TQ 5G & Edge Computing

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TQ 5G & Edge Computing Preshow

Hello, it's Paul here, and welcome to the 5G and Edge computing TQ topic. Imagine a future powered by 5G and Edge compute power devices that can do almost unimaginable things. Cars that drive themselves and never get in accidents, future homes that don't need to be asked for something, but think for you, farms were non line-of-sight-autonomous drones can identify weeds and deliver a precise shot of pesticide versus a blanket application to an entire field, medical devices that not only monitor your health, but tell you when to call a doctor and what medication to take in an emergency, even extend the expertise of a doctor through remote surgery, manufacturing plants that use video analytics to prevent worker injury. Some of these ideas are very close to fruition, and many are things that Accenture is working on. Some are a little ways off, but what all these ideas have in common is that they require a combination of 5G technology and Edge computing to become a reality. And that's the focus of today's conversation. How do we help enable these transformations? The answer? 5G and Edge computing. The combinatorial power of 5G and Edge computing is a massive opportunity for Accenture, for our clients, and for all of us to use technology to better the world. Now 5G is the next generation of digital cellular networks that fundamentally change the role that mobile technology can play for consumers, businesses, the economy, and society. Now the previous Gs were 1G that introduced mobile voice, 2G that brought text messages, 3G that created mobile data, and 4G, which unlocked the mobile internet. So now we're at 5G, which continues to enable the freedom of mobility without wires, but now offers fiber-like speeds, a near

instant responsiveness and the ability to connect millions of devices per square kilometer. It's a disruptive innovation platform that allows businesses to drive operational efficiencies, invent new products and services, redefine value chains, and you create incredible future opportunities such as the ones I just described. Edge computing is computing or processing that happens at or near the source of the data instead of at a central data center far away. By processing data closer to the source of where it's collected, Edge computing reduces data costs and network traffic and allows end devices and sensors to be cheaper and also more energy and battery efficient. All of this leads to cost-effective solutions that can be scaled and enhanced quickly. Together, 5G and Edge computing can lead to almost unimaginable innovation. While Edge provides new and faster experiences, 5G provides the connectivity to grow and expand those new experiences. 5G's ability to support trillions of separate devices will expand edge's reach. 5G speed and low latency will make the Edge so much faster that data processing will seem to happen in near real time. 5G is the fuel that makes the Edge smarter and more adaptive, and 5G working with Edge opens up almost limitless possibility. Next up in your TQ learning journey, Simon explains more about what we mean by 5G and Edge computing. Then join me back at the TQ HQ with Sarah Dugan and several 5G and Edge leaders to talk about how Accenture is playing a leading role in shaping this new future with our clients. TQ and you, just one of the ways we're powering change. Happy learning!

Edge Computing & 5G: Executive Briefing

Introduction

Most of the technologies I talk about like machine learning, software development, cloud computing, automation, they all sit firmly in the business world, but 5G? Now this is different. This is general. This is widespread. I mean, if I took a month off trying to avoid any mention of technology, refused all business calls, just stayed at home and parked myself in front of a TV, I will still hear about 5G. 5G, 5G, 5G. It's incredible! Faster downloads, faster streaming, faster everything! All the cool kids have 5G. Why don't you have 5G yet? What's wrong with you? And if there's one message we get all the time, it's 5G is faster and faster streaming, faster downloads. And it's very easy to think, so what? I mean, okay, faster is nice, but is that really such a big deal? Does it matter that much if I could now download an episode of Game of Thrones in 8 seconds instead of 108 seconds? And no, for most people, most of the time, that wouldn't matter that much. But the 5G commercials talk about streaming and download speed because it's easy to understand. We've all had slow downloads. We've all had buffering in conference calls. We've all seen video that downgrades to low quality. And yes, it'll be nice when that's not a thing anymore. But we need to move beyond this simplistic view that 5G is just about faster downloads because that's a dead end. It implies that all we're going to do with 5G is, well, exactly the

same things we were doing before, just quicker, and that's not the right way to look at this. Because what has always been true with any speed improvements in technology is they enable new kinds of business, new use cases, new applications, things we just couldn't do before now become possible. As a pre-5G example, think about a company like Netflix or Spotify or Pluralsight that rely on streaming video or audio over the internet. Now these companies didn't invent the technology to stream video or audio. We've known how to do that for years, but back in, say, the late 1990s, you couldn't build a business on it because most people just didn't have a fast enough connection. Only when a certain level of internet speed became the norm did these kinds of business models suddenly become viable and then very quickly disrupted or completely decimated the equivalent existing businesses that hadn't been thinking about this. And 5G will accelerate this, not just in media, not only for brand-new businesses, but they're going to lead to new projects, new applications, new use cases, changed expectations, and that's what this course is about and what we're going to focus on here. So unlike a lot of other 5G introductions, here I am not just going to throw a bunch of numbers at you. Yes, I could show you lots of speed tests and say things like 5G now allows up to 1000 Mbps. But, would you really have reacted any differently if I'd said 900 Mbps or 1100 Mbps? Probably not. And likewise, I don't plan to get needlessly deep into the specifics of the 5G hardware and talk at you as if tomorrow you're going to be climbing up a cell tower to fix the antennas. Well, I am going to talk about how this actually works. We'll cover the most important technologies here. We'll go over terms like mmWave, massive MIMO, platooning, and beamforming, but only in the sense of how these things help, what they'll allow us to do now that we couldn't do before. But I haven't mentioned Edge computing yet. And this executive briefing is entitled 5G & Edge Computing. And yes, these are two different subjects, but they're so complimentary it's worth talking about them together. So I'm going to focus on 5G for the first part of this course, and then we'll see how Edge computing is such a natural fit.

Background And Generations

I remember having a 3G phone, and then I had a 4G phone, and now apparently it's 5G this and 5G that. It seems like there's a new G every couple of years. Why don't I just wait a little longer for 6G? Okay, will there be a 6G? Oh yes, but not any time soon. You see, it might seem like it hasn't taken very long to go from 3G wireless communications to 4G to 5G. These terms may all seem quite recent in your mind, but it's been about 10 years between each one, and I'll say that again, it's 10 years between each generation, and that's what the G means here. So we're currently in the early years of the fifth generation of wireless communication technology. And each generation takes several years to become broadly available as they require both new devices, new phones, new tablets, and lots of other things and upgrading all the network infrastructure and the cell towers with next generation hardware. But I'm recording this in the middle of 2021, and we're still in the early years of the rollout from 4G to 5G, and 4G is still much more widely available. And yes, how far along depends on the country that you're in and the provider you use, but worldwide, 5G is still sporadic. You can find good 5G support in some cities, but as soon as you leave that city, you might get nothing at all. But if I go back 10 years to 2011, we were in the equivalent stages of the rollout from 3G to 4G. I go back another 10 years to 2001, that's when the first

commercial 3G networks were starting to become available. It's 10 years before that, 1991, when the second generation of cell networks began and back another 10 years to the early 1980s, the first generation of cellular. Now we didn't call it 1G back then because we didn't have any other generations we needed to compare it to. Now the reason it often doesn't feel like it takes 10 years is because each generation has to keep working for a long time, let's say, 20 years or more. They have to run alongside each other for many years. The networks need to support older generation devices, and the devices themselves need to connect to older networks when newer ones aren't available. So I have a recent phone here that has the components, the radio circuitry to connect to 5G networks, but it also contains the circuitry to connect to 4G, and 3G, and even 2G networks. So if I was driving on a cross-country trip, I may well see 3G displayed in some areas, even though 3G first started rolling out 20 years ago. There will be a 6G, but if it follows this pattern, we might see it around 2031, at which point, 5G will still be the most available, most widespread, and be perfectly viable until 2041. And to be honest, the timeframe is probably longer than that because this current rollout to 5G is taking more time than any of the previous generations, and there's good reasons for this. As we'll see, it's a more complex infrastructure. But no, there's no point waiting for 6G. Now it doesn't mean that they just take a break for 10 years because not only does each generation need that initial rollout, they then work on improving the networks over many years. So for most people, the change between generations isn't one massive leap every 10 years. Instead, each generation gets better over several years on the way to the next one, better availability, better download speeds. And what this can lead to is a situation where the early rollout of each new generation is pretty close to the later stages of the previous generation. So if I'm in a city that's just beginning to implement 5G, but has excellent 4G service, I may get better results from the 4G network than the 5G one. And that might be a temporary state of affairs, but it certainly happens. Now quick sidebar. You've probably seen the term LTE in advertising or maybe even on the status part of your phone. Now LTE stands for Long-Term Evolution. And it was a way to define the in-between stage, the technical improvements to take one generation closer to the next, possibly not in the way you think. You see, from the marketing of cell phone companies, I'd forgive anyone for thinking, we went from 3G to 4G to 4G LTE to 5G. But that's not really what happens. In fact, adding LTE doesn't mean better than 4G. It actually more accurately represented the in-between stage between 3G and 4G. And some providers were, shall we say, less than clear about this. And what doesn't help is we didn't just have LTE, but we also then had LTE with its own improvements sometimes called LTE Plus or LTE Advanced. And some network providers even thought that was getting close enough to 5G levels that they'd even show 5G in the status bar on a phone, even though the phone didn't support 5G and the network wasn't 5G. So, yes, there's a bit of confusion with the marketing. And the movement between generations can sometimes feel like two steps forward, one step back. But there has been a common theme. There's three things that keep improving. One, higher bandwidth, faster downloads. Two, lower latency, reducing the time it takes between making a request on one device on the network and it getting to where it's going. Now that might not sound all that important, but it's a huge benefit of 5G. And three, connection density, supporting more devices connected to the network in the same space. Not just phones and tablets, but cars, laptops, smart devices, cameras, traffic lights, sensors. So we're going to dive deep into all three of these characteristics in a few minutes, but first, we need to talk a little bit about the networks themselves.

What You Should Know About 5G Networks

I need to talk about these and what's different about them with 5G. But to understand the newest and the latest tech, let's first go old school. Back in the early years of radio and television, we'd have huge broadcast towers. These high-powered transmitters in a central location beaming a signal out for many miles around. So, yes, in a major city, one broadcast tower could potentially reach millions of people, but this doesn't work for mobile communications. First, TV and radio is basically a one-way street. So one broadcast tower can send signals out to reach millions of radios, but it can't receive from all of them. But also, if you had a good radio with a good antenna, you might be able to receive a broadcast from a radio transmitter that's hundreds of miles away, but not the other way around. First, most radios don't transmit at all. But even if they did, a small device just doesn't have the power to transmit very far. And back in the 1980s when we first started building mobile phone networks, they knew that the single, huge transmitter approach wouldn't work. That instead, we needed multiple, smaller locations spread across an equivalent area where each one was capable of transmitting and receiving, and each location is a cell in the larger network. And that's why it's called cellular. These are cellular networks. We have cell phones. I've shown this as if all these cells in the network are exactly the same size and perfectly evenly distributed. And okay, in the real world, it's different. The arrangement depends on things like population density, predicted usage, ease of installation, tall buildings, major roads, parks or how flat or hilly the area is. And sometimes these cells overlap, and sometimes the coverage isn't perfect, so you get dead zones. And as you're walking or driving, you are also moving from one cell into another. But, with any cellular network, there's a few key questions. First, the obvious one, are you just in range of a cell and does the network have a nearby transmitter/receiver? Now you might call it a cell phone tower or a cell tower or a base station. A more useful term is a cell site because they're not always towers. What generation is that cell site, 3G, 4G, 5G, and does that match the device you have? You may be standing right beside a brand newly installed dedicated 5G cellphone tower or cell site, but if your phone is from 2012, they are not talking to each other. However, if your devices are compatible, then also, how many other devices are trying to connect to that one cell site at the same time? If there's too many simultaneous users, we may have dropped calls or no connection at all. But, even if there's a good cellular network in place, to upgrade it from one generation to the next does not mean they just go around all the 3G locations and swap them out with 4G and then 10 years later take the same locations and just change them all to 5G. Because each generation has different strengths, the effective range of a cell is different. The supported number of users is different. Even the best positioning for the surrounding landscape and topography is different, and that doesn't mean, well, 5G is newer and more advanced, it must have a better range. No, quite the opposite. 5G is great at a lot of things, but range is not one of them. And with 5G, we need more locations, we need small cells, and it's one of the big reasons why this rollout is taking longer. Because for a good 5G network, you need to install a lot of small cells. However, this doesn't mean thousands of these. The way 5G works, we actually don't need as many massive dedicated cell towers with huge arrays of antennas. Instead, you'll start to notice many more small cell sites for 5G. They might be just a small white box on top of a street light or on a bus shelter or on the outside of a building, or even inside, some 5G cell sites will look more like

a Wi-Fi access point than this massive cell phone tower. And to understand why we need to build 5G networks like this, we need to talk a little bit about wavelength.

What's The 5G Frequency

Most of us know what it's like to have someone playing music in another room where you can hear it through the wall. And what you hear is the lower frequencies coming through. It's all base, muffled sound, no highs, no detail because the higher frequencies are being stopped by the wall. Higher frequencies are more easily blocked. Now you might wonder, what does this have to do with 5G? Well, we'll come back to the noisy neighbor in about 2 minutes. Cellular networks, whether they're 5G or 4G or whatever, they all transmit and receive in a specific, very well-defined range of radio frequencies. And these are defined by the standards bodies and governmental departments who get together and agree on which ranges or bands of frequencies are set aside for different uses. Some bands were reserved decades and decades ago for AM radio. Others are for over-the-air television or air traffic control or satellite communication or for the different generations of mobile communication. And most of these categories don't just have one band of frequencies, but two or three or more. If you've even used an old AM radio, you often first have to choose if you want to listen to the short wave radio band or the medium wave band, perhaps even the long wave band. And then within each of those bands you could choose a specific radio station. And yes, there's a point to this history lesson. You see, the reason the different bands were defined wasn't just two groups stuffed together. Oh, the first 100 radio stations can go in this band, and then the next 100 can go in that band, and then the other band will go over here. No, it's that the different bands were naturally better for some things and worse for others. So if you ran an AM radio station, your choice of whether to operate in the short wave band or the medium wave band or the long wave band wasn't just a coin toss. It depended on what you were trying to do. Because when you transmitted in some bands, the signal would go further, but you would lose audio fidelity. It didn't sound as good. But that might be okay for something like a maritime weather forecast where priority number one is long distance. It's okay if it doesn't sound amazing, but you could use other bands, and the quality of the sound could be better, but the signal wouldn't travel as far. So, fast forward, 5G also has different bands. It has two, two ranges of frequencies that are set aside for it. The lowest band is often called Sub-6, and the highest band is mmWave. Now for this course, I do not consider it important for anyone to memorize the frequencies here. But the low band of 5G is called Sub-6 because it's the range under 6 GHz. Now this is not that different to existing 4G transmission. And in fact, 4G, and 3G, and even 2G are also allowed to operate in these lower frequencies. But with 5G, we also have a brand-new range of allowed frequencies, a new band called mmWave, which is in this very high 24 to 40 GHz range. Now notice, these bands aren't next to each other. They're at very different frequencies, which means like with AM radio, we can expect each band will be better at some things and worse at others. And mmWave, this new band, is the incredibly fast 5G that people get excited about because these super high frequencies can carry a ton of information. This is what can give us incredibly fast downloads and very low latency, near instant communication. So you might wonder, well, why don't they just use the fast one? Why don't they just use mmWave? Good

question, dear viewer. Back to the noisy neighbor. You see, the thing about low frequencies is they naturally penetrate better. They go through walls, and buildings, and cars, and trees, but they have a downside. The downside is lower frequencies can't carry as much information, as much detail. Even with this analogy, yeah, I might hear the beat, but I can't make out the lyrics. Now, higher frequencies can provide a lot more information, but they're easily blocked. And mmWave 5G frequencies get blocked very easily, blocked by walls, by telephone poles, trees, by other people, by rain, and I'm not kidding about that. If I was standing outside with line of sight to a 5G mmWave cell site and getting great download speeds, if it starts to rain between me and the cell site, it will absolutely interfere with the speed. If I walk behind a tree, it'll interfere. If I go inside a building, I'll probably lose it completely because these super high frequencies fall off extremely quickly. MmWave signals, even in a good environment, may only have a range of a few hundred meters or less. And that's why for mmWave, for super fast 5G, we need many more 5G small cells in many more locations. And right now, mid-2021, when I look at 5G availability maps for a lot of cities across the world, they may tell me, oh yes, we have great 5G coverage here outside, not inside. Because for full, consistent mmWave coverage, we're going to need small cells both outside and inside buildings. And just as right now offices and stores have Wi-Fi access points, we're already starting to see small 5G cells being installed, first, in addition to indoor Wi-Fi points, but it may end up even replacing Wi-Fi. But we can also expect that we're not going to see mmWave coverage in suburban and countryside locations any time soon because of the amount of small cell sites it would take. But, we also have Sub-6 5G. Now those cells will have a much wider range, and those low frequencies can travel much further, and they can penetrate through walls. We can have better service, and it is technically 5G, but it won't be the super fast download speed 5G. Now, some providers like to talk about the Sub-6 5G band as being split itself into low-band and mid-band where low-band could be used for those longer distances, but it doesn't have great download speeds, and where mid-ban Sub-6 is presented as this great compromise between range and speed. But for most people, if you already had good 4G LTE service, you might not notice a big difference between that and Sub-6 5G. And mmWave is the most exciting part of 5G, but it's also the hardest to find reliable and consistent coverage.

5G And Bandwidth

Okay, I'm going to admit something. I don't really like talking about bandwidth. And yes, it's important. One of the biggest benefits of 5G is greater bandwidth that we can transfer more information faster. But so often, any bandwidth discussion just turns into a list of specific numbers of megabits and gigabits, and for a lot of people, the numbers don't help very much. But also, because we're talking about wireless networks and the early years of a new generation, any time I hear someone give me a specific number, I think, we need a disclaimer on that. With 5G, you can now download at 1000 Mbps, download speed may vary. It's not just your download speed may vary. Your download speed will vary because we're at a point where the previous generation of networks is better than it's ever been, and this new generation is not yet as good as it's going to be, but it's not just hype. 5G mmWave does allow for incredibly fast speeds, but I want to avoid the specific numbers right now and just make

a rough comparison. And yes, I'm going to be intentionally loose and approximate. Let's say I wanted to download a high-definition movie. If all I had was a 3G network, that might take me 45 minutes or an hour. On a 4G network, maybe 4 or 5 minutes, on a 5G network, perhaps a minute, maybe 30, 40 seconds. And a few years from now, we might be talking about 15 seconds or 5 or less. But here's what I believe is more important about bandwidth in 5G than the specific numbers of megabits and gigabits. The speed we will get to with 5G is fast enough, fast enough most people won't care what the speed is. Fast enough everything just works. Fast enough that what I do on one device is synchronized to all the others before I could even walk over and pick them up, and fast enough that that example I just used to download a movie, I'm not going to do it because why would I take the extra step of downloading it to my device when I could just hit play and watch it whenever I want? So fast enough download speeds, we don't need to think about the download speed. And yes, the clichés always seem to be about downloading high-definition movies, but there are many benefits. We'll have more cloud-based gaming where instead of having a game console connected to your TV, the computation is done in the cloud and just the results of it streamed to your device, whether that's a television or a phone or a tablet. And with 5G, this becomes more reliable, better visuals, much higher quality. Your phone or your tablet can behave as if it's an incredibly powerful computer. Now sometimes this is called pixel streaming. It also applies to things like 3-D visualization and manufacturing and very much to virtual reality and augmented reality. Now right now, one of the sticking points in the adoption of VR is that the headsets always require tons of cabling and they have to be connected to a powerful PC somewhere. And while there are standalone headsets that contain their own processing, they're just not as powerful as we might want. But, if the VR or AR headset didn't need to contain all that graphical processing power, but just needed to be a lightweight, fantastic display unit with great 5G connectivity, then we could have all the processing happening on another machine, which could be on the other side of the room or running in the cloud. And the ability to have greater bandwidth with 5G isn't just from being in that mmWave frequency band. That's an important part of it, but there's other aspects to the 5G hardware that allows it to be more efficient and more effective in the use of bandwidth. See, if you could see inside a 5G base station, what you'd see is often not just one antenna, but often dozens of independent small antennas. Some are for transmitting, some are for receiving, but there's also software running on this box that monitors what's happening with the antennas and continuously reconfigures them based on how many users are connected and what those users are doing. And when you have lots of separate antennas and software that can control them, you can do some interesting things. First, instead of just using one antenna to talk to one user, you can send and receive multiple data streams simultaneously. This is called MIMO, which stands for multiple-input, multiple-output. And when you have lots of antennas, it is massive MIMO, multiple antennas to send information to a single user so you're increasing performance, and bandwidth, and range, or you can use multiple antennas to talk to multiple users at the same time because the amount of data they support is incredibly high. But this constant reconfiguration also allows something called beamforming. See, when a device is connected to a cell site, well, the cell site now knows the location of that device. Even though the device may move, it's not like it's going to suddenly jump two miles away in the next second. So there's no point in transmitting a super wide signal if you can just send a more efficient narrow beam. And beamforming also allows

an antenna to reconfigure itself to target the upper floors of a tall building or, in some cases, to even bounce radio signals off nearby buildings to improve reception in a more difficult area. But both beamforming and massive MIMO aren't unique to 5G. They've actually been used with previous generations, which is how we know they work. But they've taken on much more importance here, not just improving bandwidth, but they also improve range. They improve energy efficiency because they require much less power to achieve equivalent results.

Latency In 5G

When people talk about the speed of a network, they mainly focus on bandwidth, being able to download more data in a shorter time. But there's another kind of speed that's just as important to 5G, latency, any small delay that can happen between performing an action and getting a response. That could be requesting a web page, clicking a button, pressing the trigger in a video game, telling a voice assistant to turn on the lights. So, with bandwidth, more bandwidth is better, more megabits per second, more gigabits per second. With latency, less is better. We want higher bandwidth and lower latency. Now latency is typically measured in milliseconds, thousandths of a second. And if you're on a good 4G network, then you might average, let's say, 50 milliseconds, 3G, 100 to perhaps even 500 milliseconds or half a second of network latency. But with 5G, this can be significantly shorter, 20 milliseconds, potentially less. You may even read about 1 millisecond latency in 5G. This is theoretically possible. It is not a real-world 5G use case yet. You might think, now this all sounds pretty small. I mean, if we are just talking about fractions of a second, does it really matter to have latency that's, say, 200 milliseconds versus 20 milliseconds? Well, in some circumstances, no, but in others, very much. Now one easy example, even if it's trivial is playing a game. If you're moving a character around and you press the fire button, but the character doesn't actually fire for half a second or longer, it will be annoying. You'd say the game is lagging. Or if you're using a photo app, you click the button to take a photo, but the photo isn't actually taken for half a second. That's also annoying. And think about it this way. If you're driving a car at 60 mph and a deer steps into the road ahead of you, your reaction time means the car will travel at least 20, 25 feet before you will even start to move to slam on the brakes. I'm not talking about stopping time, just reaction time. And that 20 to 25 feet is very optimistic. Most studies would say it's three or four times that. But let's say you had an autonomous car driving at the same speed scanning the road ahead with the latency of 20 milliseconds, and the distance between recognizing a hazard and applying the brakes might be 18 to 20 inches. And that's the potential that we're talking about here. You see, if we just focus on the differences in latency as this one is 317 milliseconds and this is 32 milliseconds, then it sounds academic, and unimportant, and nit picking. But when it really means one of these systems is slower to react than you are and the other one is much faster, that can and will make a difference. But you might think, okay, but if download speed can vary with 5G, then can latency also vary with 5G? And yes, it can, but there's ways to deal with that. You see, with the 5G specifications, they allow you to say when some uses of the network are more important than others. There's something called quality of service, or QoS. And this allows us to say that some devices take priority. Like medical devices or smart cars, they can be

marked as having higher priority on the network over someone who might be just, say, streaming media. There's even a standard called URLLC, or Ultra-Reliable, Low-Latency Communication. It's part of the 5G specification, and it really focuses on minimizing latency down to 10 milliseconds, 5 milliseconds or less and with very high requirements on the resilience of the network to guarantee that it's staying up and running. But we'll talk more about that in another clip.

Connection Density In 5G

So with each generation of wireless networks, we get higher bandwidth and lower latency, but we also improve connection density. But in a single area, let's say, one square kilometer, how many simultaneous devices can be reliably connected to the network? Now with 4G networks, the real-world connection density would be, let's say, several thousand. Again, I'm being intentionally vague here. I could say 2,000 devices per square kilometer, but with good coverage, it can certainly be more than that. But still, if you've been in a busy sports stadium or concert venue with 50, 60,000 people in a small area, back when that used to happen, then you'll know that consistent, reliable connections with that kind of crowd is a big problem. But, the 5G specifications define the number of devices a 5G network should support, and it's 1,000,000 connected devices per square kilometer. And again, yes, in real-world situations, it won't always be this nice, exact, clean number. But still, the network itself, the hardware, the software, the infrastructure, the bandwidth calculations, they are all designed to support huge numbers of connected devices. But, Simon, you say, do we actually need a million people in one square kilometer? And no, because this is for more than just your phone and your tablet. This is to support and encourage growth of the Internet of Things where connectivity is built into or added to all kinds of physical objects or things. If I look at the connections on my household network right now, it's already at many more devices than I would've predicted five years ago, phones, tablets, laptops, watches, printers, game consoles, televisions, speakers, voice assistance, my car, thermostats, lightbulbs, security cameras, motion sensors, smoke detectors, flood and freeze detectors. And sensors, they're one of the best examples of Internet of Things devices, sensors for temperature or vibration or humidity or light. These don't need a constant ongoing connection to take up lots of bandwidth. So they can be small, self-contained, battery-operated. They're incredibly low power. They could run for years without any attention. You just set them and forget them to provide a status or let us know about a problem. And if you take this idea away from the home and into, say, an industrial plant, if you imagine adding low-powered sensors on all sorts of machinery, lights, doors, supplies, so this piece of machinery should never be vibrating, that one should never get hot, that area should never be wet, those pipes should never be freezing, and you can have a much richer view of the health of a system. And with 5G, this connectivity becomes much easier and more robust than Wi-Fi because one of the things 5G is built for is to have huge numbers of devices and incredibly low power requirements. And if we move from smaller internet-connected things to larger internet-connected things, we can also expect more connected vehicles. And I don't just mean self-driving, completely autonomous vehicles, but just thinking about buses, and taxis, and all public transport having low latency, reliable connections, sensors within the road itself or on street lights and

traffic lights to improve traffic management, routing around accidents, prioritizing emergency vehicles. I'd actually like to talk about a transportation example to bring several of these ideas and bring them all together.

Platooning

So I'm going to talk about self-driving vehicles, but wait, wait, wait. It won't be just the cliché. In fact, what's most important here isn't the individual self-driving vehicles, it's the rest of this scenario. Imagine a road with intelligent cars or trucks, and we can think of this as what's available right now. These vehicles don't need to be fully self-driving, just smarter. They can assist a driver with keeping in lane or with cruise control that can recognize the distance of the car ahead and the car behind. So these vehicles have brains. They have sensors built into them, and cameras, and computing power that's all internal. It's all self-contained. The car is independent. Now, that's great, but we don't need 5G for that. The next step, and what 5G allows, is for them to start meaningfully communicating with each other. Now yes, they could theoretically talk to each other now. Most current smart cars have some kind of wireless connection. But the problem is, the longer latency of currently available networks means a long round trip from the car to the cell phone tower, through the telecom's operator's network, multiple hops over the internet, multiple hops back again. There's nothing instant about this, and we need instant. So with 5G, these could connect with very low latency, just a few milliseconds. And 5G is built to include this idea of URLLC, Ultra-Reliable Low-Latency Communication where we can nominate certain kinds of devices like vehicles or medical devices or factory machinery to have priority on the network. So if any data has to be dropped or discarded or delayed, it's not the data for those things. So, imagine where several vehicles move into a lane to drive together. And particularly, if these are large trucks or tractor trailers, there's significant energy savings of them being in each other's draft, in each other's slipstream. Even back in the 1970s, we had truck convoys that would do this, but the ones at the back have no idea what's going on at the front. So if there is a problem, there's just no time. The one in the front slams the brakes on, they're all just going to pile up one after the other. But with 5G, there's a use case called platooning where these vehicles would connect with very low latency, and they would drive together, extremely closely. They could be perhaps just 1 second apart. They get the benefits of being in each other's draft and they take up less space on the road, but if an autonomous vehicle at the front of a platoon recognizes an obstacle, then the low latency and high bandwidth of 5G means they can effectively see everything all at the same time. They instantly communicate about what they're going to do much faster than a human could react. And the end result is that the entire platoon can act as one thing. It can slow down together. It can speed up together, instantly. And this isn't theoretical. Transportation, vehicle, communications companies, they're already working on this and implementing it. But this is what I mean about 5G not just being about downloading movies faster. It's that having low latency, high bandwidth, lots of supported devices, and better reliability, with that, we can do things we just couldn't have done before.

Edge Computing

I'm going to finish up this course with a clip on Edge computing. Now it might seem that I've completely ignored this subject until the very end. But in fact, what we've been talking about all along, latency, bandwidth, reliability, connected devices, they're all part of this. And the basic idea of Edge computing began about 20 years ago, and it isn't just for wireless networks. Edge computing can help with any kind of internet-based system, regular websites, media streaming, mobile applications, backup services. It can help in business areas as diverse as gaming, transportation, finance, retail, almost anything. And it applies to so many different areas because Edge computing might sound like a specific technology, but it isn't. It's an idea, an approach. Some people describe it by saying Edge computing is a topology, not a technology. And okay, if you're wondering, what does that mean? Well, let me explain. You see, when designing and building any kind of software application, there are a lot of choices about the specific technologies it'll use, what operating system, what programming language, what kind of devices are supported? What format will the data be stored in? But, the topology is when we focus on the location of the different parts of this application. Where is the data going to be stored, one centralized location or on the user's device or somewhere else? And where is the processing being done? An example, imagine there's a computing resource at one specific location. Now this could be a server that's hosting a website or a database or some kind of back end for a mobile application, but where people are connecting to this machine from all over the world, and everything works. But the users who are closer have a good experience, the users who are further away have a worse experience, a slower experience. And they may even complain the application is slow and unresponsive. Now you could upgrade this machine to make it more powerful, and it wouldn't help because the problem is the network latency caused by the distance. If you have users connecting from not just hundreds, but thousands of miles away from Seattle to London or New York to Hong Kong or Sydney to Reykjavik, distance always introduces more latency. It is unavoidable. In the very best case, in perfect conditions, for every 120 miles of distance, you will add at least 1 additional millisecond going both there and coming back. Now that might not sound like much, but it means that even with the fastest fiber optic connections and ideal conditions, if you're 5,000 miles away from the computing resource you're trying to use, then every request will take at least 40 ms to travel there, then wait for whatever time it takes for that computer to react and respond and at least 40 ms back. And this might be okay in some situations, but not when you need real-time responsiveness, and round trip latency that's 20 ms or 10 ms or 5. So the basic idea of Edge computing is very simple. We reduce latency by just moving a computing resource nearer to the people who are using it. Well, okay, actually, we don't just move it because that might improve one person's experience and make it worse for the others, so we typically duplicate it. So instead of the users all connecting to one central location, they can now connect to a resource that is physically closer to them. And this is the core idea of Edge computing, to move applications, and data, and computing services away from centralized locations and closer to the Edge, meaning as close as we can get to our expected users. And when we do that, we reduce latency, but this is far more than just having a slightly quicker experience because there are applications like platooning, in the previous clip, that just aren't possible without very low levels of latency. We also reduce overall bandwidth usage because even if the users are downloading the same amount of stuff, they are not doing it over thousands of miles, which can lead to reduced usage and reduced cost. Edge computing began for things like

websites and creating global content delivery networks, repositories of files that were synchronized around the world, making it easier and faster for users to download large files and video. But it rapidly became much more useful than just moving some files closer to the users because we could also move different parts of the application itself, the actual processing power onto Edge servers or even onto the user's devices. And, even if an application did need some kind of centralized data store, it wasn't all or nothing. There might be some of the data that we could move closer to the user or onto the devices themselves. And there's other benefits than this. If we have sensitive data, healthcare data, financial data, identity information, we can use the same idea to keep that data on servers in a specific geographic region or even keeping the data completely on the user's device itself. Now in the early days, Edge computing could be expensive because you'd have to actually set up dedicated machines in a bunch of different locations. But it's become much easier and cheaper to do, partly because of the rise of cloud computing providers that provide these services and locations around the world and easier because of technologies like virtual machines and software containers that make it simpler to package up software applications and easily deploy them to other locations. Now for many years, Edge computing usually meant moving a resource into a data center that's in the same country or same geographic region as your targeted users. And sometimes that was fine. It's all you need for a big improvement. But, these days with 5G, Edge computing is going even further to the Edge, moving closer to the end users than ever before. We're seeing partnerships between the cloud providers and the telecommunications companies to actually place the computing resources physically inside a 5G network infrastructure of major cities. So, instead of using an app that talks to a cell site that connects to an internal data center, the telecoms company, that then connects that to the internet, that then hops out to a remote cloud data center to finally talk to an application that's running on that remote data center. We could move the application so it's actually running on hardware at the internal data center of the telecoms company, meaning we don't even have to go out to the internet. We're never leaving the internal 5G network. It's incredibly fast. And again, this is not theoretical. Right now, there are services like AWS Wavelength and Azure Edge Zones to do this. It's not something that every business needs to do, but for those latency-sensitive applications where every millisecond becomes a competitive advantage, not just autonomous vehicles, but gaming, augmented and virtual reality, live video streaming, and many more we haven't thought of yet, we can now get performance we could never get before. So, Edge computing is an architectural approach to designing software applications. It can improve latency. It can improve bandwidth usage. It can help with data sensitivity. With 4G and 3G mobile networks, the additional delay made very low latency applications just not feasible. With 5G, we can take this idea even further. And with that, I'm going to bring this executive briefing to a close. I hope you found this useful. You either learned something new or something gave you a new perspective on this. Thanks for watching. I'll see you next time.

5G & Edge Computing Aftershow

5G & Edge Computing Introduction

Imagine a world where augmented reality becomes ubiquitous. You could get hospital-level diagnosis at home, or a gym could give you a real-time biometrics readout and adjust your workout instantly to maximize results. Or a retail store that allows for virtual try-ons. Stay tuned for this edition of the TQ after show where we'll be talking about the key technologies that can make all of this a reality. Welcome back to our virtual TQ HQ. Today, we're talking about 5G and Edge computing, and, Paul, it's great to have you back as my cohost. -It's great to be back with yet another exciting episode of TQ, and this one's going to be particularly fun. -Yeah, I think we have a lot to cover today. But, Paul, really, all of those things I listed in the intro, do you really think all of those are possible? It seems very unimaginable, almost like sci-fi. -Well, so sci-fi's great because all of science fiction eventually happens, but it's really interesting. That's why this topic is so important. We use technology that used to be in data centers and it used to be in laptops and things that we're using, but technology is moving to everywhere in the world around us. We all see that happening, and that's all because of the Edge and Edge computing, 5G, and the explosion of technology to be part of everything we do in our everyday lives. And that's what we're really talking about is the potential and how that's going to change business and society. -Okay, well, I mean we're just getting started, and I'm already impressed, and I can't wait to see what we're going to learn today. So, before we get started, let's introduce our guests because we have some great guests joining us today. So first, we have Ram, Ram Ramalingam, our Cloud First Edge lead, as well as the Industry X product and platforms colead. We also have Teresa Tung, who's returning as a guest. She's our Cloud First chief technologist, and she's charged with growing these new areas like Edge. We have Jefferson Wang, our global 5G lead, and I understand Jefferson wrote a book, which we've had guests who've written books before, right, Paul? So, we're going to talk about that as well. And then we have Tracey Countryman, our global Industry X digital manufacturing and operations lead. So, thank you to all of our guests for joining us. I'm really excited about this topic today. -Us too. I'm glad to be here. -It's nice to be here, Sarah.

Market Landscape of Edge Computing

Okay, so let's jump right in. So we've heard Simon, and Paul, you talked a little bit about what Edge computing and 5G are, but Ram and Teresa, maybe we can start with you, and you can help us understand, where do we need Edge in our lives and maybe to help the audience bring it together with some real examples? -Yeah, I can start off. Thanks, Sarah. This is a very, very exciting and interesting topic, and I would love to relate it with what I would call the four laws which really drives Edge and the use cases in the industry. So I'll start off with the first one, what I would call as the latency requirements that's been driving in this market, where you have to make split-second decisions. For example, when you are in a retail store, you need to make a decision on whether a person is really shoplifting or really buying a thing, and that decision has to happen when the actual person is checking out. This is the kind of latency requirements that's going to drive the market and what I would call us Law of Physics. So every data cannot get pushed to the cloud; there are data that needs to reside locally, and you need to make those split-second decisions. So that's the number one. The second one, what I would call as

the Law of Economics. While cloud has been very pervasive over the last few years, pushing every data onto the cloud is not economically beneficial, and it is not the optimized use of the resources. A classic example, when a new series of Game of Thrones is coming in or a Stranger Things comes in, you don't want to position all the content in the cloud and have everybody access it. How do you strategically place this content, one for latency, and also for the bandwidth requirements drives the second part? That's the, what I would call as the Law of Economics. So then the third plot is what I would call as law of the land or law of regulations. There's a lot of GDPR requirements coming in Europe. There's a lot of data that has to be locally stored. A classic example, everyday user example is, when we open our iPhone we unlock with our thumbprint, and that a complete data is stored inside the phone. One, number one, it is safe. When your cloud provider gets hacked, nothing happens to your phone. A classic Edge device where there is a kind of a privacy protection, and this is something what I would call as the law of the land or law of regulations that's going to drive the market. That's the third one. The fourth one, the best one is the Murphy's Law, you need to have some access of critical data all the time for you. You cannot compromise on that. And it invariably happens. Bandit gets broken or network connectivity gets broken when you don't want it to happen. So that's the Murphy's Law. These are the four laws really driving this market, and we are super excited in this space for the kind of use cases we have been able to enable for our customers. Teresa is going to take us through some of the real-life examples here. Teresa? -Yeah, thanks, Ram. We are certainly doing real-world examples with our clients that use and demonstrate all of these laws. So starting with laws of physics. We're working with an automotive manufacturer to deploy visual analytics right on the production line so that the visual analysts can identify the defects right away, and it can be fixed without slowing production. We're doing laws of economics with an oil and gas company. They have a lot of wells all over the world, and many of them are at best connected via satellite. And you can imagine with this satellite connection, it's very expensive to transmit data to the cloud, and in some cases the bandwidth is just limited so you can't transmit all the high-fidelity data. And so it has to be done, and processing must happen at the Edge. We're looking at laws of regulation, where these are the real laws of the land, like Ram said. And so any time you see data sovereignty, this is where that's going to apply. And so any time you're working with, say, with a medical device manufacturer, each scan of that device, it takes a terabyte of data for just one patient. And so, one, you shouldn't be moving that data around because of the laws, but also it's just too big, and that's just going to continue to be so. And finally, laws of Murphy. So we're doing some really exciting work with a medical device manufacturer and for robotic surgery. And so you can imagine with robotic surgery it has to work. You definitely don't want anything happening while you're being operated upon. And so that's a great application for Edge. -These are great. I love this, Ram and Teresa, because those are real-world examples, easy to understand, and you can see where Edge totally has a use case there and can really bring value. So Paul, as we often do on these shows, we talk about how all of these technologies come together. So it seems like I was hearing a lot there about cloud. So talk to us a little bit about like why cloud is required for Edge? -It's great, and Ram and Teresa just talked about the four laws, and I talk to them a lot, but I haven't heard those four laws expressed that clearly before, which is another great thing about doing TQ. I learn a lot through this as well. And I think, as you listen to that, the cloud does become really important in how this comes together, and that's why we've just put out

some new research that talks about the Cloud Continuum, which is how the Edge comes together with the cloud seamlessly, the private cloud and the public cloud, out to the Edge to drive business value for customers. And that Cloud Continuum is the way to really think about how the technology world unfolds going forward. And we're doing so much around cloud and the group that the audience has heard about things like Cloud First before, as we look to the future, the Cloud Continuum and how the Edge comes into play is going to be really important for our business and for how we help our clients and their businesses.

5G Intro

Now, Jefferson, I don't want to overshadow Paul's book, but I did hear that you have literally written the book on 5G. And I understand a little bit of it. It's the next generation of digital cell technology, but maybe you can talk to us a little bit more about what it is and why it's so important. -Yeah, absolutely. And please do not overshadow Paul's book. You know, so when we wrote this book, it was before the pandemic, and it was really focused on what's the future state of the home. And if you look at today's version of the home, it's really just a connected home. It simply has a lot of requests we have to make. We actually have to actually ask for things, and there's no real predictive nature. And when you think about kind of how Paul talked about how AI plus humans are going to work together, that's really where we see in continuing that thought into the home that you shouldn't have three different apps for your security system. It shouldn't take you 2.5 hours to actually onboard a device in the home. You shouldn't have to download an application and enter in a long password. All those things should be naturally happening. And then all of these proactive pieces of data should come together, as Paul talked about, this continuum between how fast connectivity can get this information to the actual Edge and how certain pieces of data needs to be processed at the Edge and what needs to be sent back to cloud. That continuum becomes incredibly interesting when you start at the home and then you can go beyond the home with actually making people feel at home anywhere. You can make people feel at home as they return to work to a new environment. We make them feel at home as they jump into an autonomous car and they have some free time, whereas they actually moved to a vacation situation. How do we make them feel at home anywhere is really the concept. But a big premise that we wanted to chat about today is what's the role of 5G? And it's really important to almost take a step back to think about what is a generation and why is 5G different? And when you think about the background of 1G, this was back when it was just a mobile phone, we simply took the cordless phone, and people said why do I need a mobile phone? I've got a cordless phone. I can roam around my home and talk. But that was really the first generation of cellular technology. We had true mobility. In 2G, we've brought in text messaging. That was, I was working on these feature phones, not even flip phones, these candy bar phones where you'd have to mash the number two button three times just to get the letter C. But those became kind of the first part of where we could start to enter in messaging to our world. And then 3G came about. We ended up going down all over the world to start to build out these mobile data networks. And we started to get the first generation, a lot of these smartphones that we have today. And then the generation that we're in now, which was 4G. We started to unlock the mobile internet, which became incredibly powerful in that platform for the

incredible over-the-top companies like Netflix, and Uber, and Airbnb on top of the ubiquitous 4G platform. So now we're at the dawn of 5G, and what does that mean? This is the first time that we're almost democratizing the cellular network, the first time that there's access to consumers that are going to be using this network all around us who might need to be thinking about devices beyond the smartphone. And then enterprises that you heard Teresa, and Ram, and Paul talk about around how can they start to leverage a cellular network that is more secure, that is very responsive, that can connect more number of devices, and then unlock all of this data honeypot that we're walking towards? -That's interesting, Jefferson, because I want to make sure I understand this point around 5G because right now what I love is I can just put everything on my phone, and I'm good to go with one device. So is what you're saying is we're almost going to go back to a world where now we have to have multiple devices? -Well, we're always going to be circular, right? So I think in 3G we had a divergent world, and if you remember, it was your flip phone for communications, your laptop for productivity, and your iPod for your music. In 4G, we converged all of that to that rectangular slab in our hands that we can't take our eyes off of. But in 5G, we're going to move back to a divergent world. So a lot of what we're working on now with our clients is also what does that post smartphone world look like? And that world of sensors on machinery, that Tracey will talk about, that world of what is the next consumer device that might take features out of the smartphone? And we'll still see the smartphone very important in the 5G air. We'll now see certain functions taken out of that. So we'll see this new divergent world, especially in the enterprise and the businesses out there. -Okay, so it's going to be a good thing, not a bad thing? And, I mean, I'm all for having more devices connected at a time because I think all of us know during the pandemic when you're working at home and you have to tell all your kids to get off their games and your partner to get off their calls, it would be great to have lots of devices that can be connected. So thanks for the explanation. I've never really actually heard the generation by generation. And from what I understand and what I've read, it often takes 10 years or more to advance a generation. I'm going to guess when we're thinking about that, it's because we have to have the infrastructure to support that new digital cellular technology. So, Paul, is that reason the reason why we have that gap between the generations? -Well, it's that. I think it always takes a while to just develop the applications and really get that roll out of the technology. And it's also because it takes, and I'm talking about the business and consumer applications, but it also takes a while to build out these networks, something that Jeff really knows better than anybody. And we play a big role in that. And people at Accenture should know that we play a big role in helping the carriers deploy these new generations of technology. So currently, we're helping companies like Verizon, and AT&T, and Rocket M roll out their 5G networks that are going to power this new world. So that's part of what takes the time to roll out. The carriers have to deploy the capability, and then the applications and such need to be built. And that's all in process. And the good news is there's opportunity for Accenture in all parts of that spectrum. -Yeah, from end to end. That makes sense. -Yeah.

The Power of 5G & Edge Together

Okay so, Paul, we talked about Edge and cloud, and now we're talking about 5G, so how do these two technologies come together to really give us the power? -Yeah, we debated whether to put these together into one topic, and we did so because they're so related because Edge computing is about the proliferation of technology everywhere. I always bring toys. This is my little connected bulldozer that I can program with AI and things, but connected to real-world bulldozers and construction equipment and whatever it might be in the real world. So, Edge is moving everywhere, and everything is getting connected. How do you connect the Edge? 5G is increasing the way that you're going to do that. So when we think about the future of how this all comes together, thinking about the 5G and Edge together, I think, is really important. And then when you get to the applications of it, you really have to think about the connectivity plus the Edge and plus the business context, and that's why the work we're doing in areas like Industry X is so exciting when you think about digital manufacturing and connected products because it brings it all together and more. So, maybe we can shift and have, Tracey, have you talk to us a little bit more about what does this really mean when we put it all together for clients? -If you look at our clients that are going to their digital scaling and manufacturing agendas, this clearly and squarely has become one of the topics that I would say in the last 15 months, has kind of come to the rise. So first of all, incredibly hot topic on shop floor production, and I'm going to use that broadly because we have plants that produce stuff that have thousands and thousands of machines that let off data. We have thousands of workers that work in those shop floors and/or in fields. If you think about offshore platforms or upstream oil and gas wells and rigs that are moving around to dispersed assets, and then there's in the plant assets. And 5G is going to be a game changer, I think, when you think about the latency part of the equation in our production systems that are super critical. So we can't afford in manufacturing to have anything go down. So part of the hesitation, Paul, that we've seen is that Wi-Fi, the expense around doing Wi-Fi, the cost of moving per second data from machines and production lines up to the cloud and the expense of doing that has really been a hindrance to adoption. And the 5G and the capability with cellular and 5G is I think going to be the reason that clients start to move faster because things are cheaper, and it's better enabled, and it's going to make sure that nothing goes down. So to give you an example how we're going to take advantage of the 100 times increase in bandwidth, one, workers that go out to a line and need all the information. We talked about this over-the-shoulder coaching and visualization that needs to happen real time looking at an asset to solve a problem on a production line. If we can use that bandwidth and capability real time to solve problems, we're talking millions in a lack of downtime on the assets. Two, is the capacity. We have documentation that flies around for people to do work in the field with mobile devices and capability. Again, the capacity and bandwidth is vital for people to be able to do that in environments where they really only have minutes to take decisions that it can affect safety or productivity or throughput. Autonomous operations. The idea that we would have, I think, examples given earlier around cars. They can self-drive. Well, think about robots and AGVs that can self-drive in warehouses, in production, things they do operate around. Those have to be connected 100% of the time and be flexible. So the Edge compute, when they see something, they might go do something else is absolutely amazing to think about the future. And lastly, is the Edge. The ability to do AI machine learning at the Edge of the device. And I remember three years ago, I had a conversation with a refinery. They said steam traps.

The thing about steam traps, I don't have to stream the data from a steam trap just constantly flowing. That's very expensive, but I do have to send a signal when something stops. But when that steam trap doesn't let off the noise, I want it to send a signal because that means it's broken and I need to replace it. So there are incredible amounts of use cases in production and manufacturing, in TND, in the grid, and in distributed assets. They're going to absolutely take off, I think, with 5G and Edge as an option. -I think also just to build on what Tracey said, there's a really good description around when to use 5G and Edge and when you could use traditional Wi-Fi, and that's an important conversation to make. For example, you heard Tracey talk about things that have to go on, mission-critical use cases, operational-focus use cases. That's a really good set to put onto a 5G network because that's really licensed spectrum. So 5G is different than Wi-Fi because licensed spectrum is managed, it's controlled, it belongs to the owner versus Wi-Fi, while a great technology, has different sets of advantages. It's ubiquitous. It's standardized throughout the globe, and there's a big ecosystem around it, and it's very easy for developers. You heard Paul talk about this, but developers to get access to it and build on top of it. But when you want something mission critical and something that has to have low latency and something that has advantages like security, 5G for those operational pieces are really important.

A Client Story

One of the largest office furniture manufacturers in the world, Steelcase, basically said, hey, we've got a Wi-Fi network, we're having issues connecting the entire manufacturing plant. There's a lot of metal, there's a lot of reflection. We're not able to get this everywhere. Do you have another answer? So we orchestrated the ecosystem and said, let's bring in a network operator who has licensed Spectrum like Charter Communications in the U.S. How can we actually work with a Edge provider like Microsoft on Azure and then bring in Accenture and Industry X and teams to build the vertical application on top of it. So what we picked was, the business problem was that millions of dollars are spent on worker safety, so on insurance, on worker compensation, on making sure there's preventative measures. So is there a way---that's a mission critical use case that has dollars attached to it, so can we use that technology stack and that continuum from 5G connectivity to Edge processing and compute to actually cloud and solve some of this? So building this out, first use case was, how do we make sure that we can prevent? So as a worker comes in to use, let's say, a very high spinning drill press, a high-speed spinning drill press. If they don't have their eye protection on, if they don't have their hard hat on, the actual machinery doesn't start. You're not ready so we will not start the machinery in a risky environment. Use case number two, then we moved to that and said, if you are working around this high spinning drill press and some of your loose article of clothing gets close to the drill press or maybe your gloves get close to it, this is a real-world problem. Gloves get spun up in drill presses all the time. There's major, major accidents that happen. So you'll get a proximity warning. So the Edge processing takes over, it reads the video analytics and computer vision and decides, hey, you're way too close to this drill press. Let's give you a loud, obnoxious proximity warning to let you know, hey, please be careful. Worst case scenario, and the third use case, and we've proven this out, is if you touch the drill press accidentally with your glove, we instantly shut off that drill press. We avoid any of the

loose appendages that that could get worse, taken off in these situations. But just just an example of, you can't have the Wi-Fi go out in that situation. You can't have that network not be secure in that situation. And when you expand that out to multiple machines, you have to be able to take into account all of those sensors. And when you process it at the Edge, you get that law of physics, that Teresa and Ram talked about, which is, you don't have time to send that video packet all the way to central cloud and get the response back when someone is really trying to save an appendage here.

Bringing 5G & Edge to Life

Teresa, maybe you can talk to us a little bit. We've talked before on a show around Edge and how that works. I think we even talked about french fries in that one, so people will have to go back and listen to that if they haven't. But, maybe you can talk a little bit more about what's happening with Edge and 5G to make all of this even possible. -Yeah, sure, Sarah. So, let's think about generations of Edge that's made better by 5G. Right, so the first generation of Edge, that's what we know as the Internet of Things, IoT. And it's where we connect sensors and devices. Now we can see what's happening in our everyday world. The second generation of Edge are called containers at the Edge. And if we remember, container technology is something we can package, applications and everything it requires to run anywhere. And so the same application that you develop and deploy in the cloud now can be deployed at the Edge, and that includes colocating that with the device node that's generating the data and a place to act. So you could sense, analyze, and act right in the moment. And what's exciting is we're seeing an emergence of a new generation of Edge that Paul talked about as a compute continuum. Right, and so this is where that ability to sense, analyze, and actuate can be anywhere from the centralized cloud, the very Edge, and anywhere within the network in between. So if I took a retail example, in a retail example, you know, many of these retailers, there's not a lot of space on site. That space that you have in the store is fixed. And so even if you wanted to add more analytics and intelligence, you're going to run out of capabilities right there in the store. And so with 5G, I have a new option. I can still have that guaranteed speedway of data, if you will. It's a guaranteed latency, and now I can take certain parts of the applications like, say, my video surveillance and deploy it maybe within the network within the regional data center instead of needing to be either on site or in the cloud. -Yeah, those are great. So really, examples where it can be scalable, and it's easier to manage and roll that out. So, we talked a lot about cloud, and Edge, and 5G, but I have to imagine, as we talk about in all of our TQ HQs, how there's all this other technology that's also related that really makes this possible and comes into play. So, Ram, can you talk to us a little bit more about other technologies that come into play in this area? -Absolutely, Sarah. And I'm going to relate to what Paul and Teresa said. The way we should look at Edge as a continuum of cloud. Yeah, and how Edge is getting enabled on technologies is purely based on how you look at the Cloud Continuum. And the biggest gap today with our ecosystem partners today is, you know, they really approach it from a very, very traditional positioning. That gives us an opening for us to really shape and really conquer this market. And I'll walk you through the traditional ecosystem partners, which we have to work with, and their gaps in their portfolio. So if I look at, you know, the typical hybrid cloud

providers, the Dells and HP, they've already been in the enterprise infrastructure. They really understand Edge to an extent, but you know they come with what I call as an Edging approach, but they don't have a hold on distributed computing. Like we talked about, there is data that needs to be still on the cloud, but where the data and resources get placed should be a very, very informed decision, and our hybrid cloud providers are struggling in there. If I look at the cloud providers, they are getting very aggressive on the Edge market like AWS with their Outposts offerings or Google with their Anthos offering. But the challenge they have is, you know, they really don't understand the industry-specific use cases. How do I really deliver those industry-specific use cases? Then there are these third players, which is the Telecom, which Jeff was really covering on, the Verizons and the AT&Ts of the world. They really understand the network connectivity on 5G, but they really don't have a very good knowledge about the cloud concepts in here. So Accenture is in a very, very good position, combining all these three and delivering the best value for our customers. -Yeah, that's great. And it's that end to end that Accenture brings together in understanding all three of those aspects. So, Paul, this is all starting to make sense to me now, but what I am not quite getting is what this is going to mean for me like as a consumer. How will this impact me? Can you bring that to life? -You know, one of the interesting things about this versus the other Gs that Jefferson talked about earlier is that the prior generations of mobility were primarily consumer-driven. It was rolling out the networks and devices and was consumer-driven, and there were some business applications around that. With 5G, it's a little different in that the deployment of 5G is going to be more business-driven because we need the businesses to create these new use cases. We need Tracey out there creating these new Industry X scenarios that we'll then utilize as workers using employee safety solutions like Jefferson was describing using intelligent products that we're creating through Industry X. So really, the consumer manifestation of 5G will come through the work we do on behalf of large companies that are deploying 5G and Edge technologies. That's the way to really think about why this is so different and why Accenture needs to play such a big role in 5G versus some of the prior generations of technology.

Our Ecosystem Partners

Now, one other things that always comes up in the Aftershow is how we work with our partners and specifically our MAAG partners and whenever we're doing something around this scale and this magnitude of technology. But I don't think I've heard it yet, maybe a little bit, but Teresa, may be you can expand a little bit on how the role of our partners will change when we start to talk about this. -Yeah, of course. Our MAAG partners are going to be critical and, in fact, they're leading the charge. They are launching a new exciting set of Edge offerings, so Amazon Outposts, Microsoft Stack, Google Anthos, and all these new offerings make it just as easy to develop and deploy at the Edge as it is in the cloud. So you now have your choice of your centralized cloud regions, a place within a network, within a regional site, on a device. And our MAAG partners, they know what delights a developer. They know the tools that a developer needs to really transform our businesses, and that's where we're going to see them shine. And as you've heard the examples, we'll have to work with additional partners, our hyperconverged infrastructure partners. Ram mentioned companies like HP and Dell. And they're more

important than ever, as they're going to provide that infrastructure that's needed for processing, and it's going to have to consider whether it's in a factory, a hospital, a retail location with all the limitations, with safety and the footprint and the power that that brings. And of course our telcos and also our network equipment providers, they're going to be bringing this connectivity. And there's going to be a lot of choice with the connectivity, if you're going to go private or public. But that connectivity is actually that core critical foundation that unlocks this new continuum that we are talking about today, that final generation of Edge. And so we're going to have to play a really critical role, so certainly with our MAAG partners, but also how do we orchestrate amongst the hyperconverged infrastructure and telco partners? And all of this is made much more complex because they're all partnering with each other too, so clearly the ability to orchestrate this ecosystem is a great place for us. -Right, bringing together all those partners. Yeah, Paul, did you want to... -Yeah, Sarah, I was just going to add in, which is, you asked about ecosystem. The other thing that is really interesting is, first of all, it leverages such broad ecosystem, the MAAG, the network providers, the communications companies, the device companies, etc., everything that Teresa just talked about. But the other thing is the new partners that Tracy and her team are starting to work with, so it's Siemens, it's Dassault Systèmes, it's PTC, and others, so there's a whole new ecosystem that's developing of new companies that we need to work with as well. So this is a really exciting time as we put together a lot of the ecosystem we know with a part of the ecosystem that's evolving rapidly and that we work with as we merge into these new areas. -Yeah, those are really great examples as we think about all the different partners we're bringing together, new partners and new ways with some of our existing partners. And then as we've been talking about, industry plays such a critical role in this with some of the specific use cases. So Tracy, I imagine you're already seeing this today in what you're doing in the industry. Can you maybe give us another example in that space? -Yeah, and look, everything is going to be connected industry across the board. Every machine and every person's going to be connected. And while we've seen that a lot in our personal lives, we're just starting to really see the brink of that in the industrial, manufacturing, and the industry sectors. So if I reflect back to 2019, we were working on a construction project, so think about construction, mass area, lots of people, totally remote. It was in the Middle East. And we were really contemplating how could we use Edge and 4G at the time, I'll be thrilled when it can move to 5G, how can we deploy that and have visibility into a site that is somewhere else and be able to process data that is super critical around people safety, progress of the on-site, and we decided at that point in time to partner with Microsoft to do some innovation, and they are one of our preferred partners within Industry X for what we're doing and building out, particularly around the IoT and Edge that Teresa mentioned. We deployed Edge devices and 5G in a trailer in the middle of a huge construction site. We were able to put devices on equipment and people as they were doing the construction build. We were able to stream, batch, and move to predictive analytics around the data we were getting from telemetry. We could listen into the stream on the Edge and send the priority signals based on what was the most critical information coming through. We hosted the cloud compute applications on the Edge and were able to build real transparency visibility into a major site. That is what we called connected construction and was the IoT partner of the year in 2019. -Wow, yeah, that's awesome. That is a great example and the power of what you can do there. That's really cool.

Our Role in 5G & Edge Computing

So, Paul, these are some really good client examples. And clearly, Accenture is already doing a lot of this work with their clients, but what is the role, what's the type of work that we're doing in Accenture for our clients in this space? -You know, as we've talked about it a little bit, the great thing is there's such a broad role for Accenture to play as we look at this. It's getting the technology and the infrastructure right, helping a client decide between 5G and Wi-Fi. We talked about a lot of these types of things, and clients and companies need our help with these types of things. It's the services and putting together the solutions that companies are putting together as Tracey, and Ram, and others have talked about. So maybe what we can do is just maybe summarize that a little bit and, Ram, have you start a little bit to talk about what your group's doing from a connected product perspective, what you're doing, and then, Jefferson, you talk about what we're doing in the network group. We'll cover a little bit as we go down the path here, too. -Yeah, thanks, Paul. I'll give you a quick example on what we do with the devices side and one on the platform side and then give it up to Jeff. One on the devices, and this is super exciting. I was talking about immersive experiences, which is really going to enable the Edge devices. For Facebook today, if you look at Facebook has their VR device, Oculus VR. We are involved in really designing actually the complete design of the Oculus VR, and one of the core chips, which powers the Oculus VR, is completely designed and developed by us. So this is the real immersive experience we are enabling. The second one, again, on the devices side, If I talk about, not many of us would know, Google Pixel phone, the image processor inside the device is being built along with Google. That's the second one. And the third one, I cannot talk, this last week we have seen Virgin Galactic, Richard Branson, getting into space. Today, Jeff Bezos is getting into space. One of the things, you know, when Amazon launched their 1,000 satellites called the Kuiper program, one of the core components inside the Kuiper component, which it really enabled some of these Edge use cases we are talking about is designed by us. So those are the three things I can talk about from an Edge devices perspective. On an Edge platform, the one example I'm going to give is what we do for J&J, their robotic surgery platform. We really get into their stage software-enabled medical devices and robots across the companies to integrate it into one single platform, right? Where we have the Edge software, which really allows for data and video to be anonymous locally, and Edge hardware, which really provides a way of integrating all this connected medical devices to hospitals. So that's on the devices and the platform side. And Jeff can talk more about what we do on the 5G and the network side. -Yeah, thanks, Ram. You know, I think when you hear what Paul and Ram are describing, what's really interesting is it's about decisions that are made, and that's the hardest part for our clients right now, that all of this is lots of technology decisions, lots of business decisions, lots of outcomes need to be met. So it's really decisions that are made. I think that's where everybody on the call today has a really strong, important role to play. If you look at the type of work that we do, it really starts at what's the business outcome we're trying to impact, whether it's for a consumer or an enterprise. If it's worker safety on the enterprise side or productivity or it's what's the next device that we're going to leverage beyond the smartphone on the consumer side, what are the decisions that need to be made? And then once we figure out those decisions that need to be made, the strategy work around, how do you quantify that? How much is that worth? How much are we going to be able to actually see as an outcome? And then how do you decompose

those into the right use cases and the right technology required? And those decisions are really, really important. You know, Paul, myself, Greg Douglas recently had a conversation with one of the largest retailers in the world. And their big question to us was, hey, should I use a private network to deliver this in all of my 4,000 stores? Or can I get by with my Wi-Fi decision or do I need 5G? And how do you make that technology decision to really get to these results? So then you look at how do we get to compute in that continuum? There's also these decisions on Edge. Is the Edge going to stop at a regional data center? Could it move a little bit closer to potentially a telco central office, or could it move even further out where you can get more response? Ram talked about the law of physics, right? That latency is basically the distance traveled to the data, and the more we're pushing it out, the more valuable that becomes. But there's a point where the costs and benefits don't work out. So that decision on the Edge is incredibly important. So when you look at overall the type of work that we do, quantifying the business problem that we're trying to solve for consumers and enterprises, figuring out what are the right use cases, and then from those use cases, what's the right technology decision to unlock that, and then how can we potentially move into a pilot, how can Tracey and Ram help us scale that? How do we actually operationalize that and then actually run that for them is incredibly important. And you look at the types of clients we have. You heard it, the telco partnerships and the communication service providers like the AT&Ts, the Verizon, the Rakuten, and Dish, that's new players, as well as when you look at all of the actual consumers that we're impacting or the enterprises, and then how did the partners come into play? How do we orchestrate all that together? -So it's clear that Accenture has a lot to offer our clients. I mean, all of this sounds complicated, but we've got the right people, and the right skills, and the right expertise to help our clients figure this out. So, Paul, I'm curious. What's the value that the client sees in all of this? Why do they even start to explore this? What do they get out of it? -Well, I mean, it's it's the value in innovating. It's generating new growth for them, if you look at some of the examples that we're talking about. And it's kind of creating the new experiences for their consumers and their workers. We talked about worker safety. We talked about new consumer products and then operating their business more efficiently, digital manufacturing, bringing in new ways of working. So across the board, there's tremendous business benefits for our clients in moving to this world, and we're the ones that can enable that value for them.

Mythbusters

Okay, well, Paul, as you know, we like to play a few games here on the after show. So I thought we could do a little mythbuster game today with 5G and Edge. -I'm not sure I've been winning the games. As long as I have a chance of winning this time. -Well, maybe. Maybe I'll let you win. We'll see. And you guys are going to be a little creative in this one because I'm going to say a statement, and then the first one who buzzes in will have to tell me if the statement is confirmed as a myth, if we're going to bust the myth, it's not true, or maybe it's plausible and why it might be plausible. -How do we buzz in? -Well, that's where you get creative. You need to figure it out. Okay, so we talked about a lot of things that I thought sounded a little bit unimaginable, but you all tell me it's possible. So, I'm going to figure --- I'm going to say a statement, and then I'll leave it up to who can chime in and

tell me if it's a myth or not. So the first one is, when 5G shows up, I'll be able to get rid of my Wi-Fi. -Buzz . -Oh, go ahead, Paul. -And I think Jefferson should answer it. -Okay, you can't buzz all of them. -Okay, we'll play that game. So, I think that when you think about Wi-Fi and 5G, they're actually complementary. They're not going to replace each other in the near term. They're actually completely complimentary. When it comes to Wi-Fi it's really, really low cost to develop on and you get access to it, and it's needed for a lot of things. Like the traditional IT use cases, it's great on Wi-Fi. When it comes to mission-critical things, when it comes to mobility, true mobility where you can actually travel multiple kilometers or distances, 5G is a great, great solution for that. So, Paul, I'm ready to buzz for the next one so I can give it to you. -Alright, so that one we're going to say is a myth. We're going to keep our Wi-Fi. Alright, here's the next one. There's a war between Edge and cloud computing. -I'm going to buzz. -Okay, Ram. I'm not going to give it to Paul. I'm taking this. So, this is an interesting question because this happens when we talk with the cloud providers and we have been in multiple conversations with Gartner defining this market, right? So for us, Edge and cloud computing are highly, highly complementary. And this is something, which all of us need to embrace. What I genuinely see, not because I'm going to run in this, I really think Edge is what cloud has been in the last five years. So there's a lot of things that's going to move into Edge, but Edge cannot exist without cloud. So that's the second thing. So for us, back when Paul said we released this paper on cloud continuum, Edge is really a critical part of the cloud continuum, right? Cloud is still going to provide that insane amount of storage, compute resources, and decision makings on long-term data analysis. But, Edge is like we talked about, real-time decisions, latency-sensitive applications are going to reside on Edge. And for me, the magic is going to happen when Edge and cloud compute comes together. -Okay, so we busted that one as well. There's no war. They're actually working together. Alright, thanks, Ram. Okay, this next one's similar, Edge computing is reliant on 5G, myth or no myth? -I'm buzzing in for Teresa to answer, even if Paul won. -Or Paul. -Or Paul. -Okay, I'll jump in. Edge compute is not reliant on 5G. 5G is one of the mechanisms that can provide the connectivity, but we could have Edge solutions that are powered by 4G today. Edge computing, that's powered by satellite communications. Edge computing, that's powered by Wi-Fi in different modes. I think the excitement is that 5G offers such new capability and possibilities that it really expands the possibilities of Edge. -Okay, so that one is as a myth as well. Okay, I was going to guess that that one was true, but that's right because Tracey gave an example where using 4G, so that's great. Okay, here's the next one. The major benefit to Edge is real-time decision making. -Beep. The IT guy would get very upset if I do that. If it is not a myth, it is true, then one of the biggest benefits is going to be the real-time decision making by the machines themselves. And when we think about, particularly in production, the ability to have really high speed, highly reliable closed loop automation, that's going to drive the decision making in a split second and change an outcome of a process, I think it's going to be the next big wave. -Okay, great. And our last myth or not myth, Edge computing and IoT are the same thing. -Okay, I'm going to take this one. So, while it's plausible, Internet of Things and IoT is first-generation Edge. You really need the ability to sense to see what's happening. But as the first step, you're going to get a lot more value when you can analyze and act right at the Edge and anywhere in between. -Okay, so a bit of a myth there. Plausible, though. There is something there. -Plausible. -Yes, okay, well thank you guys. I could keep going, and we could keep talking about this topic as always on these shows. It's very interesting that

we could spend hours on it, but I'm not going to take up any more of your time. I love the mythbuster's game, so thanks for playing along. And I think with that, we're going to have to end and wrap up. So thanks, Paul, for cohosting with me, and we're going to wrap up this show on 5G and Edge, but remember, you can always head over to the TQ home page. You can get a lot more content. You can get case studies. You can get study guides on this topic, and there's always more to learn. So thank you for joining us today. We'll catch up soon on the TQ HQ for our next TQ topic. And until then, happy learning! -Thanks, Sarah. -Bye everyone. (Music Playing).

5G In Review

What is 5G?

What is 5G? It's the fifth generation of mobile network technology, but it's so much more than just an enhanced 4G. It represents a fundamental transformation of the role that mobile technology can play. 5G brings greater speed and capacity than we have ever experienced before. Let's talk about speed. The lag between when you start an action and when the network responds is called latency. In the 4G world, that latency or response time is usually between 50 and 90 ms. But in the 5G world, latency is under 1 ms. That's almost real time. For comparison, that's even faster than the average human response time, which is about one quarter of a second. So yeah, 5G is much more responsive with lower latency, but we also need to talk about capacity. Capacity is how many devices we can connect to the network. In the 4G world, we can only connect about 100,000 devices per square kilometer. So your smartphone, your neighbors' smartphones, and everyone's cellular mobile are all adding towards that capacity. In the 5G world, we will be able to connect approximately 1,000,000 devices per square kilometer. That kind of density means we can connect all kinds of devices to the internet using 5G cellular technology, things like drones, extended reality headsets, self-driving cars, and even robots. For you, that means a significantly faster mobile internet experience, innovative experiences, and new devices beyond the smartphone. But businesses will experience a sea change in what they can do. They will be able to connect farm equipment, factory robotics, and all sorts of devices we haven't invented yet. All this means better security and higher network reliability for mission-critical operations. 5G, it's the future.

What does 5G do?

What does 5G do? To answer that, we'll have to take a trip back in time all the way back to 1G. Of course, we didn't call it 1G back then. It was just mobile communications. The cellular revolution in the 1980s started by enabling users to make calls wirelessly over original analog voice networks. But as technology advanced in the 1990s, we had to admit that a second generation of mobile technology was here, and 1G didn't cut it anymore. 2G brought voice and text capabilities, digitization, mobile roaming, and short text messaging. 3G ushered in the smartphone age in 1998 by enabling multimedia, text, and internet access. Devices became divergent. You had

your flip phone for communication, you had your laptop for productivity, and you had your iPod for music. In 2010, 4G unlocked the mobile internet to make video streaming and community gaming over wireless networks commonplace. 4G brought convergence. Your communication, productivity, and music were all together in one device, the smartphone. And now, finally, we can talk about what 5G does. 5G is more than an enhanced 4G. Each of the previous generations were enhancements of the previous one, and all of them were one too many, meaning that everybody using them had to share the communications network with everyone else. But 5G makes it possible for the first time to develop virtual one-to-one networks. This means greater security and near real time response for everyone on that network. 5G, it's reinventing what connection really means.

Why does 5G matter?

Why does 5G matter? Because 5G is happening, ready or not. When 5G comes, it will enable innovation, new markets, and economic growth around the world. Tens of billions of new devices will connect to the internet through 5G technology and the edge. 5G will make the unimaginable happen, sparking new models, services, and products. Let's take a look into a crystal ball and see some of what is likely to happen in the 5G world. 5G will provide broadband experience anywhere at any time. It will connect transportation networks, paving the way for reliable, safe autonomous vehicles that communicate in real time with sensors embedded in roads, railways, and airfields. It will expand and increase control of remote devices, things like autonomous heavy machinery, factory automation, real-time monitoring of warehouse process conditions, and even remote surgery. 5G will bring safer child monitoring, better surveillance, and smart houses. Imagine living in a smart house that proactively takes care of your children by locking dangerous areas when there are no adults in the house. It will transform traditional infrastructure, allowing us to build smart cities and distribute energy efficiently, and it will open the door for businesses to enter entirely new industries outside the traditional area. Real estate developers may design entire cities, or you might start a company that changes the world. 5G, it matters because it's coming, and you can't afford to miss it.

How is 5G applied?

How is 5G applied? Well, it's better to talk about how 5G will be applied once the infrastructure for it is in place. In the near future, you will see many use cases in which 5G will change lives and even save them. You've probably heard the old question, if a tree falls in the forest and there's no one around to hear it, does it make a sound? Let's turn it around a bit and ask, if a tree falls on some electrical equipment out in the field, does it still start a wildfire? If you have a modernized, intelligent power grid enhanced with 5G technology, the answer is no. Why? Because 5G makes it possible to use automated infrastructure inspection to prevent a tiny fire from turning into a big blaze. Let's take a closer look. Vegetation coming into contact with electrical equipment is a primary cause of fires. Dry vegetation meets hot equipment, and poof, you have yourself a small fire. Automated infrastructure inspection can prevent that small fire from growing into a conflagration by using drones to do real-time aerial surveying and artificial intelligence on the ground to analyze imagery and identify problems. The

intelligent grid uses 5G connectivity to accurately monitor the entire grid using sensors and edge computing devices. The quality of the video stream, along with processing speed, need 5G reliability to react to emergencies in real time. Thanks, 5G.

How does 5G work?

How does 5G work? Most people don't think about how any of the Gs work if their phones and computers can still access the internet. But we're curious people, so we want to know, how does 5G work? 5G is a wireless technology, meaning it travels invisibly through the air via radio frequencies called spectrum. So does 4G, but 5G uses a different range of spectrum, and it needs a different kind of infrastructure to get you a strong, clear signal. The big cell towers that you're used to in the 4G world will disappear and be replaced with a complex web of large macro cell towers and many small cell sites across the landscape. Those cell sites are small boxes located on street lights, bus shelters, and inside and outside buildings. 5G signals travel from macro towers to small cell sites and finally to the end users through radio frequencies. The high band frequency used in 5G delivers very fast gigabit speeds, but it has a very small range, a few hundred meters or less, and its signals are easily blocked by walls, trees, people, and even weather. That's why we need to install thousands of small cell site locations throughout an area to provide good 5G connectivity. Without that infrastructure, you can't experience the full benefits of 5G.

What is Accenture's role with 5G?

What is Accenture's role with 5G? Since 5G has not fully arrived just yet, we leverage our knowledge and experience to help our clients prepare for all that 5G will bring in the future. When we work with 5G, most of the time, we focus on our large Telco 5G relationships with partners such as AT&T, Verizon, TELUS, and Vodafone. They will eventually roll out 5G that will cover a large part of the world's population because 95% of the world's population is concentrated on only 10% of the world's land. However, many of our clients conduct their industry and agriculture on that other sparsely populated 90%. That is why we formed a strategic partnership and business group with Nokia. NABG, the Nokia Accenture Business Group, allows us to deploy private 5G in remote areas. We recently worked on a proposal for a major mining client in which the client needed a 5G network in their mines and on the surface to communicate with their people, run their equipment, and collect mining safety and sensor data. By partnering with Nokia, we can deploy a private 5G network in an area of land where commercial 5G would never be deployed. Without that capability, Accenture could not deploy the critical systems that our mining clients need to operate and innovate.

Course author

Accenture

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