**Build 2018**

**Satya Nadella**

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**ANNOUNCER:** Please welcome Satya Nadella.

(Applause.)

**SATYA NADELLA:** Good morning and welcome to Build 2018, welcome to Seattle. It's fantastic to see you all back here.

You know, this morning, I got up and I was reading the news, and I hear Bill Gates is talking about stock, and he's talking about the Apple stock. And I said, wow, in the 30 years that at least I've known Bill, I've never seen him talk about stock, but today must be a new day for sure when you hear Bill talk about Apple's stock. So that's the new Microsoft for you. (Laughter, applause.)

Last year, we talked about opportunity and responsibility. And both those topics have been so far amplified, it's unimaginable. In fact, for the first time here last year is when I started talking about the intelligent edge.

And 12 months after, it's everywhere. In fact, at this conference it's going to be something that we will unpack in great detail. The platform advances are pretty amazing.

But most importantly, it's the developers who are pushing these platform advances. So to see the intelligent edge go from some sort of a conceptual frame to this real thing that's shaping the cloud is stunning.

Last year, we also talked about this notion of responsibility and that none of us wanted to see a future that Huxley imagined or Orwell imagined. And that's now become a mainstream topic of discussion.

And so I was thinking about the historical parallel where there was this much change, this kind of opportunity, this kind of tumultuous discussion, and I was reminded of a book that I read maybe three years ago by Robert Gordon, *The Rise and Fall of American Growth*. And in there he, in fact, talks about the Industrial Revolution and even contrasts it with the Digital Revolution. He gives the PC credit for the last time digital technology showed up in our productivity stats, which is nice, but in general he sort of talks about what an amazing revolution the Industrial Revolution was in terms of its broad sectoral impact in productivity and growth.

This is a picture of New York City, probably 1905, I'm told, Flatiron Building, and what you see is horse carriages.

And if you go to the next picture, this is 20 years after. And you see all the artifacts of the Industrial Revolution and its diffusion. You see the automobile. These buildings now are beginning to have sewage systems, drainage. Air conditioning is coming, radios, telephones, high-rises. It's pretty amazing.

But there's one other salient piece to this. The core technologies of the Industrial Revolution, whether it's the internal combustion engine or electricity, are nowhere to be seen, they're invisible.

And I'm reminded of this Mark Weiser quote: "The most profound technologies are those that disappear, they weave themselves into the fabric of everyday life until they are indistinguishable from it." This is from his very influential paper early '90s when he was at Xerox PARC.

And that's what's happening, that's the opportunity that we see. The world is becoming a computer. Computing is getting embedded in every person, place and thing. Every walk of life in our homes, in our cars, at our work, in our stadiums, in our entertainment centers, every industry, from precision agriculture to precision medicine, from autonomous cars to autonomous drones, from personalized retail to personalized banking, are all being transformed.

In fact, if you think about the sheer computing power that is getting distributed, and how that computing power is being used to collect data, fuse sensor data, reason over that data, create the rich experiences throughout our life, it's pretty stunning.

That's the opportunity that we have. It's in some sense endless.

But we also have a responsibility. We have the responsibility to ensure that these technologies are empowering everyone. These technologies are creating equitable growth by ensuring that every industry is able to grow and create employment.

But we also have a responsibility as a tech industry to build trust in technology. In fact, Hans Jonas was a philosopher who worked in the '50s, '60s, and he wrote a paper on *Technology and Responsibility*. He was not referencing as much the digital tech. And a lot of his work got picked up later in bio-techs and other fields. But he talks about "act so that the effects of your action are compatible with the permanence of genuine life."

That's something that we need to reflect on, because he was talking about the power of technology being such that it far outstrips our ability to completely control it, especially its impact even on future generations.

And so we need to develop a set of principles that guide the choices we make, because the choices we make is what's going to define the future.

We are focused on three core pillars, first privacy. Privacy is a human right. We at Microsoft have enshrined a set of principles that ensure that we preserve this human right, protect this human right. We ensure that when we use data, it is to benefit the user. We ensure that the user is always in control of their data and its use.

GDPR is a sound, good regulation. We have been working hard to ensure compliance with it by end of this month when it becomes in effect. We have hundreds of engineers across the company building the compliance infrastructure. In fact, we're going to help our customers who use our products and services get compliant.

But we know that this is just the starting point. It's just like security, we're never going to be done. We are going to continuously commit ourselves to work to preserve privacy.

Same thing with the CLOUD Act. No company has done more in terms of working hard to ensure that there is a framework of law that governs how legitimate governments and legitimate needs of governments to protect their citizens are balanced with privacy.

We have had four cases against the U.S. government that we've litigated since 2013. One of them went all the way to the Supreme Court.

While we were litigating, we were also working with both sides of the aisle on the legislative process.

And so we think the CLOUD Act is a good start. It creates a framework. We hope the rest of the world and the United States can create, in fact, an intergovernmental framework around this.

And meanwhile, we will continue to do what we have done, which is to ensure that customers are in control and privacy is preserved.

Cybersecurity. We need to act with collective responsibility across the tech sector to help keep the world safe.

We recently formed a program to protect our democracy where we're going to work with the campaigns, the civic society, other constituents, so that we can secure our political process, our democratic process.

We also led a consortium of 34 tech companies with the Tech Accord to ensure that citizens across the world are protected from cyber-attacks. It's the Digital Geneva Convention of our time.

Ethical AI. We need to ask ourselves not only what computers can do, but what computers should do. That time has come.

We formed an ethics board inside the company, which is a very diverse group of people who govern the products we build, the projects we engage in.

But beyond that, we are also investing in tools, because one of the key things that we have to do is put tools in the hands of developers, designers. Just like with good user experience and UI, we need good AI. We need to make this a first-class engineering discipline where the choices that we make can be good choices for our future.

You know, we're used to data sheets for software systems. We've always had these data sheets where the input/output was specified and we could reliably use software systems. We need the same for data, we need data sheets for data so that we can know where the data came from, what are the intended uses.

Debiasing word embedding, there's some amazing advances in AI around language. Except we train on the corpus of language that's out there. And unfortunately, the corpus of language that's out there has our biases. So we need the tools that can debias these word embeddings that we learn, because of the state of the art of AI.

We also need privacy-preserving AI or private AI. In many cases, you need to be able to take data, have it cross even organizational boundaries, and to be able to do that by using techniques like homomorphic encryption so that you can learn, train on encrypted data. We're already working on some of these technologies. We have libraries that work with things like Azure ML. And we're working with the healthcare and pharma industries.

So these are investments we are making today to ensure that we can all collectively make ethical AI choices.

This is what grounds us, this opportunity and responsibility is what grounds us in our mission to empower every person and every organization on the planet to achieve more. We are focused on building technology so that we can empower others to build more technology.

We have aligned our mission, the products we build, our business model, so that your success is what leads to our success. There's got to be complete alignment.

So this conference and the rest of my talk is about creating that opportunity for all the developers in the room.

We're focused on two massive platform opportunities, one, Microsoft Azure, the other Microsoft 365. And both these platform opportunities are being shaped by one major shift in the technology paradigm, the shift to the intelligent cloud and the intelligent edge.

And there are three foundational technologies that are impacting this shift. The first one is ubiquitous computing. The world's applications going forward need a ubiquitous computing fabric from the cloud to the edge. They need a new app model that is distributed, event-driven and serverless. That's what we are building with Azure.

Azure is being built as the world's computer. It already has 50-plus regions, 70-plus certifications, more regions and more certifications than any other public cloud. And that's so that we can meet the real world needs of customers, their digital sovereignty needs, their regulatory needs.

But we're not stopping there. In fact, as computing spreads, as there is need for computing at the edge, we are building out Azure, Azure Stack, Azure IoT Edge and Azure Sphere as this one computing fabric that supports this new application model.

And so let's dive right into it, let's take one at a time, Azure. We've had something like 130 new capabilities that we have shipped in just the last year in Azure. The pace of innovation is pretty stunning. In fact, there is 70 of them that are going to be launched just at the Build conference.

And, of course, we have all the customers, the brands you saw in the previous slide. It's amazing to see year-over-year growth of Azure in terms of how deeply some of these brands rely on Azure.

And Azure Stack, which is just a year old, is supporting multiple scenarios. For example, Chevron is using it so that they can essentially have Azure in a disconnected way at their oil rigs.

A bank in South Africa, ABSA, is using it for their regulatory workloads, as well as using the public cloud, Azure.

And then Schlumberger is actually doing distributed computing. So they use the public cloud, as well as Azure Stack, as one fabric to be able to distribute compute so that it's close to where the data is.

So these are all new scenarios, which are pretty unique to Azure and what it can do.

Azure IoT Edge, again phenomenal to see the progress. It runs both on Linux and Windows as first class, and we're pushing on Windows to make the management security with both Windows IoT and Windows 10 so that this runtime is well-integrated.

In fact, with Windows ML we now have an inference engine for AI that works with the IoT runtime and will be hardware accelerated.

And today, I'm really pleased to announce that we're going to open source the Azure IoT Edge so that developers can extend it and contribute to it and take it to all the places that it's needed in.

We already have significant momentum, customers such as Starbucks, Ecolab, Schneider Electric, Rockwell Automation, many, many customers, and over 230 partners who have certified over a thousand devices already for the Azure IoT Edge.

And today, I'm really thrilled to announce a new partnership with Qualcomm, who is going to bring a new Qualcomm-accelerated camera for scenarios from home security to industrial safety, and releasing a computer vision toolkit with it, so you can in fact run a container that's been trained in the cloud and deploy it right on the camera for computer vision. And this is going to be available by end of the year for developers to deploy.

I'm also thrilled to announce a partnership with DJI, a leader in civilian drones and aerial imagery.

DJI is doing two things. One is they're launching an SDK on Windows 10 so developers building commercial apps for a variety of different vertical industries now will have full access to the drone, both the data as well as the flight plans. So you can imagine what you can do in agriculture, industrial safety. Many of these applications can get written on Windows as the control plane for the autonomous drone.

And we are also integrating Azure IoT Edge right into the drone itself so again you can deploy compute, AI models that have been trained in the cloud to the edge right on the drone.

And to complete the picture, Azure Sphere. This was announced at RSA just last month. It brings together secure silicon design, a secure operating system, as well as a security and a management service altogether so that 9 billion-plus microcontrollers that ship each year -- I mean, talk about a business opportunity for all developers, 9 billion new compute nodes. And you can think of that as just part of Azure, same programming model, same toolchain. And so this is what we're building out as one ubiquitous computing fabric.

And so I wanted to roll the video of Azure Sphere, and then I want to have Sam George from our Azure IoT team come up and show you some of this stuff in action.

Sam?

(Applause.)

(Video segment.)

(Applause.)

**SAM GEORGE:** Thanks, Satya. Good morning, everyone.

The Internet of Things is transforming how companies do business. With devices collecting real-time information about products and assets, it's never been easier to benefit from IoT, and those benefits include: eliminating downtime, reducing environmental impact, and delivering breakthrough products innovations.

Today, Rockwell Automation is delivering industrial automation solutions across infrastructure, manufacturing, power generation, and so much more.

They've been using Azure IoT already to connect to the equipment that powers these industries, and using Azure Services to predict the maintenance needs and eliminate downtime for them.

So let's look into the future at some of Azure's new intelligent edge capabilities that Rockwell Automation will be using to detect visual defects and anomalies automatically.

Now, for context, as devices and sensors generate more and more data, such as video data, it's more practical to deliver compute and AI right down to the devices themselves. Now, this is where Azure IoT Edge comes in.

Azure IoT Edge enables Azure Services as well as your own code to escape the cloud and be deployed directly down onto devices and managed remotely -- all on devices smaller than a Raspberry Pi, or as large and capable as the solution calls for.

To see this in action, let's take a look at Rockwell Automation's operational dashboard.

Now, in this dashboard, I have two alerts. One is inside the building, and the other is up on the roof. Let's take a look at the one inside the building first. And when I click on it, I see the image of an anomaly that was captured.

Now, this anomaly was detected by a camera produced by Qualcomm in partnership with Microsoft. It has rich compute and AI capabilities, and it runs Azure IoT Edge.

Now, to power this, we've used Azure Machine Learning to build an AI model, and packaged it up in a Docker container, and then deployed it to this camera. Because we're using this technique, we can deploy it to millions of these in minutes.

Through various talks this week, you're going to see us show you exactly how easy it is for you to do the same thing.

Now, with Azure IoT Edge and our AI models running locally on this camera, it means Rockwell doesn't have to send all of that video to the cloud. Instead, they can simply send alerts. It also means they don't have to manually inspect all those pipes.

Now, our AI model detected a stress fracture, and if left untreated, it can be very dangerous.

So I'm going to create a ticket in Dynamics 365 to dispatch a technician. Great. So back on our dashboard, the second alert is a pressure drop in a pipe up on the roof.

Now, environments like this can be dangerous to technicians, and very costly to organizations to deploy them. So this really calls for a solution with a new perspective.

DJI is the world's leader in drone technology. From ready-to-fly consumer products to highly configurable industrial platforms capable of doing jobs that are dull, dirty, or just dangerous. And, like us, they give people the tools they need to bring their innovations to life.

Microsoft is partnering with DJI to bring Azure IoT Edge right to their drones. And this is significant because it means any Azure developer using Azure Machine Learning can develop AI models and deploy them to their drones.

It also means I can take that same AI model that went to the Qualcomm camera and deliver it to the DJI drone.

Now, this incredible drone is a DJI M210 RTK and it's capable of running Azure IoT Edge right on board. This smaller drone is a DJI Mavic Air, and it's perfect for learning the principles of flight and for developing and testing your AI models.

Now, it's all well and good to talk about drones, but I bet you'd like to see me fly one, and I would love to, but unfortunately, in a room like this, you need a commercial drone pilot license to do that, and they're incredibly hard to get.

So for that, we're going to welcome Francisco from DJI out to the stage to fly for us. Come on out. (Applause.)

Now, Francisco is going to be flying the DJI Mavic Air over the pipes that you see here, which represent the ones 150 feet up on the roof. And the Mavic Air is going to be streaming video back to the laptop here, which is running Azure IoT Edge as well as our AI model, all packaged up in a great UWP app.

And when it sees the anomaly, it'll draw that same yellow bounding box that you saw with the Qualcomm camera. All right, let's check it out.

Now, as you can see, we're detecting that anomaly in real time. But for the first time ever, we're able to stream video back from that drone to this laptop running IoT Edge and our AI model, which was developed in the cloud. And as I mentioned, the M200 will be running that right on board.

Great, thank you, Francisco. (Applause.)

Now, that anomaly was pretty easy to see, but in the real world, there's hundreds of pipes over thousands of miles, so solutions like this will save Rockwell significant time and expense.

Now, if you're eager to try this out, DJI is offering an early release of the Windows SDK exclusively to Build attendees. Stop by their booth, check it out, and try it for yourself.

You've just seen two instances of the intelligent edge in action, deploying the same AI model to both the Qualcomm camera as well as the DJI drone. And the best part is, as I find new defects in my model and retrain it, I can deploy that out in minutes to millions of devices, immediately making the intelligent edge even more intelligent. Thank you. (Applause.)

**SATYA NADELLA:** Thank you very much, Sam and Francisco. That was fantastic to see.

Moving to the next key technology, which is AI. In fact, you saw some of that in action in the drone. So let's just unpack that more.

You know, when it comes to AI breakthroughs, Microsoft has had many. If you look at just 2016, that has been the first time we had the 152-layer ResNet that achieved human parity in object recognition.

We then went on to achieve human parity on speech recognition using the Switchboard data set. We now have the joint leadership on the Stanford Q&A data set when it comes to machine reading and comprehension, which was just in January of 2018. And then in March of 2018, we achieved human parity around machine translation. You will see the pace with which these breakthroughs are coming.

You know, but the one thing that I think about as a platform company, as a tools company, is in some sense, who cares about breakthroughs we achieve? What matters is can we translate these into frameworks, tools, and services, and put them in your hands as developers so that you can take AI and have impact in every industry in every application? That's what's important. We truly are committed to, in some sense, commoditizing AI. We have to go from sort of talking about AI being in the hands of a few companies, to being a place where AI is everywhere. It's in the hands of every developer and every organization. That's the next real shift.

And that requires us to be able to scale, first of all, AI across both the cloud and the edge, we need to have the most productive tool chain to be able to create AI and customize AI.

And then you need openness when it comes to frameworks and infrastructure. They can't be locked in.

And that's what we're working on. In fact, Azure Cognitive Services, you know, he last three years, have gone from, again, early releases to full-fledged services. We have the most number of Cognitive Services, 35-plus services that are available to developers today, spanning speech, vision, language, machine translation.

But the key is that you can customize these. In other words, you can bring your data, your label data and use it to customize the models and then deploy the models where you need it inside your applications. And there are many, many customers. And this applies across vision, speech, and language, and we have many customers already doing this.

In fact, Coca-Cola used computer vision in a very innovative marketing program. BMW is building their own personal assistant for their car that's branded by them. Twitter uses our machine translation to be able to translate every tweet. KPMG uses, in fact, speech for compliance. NBA uses semantic search.

RIT is a fantastic case study of using machine translation and speech recognition to make classrooms inclusive. They customize it by teaching these systems the specific subjects. I mean, think about what it can do for an inclusive classroom.

But these Cognitive Services are also ushering in many AI-enabled devices. In fact, Huawei has built a broad range of devices. Their Mate 10 includes our machine translation and does even offline translation using their NPU on board.

Xiaomi worked with another travel company, Sanjoy, and brought a new device, which is so phenomenal because what it does is it uses speech recognition and machine translation to give every Chinese a traveler a far-field device to be able to communicate with anyone else without the language barrier.

It's pretty amazing to see this device in action without the awkwardness of a phone that you're trying to thrust in front of someone.

So in order to really democratize the creation of more of these types of AI-powered, AI-enabled devices, I'm really thrilled to announce a speech device SDK as well as reference kit that Rubel, which is one of our OEM partners and ODM partners out of China has built, this is a microarray speaker that you can take and deploy in any device. Many industrial applications now get built by recognizing ambient noise and signatures, and so these are devices that can be built by developers for even low-volume scenarios in the enterprise market, as well as consumer applications.

And talking about these AI devices, Kinect, when we first launched it in 2010, was a speech-first, gaze-first, vision-first device. It was used in gaming, and then later on it came to the PC and it was used in many applications -- medical, industrial, robotics, education.

And, in fact, I remember distinctly going to a children's hospital in Chile and seeing it used for remote physical therapy. And so we've been inspired by what developers have done, and since Kinect, we've made a tremendous amount of progress when it comes to some of the foundational technologies in HoloLens.

And so we're taking those advances and packaging them up as Project Kinect for Azure. And this Project Kinect for Azure is going to have some of the best spatial understanding, skeletal tracking, object recognition, and package some of the most powerful sensor together with the least amount of depth, noise, and also have ultra-wide field of view.

And so this set of sensors, we expect to be fully integrated into many different applications, both on the consumer side as well as the industrial side.

The next big area of AI is conversational AI. It was two years ago when we talked about bots as the new applications. Every company will build branded agents. It's pretty critical, because if these are the new apps, you need to be able to brand them -- especially the consumer-facing ones. It's not sufficient to just build skills for others' agents, but you need to be able to have your own agent that can directly talk to customers. And every agent should be able to converse across multiple personal digital assistants.

And we now see a tremendous amount of momentum with all these technologies. In just two years, we've seen many customers build both customer-facing, employee-facing bots for a variety of different use cases.

Let's just roll a video to show you what customers are doing with bots.

(Video: Conversational AI.)

(Applause.)

**SATYA NADELLA:** And at this conference, we're launching 100-plus new features for the Bot Framework so that you can continue to build these conversational interfaces and give them more of the customization. So, for example, you can have a custom wake word, you can give it custom speech, you can even give it custom personality, take some of the FAQs and turn them into Q&A. And then take the corpus of data you have in terms of conversations and use that as label data to have a full dialogue system.

So amazing stuff for you to be able to build much more sophisticated conversational applications.

We also have the capability to be able to take the applications you build and then have them show up in all channels of personal digital assistants. So having done all the hard work of having built one conversational interface, you want to have the maximum reach as a developer. So that means you should be able to publish it in Cortana, you should be able to publish it in Skype, in Facebook, and we have now 16-plus channels, by just simply registering the channel, tagging the intents, you can have your conversational interface show up everywhere.

This is, I think, one of the key concepts that we want to make sure we get across is the separation of how you build the conversational dialogue system and the tool chain you need, the sophistication of that tool chain so that you can build a branded asset from where all it shows up. They don't need to be coupled, and that's what we're enabling.

When it comes to tools and frameworks, it starts with having the best data estate. And Azure, you'll hear from Scott later about our data estate. Last year, we started talking about Cosmos DB, it's one of the fastest-growing databases today to what we've done with SQL and our data warehouse and our data lake, because you now have the ability to bring all your data in its native form and then have a best tool chain for you to be able to prep that data, to iterate on it, to build your models, and then to deploy them where you need it, either using our batch services or our Kubernetes service.

So that tool chain is what's going to be very, very critical to be something that gives you that productivity edge.

So there's one other thing, which is we want to make sure there's openness in every layer. Just because you like one of the frameworks, in fact, you should be able to choose any framework. You should be able to choose CNTK or TensorFlow or PyTorch or MXNet -- any framework of your choice.

Use those frameworks, using this tool chain to build your model, and then you want to be able to deploy it on the infrastructure. And even there, we worked with Facebook to create this Open Neural Network Exchange, ONNX, which is supported broadly now by all of the frameworks I mentioned, as well as the hardware acceleration from Intel, from Qualcomm, Nvidia. It's supported two inference engines -- Core ML on iOS as well as Windows ML supported.

So that means you have this intermediate representation between your frameworks and the hardware so that you don't get locked in. Just because you love one framework, doesn't mean you get locked into one particular neural processing unit. So we want to open that up.

And talking about AI infrastructure, I'm really thrilled to announce the preview of Project Brainwave. Project Brainwave is a distributed, real-time AI fabric that, today, is working with FPGAs from Intel to bring the best-in-class, real-time AI, low-latency AI capabilities and inferencing capabilities.

It has 5X lower hardware latency than TPU for real-time AI, and this is going to be available in preview for developers. And we're also going to extend it all the way to the edge. We're working with our system partners to take FPGA and make it available wherever Azure is available.

And we have many customers who have these high-precision and high-throughput needs who are working with us. And one such customer is Jabil. So let's roll the video to show you how they're using FPGA for real-time AI already.

(Video: Ambient Jabil.)

(Applause.)

**SATYA NADELLA:** So that brings me to the final major technology that's shaping this shift, which is multi-sense, multi-device experiences.

Microsoft 365 is the coming together of Windows and Office to build this multi-device, multi-sense experience, service, and platform. And it puts people at the center, versus devices at the center.

And it's easy for us to think about this by look at what happens and how you interact with Microsoft 365. You may pick up a phone and use Outlook Mobile in the morning, you're in the car, you're joining a Skype meeting because Skype is embedded in the car dashboard. You come to work, you work on a PC, on Word, and you're collaborating with someone from across the country. You're in a meeting where you have a large-screen device like the Surface Hub.

During a single day, you're using multiple devices, you're at multiple locations, working with multiple people, and interacting using multiple sensors. That's the world we already live in.

We need an operating system, we need a platform that abstracts the hardware at that level, that creates an app model at that level. Single devices remain important, will remain important, but this meta orchestration is what we need to do. We need to up-level even our concept of what an operating system is. And that's what Microsoft 365 does.

In fact, we can start as a developer right at least in the case of Windows where a lot of our applications are, which is on the desktop, on your laptop.

With Fluent, you can modernize for the mouse and keyboard, a Win32 app, a WPF app, a universal app, every one of these applications can be modernized using Fluent.

Of course, applications are not just rectangular windows anymore. You can add sensors. So you can add ink, you can add speech -- both far field and near field. This holiday season, you're going to have every PC, just like how they had touch, going to have a lot more of near-field and far-field with wake words or wake-on-voice capable devices out there. You can have mixed reality, you can have games, so you can add application richness with multiple sensors.

But also, the applications themselves are going to be multi-device. In fact, at this conference, you're going to see how we're taking the Windows Shell and using, essentially, the same set of APIs in Microsoft Graph to extend the shell.

Timeline, that Joe will talk more about tomorrow, allows you to go from the phone to the PC and back and complete your task as one continuous stream. In fact, I think of Timeline allowing me to treat the phone as a second screen to the PC.

And we're also introducing new capabilities for the phone. This is your ability to, in fact, take the phone and treat the PC as a second screen. So these are multi-device extensions of the shell.

Office is built, by definition, as a multi-device service. So you can be on a Mac with Teams, an Android phone with Teams, and you can build a bot that integrates into Teams.

You can have an adaptive card that integrates. Basically allows you to take your service and the action on the service is showing up as an adaptive card in Outlook either on a phone or on a PC.

You can also have Excel call a cloud function. So you can go to Azure and use Azure Functions to write a machine learning or an AI module that gets called by Excel using its cloud function functionality.

These are all things that are extensions of Microsoft 365.

Perhaps one of the most quintessential multi-device, multi-sense surface areas is Cortana. Cortana is part of Windows Shell, it's built into Outlook, it's going to be built into Teams. It has these unique capabilities. It has unique capabilities around scheduling meetings, transcribing meetings, keeping commitments. It saves me every day because it knows the mails I send where I commit to things and it reminds me of those.

And I already talked about how something like the Bot Framework can be used to build skills for Cortana as well as many other surface areas.

There's one other thing that we've been doing with Cortana, which is ensuring that Cortana can even converse with other personal digital assistants.

We want to make it possible for our customers to be able to get the most of that personal digital assistant, not be bound to some single walled garden, and for developers to have access to the maximum number of users.

And so we've been working with our friends across the lake at Amazon to really bring Alexa and Cortana together to benefit every user and every developer out there.

And to really show you this, I wanted to introduce up on stage Megan Saunders from Microsoft and Tom Taylor from Alexa.

(Applause.)

**MEGAN SAUNDERS:** In my real life, I go to the people I trust for advice. I talk to my mom about my teenagers, which is pretty often now. I talk to Joe B. about my hair, and in the ambient world, we believe that assistants will work together each and every day to help us.

**TOM TAYLOR:** Thanks, Megan. It's really been great working with you and the rest of the team here at Microsoft with Alexa and Cortana.

At Amazon, we believe voice will make customers' lives easier at home, at work and everywhere in between. We share a vision that there will be many successful intelligent agents working together to provide customers a more helpful experience.

Now, we all know it's early days, but I'm very excited to show the progress, so let's do it.

**MEGAN SAUNDERS:** Okay, you go to your office, and I'm going to go to my house.

**TOM TAYLOR:** Okay.

**MEGAN SAUNDERS:** Now, at my house, we have an Echo in the kitchen. But it's Cortana that manages my schedule and my e-mail. And to get my day started, coffee is very important, and I like milk. But with ravenous teenagers, we are often out.

Alexa, add milk to my shopping list.

**ALEXA:** I've added milk to your shopping list.

**MEGAN SAUNDERS:** Alexa, open Cortana.

**CORTANA:** Cortana here, how can I help?

**MEGAN SAUNDERS:** How's my day?

**CORTANA:** I'll take a look. I see two events for today. First up, at 5:30 p.m., celebration with Tom at Harvest Vine. And then at 8:00 p.m., pick up Maddie from soccer. What can I do for you?

**MEGAN SAUNDERS:** Send an e-mail to Tom Taylor saying, "I'll see you tonight."

**CORTANA:** Sure. I'll e-mail Tom Taylor. "I'll see you tonight." Ready to send it?

**MEGAN SAUNDERS:** Yes.

**CORTANA:** Great. I've sent it. How can I help?

**MEGAN SAUNDERS:** I'm done.

**TOM TAYLOR:** Very cool.

**CORTANA:** Later. (Laughter.)

**TOM TAYLOR:** I love being able to talk to both Cortana and Alexa on my PC. Let me show you how they help me through my day. Oh, I see I have an e-mail from Megan about dinner tonight at Harvest Vine. Hey, Cortana. Where is Harvest Vine?

**CORTANA:** Harvest Vine is about two miles away at 2701 East Madison in Seattle.

**TOM TAYLOR:** Better get going. Hey, Cortana, open Alexa.

**ALEXA:** Hi there, this is Alexa, how can I help?

**TOM TAYLOR:** Get me a ride to Harvest Vine.

**ALEXA:** There's an UberX two minutes away from your Alexa address. Should I order it?

**TOM TAYLOR:** Yes, please.

**ALEXA:** Okay. Requesting your ride. This may take a few moments. Would you like to continue?

**TOM TAYLOR:** Yes.

**ALEXA:** Okay, your Uber driver, Sarah, is arriving. Look for a Toyota Camry. What's next?

**TOM TAYLOR:** Turn off the lights, please.

**ALEXA:** What else can I help you with?

**TOM TAYLOR:** What do you think about Cortana? (Laughter.)

**ALEXA:** I like Cortana. We both have experience with light rings, although hers is more of a halo. (Laughter.) Is there anything else? (Applause.)

**TOM TAYLOR:** Thanks, that's it. (Applause.) Just a few of the things that Alexa and Cortana help me do throughout my day.

Well, Megan, it's really been great to be here with you today. I can't wait to see what customers do.

**MEGAN SAUNDERS:** Yes. We're really excited about the first step in a longer journey as intelligent friends, both in the real and the ambient world.

Now, we're committed to meeting customers wherever they are on whatever device is most convenient for them. This experience is still in a limited beta, but you can go to this website to be notified when we go live.

Now, for all of you developers out there, building skills for Cortana and Alexa is going to enable access to more people across more devices, and we can't wait to see what you will build. Thank you.

(Applause.)

**SATYA NADELLA:** Thank you so much, Megan and Tom.

So that shows you how every Windows developer, every Office developer, going forward across all of these experience scaffoldings, from Cortana to Teams to Outlook to Timeline to Windows, can become an M365 developer.

The underpinning of Microsoft 365 is this Graph, it's this ability to have users' activity across devices, across their life and work, explicitly represented, that you can use.

This data is owned by users and organizations. And they give explicit consent to developers to be able to use that data, extend that data, that means your applications can be part of the Graph. This is not a closed graph, it's an extensible graph, so that we can collectively add more through our customers with these cross-device experiences, these multi-sense applications.

This explicit representation of activity is a massive unlock to the richness of the applications that we build.

And, already, many developers are taking advantage of it -- from Adobe to GitHub to HubSpot to Sage to Trello to Zendesk, these are all graph developers. And so we expect this to grow, and this conference to help you get a better handle on the types of applications you can build that cross devices and cross sensors.

But so far, the representation has had data that is personal, that is organizational, as well as the web. But it's all been digital. In other words, it's digital artifacts that have been schematized.

We want to go to the next step. We wanted to be able to take the near world, spatial data, hospitals, factories, homes, offices, as explicitly represented entities in this graph so that you can build applications and are just not about the digital world, but span the digital and the physical world.

And this is where some of the work that we've done with HoloLens has already taken us. But we're now launching a set of SaaS applications as part of Microsoft 365 which use HoloLens to be able to bring the spatial data into the Microsoft Graph.

And to show you both these advances in Microsoft 365 for first-line work, and these new SaaS applications, and then have other colleagues join her to show all of Microsoft 365, please help me welcome Lorraine Bardeen.

(Applause.)

**LORRAINE BARDEEN:** Thank you, Satya.

We're going to show how Microsoft 365, Azure and the Microsoft Graph can bring the power of computing into the real world.

So, first, I'm going to start -- I'm going to talk about industry and about first-line workers. And then we're going to switch gears and talk about the future of meetings and knowledge workers.

So, first-line workers in any company. They're the first to the customer, and they're the first to the problem. We see a huge untapped potential to empower those two billion first-line workers around the world with technology so they can further contribute to the growth and the innovation and the success of their companies.

And, you know, this opens up a huge new business opportunity for you as well to bring your existing skills to a new customer base.

So let's start by talking about what we've learned. In the past couple years since we started shipping HoloLens, my team has been paying really close attention. What are those workflows that cut across first-line industries?

We've collaborated with hundreds of customers, and we've identified that those highest-value workflows are remote assistants, space planning, training and development, and product-focused collaboration, and real-time access to IoT and spatial data.

So let's take a look at the first two of those high-value workflows: Remote assistants and space planning through the eyes of our customer, ZF Manufacturing. Let's roll that video.

(Video: ZF Customer Story)

(Applause.)

**LORRAINE BARDEEN:** You can see how bringing those mixed reality capabilities into their workflows, it improved the quality and the speed and the outcome for both Lee and Mathias, and this is technology that connects them to other people through their work.

So my team's been hard at work, and today we are incredibly excited to announce two new mixed reality business applications: Microsoft Remote Assistant, and Microsoft Layout and these are joining the Microsoft 365 family and available for public preview starting May 22nd.

With Microsoft Remote Assistant, first-line workers can bring an expert right where they need them, and they can share what they're seeing. This is really important because often they don't have the help they need on site. They can collaborate to solve problems faster using heads-up, hands-free video calling, image sharing, and mixed reality annotations.

And the IT administrators, they can count on secure access -- secure communications -- through Microsoft Teams. And then those experts, they don't have to head out into the field or hop on a plane to solve problems. This really expedites their troubleshooting and it eliminates a ton of travel costs.

Now, with Microsoft Layout, teams can experience designs at real-world context. They share and edit those designs in real time, and they can make better decisions faster.

There are a lot of ways to design spaces right now, but it's so hard to visualize them in the real world at size, scale, and context, which means the decisions end up taking a lot longer than they should, often costly rework is needed.

But with Microsoft Layout, teams can make decisions that used to take weeks or months, they can often make them in just days.

So you remember those workflows I was talking about at the beginning. So, first, we're releasing these two applications against those first two workflows, and soon we'll be sharing more about how we're going to help with training and development and product-focused collaboration.

Right, now, we're actively working with customers to provide real-time spatial data to first-line workflows.

Now, as developers, when you design for HoloLens, you're designing for this first-person point of view, which means that you have access to just rich new data and inputs.

And then when you design for IoT, right? You're coding against the real world. And that's more rich, new data. And we believe it's the combination of these two things that's going to increase the value of your applications tremendously.

Because with Azure IoT Edge, with connections to the Microsoft Graph, and with capabilities like Bot Framework, these world-sensing devices, they contribute as members of the team and they're integrated with existing workflows.

Let's take a look at this in action at one of ThyssenKrupp Aerospace's factories. Let's roll that video.

(Video: Mixed Reality or Spatial Analytics.)

(Applause.)

**LORRAINE BARDEEN:** Some of you who were here last year will remember we showed this great demo of a workplace safety scenario in a factory.

So it's only a year later, and ThyssenKrupp is using Azure IoT Edge, Microsoft Graph, Teams, and Cortana, assembled into a workflow that's improving workplace safety and efficiency in their factory.

These world-sensing devices, they can offload work so that the first-line workers can focus on their most important work, and they also provide their company with its own spatial data in a standardized format so it can just be pulled right into existing workflows.

So these three things that we talked about today were launching these mixed reality applications, and this is in large part, it's contributing to a big audience expansion to those two billion first-line workers. It's a new set of customer needs and a new business opportunity for all of you. And we're also making available this spatial and IoT data both to first-line workers and to their companies.

Now, my team, we work to integrate cloud and edge and mixed-reality technologies into products. What we're doing is we're breaking ground so that you all can invent and get to market even faster. And we just love being on this journey with all of you.

So let's switch gears now and let's take a look at the future of modern meetings. For that, I'd like to invite out on stage, Raanah.

(Applause.)

**RAANAH AMJADI:** Thanks, Lorraine. A key component of building a Modern Workplace is creating tight connections between the people you work with, the content you create, but especially the conversations and meetings you share.

So today we're going to show you some conceptual scenarios for how you can create those connections with intelligent devices and services that understand both our physical worlds and our digital worlds.

Let's start with something we're all familiar with -- meetings.

Hey, Cortana. Set up a meeting right now with the Smart Building team to discuss the new project proposal we're creating.

**CORTANA:** Sure thing. You are all free now. Where do you want to meet?

**RAANAH AMJADI:** Find me a conference room with a Surface Hub.

**CORTANA:** Okay. Team Scrim Room is available now, too. Want me to book it?

**RAANAH AMJADI:** Yes, please.

**CORTANA:** Great. You're all set.

**RAANAH AMJADI:** Well, you can see behind me is a common office meeting room, but this one's different. On the desk, we have a prototype device built on similar technologies to the ones we showed you earlier. It picks up both audio and video that you can pair with AI Services and Microsoft 365 that help with key tasks like identification, voice transcription, and even real-time translation.

**CORTANA:** Welcome, Jamal. Hello, Dave.

**RAANAH AMJADI:** So, AI Services even identify Dave and Jamal as expected meeting attendees. I'm going to go join them.

**CORTANA:** Good morning, Raanah. Would you like to start the meeting?

**RAANAH AMJADI:** Yes, please. I know Katie and Julia are coming from another meeting, so let's go ahead and get started.

Dave, what's the latest with the Smart Building pilot?

**DAVE:** I've already done some preliminary analysis on the data, and I'm finding some high-temperature outliers, we should discuss it later in the meeting.

**RAANAH AMJADI:** Okay, sounds great.

**JAMAL:** Dave, do you know if we'll have enough of the Yanzi multisensors to update the showcase floor?

**DAVE:** Actually, I have some concerns about the location of those sensors. We should hold off on doing a one-to-one replacement until I can --

**RAANAH AMJADI:** Oh, I'm really sorry to interrupt, Dave. I actually have some ideas about the replacement. So maybe let's connecting after the meeting.

**DAVE:** Okay, that's good to know. I'll follow up with my team and post and update to the channel after the meeting.

**RAANAH AMJADI:** And I'll follow up and send Yanzi an email about those showcase sensors.

**DAVE:** Okay, that sounds great.

**RAANAH AMJADI:** Now, take a look at the transcript behind me on the left. Even though we were all speaking over each other and the sound environment here is actually pretty challenging, but AI Services, coupled with the audio and video signals from the device, could still accurately identify who was speaking and when.

You'll also notice that it picked up our meeting items and listened them on the right. And the voice recognition model has been trained, over time, the understand our team's unique communication style, and recognizes those speech patterns, even when we're speaking in business jargon.

This not only helps the interactions in the meeting room, but it helps remote participants have a more active meeting experience. Our remote teammate in China can see and hear a translation of this meeting. In fact, we can support multiple simultaneous translations.

Hey, Katie. Hey, Julia.

**KATIE:** Hi.

**RAANAH AMJADI:** With Microsoft Teams, we can continue this conversation right within the context of the work we're creating together and the business apps we use to stay on top of our project.

I can even access great third-party apps like Trello and GitHub.

So now Cortana is in this workspace with me, so she can help me stay connected across all my experiences. As you can see here, Cortana has detected that we need to find a time to meet. Instead of struggling to find time that works for everyone's calendar, Cortana will automatically offer up a few options based on our mutual availability. She'll even carry the context of our conversation forward to the meeting details. And just like that, our meeting is scheduled.

But Cortana also understands the files we're working with, can detect that I want to share the Q2 sales forecast, and will bring the most relevant documents straight into this conversation with my team that can share it in just a matter of seconds.

**KATIE:** Hi, even though I came in late, I love that I can catch up and identify everyone in the room. I'm deaf and I work with a sign language interpreter, the transcript doesn't eliminate the need for my interpreter, but it lets me give my full attention without having to worry about note-taking. This makes it a lot easier for me to bring my engineering knowledge to the table and participate in the discussion. I love getting the meeting notes at the end, too.

Hey, we need to get started on the Smart Buildings proposal.

**JAMAL:** I've already started on the outline, and there's a bunch of elements we still need to include.

Creating a proposal like this in the past was time consuming, not just for me, but for everyone on my team. I'd send emails to experts, search for information I need, and run reports from line-of-business apps all just to pull them into the document. Now, since everything is part of the Microsoft Graph, I never have to leave my document, which means that I can stay focused, ask for what I need, and it just shows up.

As I'm working on my document, I can add a simple reminder as a placeholder, or say I want to get a customer quote from my colleague, Patty.

So what I'll do is I'll at mention Patty and ask her to please provide that great customer quote.

In the past, I'd have to switch from Word to Outlook and run the risk of getting sucked back into my inbox. But now, Patty's quote will show up in the document exactly where I need it. And what's great is I can keep working. So let's do that.

Lastly, I want to provide some more information about the Yanzi Smart Building sensors. So what I'll do is at to-do and remind myself to insert the Yanzi information here. Now, this is my favorite part.

Cortana has remembered that I've used this phrase before, saw my intent from a to-do item, and then suggested the information I needed using AI. And in case you didn't notice, Patty's information showed up right as I was doing it.

The Graph becomes richer the more we use this service and will better understand our intent. In the future, developers will be able to connect and extend their own applications and data sources to the Graph, and have that information show up in the document exactly where you need it.

**RAANAH AMJADI:** Great. Thanks for that update, Jamal.

**JAMAL:** Anytime.

**RAANAH AMJADI:** Katie, what's the latest with the common area design?

**KATIE:** I've been texting with James, let me take a look. As an engineer, I spend a huge amount of time in front of my PC, but I'm also getting nonstop text messages and alerts on my phone.

On average, we open our phones more than 100 times per day, but we think we can do better with an Android phone and an upcoming version of Windows 10. Let me show you two simple examples.

As you can see, I'm getting SMS messages from my phone right here on my PC. I love being able to respond without having to pick up my phone and unlock it. It's much easier to type messages on my PC.

I can also drag pictures from my desktop. Let me send this over.

Not only that, when I get a picture from James, I can use it right away just by dragging and dropping it into PowerPoint. Let's see how this sensor would look in our common room. Looks pretty good.

I can also access my phone's notifications and can click on them to open the Windows App or see them on the Web. Here, I'm opening the Smart Building design. I'll send it to the team after the meeting.

**RAANAH AMJADI:** Great. Thanks, Katie. Dave, how about we hop into that temperature data now?

**DAVE:** Of course. Let me bring up the latest data from Power BI.

**RAANAH AMJADI:** Great.

**DAVE:** This is the last 24 hours of temperature sensor data. And I can see that most of the sensors are reporting normal values, but I've got these three high-temperature outliers. Let me reorganize the data by room type.

When I do that, I can see that most of the higher values are coming from focus rooms.

**RAANAH AMJADI:** But we looked into that, didn't we? We didn't find any equipment in the focus rooms that would cause a temperature spike.

**DAVE:** Right. But let me reorganize the data spatially, because I've found something interesting.

**RAANAH AMJADI:** OK.

**DAVE:** These are the actual three-dimensional positions of the sensors with the building plan. Let me add a 3D map there from Bing for additional context. Now I think the best way to look at spatial data is using my HoloLens. So I'm going to switch devices.

Now, I'm going to connect my device to the screen and share my view.

Now, let's take the hologram that I'm looking at and place it directly onto the meeting room table.

In this way, everyone can get a sense of what I am seeing, without having us all have to wear HoloLenses.

Now, I can clearly see that the three sensors giving us a problem are vertically aligned with one another. Let's put it back.

I want to ask my colleague Tao (ph.) to join the meeting. Hey, Tao. Now, I can see Tao's avatar looking around at the data, just as if she was in the room with us. Tao, have you got any insight as to why these three sensors that are in a vertical stack might be giving us an issue?

**TAO:** Dave, there's a hot air duct running from the cafeteria kitchen on the ground floor up to the roof. There were some changes in the kitchen recently. We may be way overstacked thermally.

**KATIE:** Got it. Maybe we could change the sensor placement for more consistent readings.

**RAANAH AMJADI:** That's a good idea.

**DAVE:** That's great. I'll follow up with the building manager to check both hot air ducts and the sensor position.

Data visualization is a powerful tool for both finding and sharing insights in data, especially when we can collaborate with multiple people across multiple devices.

**RAANAH AMJADI:** Using AI and the cloud, everything that we've discussed has now been neatly captured as a searchable transcript on the left. And a summary of all of our meeting items have automatically been created for us on the right.

Which reminds me, Dave, I need to follow up with you so you can present that data to our leadership team next week.

**DAVE:** Great.

**RAANAH AMJADI:** Great, meeting, thanks, team.

**JAMAL:** Anytime.

**RAANAH AMJADI:** Today, we've shown you our vision for the future of modern work and how you can leverage the power of AI to connect experiences across our physical and digital world.

With a range of intelligent devices and services, we can now understand the spoken and unspoken nuance of meetings, even when we're not in the room, carry those insights into our broader team experiences, and create opportunities for everyone to collaborate in more immersive ways. Thank you. (Applause.)

**SATYA NADELLA:** Thank you so much, Raanah and team, that was just pretty stunning stuff.

You know, the opportunity of this platform shift to the intelligent cloud and the intelligent edge is pretty limitless. You saw that with Microsoft Azure and Microsoft 365, I mean just two data points, that 9 billion microcontrollers are not compute endpoints, 2 billion-plus people who are first-line workers are addressable with these scenarios with Microsoft 365. Just think about that as the base for which we want to innovate and build applications.

Now, in fact, this very shift is even shaping the two other platforms -- Microsoft gaming and Dynamics 365. At GDC, we talked about how we're innovating across the console, PC, mobile, as well as with PlayFab on the cloud. And you'll see us talk more at E3 about where we're taking gaming. We're very, very excited about that opportunity.

With Dynamics, in fact, the spring release was just recently launched, we also launched this very powerful platform, the Power Platform -- Power BI, Flow, PowerApps -- which acts as the extensibility framework for Microsoft Graph, extensibility framework for Dynamics, as well as Microsoft 365, and embeddable by every SaaS ISV.

So we're excited about all these four products and platforms co-evolving with one major shift to the intelligent cloud and the intelligent edge.

So when we talk about this limitless opportunity, it's not really about adding more screen or grabbing more screen time, it's about truly figuring out how to empower more people and more organizations. That's really what it's all about.

We have a real responsibility as we think about the impact of technology to ensure the technology is reaching everyone.

In the last few years at Microsoft, I've been truly inspired by the passion of people, the developers inside as well as in this community. So we've really taken some of the advances in AI in particular and applied it to accessibility, applied it to help people with disabilities.

It's been a personal passion of mine, and it's been a privilege for me, a blessing for me to see that unfold. Every year we have this Hackfest or One Week, and each time when I see the types of things that developers are capable of doing, the magic they can create with Learning Tools in OneNote or using gaze with ALS, it just really helps me see the bigger picture of what technology can do.

Let's roll the video.

(Video: AI Accessibility)

(Cheers, applause.)

**SATYA NADELLA:** And I'm really pleased to close this keynote by announcing AI for Accessibility. This is a grant program that we're creating so that we can give grants to researchers, NGOs, developers -- give them support, platform technology, so that you can bring your ingenuity and passion to help the 1-plus billion people in this world who have disabilities.

I can't wait to see what you all build. Thank you all so very much and have a fantastic rest of the day.

(Cheers, applause.)

END