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HOW THE "INTERNET OF THINGS" IS TRANSFORMING THE GLOBAL ECONOMY

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P R O C E E D I N G S

MR. WEST: We've set up a Twitter feed at #IoT -- that's #IoT -- so any of you who wish to post comments or questions during the forum, please feel free to do so. And, of course, we should note that today is the *Back to the Future* anniversary. (Laughter) And today is the day that they went to in the future in that film and, of course, that film was very good at predicting some aspects of our technology future, in the sense that they had fax machines and connected cars, but not mobile phones. So the record was not perfect in this regard.

But it's interesting that we're thinking about technology because the latest thing is the "Internet of Things" and how it is connecting devices with one another. We see it in the form of connected cars, home security systems, energy savings devices and smart appliances, among other things. So all these things have the potential to really change how we live, how we educate ourselves, the way in which we get healthcare and the impact on the economy in general.

So today we're going to discuss the Internet of Things in terms of what it is, how it's connecting people and businesses, what the opportunities and risks are, and its impact on society and the economy.

To help us understand this subject, we have several distinguished experts. Glen Lurie is the president and CEO of AT&T Mobility. Previously he served as the president of the Emerging Devices organization at AT&T, which now is the Internet of Things organization. He has led the company's progress in home automation, as well as connected cars, among other areas. And last year he was named one of the 10 mobile game changers by Russell Reynolds Associates.

Meredith Baker is president and CEO of CTIA, The Wireless Association. Prior to joining CTIA she served as senior vice president of Government Affairs at

Comcast-NBCUniversal. Her past public service has included a term as commissioner of the Federal Communications Commission and during her tenure there she championed a forward looking approach to spectrum management, as well as flexible regulatory environment that can encourage innovation and competition.

And our last panelist is John Villasenor. John is a nonresident senior fellow in our Center for Technology Innovation at Brookings. He also is a professor of electrical engineering, public policy, and management at UCLA, and a member of the World Economic Forum's Global Agenda Council on Cybersecurity. And he has written about the Internet of Things and the role of cybersecurity in there.

So, Glenn, I want to start with you.

MR. LURIE: All right.

MR. WEST: And I'll start with a broad question and you can take it where you would like to go, which is: How do you see the biggest opportunities for the Internet of Things?"

MR. LURIE: How much time do I have for that? (Laughter) Let me start here, so the "Internet of Things" is a new term. It's a term that, as Meredith will tell you, the industry end has coalesced around. We got into this space, really, 8+ years ago. We got into it very early and we saw that everything in our lives is going to be connected and one of the beautiful things about being a wireless carrier is that that was exciting, kind of what's the next big thing?

Now, all of sudden, it seems like everybody has coalesced around this idea that everything in our lives can be connected. When I say that, let me make sure I'm clear, we view IoT as -- and when you see these massive numbers being thrown around, there's folks out there saying 25 billion connected. There's even some predictions of 50 billion connected devices by 2020. I think we've got to remember that all of those are not

connected to the wide-area wireless network, right?

This is about multiple protocols and about devices getting smart, whether it's ZigBee, Z-Wave, 900 -- I can go down many, many protocols, but obviously the wide-area wireless network is very, very critical to that element, whether you talk about a home, a business, or a car. But really, really important is, we view that everything in our lives is going to be connected. We view that a device that is not connected is dumb. It cannot communicate with other devices, it cannot communicate with you. A device that is connected is smart and the future is that devices will be smart enough to help you make your life better.

One of the things that we try to do is dispel, with this whole world of, hey, my car's connected, my home's connected, my dog's connected, my 12-year-old daughter is connected makes people uncomfortable. It makes people feel uneasy, that this must be hard to do. We, as an industry, have to make it simple. We have to make it easy and we have to make people's lives better and by doing that you have to solve problems. So we've, obviously -- AT&T, I should say -- got into this very, very early and our focus very early was, where was that low-hanging fruit? Where were those big opportunities?

And eight years later the automotive space is a massive opportunity and we've done very well in that space and continue to do so. And we believe the car -- as you heard, a lot of people recently talking about it. I think Tim Cook made some comments yesterday about this. It's kind of that next great device in your life. I would argue the home is right there with the car. The home is very personal to all of us, and how do we make that home better? How do we make it so that, in a sense, it takes care of you versus you taking care of it?

And the intelligence that IoT brings will allow you to do that. There's all

kinds of other places I can go. I could stand here for hours and talk about every vertical that's in the space and talk about the data that comes off of these devices and how that helps you with analytics, et cetera, et cetera. But this space today is just starting, right?

We have 34+ million devices on our wide-area wireless network. Many, many more inside of our digital life-connected home products, but we are just right now scratching the surface of where this is going and the opportunity that this space brings.

MR. WEST: So, Meredith, Glenn was --

MS. BAKER: Can I add on that for just a second, if you don't mind?

MR. WEST: Sure.

MS. BAKER: So I think it's really important because, Glenn said this very well, the economic impact is huge. Whether it's 15 trillion in global GDP by 2030 or what those numbers are, they're huge, but I think what you also said which is really important to stress is that, it's going to make your lives better, it's going to make people's lives better. So I think that the social impact is equally important as the economic impact. It's going to make our lives better. It's going to make us more productive. It's going to improve our healthcare. It's going to improve our highways, our education, so I think it's really important.

And just one more thing I think I'd stress is that for 10 percent of Americans their only access to the Internet is through their mobile device, so we want to make sure that in this hugely important Internet of Things that we don't increase the digital divide and make sure everybody has an opportunity.

MR. WEST: And we're going to extend on that, so we are going to have this tremendous increase in connectivity which raises the question of spectrum. How are we going to support that connectivity? So how do you see spectrum playing out in this space?

MS. BAKER: Of course I'm going to talk about spectrum. So, spectrum is going to be a really important input into the Internet of Things," but let me take a step back just to see if I can explain it in a -- as we talk about all the Internet of Things and everything being connected, that's going to drive an awful lot more traffic. By our estimates it's six to seven times more traffic. And last year we grew 26 percent and so 6 to 7 times by the end of the decade is a lot. So what are we doing about that?

So our companies are investing in the infrastructure. Glenn's company and the rest of the mobile industry spent $30 billion last year. $30 billion, so that actually make us the number 1 and number 2 investor in America. So we're investing in infrastructure and we're going to continue to do that.

We're also making our networks more efficient. So when you look at your 4G networks, they are three to four times more efficient than your 3G networks and we're unrolling things -- it's amazing what you're doing. I mean, between LTE Advance or LTM License, LTE Broadcast, all of these things are still being built to make these more efficient networks. But all of that -- if you take all of that input, that's still only going to account for 40 percent of what this Internet of Things traffic is going to be.

MR. WEST: Agreed.

MS. BAKER: So we're going to have some more spectrum. We at CTI have done some very methodical studies to be very realistic about what it is we need to make sure that we're leaders in the 5G world, and in the Internet of Things," just like we are right now. We're the global leaders in LTE. And we're going to need 350 more megahertz and I'm happy that the FCC is looking at high band. We're going to need to look at some more low bands, so the spectrum is critical to our success.

It's really important to understand about around usage and IoT. There's a lot of misconceptions, right? If you think about where usage is going and Meredith said

it very well, usage is just going up and accelerating. What's driving the acceleration of usage is video. We actually said earlier this year that half the usage on our network already today is video. Around the globe it's in the low 40 percentile and growing and obviously we made this small acquisition recently of DirectTV and just became the largest linear TV player in the world because we believe that the future is video and mobility.

But when you go into the IoT world, whether it's smarty city, whether you're trying to monitor a light outside, or you're trying to monitor traffic, whatever you're doing, not all of it's a lot of usage, right? In fact, a lot of it is monitoring and very small usage. And what these companies want is the capability to get the data off of that particular device, so there's opportunities on both side of this. So, sometimes I get questions, well, man, IoT is going to just drive it up. IoT's a piece, right? Video will probably be the biggest piece as we continue to see this growth and we can get into the details of why we think -- what's fun about it is, is it's everything.

People want to ask one question about IoT? You're talking about every single device in your life and they're all going to react differently to the network.

MR. WEST: So, John, you've written extensively about how connectivity has outpaced security in this area, so what do you see as the key challenges in realizing the promise of connected devices?

MR. VILLASENOR: Yeah, that's a great question. So let me start by giving some perspective. I've actually been working on what we now call the "Internet of Things" for, really almost a quarter of a century, although we didn't call it that back in the early 1990s, when I started doing these things. We called it mobile networking, which is really what has become "Internet of Things," so I've seen obviously enormous changes, but the principal of trying to get connectivity with devices which could be anywhere, and be any size, and moving is something that we've been --

QUESTIONER: Can you speak into the microphone?

MR. VILLASENOR: I'm sorry, can you hear me now? Hello? Hello?

MR. WEST: Actually, if you just speak up a little bit, I think that it --

MR. VILLASENOR: I'll hold it here, I think. (Laughter) Anyway, like I said, I've been working in this field for a long time. I've also been working cybersecurity and I am an optimist about the Internet of Things." I think it's going to have incredible benefits, but I'm also a realist. And so, for example, on the cybersecurity side, the innovative things will be largely useless if it's not an Internet of Secure Things. And I think one of the challenges that we've seen is that in the rush to create connectivity, sometimes that has outpaced attention to security.

One very dramatic example of that that was in the press a few months ago, some of you may have read about it, is this Jeep Cherokee that some security researchers were able to take over remotely. From miles away, sitting in some house somewhere, they were able to take over the control ---- and the people in the Jeep Cherokee were participants in the experiment. They knew that it was going to happen, but the people remotely were able, first, to take over the entertainment system -- okay, well, that maybe doesn't disturb you too much, but then they were able to disable the breaks. Well, that's pretty disturbing, right?

And the people who designed these things, of course, didn't intend for that level of control to be available, but it's because when you have these very complex systems, and you connect them, sometimes you can create these unintended linkages that you didn't think were there, but that, in fact, are there and that could be exploited.

So cybersecurity is going to be an absolutely central portion of getting the IoT to do all the amazing things we think it can do, and we know it can do, but I have some concerns that sometimes the market incentives favor a rush to connectivity and

sometimes do not favor enough attention to cybersecurity.

I'll mention a few other things -- two other things. One is that the Internet of Things is often spoken about in terms of the consumer devices, and justifiably so. There's a lot of fascinating and incredibly important things, but there's a whole other fascinating and equally important story on non-consumer applications, industrial applications, agricultural applications, things that we won't actually necessarily directly see even 10 years from now, but that we will all benefit from in many ways.

And the final thing I'd like to say is that I'm hoping that the IoT can be used to help in places where the needs are much greater than they are here. So, for example, it is amusing or interesting, perhaps, if 10 years from now my refrigerator will tell me when I'm getting low on milk, okay, but that doesn't really change my life. Whereas IoT technologies can do things in many developing countries to, for example, to facilitate access to financial services, to facilitate monitoring of water supply, to do things that can really tangibly make an enormous improvement in people's lives and I'm really hoping that as we develop the IoT we give attention to the potential to use it in those environments, as well.

MR. WEST: So, Glenn, how is industry responding to these security challenges?

MR. LURIE: Well, a couple of things. Well, first of all, we agree. We agree from just an overarching standard that security has got to be paramount. We have 124 million devices on our network today and security is absolutely first and foremost of everything that we do and everything that we think about.

Let me give an example. I think the example John gave on the Jeep -- the good news, that Jeep wasn't one of ours. (Laughter) I'm just kidding. When you think about how some things develop, that was an older Jeep, it had an older

infotainment system, that infotainment system had an open port to the Internet. Right there you're in trouble and you're absolutely right. And that's why we have to work as industry together with our partners.

Just like we've worked with industry on our smartphones. Everybody out there -- I imagine every one of you has a smartphone and I know they're all AT&T, so I won't ask. And I know that you probably do a lot of things today that you didn't even imagine you could do three, four, five years ago, right? Whether it's banking -- all the different things that you do. You do that because you have confidence that you're doing that in a very, very safe way.

Now, as you have all these other industries wireless enabling their devices, cars are a great example. They have to bring us as industry into help them. One of the reasons that AT&T has been as successful as we have -- we've announced that we have half the cars coming are ours -- is because we're bringing a full functionality with a thing called Drive Platform that really a quarter of that is security and our ability to help them think through.

If you have an infotainment system it can't have an open port to the Internet. In fact, it needs to be closed. And if you want something to come in from the Internet, it needs to be done in a certain way so you know it can only come from one place. And if it can only come from one place, that bad guys and gals can't get in and you need to think about that versus the basic controls of the vehicle. The control of the vehicle is very different than the infotainment, so the examples John used are dead on right. We have to think about this as we have the smartphone space, or any other space.

I also think the other point John made that's really critical is, this is the Internet of Everything, right? And industrial is probably the most exciting and the most on fire of any of them because there really isn't a company on the planet that isn't saying,

how do I get better? How do I make my own folks more efficient? How do I take better care of my customers?

And the idea around agriculture -- we have a test we're doing right now. I didn't realize this, but when you go out and you have trucks full of, whether it's grain or corn, they get warm. When they get warm, a certain percent of trucks go bad. I didn't know that. They came to us and said, I want to know where the truck is and how warm it is inside the bed? And if I know that then I can actually then position my trucks differently and I can have less go bad. It sounds simple. It actually is really simple for us to do, right? And we've now have solved a problem.

So these problems aren't rocket science, but they make a huge, huge benefit to -- depending on that business and, obviously, if you start talking about other parts of the world there's unbelievable opportunity here to use this to make people's lives better, as Meredith said.

MS. BAKER: So I think that you're spot on and it's so exciting to hear you and hear the passion and everything that AT&T is bringing to the table, as well as the other companies. I think the challenges -- you're up for solving this challenge. I mean, you are thinking about it, you're working with the other industries, I feel certain that the networks are going to be able to handle this and that we are going to be able to have a safe and secure environment.

The thing that I worry about is the city because I think that -- you know, are we going to do our part here? Are we going to get the spectrum that we need and are we, as we interact with all these other different industries, as we change other industries -- if we're working with 20 different industries, there are probably 20 agencies here that regulate them. And we need to make sure that we don't inhibit the opportunities that are out there through our regulatory process. In our rush to be relevant in

Washington, D.C., we want to make sure that we have some regulatory -- there's all kinds of terms that have used here before: regulatory, humiliteer or nascent opportunities to just let this industry grow.

MR. VILLASENOR: Yep.

MS. BAKER: And at this point, keep letting you do what you're doing so well, which is solving the problems.

MR. WEST: And so, John, in terms of connected devices, there's obviously going to be a tremendous increase in data availability and the opportunity to do data analytics based on that information. How do you see this affecting businesses? Like, are the data analytics going to allow businesses to become more efficient in how they use information? And, also, what's it going to mean for consumers?

MR. VILLASENOR: So I think that's a great question. I think we've already seen through services like what Google offers, and Facebook, and many other services is the incredible power of analytics, but the interesting thing is that a lot of that has been driven by traditional, older applications, not necessarily IoT-associated data. So people logging onto Facebook accounts or doing Google searches or buying things on places like Amazon, and if you look at the incredible power that has resulted from those types of data harvesting, then it's going to be sort of squared or cubed, if you think about what happens when we take the data -- obviously with due attention to privacy and those sorts of issues -- but we take the data that's going to come from this enormously greater number of devices in what we call the "Internet of Things."

And depending on whose statistic you read, it was on the order of six, seven, eight years ago when the number of devices connected to the Internet exceeded the number of people connected to the Internet. But it's already happened well in the past and, at this point, it's just a question of the multiplier, right? How many more

devices are connected to the Internet than people? And it's going to be through the roof in not too long and the amount of data from that is absolutely staggering.

The other thing I wanted to echo from Meredith's statement is that spectrum is this incredibly important resource. In this entire enterprise it is the one thing that is absolutely limited. You cannot -- it's there, it's a limited resource, you cannot create more of it. You cannot legislate more of it into existence. You can't invent more of it. You just have to use what's there. So we can innovate in almost every other dimension of that, but in terms of the actual raw -- it's like real estate. There's a certain amount of land in Washington, D.C., and you can't wave a magic wand and create more land. That's all there is, we have to use it intelligently.

So the spectrum issue is first, front and center, incredibly important, not only in the United States, but globally, as we address the IoT, because everything is going to be wireless.

MR. WEST: So, Glenn --

MR. LURIE: Yes?

MR. WEST: -- Meredith mentioned the regulatory challenges facing this sector and I'm just curious how you see those challenges? Are there things being done that you think are going to stifle or create problems in terms of innovation? Or are there things we should be thinking about doing that maybe we're not doing?

MR. LURIE: I agree with everything Meredith said. Always, by the way. (Laughter) No, I mean, look, the best thing that can happen -- I'll say from a high level -- is that we're investing, okay? So I think the reason you might believe we need someone to help us is that if we weren't investing and we weren't innovating. You look at AT&T just this last year, right? We spent a few bucks, right? We spent $18 billion on CapX which, by the way, was the highest of any company in America, period, not just in our

space. We bought DirectTV, that was $63 billion. We spent 18 in the auctions, we're spending 7 in Mexico, so we're spending and we're innovating at a higher rate than any other company in the industry.

Now I'm a little biased, but I think we are. It's just the facts of what we're doing when it comes to IoT, when it comes to what we're doing in the labs, what we're doing in our foundries, et cetera, et cetera. So there's not a problem here, right? We're growing, we're innovating, we're doing the right things for customers. Obviously our industry's very competitive and the key for us is that we need to continue to innovate and invest, right?

I think what John said, and both Meredith said, look, you think about us trying to bring things to make people's lives better, so I just got off a plane and got into a car and tried to drive here. Anybody do that lately? (Laughter) It's really hard, isn't it? (Laughter)

And by the way, people say that Atlanta traffic is bad -- oh, my lord, right? So you think about what a smart city could do for your lives. You think about the fact that those lights are all connected and that your cars are all connected, right? And just talk about traffic, which is just one sliver of what it can do and now, all of a sudden, your city becomes smart. Your city now has the ability to manage traffic -- by the way, it's called V2V -- vehicle-to-vehicle -- talking is about spectrum and about how we're going to do that in technology.

Vehicle-to-infrastructure may be more important because now your car can talk to those lights, and now if all the cars are talking to each other and all the cars are talking infrastructure, think about what could happen with traffic? Think about how much more simplistic life could get? Think about what would happen with accidents? By the way, we have the ability in the latency to stop you from hitting somebody else, okay?

So you think about really making people's lives better with technology, right? Inside that car, none of you text -- I know you don't, right? (Laughter) You shouldn't be, but if the car technology was right, and it's going to be and we're working very hard with the OEMs to do this, that phone should stay in your pocket or your purse. And you should be able to do the same things you want to do with your voice and you should have two hands on the wheel and eyes on the road.

Think about that world now, right? This is where we're heading and technology is going to drive us there, so long-windedly, in answer to your question, we just need to be left alone and let us continue to invest at the rates we are, which is the best in the U.S., and continue to innovate, which we're going to continue to do. And wonderful things are going to happen for all of us to make our lives better and that's the focus we have to have.

MR. WEST: So, Meredith, we started with this *Back to the Future* reference, so if we move forward five years from now, kind of looking at just projecting the current trends that are under way, what do you think the world five years from now is going to look like, from the standpoint of the Internet of Things? What are the types of things consumers are going to be able to do?

MR. LURIE: I want to hear this.

MS. BAKER: Exactly. Well, when we talk about these numbers we talk about petabytes and I remember actually being at the FCC the first time I heard the word "petabyte." And I was like peta-what? Is that a fossil? Is that a troglodyte?

So, a petabyte is actually three Netflix libraries, right? So currently -- well, in 2010, I think we had let's just say, eight Netflix libraries a month going through your network. By 5 years from now, it's going to be 850 Netflix libraries every month going through your network, which is kind of terrifying and terrifically awesome. And I

think it goes back to the reason why I'm so passionate about spectrum, which may be actually because I'm also so passionate about the traffic. (Laughter)

But I think that if we get this right, if the FCC continues to look at the high band where it's unused spectrum right now -- and it's big chunks -- that we might be able to use in the short-term. And if we get the incentive auction and if we figure out what's next, if we get it right our 5G world is going to be incredible. The opportunities that we have for a connected life is going to impact every part of our life. I think we talk about 99 percent of our things being connected and it's machines, and it's sensors, and it's devices. It's all of that.

MR. LURIE: It's everything.

MS. BAKER: It's everything.

MR. VILLASENOR: If I could just follow up on the investment comment? So I think it is absolutely amazing the amount of investing that companies like AT&T are using. Add to that, as somebody who actually lives in the Bay Area -- so I have to make a plug -- in the Bay Area, of course, there's this thriving startup industry and there's an enormous amount of investment from venture capitalists and others going into startup companies in the IoT space.

So you have not only the incredibly important traditional large corporations, like AT&T, but you also have this cluster of smaller players that are trying to innovate and, of course, Nest, for example, is one example of a spectacularly successful startup. So there's just an enormous amount of aggregate investment in this space in this country and you may not be able to specify exactly what innovations are going to come in 5 or 10 years, but you can be absolutely confident that there's going to be a bunch of innovations.

MR. WEST: Yes. Okay, why don't we open the floor to questions from

the audience? So if you have a question, just raise your hand and give us your name and your organization. There's a gentleman right here. There's a microphone coming up from behind.

MR. FARMER: Thank you, Nick Farmer. Can you make any quantitative assessment of the impact of the Internet of Things on energy efficiency? Broad scope -- it's global, industrial, commercial, home use, and so forth.

MR. LURIE: I can jump in on where I think people are focusing. I'm not sure I can give you a defined amount. I think we're really starting to see it play out now and I think John's comments -- it's one thing about our homes, we can go there in a second -- you've got your home opportunity, but I think we have a massive opportunity in industrial. We have a massive opportunity in solar and other types of technologies.

We just announced, actually, at Meredith's show at CTIA that we're working with a couple of solar companies to wireless enable the solar on your roof. Why are we doing that? Because today people have no idea, their house pulls in a bunch of energy, did they use it all or not use it all? Can we put that into another place and use in other places? So we are wirelessly enabling that, putting on an app so you always know exactly where your house stands.

This is a small example. Today -- you mentioned Nest, they're a good partner of ours. The gentleman, Tony Fadell, that started Nest was at Apple. I know Tony very well. You know, there's the ability for you to control your home. Not just one time from your smartphone, but actually tell your home every single time you leave I want it turned down. Every time I come home I want it turned up. I want the ability -- we're seeing and hearing from folks, savings of almost 25 percent because in most homes we don't have that capability.

You start talking about industrial, it's massive. The opportunity in

industrial to have that kind of -- just understanding where you are and having it automated, so that when you need it, it's on. When you don't need it, it's off. And you have real time diagnostics of what's happening. It's about our ability to say, this is about getting the data to people to make good decisions. So we see energy, as one of the biggest areas in smart cities as absolutely critical. And the smart cities folks were talking to cities around the globe, by the way, not just in the U.S. The first thing they're talking to us about is not traffic, even though we'd like that to be the first thing, it's about energy.

It's about simple things like, how do I make sure my street lights are being efficient because that's costing the cities so much money. And, by the way, most cities in the U.S. don't have any money, right? They have to find a way -- the only way they're going to invest in this is if they see a very, very quick payback. The fastest payback in most cases is energy.

MR. VILLASENOR: I would just add really quickly that at the home level, certainly, there's enormous opportunity. On a hot August day you can't even imagine how many empty houses around the D.C. area must have the air conditioning blasting full blast so that at 6:00 or 7:00 p.m., when someone comes home, it won't be hot.

But I think the real huge opportunity lies in the manufacturing chain. And I think the IoT gives us the ability to do audits, energy audits, at a level of granularity which simply do not exist today. And I think in a complex, multi-stage manufacturing chain a lot of places you wouldn't even know today where the energy efficiencies are, where the opportunities are to optimize. But we'll have all of that information and those processes are so energy intensive that small changes can be the equivalent of saving energy efficiently in 1000 houses, or something. So it's an incredibly important opportunity.

MR. LURIE: Completely.

MS. BAKER: And I would say, just to add on, I think everything you guys said I couldn't ever say any better, but when I talked about the regulatory experience here in Washington, D.C. and how it can be a negative, there's also some good work that's being done. It's happening at the energy level, it's happening in the car level, and it's happening in the health spot where Washington can be a convener. And the regulatory alphabet soup that we have here is hard to navigate, but I think the government can play a role in convening and joining the vocabulary because our industry hasn't necessarily worked with the energy industry before. And so to help to convene these fora, whether it's the Connect to Health that the FCC is doing, and to actually get out to communities and get people to understand how the two can work together and what the benefits are is a good role and a positive role for government to play.

MR. WEST: Okay, there's a question right here, this lady on the aisle? There's a microphone coming up from behind you.

QUESTIONER: (Inaudible), PCIA, the Wireless Infrastructure Association. My question is for Commissioner Baker. You mentioned that there's going to be 6 to 7 times more traffic with IoT and that 40 percent of that will be resolved with infrastructure and greater efficiency. Do you think that we're on the right track with making sure that infrastructure is deployed the way it needs to be to meet that goal, or could more be done?

MS. BAKER: So I think infrastructure is really one of the three legs of the stool that we need to do, between infrastructure, efficiencies, and more spectrum. But we just had good law passed in California on infrastructure, which is great. The FCC shot clock has been very helpful. I think there's always more we can do. I think we're working now, currently, in Congress on some citing on federal lands, which has been a problem and obviously the federal government has an awful lot of land which we would

love to cite more efficiently and effectively.

So I think it's really important. I think we can never sleep, like on all of these issues, because of what's coming our way. We need to continue to work to do better. And I think there's certain parts of the country that are doing well, and there are certain that aren't.

MR. LURIE: I would just say it's going to take every aspect of the ecosystem, right? It's about sighting, yes. I totally agree. But when you think about what it's going to take to meet demand, it's going to take everybody, right? It's going to take every aspect of the ecosystem from the technology -- from what are we going to do in 5G, which someone's going to ask to where are we headed, whether it's unlicensed is a big, big issue now that we're working through. It's going to be critical for us. It's going to be all the technologies around what's in device because, you remember, this is about what's in the device, as well.

It's about what John talked about with security and, really, virtualizing our networks to make them more efficient and, also, better at security. It's all those pieces for us to meet because demand is just going to continue to do this. Any of you using less than you used a year ago? I don't think so, right? So that's where we're headed.

MR. WEST: So, speaking of 5G, what are we going to do in 5G and when are we going to have it?

MR. LURIE: I have no idea. (Laughter) Look, there's a lot of speculation bouncing around around 5G and I made some comments, actually, at CTI. Look the standards around 5G aren't set, so let's just start there. There's a lot of concern -- Meredith made a comment earlier -- LTE, 4GLT was really driven by the U.S. We really drove that standard, we drove that technology, we lead the world in that.

There's a lot of concern around other parts of the world trying to lead in

5G. I think everybody needs to kind of chill and understand that once the standards are built we are obviously working very hard, as are folks in China and Korea and Japan, and other places. And the reality is that 5G is going to be spectacular, but we have to remember that's not coming for four or five years. And what we have today is really, really spectacular, as well. And that's why I don't want us to go out and over-promise and under-deliver. What we've got to focus on with 5G is -- one of the beautiful things about 5G is the Internet of Things is being considered in the standard, right, the concept of low power?

So when you talk about some of these sensors that John brought up and we've all talked about, these sensors, we want to have 10-year battery life. They use very little bit of data. Today we don't have that capability, but in 5G we hope there'll be a layer of 5G that's low power, low usage, very simple. Built really for IoT.

That's exciting, right? Lower latency, right? Do we need much higher speeds? Look, the speeds are very good today. You can pretty much do anything you want. When we get some higher speeds, we may. So this is really what's being worked and you're going to see a lot of PR come out of Asia -- a little bit out of Europe, but mostly out of Asia. That gets people nervous. We should not be nervous. We're working hand in hand and when 3GPP makes our final decisions on what those standards are, then we'll have a lot to talk about.

MS. BAKER: So I think it's a great question. It's really interesting -- what does 5G look like? And you first point, Glenn, is right. There's a lot of gas left in 4G and this platform was built to layer on and to improve consistently and constantly improve, and we're doing that. You know, it's only five years old, so you don't want to get ahead, but we are thinking about 5G and we will be leaders in 5G, just as we are in 4G, and it's important to our economy and it's important to our lives.

When you think about our lead in 4G and what it's done for innovation up and down the chain, 90 percent of the operating systems in the world, and 90 percent of apps that are downloaded are from United States companies. So it's important for us to not forget that 4G is an ultra-fast experience for us, and that will remain. And I think 5G's going to be a layering of functionality and some of the things that we're talking about is latency and scope. That's what 5G's going to start to look like for us.

MR. WEST: This gentleman right here has a question. Right there on the aisle?

MR. VINGE: I'm Gerhard Vinge. Is the speed-up and slow-down more dependent on deregulation, in that regulation soup, which you said? Or is it more dependent on re-regulation abroad? And what is the difference in efforts?

MS. BAKER: So I take your question a couple of different directions and I think that for right now, I think we need to let this Internet of Things grow and we need to make sure that, you know, the House Energy and Commerce is holding a hearing right now on automobile and cyber, that's important. We need to make sure we get it right, but I think what Glenn's company is doing with the investment and working with the automobile companies in developing the right security infrastructure is probably more important.

And I think we need to make sure we don't inhibit what they are doing by regulatory agency. I think health, some of the FDA type -- what is wearable? What is regulated under the FDA and what is not? What is that definition? I think we just need to make sure that we let all of the different things grow.

And I guess to your question about global, we haven't really talked on this, but it goes back to the standards being very important because global harmonization and the size and scale and scope of all of this is really important.

MR. VILLASENOR: Could I just maybe add, just to let us give some perspective on 5G and 4G and 3G and 2G, these things take a very long time to propagate out into the system. There are still plenty of places in the world that only have 2G coverage and that are just getting 3G coverage. There are plenty of places in the world that have 3G coverage, but will not get 4G coverage for a little while.

The other thing that I'd like to say is that the maximum speeds enabled by 4G, there's almost no app I can think of -- at least from a consumer standpoint -- that we would not be happy, that we can't already do with the speeds that are available on 4G. So the problem is not that 4G is in any way too slow, the opportunity lies in -- exactly as you said -- of broadening the capabilities to think. Because 4G was largely designed for, can we make it faster? Right? Whereas the 5G goals are more specifically, as was noted, the point being aligned for IoT in recognizing the diversity of wireless devices that need to move data over the air. And so I think that's an important perspective to keep in mind, that 4G is -- when it's not constrained by network overcapacity and things like that, 4G can deliver an enormous amount.

MR. LURIE: Can I add something to the global part of your question? It's really important. We are leading in this space by a long shot. And one of the things that we have learned over the last, probably, three or four years is that the rest of the world is very curious about what we're doing.

And the other things that's very interesting is our best customers, they don't want to go cut deals with every carrier in the world to have a global device, right? So what I mean by that is if you think about a car company building cars in Germany, right, they don't want to go out and have to know, well, that care is going to Australia, so I'm going to put an Australian set -- it completely blows up their whole way that they build automobiles and they manufacture. So what they've done is they're starting to ask, can

one company in the world aggregate the world for me? And we're doing that.

So we have cars coming off the line right now in Europe and Asia and other places because we're able to -- I've already got 124 million customers that travel the world, so we already have agreements with 600 carriers around the world, so through a technology called a global sim platform that we've built and we're the only carrier that has it working at the scope and scale that it does, we're able to take a care company and they have one carrier to work with and we aggregate the world for them.

So there are regulations around the world that make that difficult, you're absolutely right. And we're having to go work those in specific places, but it's worth it because we are able now to bring the globe into a very simple place for a customer and I'm telling you, most of the deals that we're bidding on now are not just U.S. based.

QUESTIONER: So it's getting easier?

MR. LURIE: For us, yeah.

MR. WEST: Okay, there's a gentleman here on the aisle with a question?

MR. LONGSON: Good morning, David Longson from COMTIA. My question is for you, John. None of this discussion matters unless we really focus on cyber. I think that's the bottom line. So, John, what can the inside-the-Beltway ecosystem do in terms of putting the spotlight on IoT and the cyber component of IoT, what should the administration be doing? What should the federal agencies be doing? What should the Hill be doing? Do we need, let's say, an R&D bill focused on the cyber component of IoT? Do we need more funding going into our universities --

MR. VILLASENOR: Yes. (Laughter)

MR. LONGSON: -- and to prop up more private-public partnerships?

MR. VILLASENOR: So, a couple of things. That's a great set of

questions. First of all, I think there's an enormous amount of funding already going into cyber. In full disclosure, I actually am running a piece of a new Department of Homeland Security funded project on critical infrastructure security that, among other things, we're going to be looking at IoT.

But I don't think the solution is just throw enormous amounts of new money at it. I also worry about over-regulation. I think, for example, hearings or other events that raise the consciousness level, the awareness about cyber issues and the IoT are a good thing. But I would not, for example, be an advocate of the government trying to get into the nitty gritty and specifically setting a whole set of cybersecurity standards and issuing cybersecurity grades and scores and rankings because I can tell you, as soon as the government declares somebody's system to be completely secure, somebody's going to go and hack it an prove that it really wasn't completely secure.

So I worry about a reaction that might lead to over-regulation. I think there is a lot of market pressure on folks like AT&T. AT&T doesn't want security failure, we don't want AT&T security failure and AT&T doesn't want to have a security failure, so in that sense there is a strong co-alignment, at least to a decent sense on these parties.

So I think the good news is, people recognize these issues.

MR. WEST: Near the back there's a gentleman on the aisle?

MR. JORN: Thanks, Darrell. Bill Jorn, with ROI3. We're creating apps for people in the developing countries, particularly in the lower third, if I can put it that way. Our little company has a whole debate on whether or not IoT might interface with apps, as we are thinking of them.

So could John or Glenn maybe describe in a little more detail how the utility of these IoT systems could work and tie in, on an individual basis, with a farmer's app or something like that?

MR. VILLASENOR: Well, I'll briefly say, as I mentioned a moment ago, I made the statement that a lot of the world is still covered by 2G and just to clarify, anyplace you can fly from Dulles is not still on 2G, but there's a lot of very rural areas in Africa and Asia, and so on, where the coverage isn't nearly as good.

I think the IoT has -- a mobile phone is essentially a thing, right? And it's becoming a very smart thing. One of the most interesting things is that the price point of the least expensive, off-contract smartphones is now becoming so low that pretty much anybody on the planet can afford to get one or will be able to afford to get one in the next couple of years. And that's a stunning development, right?

In 1995, people who might live in places without running water would actually have regular mobile phones, but of course, we all take that for granted now. Five years ago it sounded crazy, or three years ago when I started publishing things saying everybody on the planet is going to be able to afford a smartphone. But we're actually getting to that point today.

And so if you believe that a smartphone is a thing in the IoT, which I do, then the smartphone is -- and for these people the smartphone is not an additional portal, right? Most of us in this room we've accessed the Internet through desktop PCs back a number of years ago and maybe laptop PCs, and now tablets and smartphones, so for us things like smartphones are just yet another way to be connected. For many people in the world, hundreds of millions of people in the world, those are going to be the first and only way that they are engaged with the digital system.

And so that, for them, increases the value of the IoT. Arguably for them, it will play an even more important role in their lives than it does for us because that's how they're going to engage with information. Everything from agriculture to health monitoring to traffic information, in terms of what road might have been closed for some

reason -- just an enormous array of applications.

MR. LURIE: That's well said. All I'll add is this, what the smartphone is, really, is a piece of glass. That's what it is, right? And what it does is it's a window into whatever you want it to be, whatever app you're in, whatever world you want. There's really nothing you can't put a sensor on -- and by the way, to the same degree that smartphones have come down in price, sensors are coming down in price dramatically. There's really nothing you can't put a sensor on, build an app, and have it tell you real-time data about that sensor. There's nothing you can't track and so I can go on and give you guys -- and he'll probably lasso me -- I can give you guys just example after example of very simple things that are making big, big, big benefit, whether to the individual or to the business.

So I think what you're working on is absolutely dead in the center of this and, to the point made, because those smartphones are coming down in price, and because there's OSs, like Android and others, that are inexpensive to add to those smartphones. You're going to have apps built around IoT all over the world, and I mean everywhere.

MR. WEST: On the aisle, right here, there's a question?

QUESTIONER: Hi, I'm Beth. I'm with the American Association for the Advancement of Science and I was just really interested in -- and I'm also an epidemiologist. There's a big disconnect between wireless and mobile and, actually, what's being implemented in healthcare at the moment. Mostly because of regulation, some of which because there are scaling issues and funding issues, but where do you guys see your role in health -- and actually getting it into our healthcare system, not just creating to create for that sake?

MR. LURIE: I can start. You're absolutely right, it's difficult. It's one of

the more difficult spaces for all the reasons you said, and I can think of a few others. But I'll say this, I think where we've been able to get in and start to make, I think, a difference is around wellness. Around the ability to give that data, for people to make a decision to put something on their wrist, whether it's something to go work out, whether we're talking about monitoring somebody coming out of the hospital, those types of things.

I'm a big believer that the wearable really becomes a hub for your body. I believe that once you have a wearable that's fully connected and has all the things that it needs -- today's most wearables are backpacked off a smartphone, that's not the future. It allows you then to have the digital advantages, the other things that you want to do to track and do those diagnostics are very, very important.

One place that I'll just hit as an example, I think there's a huge opportunity is aging in place, right? We've got 10,000 a day retiring, right, and we can go down that path, and the one thing -- if you ask someone who's retiring today, who's a Baby Boomer, their most nervous about when their kids are going to take them out of their homes.

And we have the ability today, and we're going to do more with this through our digital life home security and automation business, that platform, to give you as a caregiver the ability to keep track of mom or dad, and/or both, in a respectful way and let them stay in their home many, many, many years past what they would normally have to go and be put in a home, which, by the way, the economics of that for the caregiver is massively expensive.

And, by the way, when you look at where we are today, our ecosystem can't handle it. It can't handle the number of people coming. There's one example where you can put in -- by the way, one real quick point on this. When you have home security and automation, you want to know when something happens. When you're

tracking mom or dad, you want to know when something doesn't happen.

So you have to build it differently. You have to have different types of devices for mom and dad. But the key is -- that's one example of where we can make a massive change in society, and also show some respect to the people that are aging.

MR. HAWN: Hi, Jeff Hawn from RCR Wireless. My question is about infrastructure. So, basically, since the wireless industry began the metric for how we measure connectivity has been the number of people who are connected, but I'm sure you're aware there was some concerns raised recently about this in a Senate commerce hearing. Because while the agricultural industry is rapidly embracing the IoT world, to the point where John Deere is putting a modem in every single piece of equipment it manufactures.

The infrastructure seems to have lagged. There were stories told during the hearing of farmers who have to take a flash drive to transfer data between machines because their network doesn't exist, or queuing up at the only McDonalds in town at 4:00 a.m. because it's the only place with WiFi, where they can get in touch with their suppliers, and stuff.

So do we need to revise our metric in this more machine to machine world on how we measure connectivity?

MR. LURIE: That's a very good question, I'll start. By the way, thank you, the John Deere's are all connected by us. (Laughter) And they're a very good partner of ours all over the world and I think some of those stories are good. They're important. But you've got to remember, the hard part for -- and I'm going to speak for all carriers now for a second. You know, putting a cell site that cost X, Y, or Z out in the middle of an area that's not going to get used isn't very efficient and we're already spending $18 billion -- we are 30 for the industry -- that's just a part of the business we

have to make decisions on, so we need to look at other opportunities.

And you're absolutely right, we'd love to have every square inch -- and, by the way, the majority of the population in the U.S. has coverage, you guys know that. But when you start to go out into some of those places that I imagine these folks were from, they're in places where there aren't a lot of people, there are a lot of cows, right? And we do need to figure out how to bring technology in, whether it's WiFi-based, right, or wire broadband-based or wireless-based.

I think you all are well aware that we are focused very heavily on bringing broadband out to those areas. And we spend a lot time talking about it as we got our DirectTV done and some of the things that we've committed to do with fiber, but we want to go out in those areas and deliver an economically feasible way for those folks to have high speed broadband. But the good news is -- and I think you nailed one of the key points -- is John Deere isn't connecting every tractor, right? They're doing that because of the value it brings that farmer. It gives them those diagnostics, it lets them understand what they've done that day, so it's really exciting what John Deere -- they're a very forward-thinking partner of ours and how they're going about doing that -- and by the way, like I said, that's every tractor in the world that they're connecting.

MS. BAKER: So, just to add onto that I'd say that 98 percent of the population is covered by LTE, but again you've raised a very good point, that there are a lot of places that the population doesn't exist, so that we do need to get covered and I think that that goes back to making sure, as we move forward in this fantastic wireless world, that we make sure that the digital divide doesn't divide us any more than it is.

MR. LURIE: Yep.

MR. WEST: Okay, in the very back there's a question?

QUESTIONER: Hi, we have a question from Twitter, from a user named

Anna. Should the Internet of Things depend more on deregulation or re-regulation, given that there are huge differences in regulation between countries?

MS. BAKER: Again, I think it similar to some of the questions that have been asked, which is -- it sounds almost the majority of the panel agrees that we need to make sure that we're very careful in what we regulate, to make sure that all parts of this ecosystem can flourish and grow because it's just, just, just beginning. But when you ask the question about healthcare, we are at a tipping point. When we look at the automobiles, we are there. The technology is there, we just have to -- it's just a time for it to roll out.

I feel like we've been talking about smart automobiles for a long time. They're smart.

MR. LURIE: They're smart. They're getting there.

MS. BAKER: Healthcare can be turned on its head by this.

MR. LURIE: Agreed. I would just add one thing. I think as we talked about globally, it's going to be very important and one of the groups that plays a big role, and this is GSMA, right. That's the global organization. Meredith's organization plays a huge role in this. It's about education. It's about making sure these folks are educated. One of the points made that there's Senate hearing in D.C. on IoT, and I always ask Meredith, well, who was there speaking because the folks that are speaking, I don't know who they are? And we kind of know who the leaders in IoT are and we know who the experts are, so that makes me really uncomfortable when I hear there's a Senate hearing and somebody's speaking, are they really an expert? Are they really giving the right information, so that they can make great decisions?

And we can all -- I'll stop there before someone in that back jumps me because that frustrates me because we need them to understand what's really happening

and what customers are really saying, and what the real issues are? Once we understand those, I think we can make good decisions.

MR. WEST: Any other questions?

MR. VILLASENOR: Can I just make one other quick other point. The infrastructure topic came up in rural areas, and as AT&T, they're on it, but I want to also say that urban areas are incredibly important for infrastructure, as well. And if you think about -- we tend to think of wireless as, how much can we get from our smartphone to the nearest place that signal lands? But if you then add up the aggregate number of bytes in the air in a high density place like Manhattan and you think you've got a back call all that stuff into the core network, there's just an incredibly important set of things that are going on.

Again, we don't tend to see those, but there's an incredible amount of innovation investment going on just to make sure that all that data can be serviced and brought into the system. So the infrastructure issue is one that is being addressed, but it's not just rural. It's also in urban areas.

MR. WEST: So that's a great closing comment. So I want to thank Glenn, Meredith, and John for your great insights and we'll look forward to what the *Back to the Future* will look like in 5 to 10 years. Thank you very much. (Applause)

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I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

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