

09252017 Ignite Satya Nadella

**Microsoft Ignite  
Vision Keynote  
Satya Nadella, Julia White  
September 25, 2017**

**ANNOUNCER:** Please welcome Corporate Vice President, Microsoft, Julia White.  
(Cheers, applause.)

**JULIA WHITE:** Good morning. Welcome to Microsoft Ignite and Microsoft Envision. I'm thrilled to be your host all week. That means I'm here for you, listening to you, connecting with as many of you as possible, and sharing insights from across Microsoft.

Now, first, I want to take a moment to thank the people of Orange County here in Orlando. With the impact of Hurricane Irma, it wasn't always clear that this event could take place as planned. And while Florida continues to face challenges in the recovery, we're so very fortunate and grateful for the commitment and help of the Orange County Convention Center and the local hotels to make this week possible.

For those of you who want to contribute to the hurricane relief effort, we've got set up donation stations at all of the registration desks, and we've also partnered with Clean the World, to have hygiene kit building stations that you can participate on Tuesday and Wednesday to build kits for impacted citizens.

And last but not least, we're partnered with the American Red Cross and their blood drive station will be available on Wednesday outside of the south building.

Now, this is the beginning of an incredible week. For me, this week is about bringing together this group of change agents who are building the future, because by choosing to be in technology, you serve as a change agent for all of your organizations.

And I know that being a change agent isn't always easy, so this week is about coming together as a community, about sharing, connecting, learning from each other, and supporting each other.

And, of course, this week is also about learning about all of the technology and solutions Microsoft is enabling.

Now, before we get into the keynote, I want to make sure that everyone watching across the globe is aware of our real-time translation, AI-based technology for the keynote. It's providing subtitles in 12 languages simultaneously, and you can access this at [Skycap.Studio.MS](https://Skycap.Studio.MS).

This morning, we start with Satya. You're going to see some amazing technology and hear from some absolutely brilliant people. I encourage you to consider how you'll incorporate these concepts and possibilities into your strategy.

So without further ado, please join me in welcoming Satya. (Cheers, applause.)

**SATYA NADELLA:** Good morning. It's fantastic to be here this morning in Orlando. Just a few weeks ago, it was unclear whether we were all going to be able to make it here. Thanks to the work and the encouragement of the local community, all of us were encouraged to come here and support the process of recovery. Thank you for all of you for coming to Ignite as well as Envision.

When I think about the people here, in fact, one out of every ten people have made it here from the areas that have been most impacted in the last few weeks, from the Caribbean, Puerto Rico, Mexico, Texas, and of course right here in Florida. Thank you for being here. I know how hard it is to come to a conference like this at a time like this when the impact in your local community has been devastating. Know that we are here with you and we will continue to support you and your communities in this recovery process not only in the days to come, but in the weeks and months to come, because it's going to take us all in our effort.

When I think about these two conferences and the people who have come, all of you, the diversity of roles and functions, this is unlike anything that we've seen at Microsoft conference. We have, right here at Ignite, people who have tracked us through generations of technology. We have people who administer clients, administer servers, administer cloud, developers building these applications, security professionals who really protect the digital estate of all of these organizations.

We also have, as part of Envision, people who work in the various business functions -- finance, customer service, sales -- as well as the CXOs. So the diversity that we have is pretty stunning. And it's clear as to why it is the case. It's the digital transformation, the unprecedented level of digital transformation that our organizations are going through.

Whether it is precision agriculture or precision medicine, whether it's smart factories or smart cities, what you see is increasing levels of digitization and digital technology that is impacting every walk of life and every industry.

And when you think about that breadth and depth of digital technology, and what it takes for our organizations to thrive in the future, in times of change, the most critical thing for us is to bring all of us across our functional roles, across the various expertise and skills that we have, to support this process of continuous change and renewal.

That's the theme of these two conferences. We want to be able to not only build a broad perspective of how technology is shaping business and our industry, but we also want to go deep in individual areas. And so that's what I hope we achieve during this week at Ignite and Envision.

But as we talk about technology, the other things that we in particular as technologists and decision-makers will have to keep in mind are the timeless values that drive what we do.

How are we going to use technology to empower people? Every piece of technology should help embellish the capability of human beings. We definitely want more productivity and efficiency, but we do not want to degrade humanity.

We want technology to provide new levels of inclusiveness. In fact, I'm most excited about accessibility. Julia was talking about how this particular presentation is being simultaneously translated using AI into 12 languages. How can we bring more people into as full participants in our society, in our economy, using technology? How can we make sure that there's no bias built into technology?

Lastly, how do we build trust? Trust in how we secure data, how we ensure privacy, and the control and transparency that we build all around. These timeless values and this opportunity of digital transformation is what grounds us at Microsoft in our mission -- our mission to empower every person and every organization on the planet to achieve more.

It's something that we take very seriously -- each word in this mission. The ability to really make sure that we're not only thinking about the person, but the institutions people build. We think about it at the global scale, but most importantly, for us, it's not about our technology, it is about what you can do with technology to create your own technology, to have real impact in moving our society and economy forward. That's what is central to our mission.

In fact, technology trends and paradigms will come and go, but what will center us is this sense of purpose and mission.

Talking about technology paradigms, we are well on our way in this new paradigm of the intelligent cloud and the intelligent edge. All of the experiences that you're going to see, that we're going to demo throughout today and on all the other keynotes are, by nature, going to be multi device and multi sense. You start at one device using speech, you may end in another device using ink. All of the experiences and all of the infrastructure, applications, devices, are going to be infused with AI, natural language, speech, computer vision are all just going to be part of what we do and what we expect.

We're going to invent new computing paradigms for how we support these applications. Things like serverless compute or containers, and how we distribute applications across the edge and the cloud are going to fundamentally transform the applications we build.

Now, of course, all of this is in support of the digital transformation outcome. Ultimately, what we care about in our businesses is how are we using technology to improve the empowerment of our own employees. How are we connecting with

customers? How are we optimizing the operations end to end? How are we changing, in fact, the very nature of our products and their business models? Those are the digital transformational outcomes that we seek.

And, of course, these outcomes are not new. We've gone to work on this over the years in different paradigms. But what is, perhaps, salient and hopefully becomes more and more clear to us as we go through this process is these digital feedback loops. Right? It's no longer about deploying one AI system or doing a little bit of machine learning here and there, it is about, in fact, changing the culture inside of our organizations so that we understand very deeply what it means to create these digital feedback loops across all of these outcomes. These new virtuous cycles between our products, their usage, their creation of data and the business model, that's what we've got to get intuitively.

In fact even for us at Microsoft, that's the process of transformation we're going through as we change the nature of our products, we change the nature of how we engage with you as our customers and partners.

And in order to facilitate these new systems of intelligence, we want to build these four solution areas. In fact, throughout Ignite and throughout Envision, we will talk a lot about these solution areas. We, ourselves, are trying to push far beyond any particular product boundary to focus our efforts across these solutions that drive your digital transformational outcomes. And these solution areas act as ingredients to help you drive the digital transformational outcomes.

So let's start with the modern workplace. When you think about the nature of work, it's changing. It's no longer about routine tasks, it is about unlocking the creativity inside of your organization. It is about going beyond individual productivity to teams, dynamic teams. It is about ensuring the security of your digital estate and really changing the frontier of simplicity around management of the digital estate.

And that is what's driving us to build Microsoft 365. Microsoft 365's core purpose is to unlock a new culture of work, support you as you endeavor to unlock that creativity in every person inside the organization. Help you create those dynamic teams that come together not by org chart, but by the job at hand, and do all of that while ensuring that we have simplicity of the IT infrastructure, while we have the security of the IT infrastructure. That's the purpose of Microsoft 365. And you're going to get a lot more depth, view of everything that we're doing across these four pillars of modern workplace.

So what I wanted to talk about this morning, though, is how something like collaboration and teamwork can fundamentally be transformed with new mediums and new technologies like mixed reality.

Just a few weeks ago, I had a chance to visit Ford in Detroit and really see across all of the various departments -- manufacturing, design, engineering, sales -- how a car manufacturer goes through the process of introducing something new, a new design, a new model.

In fact, it was something that I had not understood, but most of the design in the past was done using clay models. You know, they weighed something like 5,000 pounds. And so if you wanted a feedback loop on it, you actually needed to move the clay model so that people in manufacturing could comment on it, or people in sales could comment on it.

Just now think of what we can do, though, with something like mixed reality, with HoloLens and with these Oasis headsets all being used as part of Microsoft 365. How we can bring something like Teams and mixed reality together to change, in fact, the frontier of collaboration.

So we wanted to give you a flavor for how this new technology can, in fact, usher in a new era of collaboration. To do that, I wanted to introduce up on stage Raanah Amjadi from our Modern Workplace Team. Raanah? (Applause.)

**RAANAH AMJADI:** Thanks, Satya. Thank you. For companies like Ford, there's a delicate balance to strike between creating a friction-free environment for the team to do their best work, while at the same time ensuring they can safeguard and protect their IP. Leaks or stolen engineering blueprints or product roadmaps could cost them hundreds of millions of dollars in lost revenue.

So today, we're going to demonstrate some conceptual scenarios Ford goes through in ideating, designing, and developing a new vehicle.

We're also going to show you Microsoft's vision for the modern workplace, a glimpse into how Ford's design and engineering teams can strengthen their teamwork and use Microsoft 365 and mixed reality to further innovate, collaborate, and make business-critical decisions more quickly and securely.

Let's get started. With Microsoft Teams, a cross-disciplinary group of engineers and designers can work together. This integrated hub will allow them to seamlessly create and discuss various innovations as one team, such as design for an upcoming vehicle.

Here in the conversation we see a designer and an engineer need to review a specific aspect of the grill design for the Ford Fusion. So let's have a look at the new design studio, the team can do this in real time.

In the studio, you'll see we have a couple of cameras with Microsoft help mounted on top, what we call "spectator view," which is actually publicly available and hosted on GitHub. These cameras allow you in the audience not wearing a HoloLens to have a view into the shared mixed reality experience.

You'll also see a 2014 Ford Fusion, and two of my colleagues, Rachel and Terry, who are going to demonstrate how Ford is using mixed reality today to transform an existing product design and engineering process.

**RACHEL CARD:** Thanks, Raanah. As Raanah said, reducing the risk of leaks is critical to competitive advantage. And we're so proud that companies like Ford are using mixed reality to stay one step ahead.

In order to do so, they need to be able to control who has access to confidential information regardless of the devices people are using.

Security is built into the heart of Microsoft 365, allowing IT professionals to proactively manage devices and enable multi-factor authentication.

As you can see in our design studio here, the storyboards on the side wall are currently blacked out. However, as I log into my HoloLens, and verify my identity with my phone, you can now see those holograms on the storyboard come to life.

Now, I work in mixed reality every day, but I've got to say, seeing holograms come to life continues to fascinate me.

With my HoloLens on, I'm now securely logged into the meeting as well. This is one example of how companies are leveraging mixed reality to empower their engineering and design teams to create and iterate more quickly and securely.

**TERRY FARRELL:** Iterating on design like this grill theme is another example. In the past, this required multiple production parts to be physically manufactured and then fitted to a clay model of the finished car design, something that not everyone has security access to do.

For the first time ever, design and engineering can work together securely and review multiple design options in real time. Previously, this would have taken days and cost thousands of dollars in production costs.

Now, I'm just going to toggle through a couple of the final grill designs we're looking at.

**RACHEL CARD:** As the HoloLens is constantly aware of its spatial position, I can place a note in 3D space for review later. Review the angle.

With Microsoft Teams, the team is alerted to a note, and then they can see the exact same experience, the exact same 3D space that I was seeing when I captured the note.

**RAANAH AMJADI:** Back in Teams, you can see that same digital voice note has now shown up in our teams channel so the entire group can stay in synch.

What Terry and Rachel just showed you in mixed reality is being used by Ford today, but in this demo, we also want to show you how we can build on that work to enable a more modern and connected workplace.

So now the team is going to make some additional changes to the concept vehicle, and then kick off a call from within Teams to review the adjustments with another designer in the group.

**TERRY FARRELL:** Changing the design of the mirrors doesn't just affect the look and feel of the car, it impacts safety. The team at Ford can now see the real-time impact on visibility when adjusting the dimensions of that side-view mirror.

Historically, they'd need to create a full-scale replica of the car and have someone sit in the driver's seat to get that line of sight on the side view angle.

**RACHEL CARD:** But now, they're able to consider design changes as well as regulatory requirements while simultaneously seeing what the driver would see. Essentially, being two places at the same time.

The team at Ford is often working against tight deadlines, with teams all across the globe. In the future, with Microsoft technology, they'll be able to join a call and enter the same shared experience, allowing them to see their creation and to rapidly review designs quicker than ever before.

Terry's going to bring Noah into the discussion. You'll see Noah on one screen, and a view into what Noah is seeing on another screen as he's working remotely.

Noah is wearing one of our new Windows Mixed Reality headsets, which will be available starting October 17th.

Now, Noah has a fully immersive view, so as Terry makes changes to the mirror, Noah sees those exact same changes live in virtual reality.

Our vision for the future blends physical and digital worlds across devices, empowering people to collaborate in the same shared experience from anywhere around the world. (Applause.)

**RAANAH AMJADI:** As you can see, design and engineering needs to strike that right balance between a highly structured, compliance-driven business process, and at the same time, one that's fluid enough to stay on the leading edge of design. And with Teams, this interactive collaborative experience can be extended to the rest of the group. So even if someone can't join the meeting in person, they will be able to replay the conversation and see a summary of all the important moments right here on this handy timeline.

And using AI technology and Microsoft Stream, they can even search a transcript of the meeting to focus in on the topics that matter most to them right here in Teams.

We've shown you today how Ford is using Microsoft HoloLens to digitally transform a key business process and how we'll bring together in real time the entire spectrum of mixed reality -- simple augmented reality, virtual reality, and even holograms into a real,

wholly immersive work environment, a truly mind-blowing glimpse into the future of how a global company like Ford can begin to use Microsoft 365 and mixed reality to create a more modern workplace. Thank you. (Applause.)

**SATYA NADELLA:** Thank you, Raanah. It's awesome to see this new medium of mixed reality come to life. I mean, it's not about any one device and its capabilities, it's really about this rich cloud service in Microsoft 365 that helps orchestrate a new level of collaboration inside of your organization. That's the vision that we have.

Talking about Microsoft 365, one of the foundational things that it does is it creates, perhaps, the most strategic data asset for each of you. As you use Microsoft 365, you are creating this Microsoft Graph asset. It represents or it captures the knowledge of your people, their relationship with other people inside and outside the organization, their work artifacts, their projects, their schedules, that is a very rich data set that you can reason about, that you can create additional value inside of your organization. That's the vision of Microsoft 365. It's not about trying to build individual tools, but it's about creating that next platform for you to be able to drive your digital transformation.

This Microsoft Graph is extensible. In fact, we are bringing together the first phase of integration between Microsoft 365 and the Microsoft Graph with LinkedIn. You will start seeing some of the applications and scenarios that light up because of these two graphs coming together.

One of the fun things the LinkedIn team even did for this conference is if you use your LinkedIn app and go to the My Network tab, you can see all the others in your network who are attending Ignite.

So we see many, many ways where bringing the professional network with your core data can help transform how work happens in your workplace.

In fact, when you create such a rich data asset, what you truly enable is AI-first workloads, because with data, your ability to reason over data becomes possible, and when you have that, you can create a completely a new capability that you couldn't before. And that's what we're doing with Microsoft 365. Using some of the latest technology from natural language processing to speech recognition to machine reading and comprehension, we can start tackling some of those age-old challenges we've had of information discovery and information search.

I mean, something simple like search across all of the information inside of your workplace is hard because it's locked into these structured databases that are captive to each of the tools, each of the applications.

What if, because of the power of the Microsoft Graph, its extensibility, we can now, in fact, use some of the same techniques of deep learn and machine learning and change how people discover information?

And to show you this in action, I wanted to invite up on stage Li-Chen Miller from the Modern Workplace Team. Li-Chen? (Applause.)

**LI-CHEN MILLER:** Thank you, Satya. The key component to creating a modern workplace is to have the ability to seamlessly connect the people that you work with both inside and outside your organization together with the documents and content that you're collaborating on together, and the meetings and communication that you're actively engaged in.

And the way to connect these three is the Microsoft Graph, with information integrated directly from the LinkedIn Graph across Microsoft 365.

Let's check it out in real life, how does this work? Every morning, when I roll into the office and I'm at my PC banging away at my keyboard trying to get things done, the integration of data from the LinkedIn Graph together with Microsoft Graph really helps me.

Right here, I'm having an exchange with Jonah. If I wanted to find out more information about Jonah, all I have to do is click on his people card and the data from the LinkedIn Graph gives me a holistic view of Jonah's past work experience, his education. I can see that he's from a company external to Microsoft. I can also see communications that we have exchanged, as well as files that were previously shared.

You've probably figured out by now Jonah and I were not exactly best buds yet, but with a simple click of this connect button right here, we can totally be BFFs, professionally connected, and be in each other's LinkedIn network just like this.

This is the first of many LinkedIn integrations you will see in Microsoft 365 in the upcoming months, and we are committed to helping you expand your network and connect with people in meaningful ways.

Now, I want to switch contexts a little bit. I want to talk to you about search. I don't know if you guys are like me, I spend a bunch of time every day looking for stuff -- project information that's mission critical, answers to questions I probably should already know, or even I struggle to remember basic URLs to work tools, or basic links. I'm supposed to be good at this, good in technology, but I struggle.

Today, Office 365, SharePoint, and Delve does a great job of helping me find resources in the context of my work flow. We're going to continue investing in search across Microsoft 365 in order to make it more intelligent, more personal, and more contextualized. We are also going to invest to bring it to more end points.

Today, I want to show you a new end point. What if I tell you we're going to bring this Microsoft Graph experience directly to the browser where you and I are already spending tons of time surfing the internet, looking for information, right?

I'm going to show you Bing for Business. And I'm typing in a very simple query. I just typed in "Harry Shum." Bing for Business can transform the way you work by certainly and easily accessing information from enterprise resources and bringing it together with public web results in one place so that you can always find the information that you're looking for.

This case, I look for Harry Shum. You can see I got internet results here. If I were a professional celebrity stalker surfing celebrity news on the company dime, I've got every piece of information about Harry Shum, Jr., great celebrity right here.

Of course, I'm, obviously, Li-Chen Miller, employee extraordinaire at Microsoft, and this is Harry Shum, executive vice president -- a.k.a., my boss's boss -- that I truly care deeply about. (Laughter.)

Right here is the power of Bing for Business and the direct connection to Office 365, SharePoint, Delve, and Azure Active Directory, I can see information that only Microsoft employees can access about Harry. I can see his contact information, I can even see his Office 365 calendar where I have an upcoming meeting, a lunch meeting with Harry, which is super epic because this is going to be awesome. Yay for my career, and yum for my belly. (Laughter.)

And if I really want to impress Harry, I can be totally prepared for my lunch meeting by being able to see the files that Harry has shared with me before. And then if I really want to be super-duper prepared, I can totally connect with people in his organizational structure that work for Harry, so I can show up looking incredibly smart.

Now, I know what all of you are thinking, "That was a pretty simple query." Right? No problem. We're going to up the stakes a little bit.

Remember the part where I told you I'm struggling and I don't remember basic URLs? Well, Bing for Business can help us with that.

I'm just going to type in "expenses." The good news is Bing for Business is built on Bing, and with logic matching, it could actually tell the intent of what I was trying to do. And what Bing for Business just did was it integrated directly and surfaced information around line-of-business systems that Microsoft used to track expense reports.

Right here, I'm able to see the expense reports my team has submitted, as well as perform inline actions like approving and rejecting, saving me time and steps.

And what next? As I'm approving expenses, I have questions about policies. In the past, if I had a question about HR policy or IT policy, I had to go through tons of documents and links, I'd probably send an email to a colleague who's smarter than me, who probably forwarded it to another colleague who's smarter than him to find the answer.

But today, Bing for Business can totally help us with that. I'm going to type in a query that says, "What is the budget for conferences?" Hopefully, this time I can spell. Yay. Boom. That actually works.

What just happened was Bing for Business used machine reading comprehension and deep learning models to go through literally 5,200 documents of IT and HR content. It didn't just do a keyword match, it actually understood the meaning of what I was asking, and it actually found the right answer, the pertinent information for a specific paragraph in a specific document, and answered my question right there. That totally happened.

From talking to many of you, we know that every company is different. We know that for Bing for Business to truly be effective in your environment, you need to be able to customize this. I want to share with you the insights dashboard. When deploying Bing for Business in your environment, you're able to see employee usage data in an aggregated and anonymized manner. You can see what employees are searching for, clicking on, and what they're asking, so you can truly customize the experience.

Of course, everything that I just showed you today also works on mobile. But there's one more thing, what about ambient devices? And ambient devices, we have Cortana. Cortana is your personal productivity assistant, and can really connect Office 365 with a suite of productivity skills to transform the modern workplace.

I want to show you today my favorite feature, let's check that out. Hey, Cortana, I want to take vacation next week.

**CORTANA:** Okay, you're marked as out of office from Monday October 2 to Friday October 6, your auto-reply message is set, and your time off has been entered in the time-away system.

**LI-CHEN MILLER:** Boo-yah! That was awesome. (Laughter.) I don't know what you guys are thinking, but the inner geek in me is completely freaking out right now. Okay, let me take a breath, and let's walk this through.

What Cortana just did was it connected to Microsoft's HR tool to track my paid vacation. That tool that I no longer have to deal with and figure out how to click through. Cortana did that for me.

In addition to that, Cortana connected directly to the Office 365 calendar and painted that gorgeous, beautiful purple color of out of office that I am completely in love with. (Laughter.)

And then the icing on the cake, Cortana actually set my auto e-mail responder and if any of you, anybody at all, send me a work e-mail next week when I'm on vacation, you're going to get an e-mail that's going to say, "I'm living the dream in Singapore, yo, good luck, have fun." (Laughter.) (Applause.)

So what you just saw today was us bringing together the world's largest professional network and most popular productivity platform. We're committed to build upon this and extend upon it into Bing, Cortana and Microsoft 365.

Bing for Business is available as a private preview today, and we have companies like the University of Miami, BA Insights, Avanade, Winvision and Bose actively using us and deploying us today. We sincerely invite all of you to join us in our program. Thank you. (Applause.)

**SATYA NADELLA:** Who'd have imagined that scheduling your vacation is more fun than the vacation itself? (Laughter.)

When you see what you can do with these AI-first innovations, you'll recognize the importance of creating these systems of intelligence and these data assets, because none of that will be possible without the data.

And so that leads us to this next solution area, which is business applications. In fact, as we increasingly digitize our businesses, the need for new business process automation is increasing.

We can't be captive to the old way of doing things, buying these large suites of business applications and trying to deploy them. No, we need these more modular, modern apps that are role specific, workflow specific, that can be composed for the specific needs you have.

That's what we're doing with Dynamics 365. Dynamics 365 is a platform for you to be able to create these systems of intelligence, for sales, for field service, for customer service, for talent, for operations, in fact spanning these multiple functions. The idea here is to give you that modularity and that flexibility so that you can harness this next level of digitization and business process automation.

The architectural underpinnings of Dynamics 365, in fact, build on top of Microsoft 365, as well as LinkedIn. That data asset which is so paramount to building these systems of intelligence needs to accrue. That's at the core of the design. That Microsoft Graph gets extended with Dynamics 365, creating one pervasive graph structure that you can reason on.

But it's extensible. Everything that we are doing between Power Apps and Power BI, Flow, give you the ability to build composite apps on top of that infrastructure.

And, of course, Azure as a cloud platform, with capabilities and services like IoT, give you the capability now to be able to do things like connect your IoT project where you're collecting data from sensors, doing preventative maintenance and connect that to field service. That's a classic scenario that we see repeated in many, many companies. But the ability to do something like that end-to-end can only come because of an architectural underpinning like this.

Now, once you have this very rich data substrate, you can go one step further. You can start building AI first business process applications.

Last year at Ignite, I showed some of the work we were doing in customer service. We took, in fact, inside of Microsoft all of the data that we have about our products, about the call logs we have with customers, and started reasoning on top of that, and empowering the customer service agent to be able to do their jobs better. The goal was to improve customer satisfaction while becoming more efficient.

And now we've taken that very application, that AI first customer service module, and scaled it out beyond Microsoft. In fact, let's roll the video of Hewlett-Packard using it.

(Video segment.)

**SATYA NADELLA:** This is just the beginning of a complete new journey of building these AI-first business applications. And so we're really looking forward to the next year where we take this module and scale it out in your businesses, and learn from it, and then, of course, have it go to all the other areas of our operations.

So that brings us to the last two solution areas. This is the core platform, apps and infrastructure, data and AI. This is what we talked about where Microsoft 365 and Dynamics 365 as services that we build so that you can drive your digital transformation.

The reality is every one of you today, you are a software company, you're a digital-first company. You are building applications that are really at the core digital products. And these two solution areas give you that platform.

And what's been most inspiring for us is to see the kinds of applications people are building using Azure. Azure gives you that capability, both of the intelligent cloud, as well as the intelligent edge, because of its hybrid capability. It gives you the productivity. What we have done between Visual Studio and TFS Service is give you that agility of being able to do continuous integration, continuous deployment, and build applications and improve the productivity of your own software developers.

Building AI, some of the most biggest, largest advances in the last year have been how we can take something like speech recognition, give you the APIs for it, not just the APIs for some standard speech recognition but something that can learn based on the ambient noise, and be customized for your specific environment. Same thing with image and computer vision, machine reading and comprehension. That depth and breadth of AI capabilities that you can infuse into your app and democratize what it means to write AI apps, that's core to Azure.

Security. But what has been truly inspiring is these AI first and mixed reality-first applications that many of you and all of you are building.

In fact, the first example is what Trimble has done. Trimble is using both Azure and mixed reality to build these digital twins across industry but in this case for the mining industry. Just imagine how you can really change the efficiency of a physical operation in a mine by creating this digital twin that allows you to visualize, to reason, to predict what's happening in the physical mine. That's an example of one industry completely being transformed by these two technologies, AI and MR.

Let's look at Tetra Pak. Tetra Pak is in the food packaging and processing for liquid food industry. They have built an end-to-end solution across their manufacturing so that they can ensure the quality, they can ensure that when things break, they can be fixed in real time. They can, in fact, predict breakage before it happens using again mixed reality and some of the AI capabilities.

Take a look at Land O' Lakes, what Land O' Lakes was able to do with precision agriculture for their tenant farmers and improve the yield of those farms. These are farmers who have had these farms for generations. But because of the technology solutions that Land O' Lakes has made available to these tenant farmers, they're able to now, in fact, get more economic surplus out of their land.

They have themselves inside of their Purina line of business are being much more competitive. In fact, there's been so much entry into pet foods that they needed to change, digitally transform how they introduce new products, the speed with which they could react to market trends.

Innereye is a project that is a collaboration between the University of Washington and the University of Cambridge in the UK around cancer.

One of the challenges of chemotherapy is that radiologists have to take the images and plan out the chemo regimen very carefully, because the goal is to make sure that you have the radiation impact the tumor but not the rest of the organs. And that process has to be done with precision. It takes time.

But what if we could deploy AI? And that's what the Innereye project does, AI that allows radiologists to plan the chemotherapy with better accuracy, and then help the doctors spend more time with the patient.

Talking about medicine and healthcare, Epic is using Azure and building out their cognitive platform on top of Azure. Two hundred million North America health records are stored in Epic.

Take something like hypertension or high blood pressure. It kills something like a thousand people a day, costs our economy \$50 billion. Just imagine if you could use AI. What if Epic just lit up their feature because of the cognitive platform they've built so that you can detect, long before high blood pressure happens, the likelihood of that happening, and take preventative care? That's the kind of impact that you can have.

These intelligent cloud and intelligent edge applications are nothing way into the future; this is happening today, this is happening across industries, across business process, and it's happening because you are pushing the frontiers of what is possible with these new platforms. That's what's fueling, in fact, our own innovation cycle.

And when I think about the pace of change here, I'm reminded of this quote from Bill when he talks about how we sometimes tend to overestimate what we can do in the short run, but underestimate what we can do in the long run.

And the progress we have made with AI and MR is just amazing. In fact, when I think about the compute power, Craig Mundie, who happens to be a former CTO of Microsoft, was telling me how the first set of supercomputers that he was very much part of were built using just 13,000 transistors. And the Xbox One X has 7 billion transistors.

So we've come a long way in terms of creating this abundance of compute power. But yet we still have many unsolved problems, unsolved computational problems.

I mean, just take the challenge of energy. What if we could discover that new material, that new superconducting material that could enable us to have lossless power transmission? That could be the answer to our energy challenge.

What if we could tackle global warming by discovering that catalyst that could absorb carbon?

What if we could tackle the challenge of food production by figuring out, in fact, how natural enzymes work? In fact, here we are in 2017, and we can, in fact, model these natural enzymes so that we can then figure out what artificial catalyst can mimic it.

Take medicine. We talk about precision medicine, but in order to be able to really make sure that precision medicine has the efficacy, you need to be able to model the drug interactions, again an unsolved problem.

It's these unsolved problems, computational problems that were the inspiration over ten years ago when, in fact, Craig Mundie and a team at Microsoft got started on this journey to build a quantum computer.

You know, we set out with a goal of not just trying to achieve a few scientific milestones, we sort of went back to the very core first principles and said, what would it take to build a truly scalable quantum computer?

And the intuition behind the power of a quantum computer is best understood perhaps by thinking about and visualizing the limitations of a classical computer.

Take the corn maze, and if you said, let's try and solve this. You know, the way the classical computer would try and tackle this is to start, trace a path, hit an obstacle,

retrace, trace another path, retrace, trace another path, retrace. So it's this brute force mechanism, because we're captive to the von Neumann machine.

But a quantum computer changes this. A quantum computer enables you to encode information, not just as one or zero but as one and zero simultaneously. That means it unlocks amazing parallelism.

So you saw that, you could take a quantum computer and solve some of these unsolvable problems because they approach it with that amazing parallelism where they'll take every path in the corn maze simultaneously. That's the intuition behind the power of quantum.

Of course, building a quantum computer requires a lot more than just that simple intuition. We have had to assemble a world-class team. In fact, we've had to take a very novel approach of bringing together breakthroughs in math, fundamental physics, and computer science together, and put a system or get started on a journey to put a system that's going to be a truly scalable general purpose quantum computer.

And to help give you a bit more insight into this journey that we are on, I wanted to invite up on stage a few of my friends. Dr. Michael Freedman, who is a Fields Medal Winner in mathematics; Dr. Charlie Marcus and Dr. Leo Kouwenhoven, who are two physicists; and Dr. Krysta Svore, who is a computer scientist. Please help me welcome all of them onstage.

(Applause.)

All right. So, Mike, let's start with math. I know one of the foundational things to our quantum approach is this topological qubit.

**MICHAEL FREEDMAN:** Yes.

**SATYA NADELLA:** Give us a little bit of intuition behind that.

**MICHAEL FREEDMAN:** Sure, let's start with the first word, topology. Topology is the study of those properties of shapes which don't change when you deform them. So the basic example would be if you imagined a loop of string in space. It could be a simple loop, almost like a circle, deformed a little bit; or it can be more complicated and tied in knots in some way. And it's a global property. The information of whether it's a knot or an unknot can't be observed by looking at small segments. You have to step back and see the global picture.

Now Microsoft's qubit will be based on a new form of matter called topological matter that also has this property that as the information stored in the matter is stored globally, you can't find the information in any particular place. Now how does that work? Well, it's based on an idea called electron fractionalization. The basic information, is the electron there or not there, is fractionalized and it's spread out. That information about the electron is broken into two Majorana particles and they're physically separated in the

material. And the fact that this property of being there is nowhere in particular but spread out makes it nearly impossible for the environment to interact with the electron.

**SATYA NADELLA:** Pretty amazing.

**MICHAEL FREEDMAN:** It protects it.

**SATYA NADELLA:** Just the fact that information can be coded into essentially these knots. But you can't observe it locally, but you can see it globally. It's pretty stunning. But you had said something to me which I had not understood when I was learning math, I guess, is this has something to do with square roots.

**MICHAEL FREEDMAN:** It does, deeply. The Dirac equation, which describes the electron is the square root of -- it's called the Klein-Gordon equation. It's a relativistic weight equation. And when you take its square root you find a special form of Schrodinger's equation. Do you remember that cat?

**SATYA NADELLA:** About the cat, yes.

**MICHAEL FREEDMAN:** Which is perfect for describing electrons. It's an amazing thing in math and engineering and physics that the square root is almost always more powerful than the original object. So many people in the audience will have worked with it, the square root of minus one. And really it does just about everything in engineering. Interference, impedance, dissipation.

**SATYA NADELLA:** So it's not imaginary.

**MICHAEL FREEDMAN:** It's not imaginary, it is engineering. And we're working with a different square root but just as important a one.

**SATYA NADELLA:** So awesome.

So, Leo, now if you take that math foundation, the topological qubit and the topological matter, ultimately though we've got to instantiate it in some physical way. How are we going about that?

**LEO KOUWENHOVEN:** Well, luckily, Mike and his collaborative also came up with some specific proposals on what to do in order to observe these Majorana. And the idea is that you can construct an electronic device based on carefully designed materials that do include semiconductors but also superconductors. And if you cool this electronic chip down to very, very low temperatures, then one should be able to observe these Majorana. And I'm an experimentalist, a physicist, and we picked up this idea and we're able to report the first group of Majoranas actually in 2012.

And the Majoranas are really important for us because they are, in fact, quantum super positions of simultaneously having a particle and not having a particle. That is this

electron fractionalization that Mike was talking about. So it's quantum information that is stored globally that is protected against errors by topology.

I realize that is a mouthful of nice words.

**SATYA NADELLA:** I know, but how does it look?

**LEO KOUWENHOVEN:** Let me bring you back to something practical, something that you can hold in your hand. What I've done is actually I've brought one of these electronic devices that we use to study the special properties of these Majorana Fermions. And we would actually, Satya, like if you could start thinking about Majoranas on a daily basis, every day. So I hope you'll set this Majorana chip and put it at some visible spot in your office.

**SATYA NADELLA:** You know what, I've been looking forward to this day, the Majorana day. And you said something else, you said I should keep it but not look at it?

**LEO KOUWENHOVEN:** Yes, be very careful, because as you know, if you observe, if you look at a quantum position you destroy it.

**SATYA NADELLA:** That's right. That's why I don't see the cat both dead and alive.

**LEO KOUWENHOVEN:** Do you also want to have the box?

**SATYA NADELLA:** Yes. Thank you. That's pretty awesome.

Charlie, this seems like a transistor moment to me. But obviously we've got to build a computer. So how are we going about scaling this?

**CHARLIE MARCUS:** I think that's exactly the right metaphor and I think that because this is a kind of an abstract and esoteric topic, it's worth remembering that that first transistor, you have that picture of the history of the transistor in your head, really didn't become the technology of today until we figured out how to put a lot of them on a chip, and maybe even more importantly to have one transistor turn another transistor on or off, which of course was the materials development. We had to understand semiconductors in order to be able to use electricity to switch electricity.

But electrons that from the transistor have their own additional trick. We've known for 100 years that, for instance, the electrons of an atom don't just buzz around like the planets going around in the solar system, but that they're just kind of a cloud of probability. But that trick, if you imagine the same kind of extension from the transistor to the chip, if you say, well, I'll take this electron which isn't anywhere at the same time, and use it to control and other electron which isn't anywhere at the same time, then you have the essential idea of quantum computing. That is everything is turning itself on and off, but nothing has a state until it's measured. And it seems like a fantastically powerful

idea because then everything is on and off at the same time. So there's all of this parallel computing.

**SATYA NADELLA:** And how does the system look, though?

**CHARLIE MARCUS:** I think it's important to say when we start building these things, at least Microsoft's belief, that this idea may not be enough, this idea of on and off at the same time, because those states are so fragile that as soon as you look at them, like you do with the chip or you measure them in any way, all of that magic disappears.

So instead of doing the original transistor model, or the atom model of 100 years ago, that kind of model which hasn't existed before. I mean, we've had 100 years to get used to quantum mechanics and 100 years to get used to atoms. But, we've only had a few years to get used to this electron fractionalization idea. So what we need to do then is the same generalization. We need to take these fractionalized electrons and have one of them affect another one and another one and have a whole chip of each of these fractionalized electrons controlling the state of another one.

So these chips are going to get bigger than that, but the same operating principle of the fractionalized electrons protected as non-local information, but then turning on and off its neighbors will be the principle of operation. It's important to say, though, that even with this topological protection room temperature is not going to be enough to have this machine work. It still has to be down at the very low temperature. So I think what this machine will look like is something like this box right over here behind us, maybe also up on the screen in a second. Don't look at it. (Laughter.)

**CHARLIE MARCUS:** It's actually a quantum joke, I think, there and not there.

**MICHAEL FREEDMAN:** That was an excellent joke. Okay. So I'll say in words what that means differently.

**CHARLIE MARCUS:** You did that on purpose.

**SATYA NADELLA:** Why don't you describe it in the slide?

**MICHAEL FREEDMAN:** So if we just say what this thing is going to look like is the hard engineering part of getting this little chip and its neighbors connected all up is to get that thing down near 0.01 degrees kelvin, where the whole chip can operate. You don't have to worry about Schrodinger's cat being alive or not alive at that point, because it's not going to survive at the bottom of one of these dilution refrigerators.

But the chips work just fine down there and not only do they work fine, but the quantum super positions continue to be in the super position state, because at those low temperatures there's no vibration to do the accidental measurement where nothing happens down there. And all of the little skinny lines that you see going down are what we need in order to control --

**SATYA NADELLA:** So they've figured the quantum problem.

**MICHAEL FREEDMAN:** There it is. So it's there and not there at the same time. Anyway, if you look at that thing you'll see that there's a lot of these vertical lines moving down and those have to solve this very tricky problem of controlling the chip, but not accidentally measuring it.

**SATYA NADELLA:** So where are we? I mean there's so much magic here. I mean you have this cryogenic material. There is all of these parts that all have not only new materials, but new physics has to come together to build this out. So where are we on this journey?

**MICHAEL FREEDMAN:** Well, I have to say I think that this is what Microsoft has done that's really unique in its approach to quantum computing, which is to first of all recognize that each one of these steps is actually very hard. In fact, it may seem like making the chip with the Majoranas is the hard part, or thinking of the idea is the hard part. But actually they're all hard. And everything from the software that we'll hear about in a second to the cryogenic engineering is extremely difficult. So where are we?

We've invented new materials that support Majoranas. We've built the chips. They're back in our labs in the refrigerator down at the bottom of the refrigerator with our students and colleagues working hard to check off the list of all the properties that they're supposed to have, to fractionalize the electrons and verify that they're at the two ends of the chip. And the work is going forward.

**SATYA NADELLA:** That's awesome. That's explains, I guess, why we have one mathematician, but two physicists.

**LEO KOUWENHOVEN:** Exactly.

**SATYA NADELLA:** So, Krysta, going to computer science, from a computer science system perspective how does this all look?

**KRYSTA SVORE:** Yeah, so in the slide previously we saw this stack. So at Microsoft we're building this complete stack, a comprehensive full stack solution so that we can actually run revolutionary applications on this newly revolutionary device. So this includes the quantum chip that we've just discussed in this dilution refrigerator. But it also includes a cryogenic classical computer that's also operating in the dilution refrigerator.

And this is unlike any classical computer we have today. It has to operate at 4 kelvin. That's around minus 452 degrees Fahrenheit. That's pretty darn cold. And we need that to control the quantum computer itself. And then, of course, my favorite part, on top of all of that you need software.

After all, we sit at room temperature. We're not going to be able to jump into this really cold fridge and program the computer from there. We're going to sit out here and have tools that enable us to program the quantum computer and then, of course, software will be throughout this fridge enabling the cryogenic computer to control and operate the quantum stack.

**SATYA NADELLA:** That's pretty amazing. So if people in the room want to get going with the quantum computer and this software stack what would they do?

**KRYSTA SVORE:** Well, at Microsoft we think about tools and especially software tools. So that's what we're developing for all of you in the audience to get involved. So we're building out a full software stack and this I'm really excited, especially about this new programming language we've designed. It's a domain-specific language and it's designed especially for programming a scalable quantum computer. And so this language, it enables you to write quantum solutions, quantum applications. And then from there we've integrated it into the tools, a tool I know you love, Satya.

**SATYA NADELLA:** Visual Studio.

**KRYSTA SVORE:** Visual Studio, so we've integrated this language into Visual Studio and with that we're able to provide quantum debugging support. The ability to visualize a quantum state as it goes through the program. You can syntax color your code and it makes it very readable, very understandable, very digestible. It's tools that you already know and have a feel for.

And then on top of that you can test your algorithms in advance by running them in a simulator. So we're offering both a local simulator that you can run on your laptop, your desktop, that allows you to simulate around 30 qubits for your quantum applications. And then I'm really excited about a state of the art Azure-based simulator that we have that enables you to simulate around 40 qubits in Azure.

**SATYA NADELLA:** That's so awesome. So thank you all so very much. I'm so excited about the progress you are making, the foundational math, physics, and computer science coming together to help us tackle some of the biggest challenges that we still face as a world. Thank you. (Applause.)

**KRYSTA SVORE:** Thank you.

**SATYA NADELLA:** Thank you, Krysta.

So I want to close out where I started. At Microsoft for us whether it was building a Basic interpreter for the Altair, or whether it was building the simulator in Azure for quantum computing. The core soul of our company, the core purpose of our company is to empower every person and every organization on the planet to achieve more. That means we want to democratize the access to technology so that you can create more technology.

And when I was thinking about some of this math that Mike talked about I was reminded of a poem I've read by Vijay Seshadri, the Pulitzer Prize-winning poet from 2014, in a poem called Imaginary Number. He says, the last line goes something like, the soul like the square root of minus one, is an impossibility that has its uses. It definitely does.

We all seek to unlock the unimaginable and solve the impossible. That's the quest we are on. Thank you all so very much for being here this week with us at Ignite.

Thank you so much.

(Applause.)

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