto assets th...

Prev 1 Next

Unlike the other companies, Layer1 is looking to build and fund blockchain protocols and infrastructure. The company raised \$50M in Q4'19 specifically to build a solar and wind powered Bitcoin mining facility in West Texas.

Smart city projects are still most successful when they tackle discrete, sometimes isolated, city issues.

By Lauren Horwitz

Smart city initiatives are underway across the country. But they face funding and technology challenges. Many cities want to upgrade infrastructure to improve resident experience, safety and to generate revenue.

But modernization can be too costly without help from private companies.

Only about 16% of cities can self-fund their infrastructure projects. That prompts some to join forces with private companies to fund infrastructure projects such as smart streetlights, internet connectivity initiatives and smart parking meters. As a recent McKinsey report noted, public-private partnerships often involve distinct roles for both entities: cities are cast with the role of implementer, while private companies serve as investor.

In San Leandro, California, for example, public-private partnerships have fueled various smart city initiatives.

Private dollars have enabled these projects to expand and even drive revenue for the city. But public-private partnerships can't solve overcome the siloed nature of IoT technologies in action: That is, cities continue to struggle not only to identify smart city project funding but also to successfully extend smart-city projects beyond single-use IoT instances. [See Figure 1 from McKinsey and Co. "Smart cities: Digital solutions for a more livable future."]

Still, the smart city market is growing at a clip.

The global population is set to reach 9.7 billion by 2050, two-thirds of which will live in cities, according to United Nations estimates. And the global smart cities market is expected to reach \$237.6 billion by 2025, expanding at a CAGR of 18.9% from 2019 to 2025, according to a May 2019 study conducted by Grand View Research Inc.

This growth, say experts, takes a segmented approach, with cities working on specific problems.

"We will continue to see more examples [of smart city applications]," said Jessica Groopman, industry analyst and founding partner at Kaleido Insights. "We will see vertical-specific applications in emerging applications in parking, lighting, energy and trash, for example."

Expanding Connectivity Brings Revenue, Competition

This siloed approach reflects San Leandro's experience.

San Leandro's smart streetlighting project should be characterized as a success—with some caveats about the single-purpose IoT approach. The project upgraded streetlights to LED bulbs, which has saved the city millions in energy costs and reduced its carbon footprint. Via that project, the city also introduced IoT sensors, creating a 4,800-node mesh network with its streetlight infrastructure. In addition, they have positioned IP cameras at various intersections.

Sensors can help cities manage traffic flows and lighting, as well as improve pedestrian safety. Positioned cameras can also aid in investigations with vehicles involved in accidents or crime.

But, as Tony Batalla, the city's chief technology officer noted, it has been difficult to extend beyond single uses cases for IoT sensors. "The [lighting] system isn't built for applications to be attached to it. It requires a ton of software

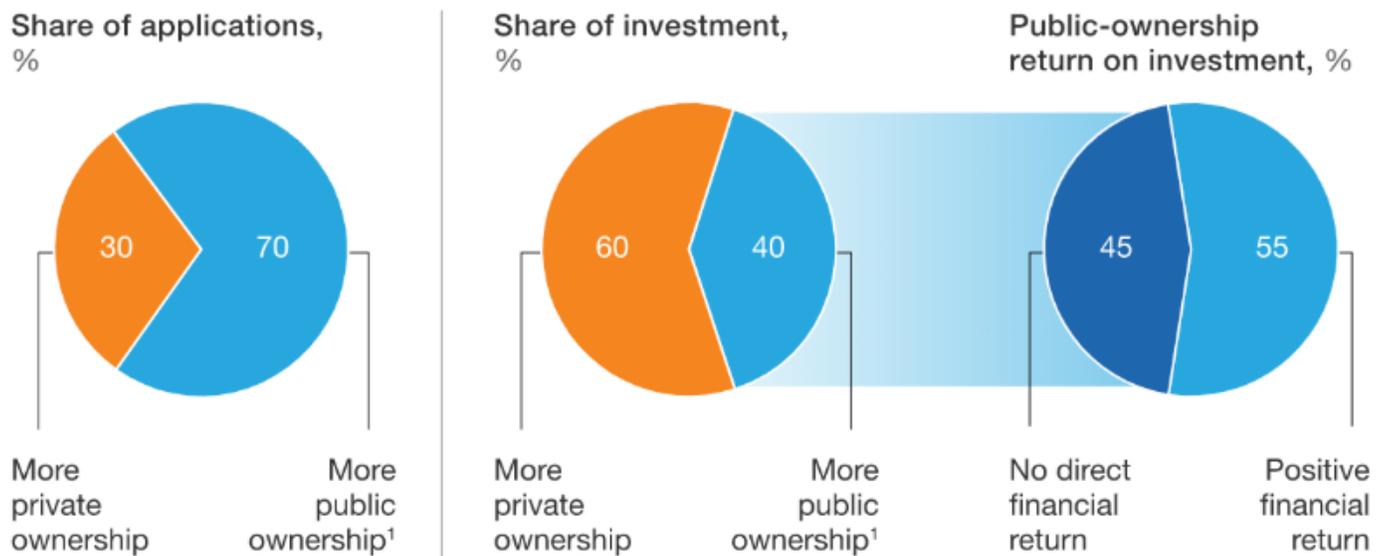
and hardware engineering [to add a new use case],” Batalla said. “What’s been challenging is broadening IoT networks beyond single use cases and expanding the use cases on that network. Now that we have a city-wide IoT network, what can you connect to it? What other sensors can you deploy?”

Batalla and his team have evaluated various areas where IoT might help the city—trash pickup, air quality, pool management and more. But, he said, it’s been challenging to identify a project that has enough momentum to garner funding and one where developers can develop an application for it on top of the existing IoT network. “That’s the hardest part,” Batalla said.

Experts agree that many smart city projects are still constrained by this single-purpose IoT approach.

“It’s going to be some time before we see that longer-term vision of everything is interconnected, municipal services, a platform of city data—we’re not there yet,” Kaleido Insight’s Groopman said.

The public sector would be the natural owner of most smart-city apps, but the majority of investment could come from private actors.



¹Energy, water, waste utilities, public-transport operators, and hospitals assumed public for this quantification, although this differs around the world.

Note: Autonomous vehicles excluded; technology has not been deployed at scale, and required investment by 2025 not yet clear.

McKinsey&Company | Source: McKinsey Global Institute analysis

Toward Multipurpose IoT

Some projects show the potential for multiple uses, however. The city installed cameras at some city intersections for transportation and is evaluating them for public safety, for example. These cameras can identify vehicles involved in accidents or even in crimes. Traffic cameras, another common use, take a snapshot of cars when they run a red light, and according to some data have reduced collisions by 30%.

Batalla said cameras also afford the opportunity to evaluate traffic patterns, see traffic flow in real time, and further reduce accidents and optimize flow.

In this way, cameras not only can be used in public safety but also help optimize traffic signal timing. That requires, as Batalla noted, city officials to use camera data to change traffic behavior.

“The really important thing is that you use that information to inform your policy decisions,” he said. “You change your program and change your signaling timing to reflect what is happening on the street in real-time. That’s where you start to see the value of smart city technology,” he said.

At the same time, Batalla acknowledged there are important privacy implications with cities’ use of cameras. (San Leandro has developed a policy to govern camera usage in the city.) The debate is particularly fervent concerning facial recognition technology.

A recent National Institute for Standards and Technology (NIST) study revealed that facial recognition software can suffer from racial bias; algorithms generate a higher rate of false positives for Asian and African-American faces relative to images of Caucasians—by a factor of 10 to 100 times.

As a result, some areas have moved to ban this potential privacy incursion. In October, California officials signed a temporary ban on police departments’ use of facial recognition with body cameras, and the city of San Francisco has banned law-enforcement use of the technology for privacy reasons.

Batalla noted that cameras in San Leandro have been for vehicle identification, but not facial recognition.

“There is no push for facial recognition technology today in San Leandro, so the city council is not banning it, but perhaps taking a wait-and-see approach,” he said. “We are more comfortable recommending cameras be strategically located around hotspots.”

Other technology trends, such as digital twins, may also help IoT break out of its single-use box.

A digital twin of a city intersection can depict signal timing, traffic flows and pedestrians in the crosswalk as well as other factors, such as CO emissions, temperature or other relevant factors.

The city of Palo Alto has a digital twin analyzing 120 intersections for vehicle and pedestrian traffic in real time. The digital twin visualizes traffic lights, foot traffic and so forth to identify traffic chokepoints and safety issues in real-time.

“You can monitor CO₂, streetlight data, people data in a single pane of glass,” said Bill Pugh, co-founder and managing partner at Smart Connections Consulting, “Digital twins will be hugely prevalent in 2020.”

Ultimately, cities may be able to use tools such as digital twins to gather data for multiple smart city projects and kill several birds with one stone, with a tool that provides a view into several problems at one time. But, as Groopman noted, a unified approach to IoT deployment will take time.

Developing the IoT Network

Today, San Leandro also enlists public-private partnerships to develop its IoT network beyond single-purpose IoT applications. A planned upgrade—which Batalla dubs its “version 2.0 of the network”—will enable the city to deploy applications for services such as water management, parking or energy efficiency without requiring excessive custom development.

The city works with its private developer partner, and he says, each have a role to play here as well. Ultimately, the city role is about delivering better resident experience.

“We’re not product innovators. We’re working with the product innovators—private companies—and saying here’s what we would like to see,” Batalla said. “And that in turn enables us to do service innovation.”

But today, experts say, the reality is that most IoT uses are segmented and vertical. City planners may want to approach smart city projects with a broad brush and tackle various city challenges, but the reality is they need to be laser focused in their approach.

“Move beyond viewing the IoT as a general technology wave by applying an industry lens to identify relevant use cases,” counseled Chet Geschickter, Gartner research director in a Gartner e-book on IoT deployment.

By Darrell Etherington

At the FAA's 23rd Annual Commercial Space Transportation Conference in Washington, DC on Wednesday, a panel dedicated to the topic of trends in VC around space startups touched on public versus private funding, the right kinds of space companies that should even be considering venture funding and, perhaps most notably, the big L: Liquidity.

Moderator Tess Hatch, vice president at Bessemer Venture Partners, addressed the topic in response to an audience question that noted while we've heard a lot about how much money will flow into space-related startups from the VC community, we haven't actually seen much in the way of liquidity events that prove out the validity of these investments.

"In 2008, a company called Skybox was created and a handful of years later Google acquired the company for \$500 million," Hatch said. "Every venture capitalist's ears perked up and they thought 'Hey, that's pretty good ROI in a short amount of time — maybe the space thing is an investable area,' and then a ton of venture capital investments flooded into space startups, and all of these venture capitalists made one, or maybe two investments in the area. Since then, there have not been many — if any — liquidity events: Perhaps Virgin Galactic going public via the SPAC (special purpose vehicle) on the New York Stock Exchange late last year would be the second. So we're still waiting; we're still waiting for those exits, we are still waiting for companies to pave the path for the 400+ startups in the ecosystem to return our investment."

Hatch added that she's looking at a number of companies who have the potential to break this somewhat prolonged exit drought in 2020, including five that are either quite mature in terms of their development, naming SpaceX, Rocket Lab, Planet and Spire as all likely candidates to have some kind of liquidity event in 2020, with the mostly likely being an IPO.

Space as an industry was described to me recently as a "maturing" startup market by Space Angels CEO Chad Anderson, by virtue of the distribution of activity in terms of the overall investment rounds in the sector. There is indeed a lot of activity with early-stage companies and seed rounds, but the fact remains that there hasn't been much in the way of exits, and it's also worth pointing out that corporate VCs haven't been as acquisitive in space as some of their consumer and enterprise technology counterparts.

The panel touched on a lot more apart from liquidity, which actually only came up toward the end of the discussion. Panelists included Astranis CEO and co-founder John Gedmark; Capella Space CEO and founder Payam Banazadeh and Rocket Lab VP of Global Commercial Launch Services Shane Fleming. Both Gedmark and Banazadeh addressed aspects of the risks and benefits of seeking VC as a space technology company.

"Not every space business is a venture-backable business," said Banazadeh earlier in the conversation. "But there are a lot of space businesses that are specifically going after raising venture money, and that's dangerous for everyone — because at the end of the day, venture is looking at high risk, high return. The 'high return' comes from being able to get substantial amounts of revenue in a market that's big enough for those revenues to be coming from. But if your idea is to go build, maybe, some very specific part in a satellite, then you have to make the case of why you'll be able to make those returns for the investors, and in a lot of cases, that's just not possible."

Banazadeh also concedes that doing any kind of space technology development is expensive, and the money has to

come from somewhere. Gedmark talked about one popular source, government funding and grants, and why that often isn't as obviously a positive thing for startups as it might seem.

“Small government grants can be great, and obviously a fantastic source of non-dilutive capital,” Gedmark said. “But there is a little bit of a trick there, or something to be aware of: I think people are often surprised how much time is spent in the early days of a startup refining the exact idea and the product, and if you're not certain that you have that product market fit [...] then, the government grant can be extremely dangerous, because they will fund you to do something that is sort of similar to what to what you're doing, but it really prevents you changing your approach later; you're going to end up spending time executing on the specific project of the program manager on the government side and you're executing on what they want.”

VC funds, on the other hand, come with the built-in expectation that you're going to refine and potentially even change direction altogether, Gedmark says. Depending on the terms of the public funding you're seeking, that flexibility may not be part of the arrangement, which ultimately could be more important than a bit of equity dilution.

The launch of Apex.OS 1.0 makes autonomous car development simpler, safer, and more secure

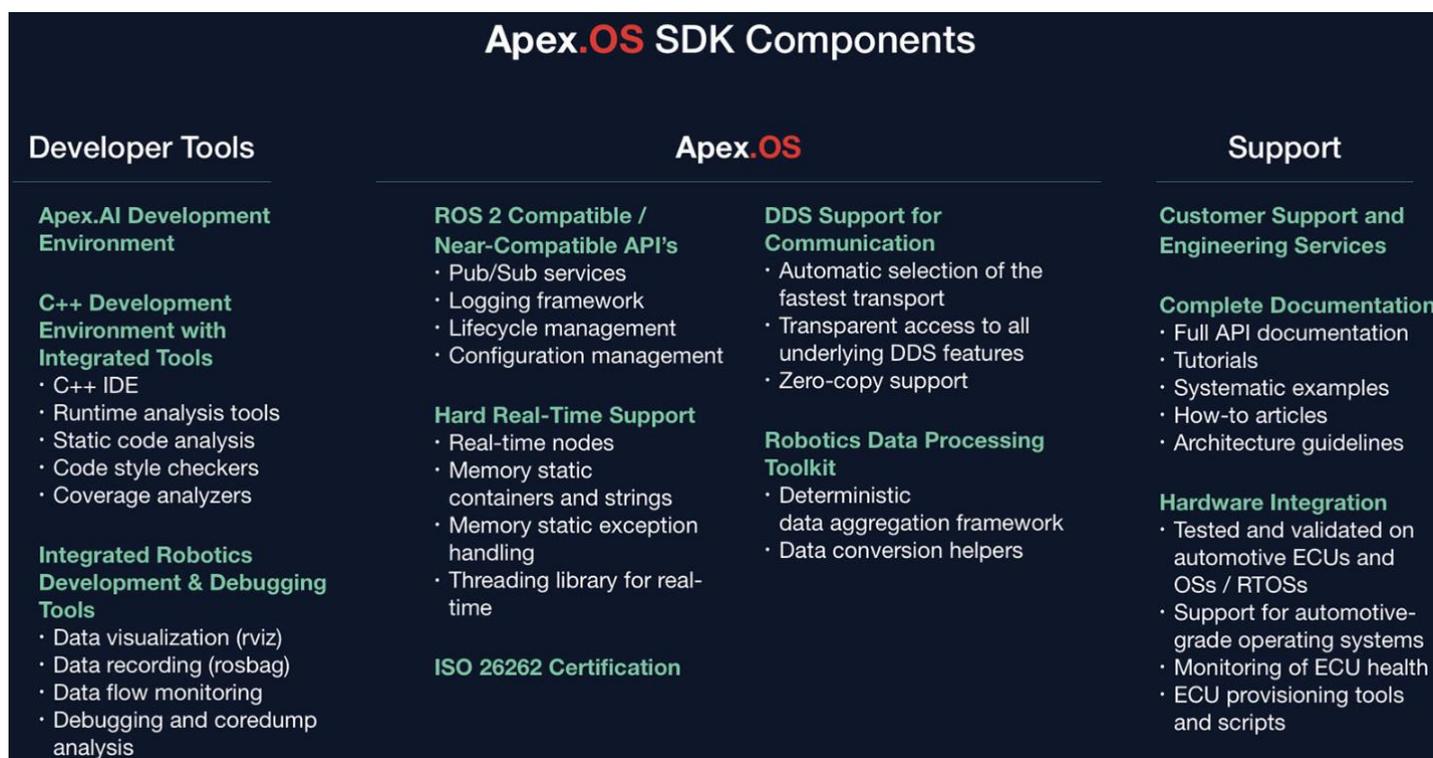
By Evan Ackerman

The facets of autonomous car development that automakers tend to get excited about are things like interpreting sensor data, decision making, and motion planning.

Unfortunately, if you want to make self-driving cars, there's all kinds of other stuff that you need to get figured out first, and much of it is really difficult but also absolutely critical. Things like, how do you set up a reliable network inside of your vehicle? How do you manage memory and data recording and logging? How do you get your sensors and computers to all talk to each other at the same time? And how do you make sure it's all stable and safe?

In robotics, the Robot Operating System (ROS) has offered an open-source solution for many of these challenges. ROS provides the groundwork for researchers and companies to build off of, so that they can focus on the specific problems that they're interested in without having to spend time and money on setting up all that underlying software infrastructure first.

Apex.ai's (**Chambiz DF 9 Feb 19*) Apex OS, which is having its version 1.0 release today, extends this idea from robotics to autonomous cars. It promises to help autonomous carmakers shorten their development timelines, and if it has the same effect on autonomous cars as ROS has had on robotics, it could help accelerate the entire autonomous car industry.



For more about what this 1.0 software release offers, we spoke with Apex.ai CEO Jan Becker.

IEEE Spectrum: What exactly can Apex.OS do, and what doesn't it do?

Jan Becker: Apex.OS is a fork of ROS 2 that has been made robust and reliable so that it can be used for the development and deployment of highly safety-critical systems such as autonomous vehicles, robots, and aerospace applications. Apex.OS is API-compatible to ROS 2. In a nutshell, Apex.OS is an SDK for autonomous driving software and other safety-critical mobility applications. The components enable customers to focus on building their specific applications without having to worry about message passing, reliable real-time execution, hardware integration, and more.

Apex.OS is not a full [self-driving software] stack. Apex.OS enables customers to build their full stack based on their needs. We have built an automotive-grade 3D point cloud/lidar object detection and tracking component and we are in the process of building a lidar-based localizer, which is available as Apex.Autonomy. In addition, we are starting to work with other algorithmic component suppliers to integrate Apex.OS APIs into their software. These components make use of Apex.OS APIs, but are available separately, which allows customers to assemble a customized full software stack from building blocks such that it exactly fits their needs. The algorithmic components re-use the open architecture which is currently being built in the open source Autoware.Auto project.

So if every autonomous vehicle company started using Apex.OS, those companies would still be able to develop different capabilities?

Apex.OS is an SDK for autonomous driving software and other safety-critical mobility applications. Just like iOS SDK provides an SDK for iPhone app developers enabling them to focus on the application, Apex.OS provides an SDK to developers of safety-critical mobility applications.

Every autonomous mobility system deployed into a public environment must be safe. We enable customers to focus on their application without having to worry about the safety of the underlying components. Organizations will differentiate themselves through performance, discrete features, and other product capabilities. By adopting Apex.OS, we enable them to focus on developing these differentiators.

What's the minimum viable vehicle that I could install Apex.OS on and have it drive autonomously?

In terms of compute hardware, we showed Apex.OS running on a [Renesas R-Car H3](#) and on a Quanta V3NP at CES 2020. The R-Car H3 contains just four ARM Cortex-A57 cores and four ARM Cortex-A53 cores and is the smallest ECU for which our customers have requested support. You can install Apex.OS on much smaller systems, but this is the smallest one we have tested extensively so far, and which is also powering our vehicle.

We are currently adding support for the Renesas R-Car V3H, which contains four ARM Cortex-A53 cores (and no ARM Cortex-A57 cores) and an additional image processing processor.

You suggest that Apex.OS is also useful for other robots and drones, in addition to autonomous vehicles. Can you describe how Apex.OS would benefit applications in these spaces?

Apex.OS provides a software framework that enables reading, processing, and outputting data on embedded real-time systems used in safety-critical environments. That pertains to robotics and aerospace applications just as much as to automotive applications. We simply started with automotive applications because of the stronger market pull. Industrial robots today often run ROS for the perception system and non-ROS embedded controller for highly-accurate position control, because ROS cannot run the realtime controller with the necessary precision. Drones often run PX4 for the autopilot and ROS for the perception stack. Apex.OS combines the capabilities of ROS with the requirements of mobility systems, specifically regarding real-time, reliability and the ability to run on embedded compute systems.

How will Apex contribute back to the open-source ROS 2 ecosystem that it's leveraging within Apex.OS?

We have contributed back to the ROS 2 ecosystem from day one. Any and all bugs that we find in ROS 2 get fixed in ROS 2 and thereby contributed back to the open-source codebase. We also provide a significant amount of funding to [Open Robotics](#) to do this. In addition, we are on the ROS 2 Technical Steering Committee to provide input and guidance to make ROS 2 more useful for automotive applications. Overall we have a great deal of interest in improving ROS 2 not only because it increases our customer base, but also because we strive to be a good open-source citizen.

The features we keep in house pertain to making ROS 2 realtime, deterministic, tested, and certified on embedded hardware. Our goals are therefore somewhat orthogonal to the goals of an open-source project aiming to address as many applications as possible. We, therefore, live in a healthy symbiosis with ROS 2.

By Hardik Shah

It's 2020 and the question at the top of everyone's mind is, what technologies will dominate this year and beyond? In recent years, we saw transformation changes with technologies like blockchain, IoT, robotics, and artificial intelligence. This year is no-different. In today's business climate with competition at a global level, smart organizations are seeking new technologies to gain competitive advantage.

1. Artificial Intelligence (AI)

AI is one of the important technology trends for 2020. In 2019, the global spending on AI was \$35.8bn. However, it's projected to hit \$46bn in the year 2020. Oracle says, by 2020, about 78% of brands will have implemented AI. AI is seen as a savior in redefining conventional business operations.

Apart from refining business processes, AI is also used to:

- Further enhance personalization
- Tighten cybersecurity aspects
- Test and maintain software applications
- Automate bug detection and fixing
- Optimize server operations and more

2. Augmented Reality And Virtual Reality (AR/VR)

One of the most underrated technologies, AR/VR could see a revival in their implementation this year. It is estimated that 32% of companies would incorporate this technology to enhance their product experience in the next 3 years. With virtual try-on jewelry and fashion apparel concepts already hitting the market, we could say that the booming of IoT will also help boost its market penetration. From retail and real estate to manufacturing and training, we could see the use of AR/VR in diverse formats.

3. Progressive Web Apps (PWA)

With billions of users connecting to the internet from their phones, it makes complete sense for businesses to go mobile-first. Arriving as a boon for such businesses to make their online transition seamless is the concept of PWA. The hybrid tech that bridged the gap between native apps and websites increased page views by 134%. What's more, it also lowered bounce rates, increased engagement rates, reduced development costs, and increased delivery time. Some of the most popular websites like Trivago, Tinder, AliExpress have implemented PWA and this is the right time for your business to do it too.

4. Programming Language Trends

The rise of advanced concepts and technologies in software development paved the way for newer and more efficient programming languages as well. STL model forecasts that Python could be lead or be overtaken by Java in 2020. Model also suggests that Java and JavaScript will have the same traffic-flow in high income countries in 2020.

5. 5G Network

While there are places where 4G technology is yet to reach, countries like the US and China have already implanted 5G networks into their infrastructures. The implementation across countries is so rapid and dynamic. Gartner predicts that worldwide revenue from 5G networks is anticipated to hit \$4.2bn in 2020. CCS Insight forecasted that there would be over 340mn 5G connections by 2021 With the estimated reach of 5G, aspects around the network like privacy regulations, transparency in terms of data collection and usage, security and more will also be worked on.

6. Business Intelligence (BI)

The amount of data generated today acts as one of the most perfect avenues for companies to make crucial business decisions. Thankfully, companies are seeming to understand the inevitability of business intelligence for their ventures. Data analytics is offering tons of insights and patterns on customer and employee behavior. This helps companies to make a lot of crucial changes to their workflows and go-to-market strategies. In the coming year, this application is only anticipated to surge further. Some of the below-mentioned aspects will be trending this year as companies explore these to better suit their operations and strategies.

- Better Predictive analytics
- More Business intelligence platforms
- Smarter NLPs
- Newer data touchpoints
- Thorough Data governance
- Mobile business intelligence

7. Edge Computing

Still considered a growing market, edge computing is expected to witness explosive growth in 2020. With a projected growth rate of 50%, this industry will experience more takers from telecom companies, software platform providers, data centers, public cloud providers, content delivery agencies/networks, and more.

8. Big Data

To quickly understand the power of Big Data, realize that Netflix saved close to \$1bn by using Big Data for customer retention. Companies have also increased their profits by 8-10% with its implementation. Some of the aspects where Big Data is applied include

- For more effective research and development
- For enhanced business efficiencies
- For quicker innovation cycles
- Better quality of product/service

9. Internet Of Things

The number of devices connecting to the internet is phenomenally increasing by the day. It is expected that over 29 billion devices will be connected to the internet by 2022, out of which over 18 billion would be IoT devices. Apart from the consumer-specific applications of IoT in terms of gadgets and home automation systems, IoT will also witness a widespread application

- to boost agriculture
- in healthcare to fight counterfeit medicines
- in making cities smarter with smart power grids
- traffic management systems
- surveillance and security
- retail and more.

If you're a retail shop owner, now would be the best time to use IoT to customize your store visits and push sales.

10. Blockchain

Still a buzzword for a lot of companies, blockchain technology can work wonders for your business by

- securing payment processes
- reducing costs
- increasing efficiency of transactions and more

One of the key trends when it comes to blockchain is that over 77% of the financial institutions will adopt this technology to work on the above stated purposes. With more companies understanding what blockchain can do for their businesses, this industry is also expected to hit a global revenue of \$3.9bn by the year end.

Conclusion

So, these were the technology trends for 2020. If some of these techs were in your list of to-dos this year, we recommend fast-tracking the implementation process. If none of these were on your list, it's time to re-strategize your business operations and goals for the upcoming year. Each tech mentioned works on increasing your profits and customer and employee satisfaction. Go for the ones that meet your budget requirements and make 2020 count for your business.

By Jennifer Matthews



Researchers at Penn State are looking at innovative ways to improve energy storage in an effort to better utilize renewable energy technologies.

"One of the primary obstacles stopping us from relying heavily on renewable energy systems is that we can't regulate when they provide us power," said Derek Hall, assistant professor of energy engineering at Penn State. "Ideally, we want to find some sort of energy storage technology that can complement renewables to help us transition to a more sustainable energy infrastructure."

Renewable energy systems, such as wind and solar, are capable of producing enough electricity to power entire communities. However, they rely on natural processes to produce the electricity needed, and nature can be unpredictable. This results in ebbs and flows in renewable electricity generation. At times, wind and solar are able to produce more than the grid can handle, driving electricity prices into the negative. Alternatively, if the wind stops or there is a period of poor weather, production halts and prices skyrocket.

This phenomenon inspired Hall to start exploring more cost-effective, energy storage strategies through multiple collaborative research projects at Penn State.

Enhancing battery chemistries

Hall, along with Christopher Gorski, associate professor of environmental engineering, and Serguei Lvov, professor of energy and mineral engineering and materials science and engineering and director of the Electrochemical Technologies Program at the EMS Energy Institute, are using ligand chemistry to enhance the electrochemical performance of cheaper battery chemistries, thanks to an Institutes of Energy and the Environment (IEE) and Materials Research Institute grant.

"The goal is to try to find cheaper materials to make batteries with," Hall said. "The main hurdle stopping us is that most cheap materials have small energy storage densities, which leads to poor battery performance."

Ligands are ions or molecules that bind to a central metal. They are commonly used in nature and biomimetic processes to alter metal reactivity, but they have not been previously used in flow batteries. The researchers are using materials such as copper, iron and chromium, which are cheaper than traditional materials such as lithium,

cobalt and vanadium, and pairing them with ligands in an effort to significantly reduce the capital costs associated with producing batteries.

The team will then perform experiments to identify if the metal-ligand complexes achieve high energy storage densities. They will do this in three steps: thermodynamic, kinetic, and full cell testing. In each step, different key parameters will be tested for a typical redox flow battery. The thermodynamic phase will explore how the ligands impact the electrode potential, then the kinetic phase will test how much electrical current can be harnessed. Finally, the researchers will test all the components together to see how they work in unison.

"A lot of parts to this story are still missing, so this will be largely a fundamental research project," Hall said. "There's no real unified theory explaining how ligands impact electrochemical reactions."

The researchers hope this project, titled "New Low-Cost Flow Battery Chemistries via Ligand-Enhanced Redox Reactions," will provide preliminary results needed to pursue larger grants aimed at developing new flow battery chemistries and gain fundamental insights into why and how ligands alter the reactivities of metal complexes.

"We need to start exploring all our options for energy storage because switching over our infrastructure to renewables is a major transition that is time sensitive," Hall said. "When we built our fossil fuel infrastructure, we did that over many decades. Now we need to figure out what the best choices, or most functional choices, are, and then build a whole lot of it really soon."

Converting waste heat into power

Hall is also working with Bruce Logan, professor of environmental engineering, and Matthew Rau, assistant professor of mechanical engineering, on research funded through another seed grant that looks to enhance the performance and the power output capabilities of flow batteries that are charged with waste heat rather than electricity.

"If we could find a way to redirect waste heat into electricity, even if it's a small amount on demand, this can help lessen our need for more electricity generation," Hall said.

Like with Hall's other project, this team is using a type of flow battery technology, but with a unique thermal recharging method. The project, titled "Increasing Power Densities and Cycle Efficiencies of Novel, Thermally-Charged Flow Batteries Using Advanced Flow Cell Topologies," will try to improve power density through distinctive battery flow field designs. They will do this through computational modeling using COMSOL Multiphysics software.

"The technology we're working on uses a specific chemical composition where you can recharge the chemical reaction using waste heat instead of electricity," Rau said.

In a traditional battery, a chemical reaction creates the discharge potential, generating electricity. When the process is reversed to recharge the battery, some electricity must be used to do so. For this new technology, the researchers will recharge the battery by separating two chemicals using waste heat. When those chemicals are combined back together, they will create a chemical reaction that generates electricity, therefore eliminating the need to use additional electricity to recharge the battery.

"This would be a competing technology to the traditional energy-storage methods, such as lithium ion batteries, but unique in the fact that it doesn't require electricity," Rau said. "It requires heat to charge, so we're essentially opening up a new resource that could potentially power industrial processes or part of the electrical grid."

The basic idea has been around roughly five years, Rau said, but the researchers are looking to improve the performance of the basic model, so that it can become commercially viable.

"Developing this technology will not be easy," he said. "These batteries flow electrolytes through porous electrodes. The fluid flow alone is complicated enough to model without even considering the chemical reactions also occurring. We are developing the expertise to accurately model how the fluid flow in these batteries affects the different chemical reactions and ultimately how these parameters relate to the battery power output."

The researchers are hopeful that preliminary experiments done prior to starting this study have given them the tools needed for success.

"We currently have little use for waste heat in industry and in power generation," Rau said. "It just gets discarded with the cooling water or spewed into the atmosphere in an exhaust stack. If we can actually harness that the waste heat, we'll increase the energy efficiency of many different industries."

These projects illustrate the need to develop large-scale, energy storage technologies that pair well with renewable energy technologies, Hall said.

"There's not going to be one solution that just wins out," he added. "It will likely be a mix. It's sort of an all-hands-on-deck situation. We really don't know which one is going to work out or when it will be needed, so I think exploring multiple options is the best way forward."

By Doug Aamoth

Sometimes international travel sounds more romantic and exciting than it actually is. Between long-haul flights, jet lag, unfamiliar surroundings, foreign languages and customs, you shouldn't be bashful about seeking out any advantage you can get. Here are some apps to help you do just that.



1. PACK LIKE A PRO

Insane baggage fees, limited overhead space, wheel-busting cobblestone streets, you name it. Now more than ever, it's imperative that you bring your perfect packing

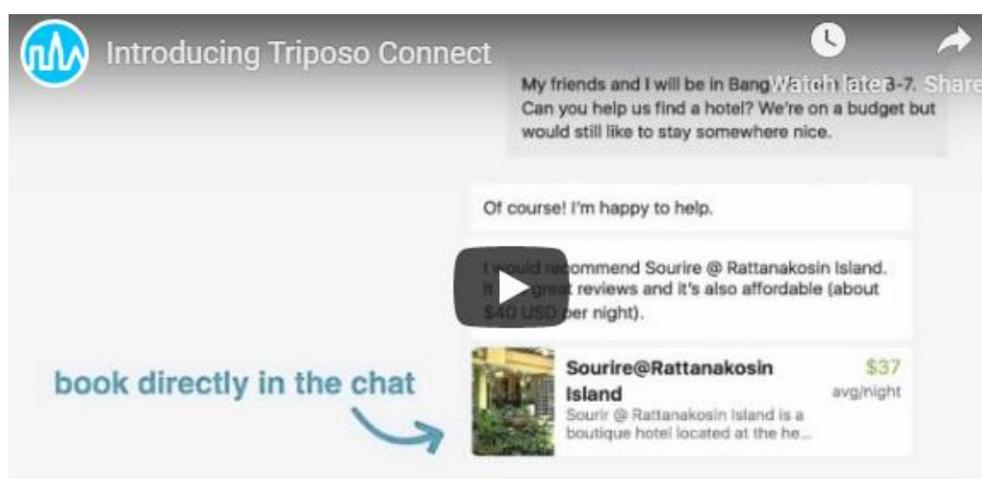
game every time you travel. In that spirit, take PackPoint (Android, iOS) for a spin. The \$3 app collects some basic info from you—where you're going, how long you'll be there, which sorts of activities you'll be doing—and then pulls in helpful info such as the weather forecast to create a custom packing list for you, right down to the last sock. The app can connect to your TripIt account to import upcoming trips automatically and export your lists to Evernote once you've got them nailed down.

2. JUKE THE JET LAG

Nothing puts a damper on globe-trotting like some aggressive jet lag. Fortunately, there are a handful of tricks you can use to condition your body to foreign time zones. The Timeshifter (Android, iOS) app ingests your travel plans and then leverages sleep studies and circadian neuroscience to prompt you when to avoid bright light and caffeine (or seek them out), ramping your body up before you've even left home. You can use the app for quick trips and multicity stops, and you can even daisy-chain trips together if you've got a short turnaround time. The first trip is free to try, after which there's a per-trip fee or a \$25 yearly fee for unlimited trips.

3. WANDER WHEREVER

So you've made it to your destination. Now what? Let the free Triposo (Android, iOS) app be your guide. Sporting 50,000 destinations around the globe, the app crawls pertinent data from popular travel sites to cobble together information for just about any landmark, activity, or restaurant you'd care to visit. There are built-in maps as well, which you can



download to work offline so you don't have to depend on spotty cell service. The app is ad-supported but can be unlocked for \$4 if you're keen to get rid of the marketing messages.

4. TALK THE TALK

Learning a new language from the ground up is an admirable goal, but sometimes you just need enough to get by. The suitably named Travel Phrasebook (Android, iOS) features commonly used phrases for 18 languages, categorized by scenario: greetings, dining, emergency, and more. Best of all, when you tap on the phrase you need, the app will speak it aloud for you so you don't have to worry about nailing the accent perfectly. There's an ad-supported version with a handful of common phrases. Or you can pay \$5 to unlock the entire phrase list for one language, or \$20 for everything.

5. CRUISE THROUGH CUSTOMS

Once you finally land stateside again, the only thing standing between you and American soil is a long, long customs line. Make short(er) work of it with the handy Mobile Passport (Android, iOS) app. Accepted at more than two dozen U.S. points of entry, the free app lets you submit your customs declaration paperwork electronically, snap a photo of yourself, and then use a special mobile passport line once you get off the airplane. Though the free version is perfectly fine for infrequent trips, the \$15-per-year Plus version lets you scan and store your passport info so you don't have to enter it every time.

