

Emerging Technology Predictions 2021

A man wearing VR goggles is shown in a black and white photograph, interacting with a 3D architectural model of a building. A large, vibrant pink graphic element, consisting of overlapping geometric shapes, is overlaid on the right side of the image, partially covering the man and the model. The background is a blurred indoor setting.

Trailblazing technologies will make an outsize contribution to success in the year ahead.

splunk[®]>

A woman with dark hair, wearing a long black dress and grey sneakers, is walking from left to right. She is holding a bright pink umbrella over her head. The background is a plain, light-colored wall.

Emerging Into the Data Age

What we really want to see emerging in 2021 is all of us, from our homes. By summer, a semblance of normalcy and stability should begin asserting itself globally. Old patterns will return, but with changes. Other regions may maintain the habit of wearing face masks in public even after the pandemic. Temperature checks as you board a plane may be a thing, and restaurants might never feel crowded again.

A pattern that wasn't interrupted by the pandemic, but instead shifted into overdrive is digital transformation. The Data Age — defined by greater interconnectedness through ubiquitous digital technologies — was already here. Now it's really here.

“COVID-19 has been a catalyst, greatly accelerating digital transformation,” says Ammar Maraqa, Splunk's senior vice president and chief strategy officer. “For business and IT leaders, the strategic long view has been dramatically compressed. Disruptions anticipated in five or 10 years have been compressed to a horizon of months or weeks.”

For a lot of organizations, high-speed transformation is going to look like a lot more cloud. Organizations that were already fairly mature in their cloud adoption are pushing into automation and machine learning. Orgs that can really push the envelope are planning for 5G, investigating augmented reality or blockchain, or deploying edge computing solutions.

“

Disruptions anticipated in five or ten years have been compressed to a horizon of months or weeks.”

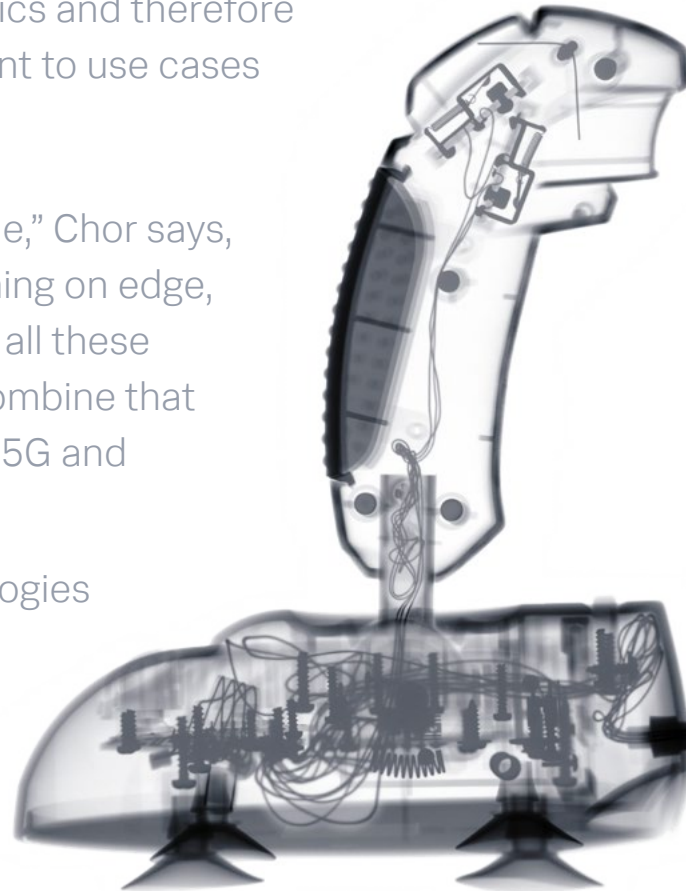
Ammar Maraqa, senior vice president and chief strategy officer, Splunk



A lot of powerful software is in our near future — in large part, says Splunk’s head of mobile engineering, Jesse Chor, because of a key hardware development: the rise of the graphics processing unit (GPU). The central processing unit, the computer’s brain and a fundamental determiner of how fast a program can run, continues to steadily improve. But in recent years, the GPU — originally designed for 3D graphics and therefore central to gaming — is increasingly important to use cases beyond “first-person shooter.”

“The evolution of GPU is going to be a big one,” Chor says, “because that’s what unlocks machine learning on edge, that’s what unlocks AR, that’s what unlocks all these great future experiences. And then if you combine that with the low latency and high bandwidth of 5G and WiFi 6, you’ve got everything you need.”

This year’s predictions for emerging technologies include a number of ways to keep the most powerful GPUs busy.



Playing the Game

Sure, gaming isn’t the only use of advancing GPUs, but it’s still a big one. Splunk’s chief technology officer, Tim Tully, says the improvement in GPUs makes gaming a more interesting tech space than ever. He also admits that since the pandemic, he has become a more regular gamer.

“GPU advancements are allowing developers to make these super-immersive games, and VR will be an interesting element there,” he says. “And since the pandemic, gaming has become an even bigger activity, a more important escape mechanism, than ever. I think it will consume more of the budget we used to spend in restaurants or movie theaters.”

Predictions and Survival Strategies for 2021

06

Artificial Intelligence/Machine Learning (AI/ML)

Self-learning ML will help us see beyond buzzwords to value

Challenges: Adversarial attacks, AI ethics, human training

14

5G/Mobile

5G will be delayed, then big. Meanwhile, look at WiFi 6.

Also: Contactless payments, two-factor authentication and biometrics.

21

AR/VR

AR: Pandemic setbacks may lead to immersive collaborative tools and healthcare.

VR: The hardware's there. It's do-or-die on the software front.

26

Biometrics

Biometrics was already taking off before the pandemic.

28

Blockchain

The marketplace finally gets blockchain; it's focused on efficiencies today, and will see wilder possibilities in the years ahead.

34

Edge Computing

Where it all comes together.





Artificial Intelligence/Machine Learning (AI/ML)

The adoption of AI/ML technologies was already under way when the pandemic hit, but since COVID-19 disrupted public health, the economy and pretty much every other aspect of how we live and work, organizations have significantly sped up their incorporation of machine learning algorithms.

“We’re seeing that particularly, but not exclusively, with security use cases,” says Ram Sriharsha, Splunk’s head of machine learning. For algorithms already in use, the pandemic has created challenges. Predictive retail algorithms falter when our behaviors change suddenly and significantly. As the [MIT Technology Review noted](#) in May, “Machine-learning models trained on normal human behavior are now finding that normal has changed, and some are no longer working as they should.”

In other words, online retailers’ recommendation engines weren’t quite ready back in March for everyone to suddenly care about nothing but toilet paper and hand sanitizer.

At this point, machine learning has mostly caught up with the changes caused by the pandemic and recession. And across industries, algorithms have been, if not commoditized, then democratized. The major cloud providers are offering the hardware and software to bring the power of machine learning to their customers. Those providers and other third-party vendors are delivering “AI as a service.” And, more importantly, the idea of artificial intelligence has taken hold in the corporate imagination.



Prediction

AI/ML will be held back by its own limitations — until it can learn on its own.

One thing holding back AI/ML adoption is the resource overhead, says Ram Sriharsha, Splunk’s head of machine learning.

“The problem with the traditional ML pattern, in which people spend a lot of time building and deploying models, is that it just doesn’t scale,” he says. “Organizations are evolving at a much faster rate, and the questions you’re asking your data are evolving. You can’t hire data science teams fast enough to keep up.”

The answer, he says, is to automate the learning in machine learning. “You not only have to automate the process of creating models and deploying them, you have to automate the process of learning and relearning.”

A challenge closely connected to the human-intensive process, he notes, is the fact that most machine learning models rely on well-structured, clearly labeled data to learn.

“You’re going to see increasing amounts of R&D energy trying to solve these two problems, which is how to make the algorithms learn with as few labels and as little human input as possible,” Sriharsha says. “The more I can throw ML at unstructured data and have the algorithm figure out how to extract what it needs from the data, the more powerful its contribution to the organization will be.”

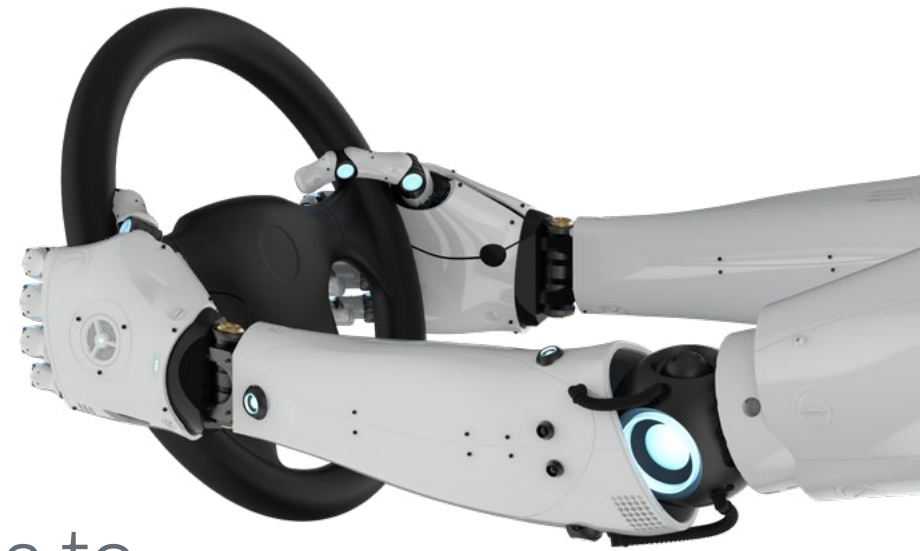
It’s a lot harder to get an algorithmic model to work with the shifting, unstructured sources of data that would drive better retail recommendations or supply chain refinements than it is to get a model to master structured board games like chess and go, but that’s what CIOs want. It’s definitely what our CIO wants.

“I’m keeping my eyes on self-learning systems,” says Splunk CIO Steve McMahon. “I want my process automation largely to be self-aware, so to speak, and learning so that it can identify the greatest opportunities.”



I’m keeping my eyes on self-learning systems.”

Steve McMahon, CIO, Splunk



Prediction

Defense against adversarial learning will improve in the next few years. Because it has to.

Last year, our [predictions report](#) warned of the potential threat of AI sabotage: You can poison the outcomes of AI-driven automation by poisoning the data it learns from. We gave the example of tricking an autonomous vehicle into misunderstanding a stop sign. In September, researchers found that a tiny sticker on an object the size of a fighter jet [could hide it from an AI](#) processing drone footage. The threat of data deception remains on the horizon, and a new area of research will have to rise to the challenge, because today's AI is as naive as a week-old puppy.

“Machine learning algorithms trust the data they learn from,” Ram Sriharsha says. “But what happens if people are trying to hack you? As an industry, we haven't thought carefully about how to learn in the presence of adversaries.”

He says that researchers will need to explore how to make their models robust against adversaries. And he says that now is the time to develop those techniques, because the potential power of such attacks will grow thanks to standard market forces.

“In time, there will not be hundreds of machine-learning startups selling hundreds of machine-learning platforms,” Sriharsha says. “There will be a few, or one.”

And just like the dominance of Microsoft's operating system gave hackers one big target, a small number of dominant AI platforms would draw all the attacks.

“Once that market consolidates around one platform that almost everybody is using, hackers are really incentivized to figure out how to break it,” he says. “With that kind of adversarial attention, we have to spend a lot of energy right now to build robust algorithms that can withstand attack.”

“

As an industry, we haven't thought carefully about how to learn in the presence of adversaries.”

Ram Sriharsha, Head of Machine Learning, Splunk

Strategy

Look beyond AI's buzzword heat to get real, meaningful value from AI/ML.

AI is often a black box, a vague promise, a hope for a Star Trek future. Certainly vendors are slapping “Now with AI!” on products like it's extra raisins in your Raisin Bran. And corporate customers are getting caught up in the ill-defined excitement.

“A lot of customers won't even think about using your product if it doesn't have AI built into it, or the potential for it to be integrated as soon as the initial use cases or outcomes are derived,” says John Sabino, Splunk's chief customer officer. “But a lot of the time when people ask for AI, they're just checking a box. They're not sure what it is, but they're afraid of being left behind.”

Simon Davies, vice president of Splunk in APAC, says that organizations in the Asia-Pacific region are already outgrowing the buzzword phase. “They've moved on from AI being something that you specifically think about to being a core part of any type of decision or technology,” he says. “Instead, the conversation is about ‘How can your platform assist us?’”

Delivering an AI-based product, that's a vendor's job. But how an organization uses AI to be more competitive or deliver better outcomes, that's a strategic consideration. Which is important for an organization to consider, Sabino adds. “You're looking to build relationships with providers who really understand how to leverage AI, and who really understand your business and use cases, because this is a strategic relationship. It's how a company in a competitive industry can leapfrog the competition.”



“

A lot of the time when people ask for AI, they're just checking a box.”

John Sabino, Chief Customer Officer,
Splunk

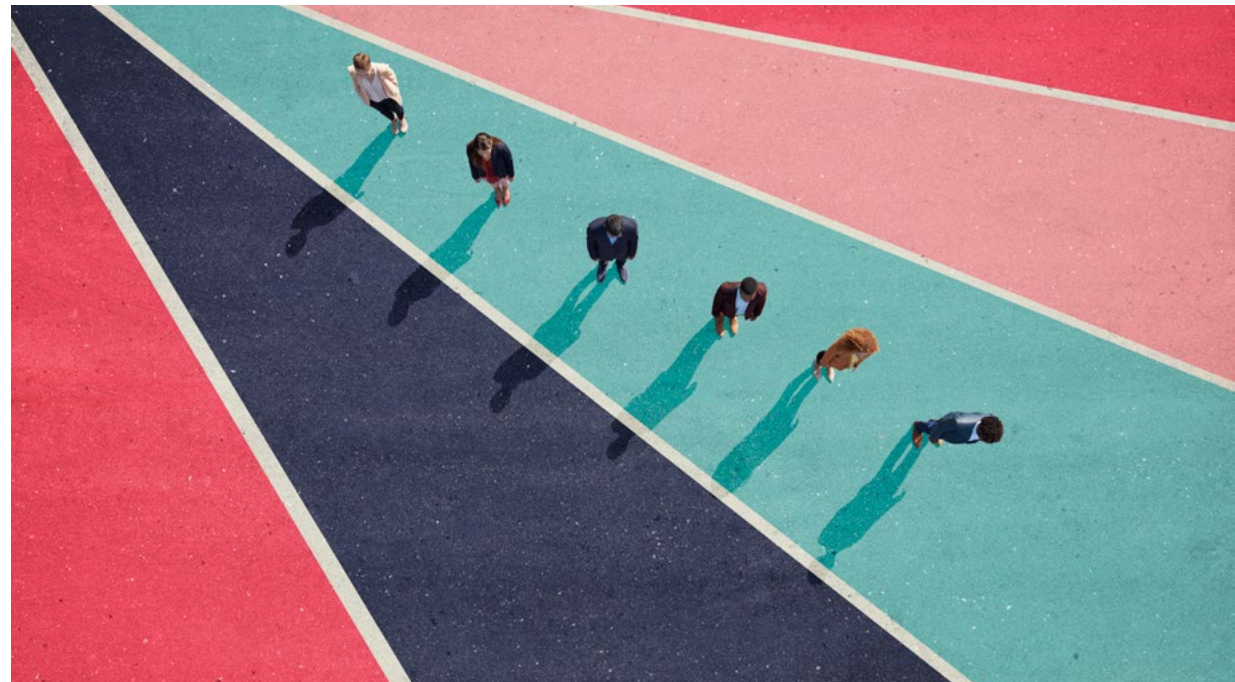
Prediction

Increased attention to the challenges of ML bias will build ethical responsibilities into engineers' job descriptions.

As we leave more decisions to algorithms, there will be increased attention to how they're making those decisions. The utopian vision of fair outcomes derived from dispassionate examination of objective data overlooks the matter of who selects the data sets and designs the algorithms themselves: flawed and inevitably biased human beings.

We've seen examples of bias already. Our predictions last year noted the adversarial learning example of jerks (technical term) teaching a crowdsourced chatbot to be racist. Algorithmic bias in the mortgage industry is [a well-known failing](#), and facial recognition [hit a wall amid multiple controversies](#) in 2020.

A July [paper in Royal Society Open Science](#) discussed the problem of "unethical optimization" and mathematical methods for detecting and eliminating such biases. Ram Sriharsha expects that pursuit to take on added importance in the next few years. But he says that the goal of completely eliminating bias is doomed to failure, so it has to be coupled with a goal to at least understand bias when it (inevitably) occurs.





“Take the classic example of loan applications being racially biased, even when it’s not an intention but an inadvertent result of the data you fed it,” Sriharsha says. “You can’t teach an algorithm, ‘Recognize race and don’t be a jerk about it.’ So explainability is going to be crucial.”

If we can understand how an algorithmic model produced an objectionable outcome, we can more quickly adjust it to produce better, fairer conclusions. Was the training data biased because it didn’t accurately reflect the full ethnic and gender makeup of society? Does a particular data set reflect societal biases that the model is then reinforcing? Are there other data sets that would contribute to a clearer picture of our society, and produce outcomes that better align with an organization’s or community’s values?

Explainability can help us fix errant models as they err, but the bigger question, Sriharsha says, is how we handle ethical issues up front, before the models are turned loose.

“It starts with education, evolving the course work we use to train future computer science engineers,” he says. “But more

than that, we’re already seeing partnerships designed to prevent these unintended biases. If computer scientists in the past have worked in isolation, now they’re working with ethicists, economists and sociologists to understand the societal implications of certain models.”

If we can’t teach every software engineer to be a sociologist, urban planner, community activist and moral philosopher, we can at least make sure the engineer has them all on speed dial.

These consultations, and the very act of considering wider ranges of consequence, mean that better, fairer models will take more time and consideration to build. Problem: “Let’s slow down and think this through” is not typical Silicon Valley cocktail conversation.

“‘Move fast and break things’ has been the mantra of Silicon Valley,” Sriharsha notes. “And I think that for Silicon Valley entrepreneurship to remain at the top, you have to move fast. Especially in a rapidly evolving field like AI. But we’ll probably have to learn to move fast and not break things.”

“

**Explainability
is going to
be crucial.”**

Ram Sriharsha, Head of Machine Learning, Splunk

Prediction

Machine learning will help speed the discovery of new medicines — in part by looking at previous “failures.”



This prediction looks at one of the fields where data obsessed us all in 2020: healthcare. The current crisis is finding new applications of artificial intelligence, with the healthcare sector seen as a major growth area. For instance, the U.S. Centers for Disease Control [developed a coronavirus chatbot](#) that uses AI to tell you whether you need to go to the hospital.

But a challenge in applying machine learning to healthcare is that it's a human-intensive field, in which a lot of what happens in terms of treatment and research moves, by necessity, at a human pace. And the smallish numbers involved in clinical trials or individual treatments don't really cry out for advanced algorithmic support, Sriharsha notes.

“Where I feel AI/ML make the most sense in medicine today is not in current trials, but in the thousands that have already occurred,” he says. “Clinical trials are extremely expensive. Companies spend billions of dollars on them, and many fail. There are vast troves of data on the structure of drugs that didn't move forward, but might have undiscovered promise.”

Some clinical trials are stopped not because a drug fails, he says, but because it wasn't effective enough in an envisioned scenario. But it's possible that those drugs, or new structural variations of them, could be more effective in other important scenarios. This existing, unused data could help researchers more quickly zero in on new, effective medicines.

“If you want to see the biggest impact of AI in healthcare and life sciences in the next 10 years,” Sriharsha says, “probably that is where it's going to happen.”

Prediction

Smarter AI will work wonders, and challenge human workers.

AI/ML, drawing insights from data and acting on it through automation, will transform just about every digital interaction in our lives. And at this point, nearly every interaction in our lives has a digital component. As the above trends come together — ethically sound algorithms that are robust against adversaries, and that can learn on their own — we'll see them act more like humans, making more consequential decisions and actions.

Humans, however, will still have work to do in a world so transformed by AI. Ram Sriharsha says that the human disruption will be substantial. Many current jobs will be eliminated or fundamentally altered, and many new jobs will be created. In both cases, a new workforce will be needed, and organizations should begin retraining now.

Companies should be training their workforces, Sriharsha says, noting that such training used to be more common. "Companies are going to realize that it's a value-add for them to train their employees now. In-house training on new methodologies, new techniques and so on, is going to be important."

A McKinsey article in May says that the COVID-19 pandemic has illustrated the effects of sudden change on a workforce, and

underscored the need for training as companies must match workers to rapidly evolving roles:

This dynamic is about more than remote working — or the role of automation and AI. It's about how leaders can reskill and upskill the workforce to deliver new business models in the post-pandemic era.

To meet this challenge, companies should craft a talent strategy that develops employees' critical digital and cognitive capabilities, their social and emotional skills, and their adaptability and resilience. Now is the time for companies to double down on their learning budgets and commit to reskilling. Developing this muscle will also strengthen companies for future disruptions.

And every organization's strategy coming out of 2020 is to build resilience to further disruptions.



“

In-house training on new methodologies and techniques is going to be important.”

Ram Sriharsha, Head of ML, Splunk



5G/Mobile

Pretty much since the invention of the smartphone, the focus of our digital lives has been the screen in our hands. For software developers, mobile first was a mantra for years until now it's so basic that it needn't be said. Splunk's chief technology officer, Tim Tully, notes that he can do 80% of his job on his smartphone (but adds that, since COVID-19 sequestered him at home, he's reverted to a heavy, powerful desktop machine for the first time in a decade).

The rise of the mobile device was significantly driven by the arrival of 4G networks that allowed mobile data streaming, which in turn powered the success of Netflix and YouTube, Uber and Lyft, all the social media networks and more.

(Before 4G, we still mostly used phones for talking. Now, we use our phones for data and bark instructions at an AI-enabled hockey puck that lives on our coffee table.)

5G is next on the horizon, but there are significant roadblocks that will slow its rollout. Before we consider the longer term, there are immediate mobile trends that were greatly accelerated by the pandemic. To name two: two-factor authentication and digital payments.

Prediction

Two-factor authentication will become the widespread norm, not an option.

The sudden wave of office workers logging in from home raises security concerns, because now there are more people logging in from outside your network who might not be who they said they are.

It's a challenge that should be keeping security experts and mobile software engineers awake at night. "The surface area of security has expanded because of COVID and mobile," says Splunk Head of Mobile Engineering Jesse Chor, "and I think it's definitely a concern."



Expect to see more adoption of two-factor authentication, whether by a phone app that asks, "Did you just try to log in?" or a biometric scan. Mick Baccio, a Splunk security advisor who has worked for the Dept. of Health and Human Services and the

White House, and was CISO for the Pete Buttigieg presidential campaign, agrees that 2FA is growing, and he sees hardware tokens as the likeliest solution. Hardware tokens include little USB security keys, or can be incorporated into mobile phones.

"A hardware token pretty much shuts down the risk of account takeover," Baccio notes. "Who doesn't want to shut that down? It's one of the biggest problems security teams face. Just shut it down and move more resources to your next biggest problem."

"The scary part now is that there are only two incumbent mobile operating systems," Chor says. "If Apple or Google screw up their operating system, think about how devastating a vulnerability could be. A simple bug around my PIN, say, could let you get into my work network, hack my email, use my ecommerce accounts, hit my bank. You can basically be me."

“

Hardware tokens include little USB security keys, or can be incorporated into mobile phones.”

Mick Baccio, Security Advisor, Splunk



“

I think COVID is going to really accelerate the adoption of biometric identification for security and payments.”

Jesse Chor, Head of Mobile Engineering, Splunk

And as for the form factor of the two-factor, Chor says he’s “a big fan of biometrics. I think COVID is going to really accelerate the adoption of biometric identification for security and payments.”

An important value of biometric logins, Chor says, is that it replaces the physical device. If the mobile phone is the interface for the biometric identification, but does not store biometric data, it’s useless to a thief. (See below for more on biometrics.)

“Just like we don’t send passwords over the air anymore, we send hashes, the devices will send a hash of your biometric data,” Chor says. The device becomes a conduit for information that is confirmed in the cloud. A lost or stolen phone is no security threat, as long as you still have your thumb on hand. “I think security is going to head that way, where the phone is just a conduit.”

Prediction

Contactless payment will rise faster than expected. (Like, really fast.)

COVID has driven adoption of digital payments, in terms of contactless payment apps such as Apple Pay, Google Pay, Samsung Pay, Square Cash, Venmo and PayPal One Touch. And after the pandemic recedes and we achieve a “new normal,” expect the convenience and no-touch benefits to continue to gain traction.

“People still go out and buy things, and when they do, they’re more often using contactless payments, which generally involves a phone,” Jesse Chor says. “And ideas like the digital wallet — Apple Pay — will make a lot more sense to a lot more people.”

In [an April report](#), Bain & Co. noted that disruptions to businesses from restaurants to retail to the entire travel industry meant that payment volumes were down, and payment services providers were suffering. But not so, the contactless payment industry. Bain observed signs of growth, including hiring at several of the payment providers, and predicted faster-than-anticipated adoption even after the pandemic ends and the economy recovers. Bain’s pre-COVID estimate was that 57% of transaction value would be done digitally by 2025. Since the pandemic, Bain has revised the prediction to 67%.

Simon Davies, vice president of Splunk in APAC, says COVID has pushed several emerging technologies to center stage in the Asia-Pacific region. “Before COVID, people were already doing things like blockchain, mobile technologies, etc. but weren’t

seen as being mainstream,” he says. “Now contactless payments have become much more prevalent — essentially the norm. That wouldn’t have happened quite as quickly if it weren’t for the pandemic.”



Prediction

Despite rising appetite, 5G won't hit in 2021. Expect rollout to be held up by hardware challenges at least into 2022.



Pre-COVID, the telecom industry was eager to roll out 5G, the next-generation telecommunications standard that promises greater bandwidth and lower latency, and a cell tower every eight feet or so. The technology could make our mobile devices more powerful, and fuel other emerging technologies, including virtual and augmented reality. These days, robust deployment of 5G looks more like a three-to-five-year proposition.

Tech industry news site EPS News [predicts slow and uneven 5G adoption](#): “Before the pandemic struck, the mobile industry was rushing to bring 5G networks and technologies to market. With declining revenue and a shrinking market, this shift is less likely to take place soon. Some carriers and manufacturers already delayed upcoming releases of 5G devices and services.”

Analysts at 451 Research also see the delays, but note that this is no time to sleep in, writing¹ in July, “5G will not move the needle in the enterprise in 2020, but planning must start now. ... A couple of years from now, 5G networks will support ultra-low latency and mission-critical communications that enable the applications and processes supporting the digital transformation of industries, some of which will see acceleration due to COVID-19.”

“5G’s problem is the chicken and the egg,” says Jesse Chor. “You need demand that’s realized in devices that can use 5G, and you need the carrier infrastructure. But who’s going to build one without the other?”

“I think the biggest obstacle for 5G is the physical limitations of the technology,” he says. Not only does the new standard require new cell towers, but 5G has a much shorter range than 4G, and is not great at penetrating walls, meaning we’ll need a lot more towers than earlier standards required. That’s expensive, and also, there’s a global pandemic.

“Especially with COVID, manufacturing has been slowed, and it’s really hard now to get fleets of people to install things, to even get the proper permits,” Chor says. “But despite the



¹ 451 Research, “[Update: 2020 Trends in Applied Infrastructure & DevOps](#),” July 2, 2020

real barriers to adoption right now, the demand for higher bandwidth is going up. Between work-from-home and the hunger for streaming entertainment, people are very bandwidth-hungry.”

Chor sees the tipping point coming from the device side: “I think phone manufacturers need to get on it. We’ve just seen it with Apple, which launched the 5G iPhone 12 in October. That could increase the total addressable market by 30% or so. Other carriers will follow, especially if they have assurances from carriers about when 5G coverage is coming.”

Another impediment to rollout is that the pandemic has shuttered key locations for initial rollout. Chor expects corporate and college campuses to work with carriers to roll out the infrastructure.

“Once offices broadly reopen, I think a lot of tech companies will start instituting 5G within their campuses or buildings and pump it up that way, because there’s a lot of productivity they can gain with connected devices with low latency,” Chor says. And if tech employees or college students and staff are enjoying high-speed bandwidth as they work, they’ll drive demand where they live.

Look for initial networks to roll out in Asia, he adds. “China is already rolling it out in a lot of places. I was there just prior to COVID, and I saw the towers popping up everywhere,” he says. “And developing economies, in Asia and elsewhere, have an advantage in terms of lacking legacy infrastructure. It’s just a different discussion when you’re starting from near-zero, versus upgrading from an extensive legacy investment.”

The World Economic Forum lists 5G as one of [10 emerging technologies to watch](#) in the wake of COVID-19, from distance learning and telehealth to drone deliveries and contactless payments, and notes that nearly every other technology on the list depends upon stable, affordable, high-speed internet. But while acknowledging the power of the technology, it also notes that “the adoption of 5G will increase the cost of compatible devices and the cost of data plans. Addressing these issues to ensure inclusive access to the internet will continue to be a challenge as the 5G network expands globally.”

Never Mind the 5G, Here’s the WiFi 6

Jesse Chor says that a lot of the benefits we want from 5G will be delivered first by WiFi 6, an available but not-yet-widespread technology.

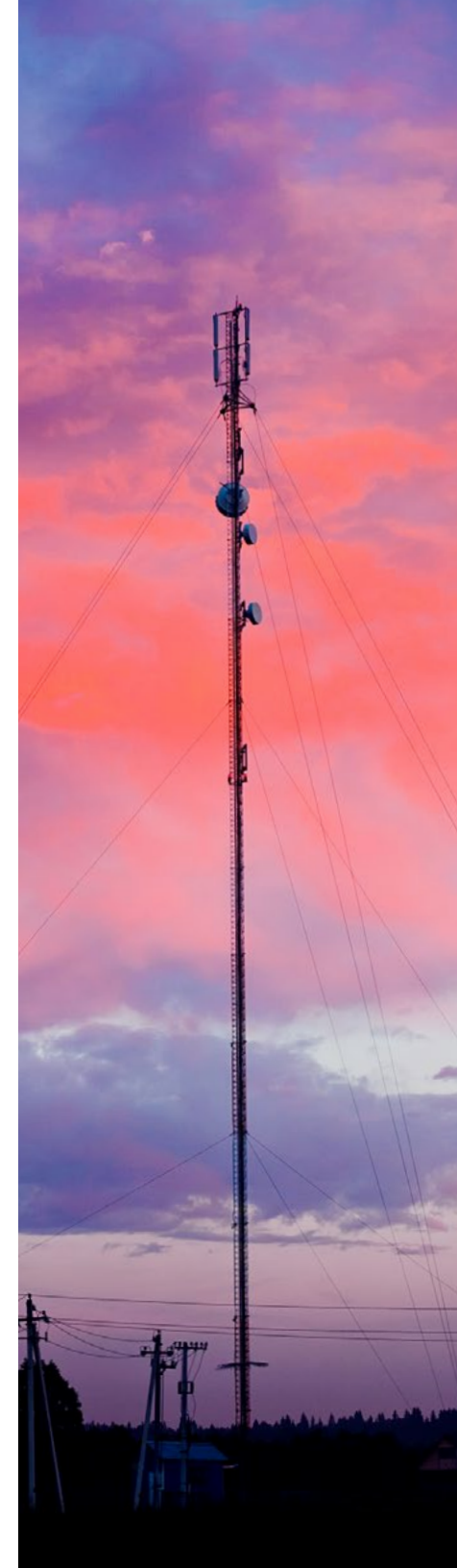
“WiFi 6 is at least 10 times faster than regular WiFi, so it will bring the bandwidth and low latency we talk about with 5G,” he says. “If you’re a business, you want to roll it out fast, and you can have it today — you just need connected devices that can use it.”

Many new devices, such as iPads and iPhones, are ready for WiFi 6. Schools and corporate campuses can benefit from the technology, and it will be a major part of the bandwidth equation that includes 5G.

“WiFi 6 is great for internal devices you control, manage and own. 5G would be for outside devices that you don’t necessarily control and own, but you want them to be connected,” he says.

A shopping mall would want 5G available for shoppers, for instance, but might use WiFi 6 internally for retailers and management.

“Just like 5G, WiFi 6 will soon be ubiquitous,” he says. In a few years, pretty much any WiFi enabled device you buy will be WiFi 6.”





Chor notes that 5G promises much more than just higher bandwidth. Both 3G and 4G networks ushered in new services, and whole new industries, from Lyft to Door Dash to the kaleidoscope of digital streaming channels. Telecommunications bandwidth unlocks tremendous economic power.

“And I’m sure that 5G will do the same, with greater bandwidth and lower latency unlocking new things we didn’t think of,” he says. “If you look at the market caps of internet companies, they exploded every time another telecom standard was unlocked.”

Among the new possibilities to be unlocked: new mobile form factors. **(Prediction: In the future, we’re all Tony Stark.)** “The future of mobile is hands-free, wearable devices,” Chor says.

“Connected glasses, like a phone on your face, totally makes sense, especially given the rise of AR/VR.”

It will take a few years, say five to 10, and it’s not just about use cases.

“You need advancement in material sciences, battery technology, a lot of stuff that needs to catch up,” Chor says. “But once we have them, who would not want glasses that do everything? Then you’re like Iron Man. It will be a while before we get there, but it’s definitely coming.”

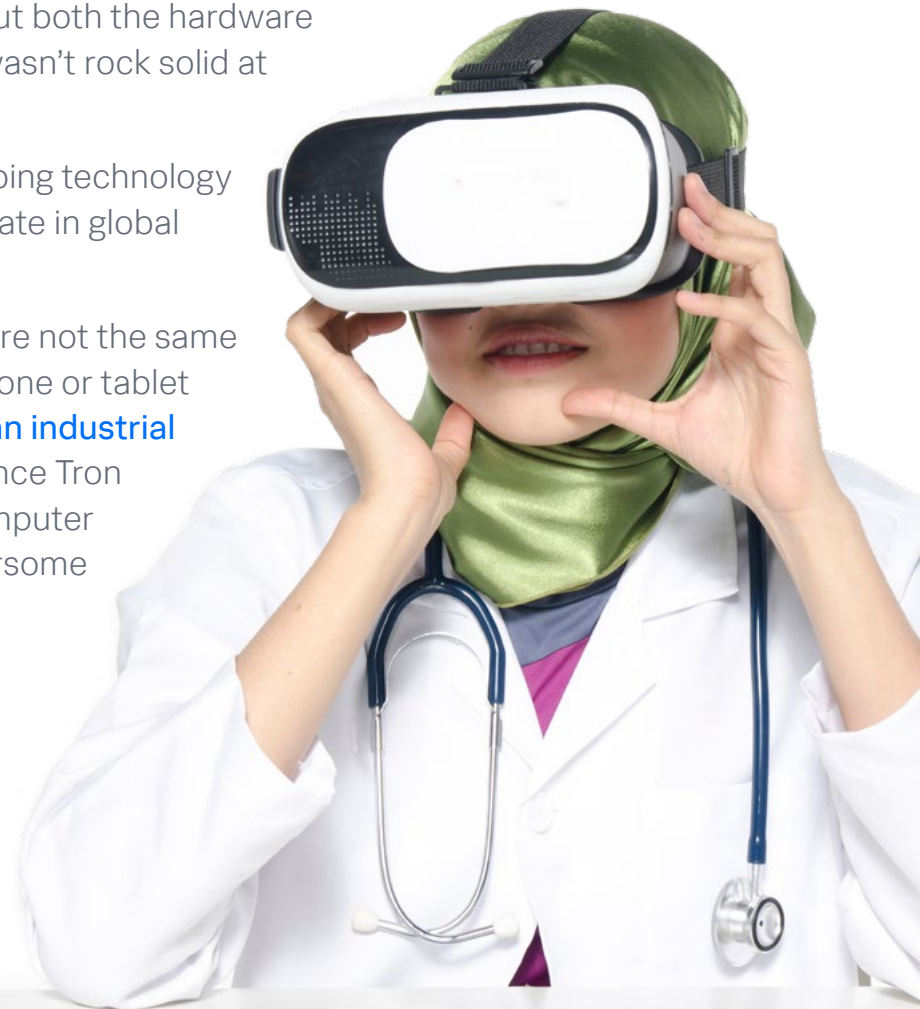
AR/VR

Speaking of augmented and virtual reality (AR/VR): If ever there was a time when people might yearn to retreat into a digital reality, 2020 was surely that time. But both the hardware and the software were still finding their footing, and like anything that wasn't rock solid at the start of the year, COVID-19 presented a setback.

But the setback will be temporary. In July, IDC took stock of the developing technology and [estimated that](#) from 2019 to 2024, the compound annual growth rate in global AR/VR spending would be 76.9% worldwide, reaching \$136.9 billion.²

AR and VR are naturally lumped together in many discussions, but they're not the same thing. Augmented reality overlays data on live video, often through a phone or tablet camera. (Think Pokémon Go, or watch this Splunk video [demonstrate an industrial repair scenario](#).) Virtual reality is what we've been expecting at least since Tron hit movie theaters in 1982: Interactive worlds created entirely from computer graphics. VR requires headsets, currently on the expensive and cumbersome side, to create true immersion.

Virtual and augmented reality improve collaboration and access to knowledge. As a greater percentage of our retail activity and business communication move online, there will be demand for more immersive experiences. Additionally, industries not nearly as well-established as ecommerce are making massive shifts to digital platforms: Remote learning and telemedicine are entering many school districts, universities and medical practices for the first time.

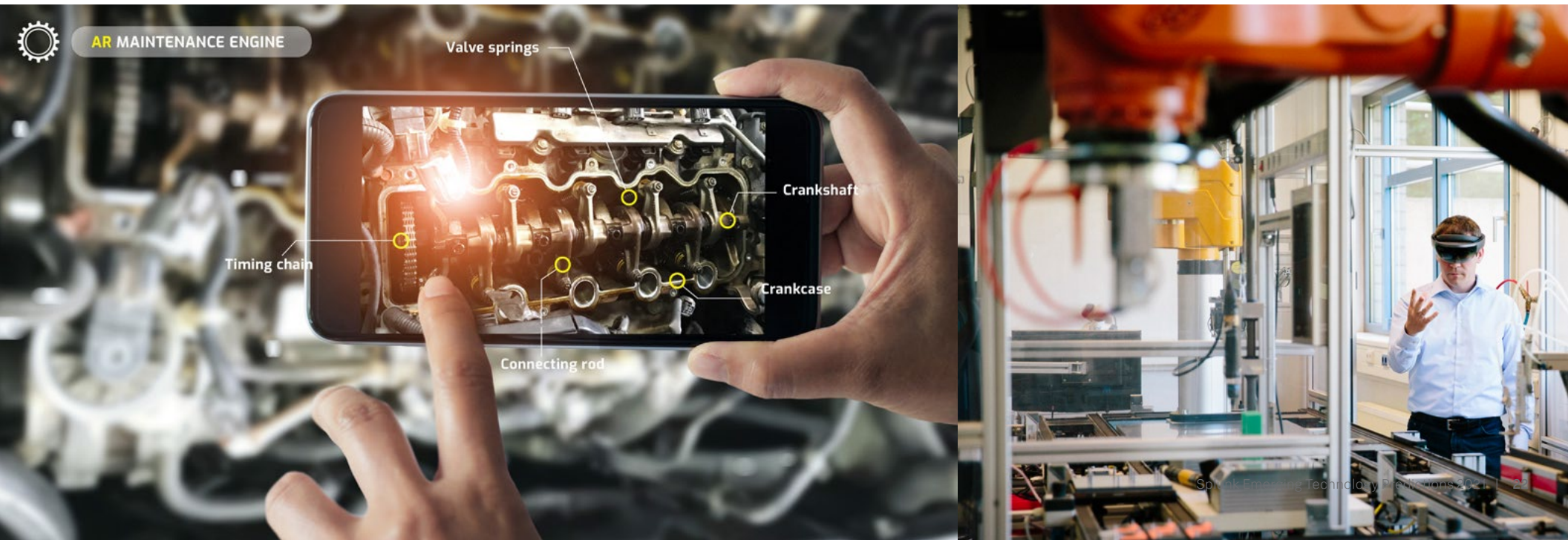


New medical applications are already appearing. Doctors at George Washington University Hospital have been using VR to [uncover lung damage from COVID-19](#) since March.

“Telemedicine has certainly accelerated, with medical practices working in partnership with insurance providers,” says Simon Davies, vice president of Splunk in the Asia-Pacific region.

“One of the most interesting VR advancements I’m seeing is in data visualization and event management. The ability to effectively consume data is critical to timeliness. Organizations are using virtual reality to consume 20 to 30 dashboards, coupling human intelligence with machine intelligence to distill meaningful insights in real time.”

An [AR/VR survey of venture capitalists](#), released in March by law firm Perkins Coie, predicted that AR will continue to outpace VR, in part because mobile devices are already everywhere, and they’re better suited to AR overlays than full-immersion VR.



According to the World Economic Forum

According to the [World Economic Forum](#), AR does three things very well: visualization, annotation and storytelling — each of which can be very useful to workplaces, schools and institutions during and after the pandemic. Further, AR/VR experiences could help mitigate the isolating nature of lockdowns and lingering effects on, for instance, business and leisure travel.

The WEF links to news stories about the following examples:

- Virtual [job training](#) for young adults with autism
- AR [visualization of air pollution](#) worldwide
- “All 185 first-year medical students at Case Western Reserve University (CWRU) are [using HoloLens and HoloAnatomy, an award-winning AR app by CWRU and Cleveland Clinic](#), to learn from their own homes.”
- “[London’s National Theatre](#) is using AR to help make its performances more accessible for people who are deaf and hard of hearing.”
- [Microsoft’s Project Tokyo](#) helps visually impaired people to “see” using AR and AI and the HoloLens. The device can detect the location of people in the user’s environment, and recognize faces, relaying the information to the wearer via audio.



Prediction

AR/VR's breakthrough application will be immersive collaborative communication.



"I think of it as Zoom on steroids," Jesse Chor says. The toll remote work takes on collaborative communication means we'll want more immersive solutions that make interaction easier and more effective. "Not like a Zoom call today, where everyone talks over each other: 'Oh, sorry, you go ahead.' 'No, you go.'"

5G bandwidth and more powerful laptops will reduce latency problems and provide opportunity for new ways to collaborate, to share visual presentations, on-the-fly notes and more. Post-COVID, more workers are going to continue to work remotely, and tech companies have long believed that innovation arises from the live, daily mix of coworkers, and that the hallway and kitchen are as important, if not moreso, than designated conference rooms.

"So the question becomes, how do remote teams effectively replace actually being in front of each other? We're going to want virtual collaboration to be as close to the real thing as possible," Chor says. "I think the next iterations of video conferencing will incorporate AR and VR technology."



Prediction

We'll see a breakout hit in consumer/entertainment VR by early 2022, or virtual reality will drop off the radar.

Any consumer entertainment model requires a combination of hardware and content. The hardware element, Jesse Chor says, is there. But that isn't enough.

"Virtual reality is at a very, very interesting spot," Chor says. "It's not new — it has been around forever, and it's at a very vulnerable time now."

He notes that the success of entertainment technology is driven by content. A new device might be an obsession only for the hardcore hobbyist until a viral hit drives mainstream adoption. Chor says VR's hardware is there. The Oculus Quest, released in 2019 and sold out everywhere in 2020, is the Nintendo Switch of VR: A cheap, attractive device to drive adoption. Now we need the critical-mass software, the breakthrough game.

"It's do-or-die; either that breakthrough comes in 2021, early '22, or it'll be another 10 years before it gets visited again."

So VR needs its "Legend of Zelda: Breath of the Wild" or "Super Mario Odyssey." Otherwise, Chor says, companies will lose patience and stop investing in the technology. He's optimistic that a hit will emerge to capture interest. "Because with COVID, there's an audience for anything that's driving immersion at home."

And there's only so much bread we can bake.



Biometrics

Biometrics was already taking off before the pandemic. Apple devices had been asking for your thumbprint for years, and the newest iPhones really want to be unlocked by your face.

In addition to biological attributes such as thumbprint, voice and facial scans, biometrics includes behavioral measurements, and that goes back centuries: Verifying identity by comparing signatures is not exactly cutting edge. Similarly, what time you regularly log into a system, your typing style, how you walk — all are being used today to identify individuals.

UK schools have used fingerprinting or face scanning for access control, recording attendance, buying lunch, checking out library books. One school, University Technical College, Leeds, has had to [abandon its fingerprint sensor access controls](#) due to the coronavirus pandemic, replacing them with proximity card sensors, facial recognition and, for health purposes, a thermal camera. (On the other hand, a French court [blocked high schools from using facial recognition](#).)

Japan's Seven Bank was [testing ATMs that use facial recognition](#) in late 2019, and in 2020 trials were under way to [use facial recognition for cashierless checkouts](#) in Japanese 7-Eleven stores.



Prediction

Biometrics will move up in the world. And into the cloud.

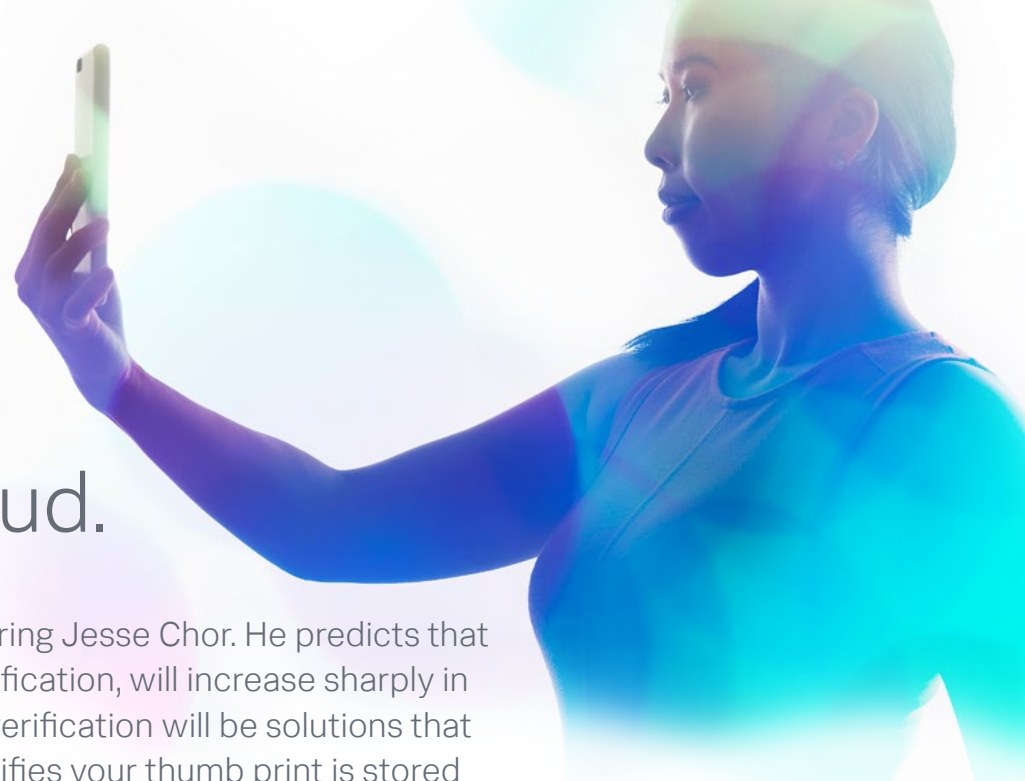
“I’m a big fan of biometrics,” says Splunk Head of Mobile Engineering Jesse Chor. He predicts that biometric adoption, like (and as an example of) two-factor identification, will increase sharply in the Data Age. And he predicts that a key evolution in biometric verification will be solutions that don’t store your data on your device. Because if the app that verifies your thumb print is stored on your phone, bad guys need only hack your phone (which may be preferable to hacking your thumb, actually).

“The data won’t be stored on your phone,” Chor says. “It’s going to live in the cloud. The phone just sends the thumbprint it receives to another entity, and it’s up to that entity to decide, is this the right one? And your device won’t send your actual biometric data, but a hash, just like we do with passwords now.”

While biometric identification is a great way to minimize security breaches that depend on account or identity theft, the field is highly controversial, particularly around facial recognition. In September, the city of Portland, Oregon, banned use of facial recognition by government or businesses, a more stringent ban than bans on government agency usage already enacted by San Francisco, Oakland and Boston. Controversies around the technology have led to calls for greater regulation. A 2019 profile of one facial recognition provider’s practices ran in

The New York Times under the headline, “[The Secretive Company That Might End Privacy as We Know It](#),” and use of facial recognition and other biometric data collection (including DNA samples) as part of China’s [oppression of its Uighur minority](#) generated international condemnation.

Chor notes that legal and ethical guidelines will have to be worked out on the national and international level, and permissible use of biometric data may vary. (A September article in the MIT Technology Review [discusses such efforts](#).) But biometric technologies are too important and useful to kill. Whether we’re doing our jobs or managing our personal finances, the most important aspects of our lives are digital, and increasingly under threat of cyberattack.





Blockchain

The enterprise blockchain ecosystem has rapidly matured, and Splunk’s head of blockchain, Nate McKerverey, measures that in a very hands-on way.

“2020 has been the first year where I have not had to explain blockchain once to organizations,” he says. “They come in understanding it to a high-enough degree that we can show them what problems we’re solving, which is a wonderful thing. Looking back, 2018 was the year of ‘what is blockchain’ conversations. 2019 was full of ‘nobody needs blockchain’ discussion, and in 2020 we’ve reached, ‘Okay, I understand where it’s useful and valuable. Now, how can you help me be successful?’”

The 2021 conversation, he predicts, will be, “What is your blockchain strategy?”

“In two years,” he says, “some companies will realize that if they don’t have a blockchain strategy, they’ll be less competitive because they won’t be as efficient as their competitors.”

With that in mind, he provided a rapid-fire series of predictions around digital ledger technologies.

Prediction

COVID will accelerate blockchain adoption.

McKervey says that when the pandemic lockdowns began, he assumed that organizations would conserve resources and focus on core technology investments.

“I even told our leadership that I expected emerging technologies to be the first ones to be cut,” he says. But by autumn, not one of the more than 100 organizations he was talking to had suspended their blockchain initiatives. “In fact, we’ve had more inbound interest.”

An [August article at CIODive.com](#) backs him up. The publication spoke to experts who also had expected 2020 to be a bad year for blockchain, but were seeing continued interest, particularly in supply chain and other use cases where value is obvious. As Congress [continues to urge](#) the utilization of blockchain technology, we expect no slow down in interest.



A grid of wooden blocks, with one blue block standing out in the foreground. The blocks are arranged in a pattern that recedes into the background, creating a sense of depth. The blue block is positioned in the lower-left area of the grid, contrasting with the natural wood color of the other blocks.

Prediction

Successful blockchain implementations will focus on efficiencies.

As blockchain emerges from that 2019 trough of disillusionment, McKerverey expects adoption to accelerate in the pandemic/post-pandemic era. The degree to which the pandemic interrupted supply chains will particularly drive interest in blockchain technologies, which can improve visibility into the source of goods, and where they are at any time, and how overlapping supply chains interact.

“If my supply chain is 10 times more efficient than yours, your vendors aren’t going to want to work within your supply chain,” McKerverey says. “We’re seeing organizations decrease paperwork and manual processes by 97%. If their competition doesn’t do the same, they won’t be able to compete.”

The financial services industry was our big pick last year for blockchain strides. That sector continues to be a strong area of blockchain interest, with particular interest in central bank digital currencies (CBDCs), but expect supply chain applications to see the greatest near-term improvements, largely driven by the pandemic.



Prediction

In the short term, organizations will struggle to turn blockchain test projects into full-scale successes.

Blockchain initiatives still start with small proof-of-concept projects that prove value on a small scale, and success drives full implementation ... which is where the trouble often starts.

“The move to production is where the real challenge comes,” McKervey says. “When you do a proof of concept, you just have to show that it functions. When you move to production, it needs to be secure, stable and to perform at scale.”

The trouble, he says, is often a lack of observability. Problems in production have to be diagnosed. You need visibility into data from the digital ledger itself, your infrastructure, your applications. Often organizations stitch together a mix of individual tools to analyze and visualize each type of data. And they may have to write proprietary code to analyze the ledger data. It reminds him of the days before Splunk, when sysadmins would write scripts to awk and grep through log files.

“The problem is, then they have this code that they have to support and scale and modify as the ledgers get upgraded and modified, and that’s a huge hurdle we’ve worked with customers on,” he says. As a result, he expects to see vendors respond with more interoperative monitoring solutions, or, as Splunk provides, cohesive observability solutions that combine logs, metrics, traces and ledger data.

Prediction

While blockchain consortiums are a leading model, they'll be hampered by coordination and visibility challenges.

A lot of enterprise blockchain experience right now is through consortiums, in which companies in a certain industry or supply chain collaborate via a digital ledger. The consortium operator, which is not a stakeholder in the partnership itself, may be coordinating the solution, but lacks visibility, as do the members of the consortium. And visibility can be a challenge when some data may be proprietary to a specific participant, and when some of the participants may be rivals.

Among the biggest challenges, McKervey says, is getting to a decentralized state. Often the consortium starts with centralized control by the operator, with the goal of decentralizing the control. This can only be achieved when sufficient visibility across the consortium is obtained. Sufficient visibility is a difficult

target, since the members use different infrastructure, cloud providers and monitoring solutions. This parallels the challenge individual organizations find as they power up from proof of concept to full production, and is another force that will drive a more cohesive approach to observability.



Prediction

In about three years, blockchain gets really exciting.

The short term for blockchain is in security and efficiency, but looking a few years out, new business-transformative blockchain-based solutions will emerge and most won't even know blockchain is part of the solution. Secure voting, tracking of political donations, tracking of disease outbreaks and securing medical supply chains are all happening now, but business-transformative use cases are hard to predict. (Did the taxi industry see the Uber model coming? Exactly.) Decentralized identity will be an enabler of these new business models.

Decentralized identity is especially interesting, McKervey says. Individuals and organizations use many globally unique identifiers, such as: communications addresses (email address, user name, etc.), ID number (passport, driver license, tax ID), product identifiers (serial numbers, barcodes, RFIDs). The vast majority of these globally unique identifiers are not under our control, and may be open to fraudulent use: identity theft. The idea of a means of identification that is secure, global and not controlled by a central body has many appeals and applications.

“That stuff is a ways out, though,” McKervey says. “Right now we’re still seeing blockchain develop as a strategic technology for businesses and the public sector. We’re at the stage where blockchain is beginning to increase efficiencies, but most CIOs aren’t yet seeing blockchain as a top initiative.”

When will they get the message? “When leaders see their business model disrupted,” he says, “and by then it may be too late for their organization.”





Edge Computing

Edge computing is an inevitable progression. We're already managing a great deal of the data and interactions of our smartphones and laptops via the cloud, with software that's delivered as a service rather than installed on the endpoint. And we're constantly digitizing more stuff. We're putting sensors into warehouses, onto trucks and freight trains, in industrial machinery.

The result is that we're measuring things and making decisions about devices on the edges of our networks by shipping the data to a central, probably cloud-based datacenter, doing the analytics, and sending back automated instructions. All that back and forth takes time, and latency is a problem.

(That's right, a quarter-century ago, we were all on dialup, and now we're complaining about the speed of light. Sounds funny, but half-second latency won't be a laugh when your car is driving itself through rush-hour traffic.)

Our main prediction about edge computing (in which analytics and automation do all the "thinking," and take action, at the network periphery rather than reporting back to the mother ship) is that it's here, it's necessary, and it's getting better. What's interesting is the way in which the edge provides a perfect arena for every emerging technology we've been discussing.

Prediction

Emerging technologies come together at the edge.

John Sabino says that the real power in emerging technologies is not any one of them, but the combinations. “I think the keys are AI/ML and automation, and when you add them to IoT, edge computing and 5G, you can transform entire industries — logistics, manufacturing, healthcare, energy.”

Tim Tully sees the same effect, and notes that smarter AI, and more powerful hardware and robust connectivity will be transformative for applications of edge computing. “More and more is happening at the edge, because we can do more and more computation as the hardware and software gets more sophisticated,” Tully says. “Local processing reduces the latency of moving the data to the cloud to process, and you get the same results.”

“When I was at GE, we had this concept of an industrial internet that is only gaining steam,” Sabino adds. “You can see it on brewery lines right now. You might have four master brewers that might operate a multimillion-gallon line.”

Progress. We’ll drink to that.



Future Steaks, Working Assumptions

We asked Jesse Chor for his most far-out, decade-plus prediction, and he gave us a pretty wild vision. Today's 3D printers can handle machine parts and numerous consumer goods. Chor says that's just the foot in the door for digital printing.

"I look at COVID-19 as an example," he says. "Without a doubt, it's going to accelerate vaccine production and testing, but I'm also looking ahead to a world where we digitally print vaccines, we digitally print medicine. It's going to be world-changing, and even that's just a start. Imagine digitally printing food."

Sounds amazing, though if we're predicting Star Trek futures, we're more excited about visiting a VR holodeck than eating a filet mignon printed by a food replicator. To ground us back in the present, we asked Tim Tully for his most immediate, prosaic prediction.

"We're all going to have to update our home networks," he says. So many people are working from home, perhaps while a working spouse and distance-learning kids compete for bandwidth. And even if that's not you, you're probably consuming a lot more digital entertainment at home during the COVID era, in place of a more on-the-go social life.

"If you have three kids in the house on Zoom doing school plus two working parents, that's probably 5x the amount of traffic you've ever had to have before," he says. "I've helped a number of our execs upgrade to enterprise-level or prosumer tech."

So bring on the WiFi 6, and get on the Oculus Quest waiting list. The future is now.



Contributors



Jesse Chor

Jesse is head of mobile engineering at Splunk. Before that, he was director of software development engineering at Yahoo, which had acquired Sparq, a mobile marketing startup he founded and led as CEO.



Steve McMahon

Splunk CIO Steve McMahon has 20+ years in the high-tech industry, having previously held transformative roles at Cisco, IBM and several startups. At Splunk, he has led the Business Transformation, Global Customer Support and Cloud Operations and Engineering organizations.



Simon Davies

Simon is vice president of everything Splunk in the Asia-Pacific region. Before that, he was Microsoft's vice president of business applications for Asia Pacific and Japan, and held leadership roles at Salesforce, Oracle and Citibank.



John Sabino

John is Splunk's customer success officer, which means he and his team help customers adopt industry best practices and Splunk technology to drive success through data. John was also senior vice president of commercial operations for both GE Capital and NBC Universal.



Ammar Marafa

Ammar is Splunk's senior vice president and chief strategy officer. He joined in 2015 as vice president of business operations, and has held several key leadership roles since. Back in the day, he led corporate development and strategy at Cisco, held product roles at Dell, and started his career as a growth-focused consultant with Bain & Co.



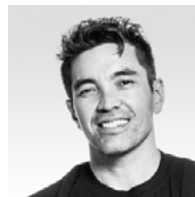
Ram Sriharsha

Ram is the head of machine learning at Splunk, leading the application of state-of-the-art ML techniques, including the ML that powers Splunk. Previously, he led engineering and product development for genomics at Databricks and started the R&D center for Apache Spark in Amsterdam. He was a principal scientist at Yahoo Research, and he holds a PhD in theoretical physics from the University of Maryland.



Nate McKervey

Nate is the head of blockchain at Splunk; he has been a data junkie since he discovered Splunk in 2005, as an engineer at Harris Corporation. Now he's on a mission of next level business transformation using distributed ledgers for multiparty systems.



Tim Tully

Tim is our chief technology officer, responsible for Splunk's Products and Technology organization. Before that, he spent 14 years at Yahoo as chief data architect, VP of engineering and more. He's big on the intersection of data, design and mobile, and advises entrepreneurs, startups and universities.

Get the 2021 predictions Executive Report
and our focused editions on Data Security
and IT Operations for more insights.

[Learn More](#)

Splunk, Splunk>, Data-to-Everything, D2E and Turn Data Into Doing are trademarks and registered trademarks of Splunk Inc. in the United States and other countries. All other brand names, product names or trademarks belong to their respective owners. © 2020 Splunk Inc. All rights reserved.

20-15669-SPLK-Predictions 2021-Emerging Tech-113

splunk>

