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THE PROMISE OF SMART TRANSPORTATION NETWORKS

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P R O C E E D I N G S

MS. WATERMAN: Good morning, everyone.

GROUP: Good morning.

MS. WATERMAN: I'm from California, so it's very early morning for me. Well, welcome. Thanks so much for joining us this morning. My name is Amy Waterman, and I work for Intel Corporation.

And I wanted to start by saying that Intel is absolutely delighted to be here this morning to participate in a discussion on the recent research collaboration with the Brookings Institution, and the China Academy of Information and Communications Technology.

It's been an honor for Intel to support this work. This work is highlighting the critical steps to advancing the future of smart transportation, and the necessary technologies, such as 5G, that will enable advanced transportation capabilities worldwide. 5G will take the industry well beyond communications, bringing together wireless computing and the cloud, it will truly enable seamless and ubiquitous communications for billions of devices and things.

With 5G devices will be able to communicate with one another, with edge servers, with the core data center across very wide areas, and this will all be done via low latency connectivity which, in turn, will release a tech explosion of innovation across an array of verticals, not the least of which is transportation.

Smart vehicles have actually been on the road for some years now. In fact, in 2015 Intel demonstrated the ability of self-driving vehicles as part of a 3400-mile road trip. But since then we've been doing a lot of other work, and today, we are making significant progress, and one of the ways we are doing that is an expected deployment of

100 fully autonomous vehicles.

These vehicles are using some of our technology from our Mobileye acquisition which includes computer vision, sensing and mapping capabilities. It also utilizes Intel's open compute platforms, our expertise in data center, and 5G communication technologies.

At Intel we believe that the 129 million self-driving cars that will be hitting the road between 2020 and 2035 can be enhanced by broad-scale deployment of 5G, and in fact, it is only with 5G, that will see the full capabilities of smart transportation realized.

The future of autonomous vehicles rests on their ability to securely and reliably connect at ultra low latency. With an evolutionary path to 5G, cellular vehicle to X technology will offer superior performance to support connected vehicles as they communicate with transport infrastructure.

As the research you are going to hear about today, produced by Brookings and CAICT, highlights, it's essential that we make the necessary investments in infrastructure, technological innovation, and in policy.

Why is this so important? This is important because in the U.S. it's estimated that investments in physical infrastructure, and the Internet of Things, to support transportation in particular, could create between 3.9 and $11 trillion in annual economic growth by 2025.

This is addition to the trillions of dollars service providers are investing in upgrading their networks on the path to 5G, and is in addition to the $40 trillion estimated smart cities in the U.S. are contributing to modernizing their digital infrastructure.

China has been even more aggressive in their pursuit of smart

transportation and intelligent-connected vehicles. The Chinese Government, industry and enterprises, have jointly developed new initiatives and launched a series of pilot projects to speed up deployment. One in particular, is a program called, Made in China 2025, and it includes many projects several of which are designed to advance China's automotive industry and transportation system.

The government has set a goal that by 2020, over 50 percent of vehicles will include driver assistance, partial automation, or conditional automation systems. And the goal by 2025 is 80 percent. There is much that we can learn from China's leadership and transportation, and their recognition of what many of the benefits could be.

If governments and industry in the U.S. and China continue to invest in developing the technical and physical infrastructure as well as the policy, we believe that the societal, environmental and economic benefits that can be achieved are unlimited. Smart vehicles hold the key, not only to improving quality of life but also could save millions of lives.

Imagine a world where traffic accidents caused by human error are virtually eliminated. Think also, and I think this is the most interesting part, think also of where a world where the elderly and citizens with limited mobility can have access to the same resources, the same locations, and experiences as everyone else, where transportation is no longer a barrier, but it is a gateway.

Envision that the impact of taking millions of millions of cars off the roads, imagine the reduction to CO2 emissions and the impact this could have on traffic congestion and the climate. Smart and connected vehicles also could create a wealth of economic opportunity. It's estimated that by 2050 the sales of autonomous vehicles alone, will comprise 50 percent of new sales, and this will result in $7 billion added to the

global economy.

And this figure does not account for the potential of launching new industries and services, and all of the supporting technologies that could be created to support the myriad of connected things. The commitment by governmental organizations like CAICT, and the collaborations between these groups and research institutes, like the Brookings Institution, and providers of technology like Intel; are essential to illuminating the possibilities.

We are very pleased to be engaged in automotive research with CAICT and Brookings, and I'm looking forward to hearing the perspectives of our presenters today, this research and the opportunities in China and the United States, is an essential component to identifying the necessary investments in infrastructure, regulation and standards.

We are confident that with close collaboration between governments, technology providers and auto manufacturers, we can lay the foundation today for the support of smart transportation and 5G for tomorrow. My hope I that together we can realize a vision of smart and connected transportation with equitable access and safe and enjoyable transportation for everyone.

And with that, I would very much like to introduce and welcome, Mr. Yu, the CTO of CAICT to share some opening remarks. Thank you. Mr. Yu? (Applause)

MR. YU: Distinguished, Vice President Darrell West, Amy, ladies and gentlemen. Good morning.

GROUP: Good morning.

MR. YU: Yes. It's a great pleasure for us to be at Brookings again. Four years ago we were here to join for the release of the whitepaper on mobile cars, and

conducted a very good discussion. The result of our joint research, a research the particularly inflows in both countries, I hope our joint research on smart transportation this time (inaudible) of our support for government and the industry in both China and the United States.

As you know, smart transportation is the regard -- an important approach to tackle traffic safety issues, congestion and pollution. New-generation ICT especially 5G, IoT and AI are used to accelerate intelligent development of transport system. They are also used to help improve transportation system to safety and the efficiency to facilitate the development of fully automatic driving and construction of future transport system is highly collaborative and intelligent.

On the other hand, smart transportation is also seen as the key to promote transformation and the upgrades, both of traditional automobile and the transportation center. And shape new drives of economic development, intelligent connected vehicles together with electric and shared vehicles will reshape we believe -- will reshape the future of our (inaudible) and even the transportation system.

China pays great attention to the development of smart transportation it has made positive progress in top-level design, technical research, standardization to application, demonstration and the industrialization.

Regarding intelligent connected vehicle, the work program on innovation and the development of connected vehicles was released, and it's a strategy, and the innovation, and the development of intelligent vehicles was formulated with public opinions.

Related ministry cooperated with the provinces, and how to promote the development of, we called 5 plus 2, altogether 7 demonstration areas for application of

connected vehicles, such as the City of Shanghai, and the Zhejiang Province, and the Wuxi. Meanwhile, in order to facilitate trade, the cars sector and the cars industry collaboration, MIT, joint with other -- joined hands with other ministries to set up a special committee on development of connected vehicles.

And CAICT has been active, supporting, make policies on smart transportation in China. We also take the lead to set up, we call the C-V2X Working Group and the IMT-2020 is a Promotion Group for 5G and in the resource, a member of this promoting groups. The 5G Promoting Group is to drive technological and the industrial cooperation with cross-industry research institutes and the enterprise around the world.

CAICT enjoys a sound foundation of research and cohort with the United States research institutes, and the industrial organization and enterprise. The continuous, conduct of joint research with Brookings and the sound effort, I believe in both countries.

I hope the attention today will enable the two countries to deepen, understand the policies, standards and the industrial promotion on smart transportation, prompt establishment of a long-term collaboration mechanism and drive for technology innovation, application promotion under industrial development on both, two countries, and the two are built for (inaudible) on smart transportation.

At last, I would like to say special thanks, Amy and the Intel for your courteous support to the project. And I would specially thank Mr. Darrell West; we have a very good cooperation on the joint research for the past four years. And I wish the conference great success. Thanks, everybody, thank you. (Applause)

MR. WEST: Thank you. So, I would like to join Amy and Mr. Yu in

welcoming you here today. We have a large number of people in the auditorium, and a number of people are watching our webcast as well. So, we are excited about the program, we appreciate Intel's financial support for the project. For those of you who would like to make comments, we have set up a Twitter handle at hashtag Smart Cities, that's #SmartCities, so feel free to post any reactions that you have.

As Mr. Yu mentioned, this is our second project with the experts from the Chinese Academy of Information and Communications Technology. Several years ago we worked on a project about mobile health in China and the United States, and put out a paper and did events both in Beijing as well as here in Washington, D.C., and we got a very positive response to that paper. So, when the opportunity came up to do another project with CAICT we were happy to do so.

So, our latest project such as, smart transportation in China and the United States, and on our website we have a whitepaper published both in Chinese as well as in English entitled, *Smart Transportation in China and the United States*.

And what the paper does is to compare what the two countries are doing are doing in the transportation area, the progress that has been made and the obstacles that need to be overcome in order to move forward.

So, what I'm going to do is discuss the opportunities, the challenges and what's happening in the United States, and then my Chinese counterpart, Yuming Ge, will discuss Chinese development, and/or recommendations for moving forward. And first, let me call up my PowerPoint.

So, today is a time of great opportunity in transportation, so here is the Google self-driving car that has now logged over a million miles on the highway. In China this is the Chinese version of the driverless car. I was in Beijing visiting the company

Baidu, which is the Internet search engine that's very prevalent in China. And so, like Google, Baidu is spending a lot of time developing its vehicles.

And so the issue is that every country around the world that's focused on transportation is suffering from certain problems. Many large cities have congested highways, our streets today simply are not equipped for the number of vehicles that travel them, traffic delays are estimated to waste more than 3 billion gallons of fuel each year, and 7 billion hours of citizens' time.

There also is the big problem of highway fatalities. There have been about 35,000 fatalities in the United States resulting from highway accidents. In China there are 260,000 people who die each year from automotive accidents.

In the United States about 39 percent of all highway fatalities involve alcohol, and 94 percent of U.S. accidents are estimated to involve human error. And so there obviously are a lot of issues associated with autonomous vehicles, but there is very little drug driving or distracted driving with autonomous vehicles.

Of course, this week we did experience our first U.S. fatality resulting from autonomous -- or an autonomous vehicle, the one that happened in Arizona. And I'll talk about that more in a minute.

Air quality is a huge problem in every urban area, transportation contributes to the carbon dioxide emissions, and the overall air pollution that we are seeing there, the economic cost of accidents amount to over $242 billion in cost from those types of accidents.

But the good news is that there are advances in smart transportation that offer hope of improving each of those problems. And this includes advances in terms of intelligent vehicle systems, in-road reflectors and devices that are embedded in the road

that can help guide the path of those vehicles.

Vehicle sensing systems and collision avoidance systems that are becoming more prevalent, remote sensors along the highway, and the application of dynamic traffic lights that are based on traffic flows and help ease the congestions problems because they are dynamic in nature, and based on real-time development. So, if there's a lot of traffic in one direction, the traffic light will adjust to those flows and help to ease the path forward.

These advances also dovetail with advances in digital communications. Obviously we are on the cusp of rolling out 5G networks in a number of major American cities; we are reaching the point of near ubiquitous connectivity in those places. The 5G networks are going to enable much faster and more intelligent design in use of those networks. We are seeing the emergence of high-speed broadband vehicle to car connected systems, reliance on cloud computing, and AI algorithms that are going to help drivers avoid accidents and understand the road conditions.

The result of all these developments is that transportation is poised to become one of the most advanced examples of technology innovation. As Amy noted in her remarks, by 2035, industry experts are estimating there are going to be 129 million autonomous vehicles on the road. And so things are going to change very rapidly. The issue of driverless cars is not a futuristic vision that's 5 or 10 years away, they are on the road now in pilot tests, and are going to be on the road for real starting next year.

So, I'm going to discuss the situation first in the United States, and then my Chinese counterparts will discuss the situation in their country.

In the United States there is a lot of experimentation taking place, car companies are investing billions of dollars. My Brookings colleagues, Cam Kerry and

Jack Karsten put out a report that found that there's been over $80 billion in investment in autonomous vehicle technology, between 2014 and 2017.

So, we are expecting a rollout by next year of fully autonomous vehicles in many cities across America. This is probably going to happen first in the car-sharing area, and in the area of truck delivery, it will be a while before it actually reaches the car consumer market, just because the cost of the vehicles will be a little more expensive.

We are seeing a lot of road testing that is going on now. Waymo, the division of Google, has driven over a million miles on the road, and so there are lots of things that are taking place to try and advance the technology in this area.

But obviously this week there was a major setback. We saw the first fatality from and Uber autonomous vehicle that struck and killed a pedestrian in Arizona. There is an investigation underway regarding the details of that, pending the results of that investigation Uber has announced that it is suspending its road testing until it determines exactly what happened.

Other companies are considering the same type of thing. So, this obviously is a challenge for the entire industry, and all of us want to learn a lot more about what went wrong, and before we see widespread deployment of this issue.

One of the challenges in the United States is at the public policy level, in the sense that when you think about the transportation area, much of the regulation is not federal in nature, it's at the state and local level, and so the result is that we have fragmented regulation, many of the traffic rules and regulations governing the conduct of vehicle is handled at the state level.

It's one of the reasons why Uber went into Arizona, because Arizona was an autonomous-vehicle-friendly state, where the Governor had made a priority to

encourage companies to come in, do actual road testing. But across the country we still have a situation, largely, where there are 50 states that have different rules on cars, on drivers, on liability questions, and so on.

So, that's a lot of variation in terms of the rules and regulations. That creates problems for autonomous vehicles, just because the states are not consistent in how they are thinking about the future of autonomous vehicles, oftentimes there are contradictory rules and regulations. And so we need more consistency regardless of the place within the country.

There have been some policy changes designed to ease the development of this sector. For example, the U.S. Department of Transportation has issued guidance to attempt to simplify regulation in this area, and in its guidance it basically left the traffic rules to state and local government are pretty much consistent with what has been the case in the United States.

But it did turn the regulation of transportation software more over to the Federal Government. It basically put the Department of Transportation in charge autonomous vehicles in terms of the software component, and basically that was an effort to try and create a national standard for moving forward, and to deal with this problem of 50 different sets of state regulation.

The DOT guidelines also set up a process by which it would work, it said it would work with the car manufacturing companies to offer guidance as new situations emerge, so the car company could go to the particular regulator and the federal level, and kind of talk about what they were experiencing, ask for advice on how certain types of situation should be handled, and then the Federal regulators would offer their guidance. So, again, that was a way to try and simplify the regulation and create a more consistent

path for going forward.

The other big development this week has been the rise of possible trade war with President Trump imposing tariffs on steel and aluminum. This obviously is a big deal for the sector of autonomous vehicles in general, because a substantial part of manufacturing costs involve those raw materials. Those types of tariffs will raise the cost on cars and slow innovation.

So, we think the U.S. administration should reconsider that policy on tariffs before things get out of hand. It is something that is very important in terms of encouraging digital innovation in general, but it's particularly relevant in terms of the transportation sector in particular.

At this point I'm going to turn the rest of the prescription over to Yuming Ge. He is a Research at the Chinese Academy of Information and Communications Technology. And he will discuss the Chinese situation, and then after that we will take some questions. (Applause)

MR. GE: Hello, everyone. My name is Yuming Ge from CAICT. Thanks very much, for Darrell West's introduction, and it's my great honor to be here to have more discussion on the smart transportation with the expert from the American side.

So, Darrell West has introduced much more about what is going on from in the United States and what's -- the problems we are meeting. So, next, I will introduce much more information from the China side, what is going on in China about smart transportation. And finally, I will give some -- maybe will have some common views for the future, how to promote the development of the technology innovation, and the future industry.

Here, from my side, I will talk four aspects today, the first is the current

state in China, and the second is the task of the next step, and to promote the next step, what is going on, and we need what's the measurement, and the closer cooperation between China and the U.S.

From the top-level design in China we have published several policy documents to support the development of smart transportation, also the connected vehicles, intelligent vehicles, even we have different word from the different industries, but almost the same ideas is that to yielding the ICT technology to change the traditional industry of the transportation and the vehicles.

From the national level, we have the Made in China 2025, is to promote the intelligent vehicles and other products, and also we have the Internet Plus, the strategy for the innovation of the Internet, together with the traditional industrial, so here one action is the convenient transportation. Here it's talking about connected vehicles.

And then we have the five years plan for the transportation, we want to do more and more work using the ICT technologies to change the traditional transportation and the way we are set up can have similar transportation system. And we know that for the transportation, for the smart transportation it's a cross-industrial aspect, so in China, we have more than 20 departments working together, we have a Special Committee to joint, solve the problem of the smart transportation.

Then from the ministry level, we have published the document of the Internet Plus convenient transportation, and from the vehicle aspect, we have the middle and the long-term deployment plan for the automotive industrial, and also from the NDRC we have intelligent vehicles innovation deployment strategy. This strategy is still under discussing, and it's already the draft version, to the public, in the year just beginning.

So, this is from the policy level. And then we know that for the cross-

industrial promotion, we need to do some standard work together with different aspect, different industrial. So, in China MIIT working with ICT together to join -- the whole view of the standards need to do in the different aspect, we have the common intelligent connected vehicle, we have the general requirement, and we have the information communication, and then we have the electronic products totally under the guidelines of the connected vehicles, so more than hundreds of standards are planned to do.

So, we also, for the connected vehicles, we have to, following the (inaudible) of the cellular V2X, how we do the standards in China, about LTE-V2X from the -- not only the fixed layer, but up layers, the application layers, and also the data, how to set up the future of the applications. And also we have the standards for the smart transportations, more than its -- almost a hundred standards are undergoing -- yeah, are formulated.

And then from the industrial view we have a lot of product already to change the world, to change the mobility services, and to change the smart transportation. On the other hand is that we have some of the product of HMI in the car already, and also we have the product for the V2X communications, and also we have the products for some of the other products like the FCW and LDW, some of these kinds of devices, smart devices in the recourse.

And also, in the future the product, the device, it's not so important, the important the data, the data coming from the connectivity, data coming from the vehicles. So, according to this data, the filter -- the ecosystem, basing on the date of application is more and more important. Plus as we had seen, we have the car-sharing already, and almost 400 million of peoples are sharing the cars in China already.

So, we already have the UBI, the insurance basing on the data coming

from the vehicles. So, you know, in the filter you can see the ecosystem, it's changing basing on some of the smart devices, and basing on some smart -- on the intelligent technology that's used in the inside of the vehicle, and then used for the vehicular communications.

Also to promote the cooperation in China, we have set up some of the organizations and the alliance, just like, Mr. President, you have introduced the IMT-2020, it's working to promote the ICT technologies to face the traditional, industrial like the transportation, and also we have the China ITS Industry Alliance, and we have also the alliance from the vehicles of the China Industrial Innovation Alliance, for the intelligent connected vehicles.

So, this is different alliance from different aspects, different view from different industries, but we are also working together in China to promote the whole smart transportation ecosystem.

And also we know that for the innovation of the new technologies, when we will do a lot of research work, and also we need to be the -- the technology could be commercial. We need to set up some demonstrations and pilots. In China we have set up almost seven demonstration zones to do the test of innovation technologies, and also the MOT, it supports eight provinces in China during this year to set up the intelligent transportation system technologies. Okay. So, that is what is going on and what we have done in China.

How about the future? Already we have the smart transportation, it's not yet, so we need more work on this point to promote the development of the industrial, and to promote the innovation from the user side. So, we work together, we dialog together, we get full conclusions for the future of the next step to promote the development of the

smart transportation.

The first is the infrastructure. We know that for the roadside we already have the infrastructure, but it's not connected, it's not implementation, some of the information you can only see, but not get information from the (inaudible). So, first we need to -- the infrastructure more and more is connected and that the infrastructure could be smart.

And second to that, if only this infrastructure is ready, it's not enough. We need to construct a network connecting all the elements for the transportation, like the personals, and the infrastructure, and the vehicles, and even the cloud of the network. So, we need the V2X communications, we need 5G, we need AI in the future to construct this whole network. And according to this communication network, it will be high reliability, low latency, and high bandwidth under the -- to support the high mobility.

And the third is that we know that not only for the transportation, even for the autonomous driving, the navigation under the MIIT, especially the high percent MIIT is more and more important, so we need to do more piece of work on this point to do the services based on MIIT, based on map under the high percent MIIT together. This map is not only the percentage, but accuracy, but of the more and more information. We need to do the real-time information of the map.

And the last one is not the final one, maybe we need to apply more and more information of the technology, of the cloud computing, and the big data technologies. I also explain that technology is not the aim of ours -- to promote, promote of the industrial under the ecosystem to set up. So, basing on the data they can construct a new ecosystem, together with the ICT experts and the ICT companies, together with the traditional car manufacturing and the transportation companies together.

So, we have some aspect already maybe using the connect vehicle information, we can do the digital control of the signals of the lights. And also we have the car sharing, and how the autonomous open source platform, like Google maybe, and also in China we have the Baidu to open source for the autonomous technology innovation.

And to be sure, all these tasks could be done, and in the future we need more and more measurements to set up. The first is the deployment strategy from the top-level design. We need to promote the cooperation between different industries from the government level, and from the alliance, from some of the organizations.

And then it's the standards, because from the different industries, while we are discussing we have different ideas, and even the language is not the same. So, we need some of the standards to the vehicles, and to the transportations, and ICT guys working together.

And then we need to strengthen the international cooperation. As Darrell West has explained, in the future this industrial smart transportation is not a local aspect, it should be global, so we need to more and more international cooperation working together to promote the innovation.

And fourth is the data and the privacy. You know, now that if in the future the vehicles are connected, all the data may be contacted by others, so how about protection of the data, how to be sure we have the privacy is more and more important. And then we need to be sure of the safety, yeah. If the car is autonomous, if the transportation is autonomous, how to be sure the transportation could be safety, and we need to be sure for the safety of the cyber security also is very important.

So we already a lot of talks, with Darrell West together, and we know that

from the United States, from China, we are facing the same situations, facing the same problems, and we are also working -- want to be working together in the future to try and to promote the innovation, and trying to promote the industrial cooperation between the United States and the China side.

So, let's welcome Darrell West, and our Vice President Yu, together, they can have more discussing here. Thank you. (Applause)

MR. WEST: So, thank you very much for that presentation. So, that kind of sets the background in terms of some things that are happening here in the United States as well as what is happening in China.

So, I just want to start with a question about the role of technical standards in autonomous vehicles. I mean, we know in other areas of digital innovation that having some agreed-upon standards makes it easier for companies to innovate and to be able to move forward.

You mentioned in China there already have been the development of I think 90 standards, and that you've worked with MIT on that. Could you just talk a little bit about what you're doing in the standards area, and how the process has worked? Either one of you?

MR. GE: (Speaking in Chinese) Let me answer this question with two parts. So, first of all in terms of standards it is a joint effort between multiple departments and agencies in China, and we have to take lots of elements into consideration. So, we are talking about communications, transportations, and vehicle.

So, let me get a little bit more specific here, in terms of V2X for vehicle communications, and we are talking about ICT and MIT, so in terms of the applications and the Internet standards, then we'll have the joint efforts between our ministries and

agencies that are responsible for communications as well as our technology. So, together they'll set up standards, and to promote innovation in terms of standards.

MR. WEST: And if I can just offer a comment on the same topic of standards in the United States. This is an area where the United States has fallen behind, specifically in the autonomous vehicle area, the desire is to have standards just to make it easier for the multitude of automotive companies, and technology of firms that are operating in this area, to have some agreed-upon ways to advance this technology.

Unfortunately, the United States has not really mandated many technical standards in the area of autonomous vehicles. It's something that we actually share with the European Union, the European Union also has lagged in developing technical standards, and I think this is an area where we need to do a much better job if the United States wishes to remain competitive, because China has actually made much more progress in this area than we have.

I think my answer sounded much more articulate and sophisticated in Chinese than in English. So, thank you very much for that.

I have one more question, and then we'll open the floor to any questions or comments that you have. And the question involves security and privacy. So, at the end of our presentation, you mentioned the importance of maintaining security and promoting privacy in autonomous vehicles. How is China thinking about these issues? What are you doing to try and advance both privacy and security with autonomous vehicles?

MR. YU: So, let me take that question. In terms of data security and also privacy, this is an issue that's not only important to China but also for the rest of the world. So, in China we do take this challenge very seriously. We do have the Internet Security Law, and in terms of data protection and privacy that's where it is governed.

Also across many department agencies, they work very hard to make sure that we have rules and policies governing that.

However, when we are talking about very specific issues, regarding autonomous vehicle, there is still work to be done, so the laws and regulations governing those are yet to be completed, and I believe that even though we have laws and regulations governing the communications part of it, it is going to be our next step to do more research, and to think about how we should write the laws or regulations governing privacy and data security in terms of autonomous vehicles.

MR. WEST: And in the United States we obviously face challenges, both in terms of security and privacy in regard to autonomous vehicles. I think one of the things we will need to consider is the adoption of what I would call anti-malicious behavior activity as it relates to autonomous vehicles. Maybe you can translate that part.

So, for example, a couple weeks ago I was at a Southern University giving a talk about autonomous vehicles and this university has already adopted autonomous people movers for the students. It's a large campus so they have these autonomous vehicles that students can take to move across the campus.

And what is happening on that campus is skateboarders are seeing these autonomous people movers, and basically riding their skates right up to the autonomous vehicle just to see how it's going to react. It's kind of like a digital game of chicken that is taking place.

And my worry is that this will become a more prevalent part. You know, we've heard about people using laser beams or lights to try and distract the LiDARs of autonomous vehicles. So, we need to think about anti-malicious behavior legislation so that people aren't playing games with the technology in trying to deceive it into taking

actions that otherwise would not be called for.

And in the privacy area, we need to do a better job in terms of consumer notification in cases where there are data breaches, and we've already seen in other sectors that from time to time there are either breaches of personal security, or intruders who gain access to systems or other ways in which our private information is being compromised. And obviously we need to maintain security to limit those things, but when they do happen it's important that the consumers get notified very quickly so that they can take whatever remedial action is required by that.

Oftentimes a lot of the current data breach legislation is at the state level, and the states vary enormously in exactly what the consumer notification requirements are, but I think this is an area that we need to be more vigilant in order to help ensure that personal privacy is maintained.

By the way, I kind of like this format where I get to ask myself a question, and then I can answer it. It's a great way to answer, that you like the questions that come up.

But we want to give you a chance to participate as well, so if you have a question or a comment, raise your hand. Right here, we have a gentleman with his hand up. There's a microphone coming right behind you, if you can give us your name and your organization; and then after your question we'll have the Chinese translation of it.

QUESTIONER: Sandy Apgar, CSIS. A two-part question: first, are the technical standards for autonomous vehicles, or for that matter any other type of transportation equipment, universal? It seems to me that an autonomous vehicle, wherever it may be geographically, has technical standards that are identical. And if they are, should this be approached on a multilateral basis, and not simply national?

And second, if we did have universal or at least widely-accepted technical standards, with the fragmentation that you, Mr. West, described at the beginning, particularly in the U.S., be reduced, if not entirely solved, through standards?

MR. WEST: Okay. Great questions. Do you want to translate that? Why don't I answer first, and then if you want to add anything.

MR. GE: Yeah. Okay.

MR. WEST: I think ideally, in the area of digital innovation we would want technical standards to be global in nature. And so, for example, mobile technology is now ubiquitous around the world. There, we had internationally-agreed-upon standards that I think really easily the innovation led to kind of a successful in globally integrated mobile system, and that enabled a lot of innovation in lots of other areas, health care, education, transportation, and so on.

In the autonomous vehicle areas so far, you can imagine it's very complicated to global agreement on anything, so right now, we are kind of starting at the national level, or the regional level, but even at that level, the United States is having great difficulty agreeing among ourselves on what the technical standard could be.

The European Union has failed in exactly the same way, and so, kind of, when you have difficulty at the national level, you can imagine how challenging it is to get global standards on autonomous vehicles.

MR. GE: Yes. So, I would just like to add a few words. So, I very much agree with what Darrell just mentioned. Now, there is no universal standard when it comes to AVs, but a lot of times when you talk to people about transportation, about communications everyone will agree that it's a great thing that we have this universal standard for 5G, so based on that we were able to promote innovation and to build on

that.

However, when it comes to autonomous vehicles, first of all the technologies themselves are still in their infancy. So, we are still not very clear about what exactly we need to have standard. So, when you think about autonomous vehicle, a lot of times, you have to let the automaker decide what they want to customize and what needs to be actually required, or needs to be standardized.

For example, for Google the AV that they're testing now, they don't really need as much connectivity, so then maybe they don't need as much standards.

So, in terms of autonomous vehicles, within China we are working towards better standards especially in terms data and communications. So, we know that in the United States there's also SAE 2735 Standards, that's governing the communications aspect. So, within China we are also looking at how we should better protect data in terms of communications.

I also know that internationally, ISO is also working on this level, and to see how they could better sustain this for networks and for interconnectivity.

MR. WEST: Okay. Other questions, right here, there's a lady on the aisle with a question.

QUESTIONER: Good morning, ladies and gentlemen. Thank you so much for your presentation on smart transportation. My question is, and for -- my company is called Saguros International Group, I'm focus there -- I focus more with groups that work -- do towards (inaudible). Looking at your G5, how do you look at the measurement, and what he was saying, and even here in America, looking at access to translation?

That is, a Japanese may enter the vehicle, and want something, to ask him

something in Japanese, or Chinese, or Spanish. How do they get to know, and get into the vehicle and go where they are going? I've seen such vehicles here. So looking at translations in the vehicle, in the G5, how do you look at universal and locally here? Thank you.

MR. GE: So, that's a very interesting question, and I'll answer you in twofold. So, first of all when we are talking about HMI, so human machine interactions, a lot of that is also done through AI, through artificial intelligence. When we are talking about translation or language capability, we are not only talking about language between people, but also the language between the car and the people.

And so the cars themselves, with the help of AI, they will not only be able to understand the oral language of the humans, it will also be able to understand the behaviors, and the emotions, and also the behaviors of the other cars.

I will explain that. Obviously, the more difficult part will be, how does a car communicate with another car. So, a lot of times when we are talking about communications we are talking about people-with-people communication; or perhaps people to devices or vehicles communication.

But the really challenging part is for cars to be able to communicate to another car, so for device to be able to communicate to another device. So, that's also what we are doing with the 5G, and with our research. That's also another reason why we need standards. We need to make sure that one car manufacturer -- that one company is going to be able to communicate with another car that's manufactured by a different company. So, they need to be able to understand each other, in just their behaviors and their patterns.

MR. WEST: Okay. Fred has a question, right behind you, rather here on

the aisle.

MR. ALTMAN: I'm Fred Altman, I'm retired. I just have a couple points. By going to the self-driving cars will reduce the total number of cars, but the number of hours each of these are going to be on the road, is going to be considerably increased. So, what is going to be the net effect on the number of hours, vehicle hours or something like that? The other one is just sort of a trivia. How does this all interact with going from gasoline engines to electricity motors?

MR. WEST: Maybe I can answer the question about the vehicle hours. I think you are exactly right, that what industry exporters are anticipating is going to happen over the next 20 years or so, is there will be fewer cars on the road, but each car will probably be on the road, longer and longer.

And secondly, what the car manufacturers are worried about is there's going to be a drop in car ownership, because if you already look at car ownership by age, young people are dropping even compared to their own previous history, the idea that they should own a car. Increasingly young people are relying on car-sharing services.

So, we are assuming that there's going to be the technology changes, but there are also going to be social and economic changes in how we think about cars, how we use cars, and the extent to which we own them. But in terms of the possible benefits, in terms of air pollution, people still believe there's going to be a net benefit even, you know, with the types of shifts that we are talking about, that the shift towards autonomous vehicles will help with traffic congestion, and also help in terms of the quality of air.

MR. YU: So, I would just like to quickly add. I very much agree with what Darrell just said. In fact, in China, within the car industry, we also have four trends that we are seeing in the future. So, the first of all, that we are going to see more -- we are

definitely going to see more of these autonomous vehicles on the road, and we are also going to see more AI incorporated in these vehicles.

And then we are going to see vehicles using more and more new energies, and then we are also going to see more and more people using shared rides and shared services. So, I feel that all these trends are essentially consistent with what you just said.

MR. WEST: Thank God for that. There's a question right here, this gentleman close to the window, back there.

QUESTIONER: My name is Kumar, and I'm retired. It's unclear to me how vehicles would -- cars would react or communicate with other vehicles on the road, like bicycles, and motor cycles, and scooters. So, how do you deal with that?

MR. GE: So, I will answer you in three different aspects as well, from a technical point of view. So, first of all, when a car is automated, or when we are talking about AV, then this car itself will be equipped with many different technologies, for example, radar or LiDARs or even cameras, so the car itself could proactively detect and sends what's surrounding the car itself, whether it is just human, or a bus, or any other vehicles that's on the road. So, they can proactively take control, and make sure that the can respond accordingly.

And then from the second aspect is from people's point of view, so more and more people could be connected to the network, and through many different kinds of terminals or devices, they could also send information to the cars or to bikes, or other vehicles on the road.

And then the third part will be on the roadside, so when roads are retrofitted, then they are going to be equipped with sensors and cameras, and incorporated with AI technologies, so they'll be able to collect lots of information about

what's going on the road, about what's going on with the vehicles, and about the traffic.

And together they will incorporate it into a highway, so the information highway, and with that, there will be able to better control the traffic, and send information to each of the vehicles on the road. So, when we talk about highway today, we are talking about the physical highway, and it's a relatively simple idea, but in the future we might actually be able to establish virtual highways, where all kinds of information that I just talked about and all elements of traffic participation will be able to contribute into that system.

MR. WEST: There's a question right here, the microphone right behind you.

MR. CONNORS: Thank you. My name is Jim Connors. I'm impressed with the fraternity stories of how America deals with this by skateboarding into the machines, and shining lasers to screw up the logic. Does China have that kind of problem? (Laughter)

MR. YU: That's actually very interesting. So, in China I feel that our students behave a little bit better and not as naughty. (Laughter) I do know that in China there are hackers that would do things like that, and we actually also have safety and security experts that do these experiments on purpose to make sure that when they are faced such interference it they will still behave as it normally would.

So this is some kind of test that we actually do, especially in terms radar, LiDAR, and how the car collecting information, and I think this is actually a very important thing that we do.

So, I would just like to add, what happens in the United States might also happen in China some day. So, that's why I very much agree with what Darrell said.

Maybe we need some sort of laws, regulations to regulate people's behaviors, and maybe that will also help.

MR. WEST: There's a question right here, this gentleman right here.

MR. CORBETT: Hi. Kenyon Corbett, Transportation Learning Center. There's a lot of exciting benefits with the autonomous vehicles, and the smart transportation, but I'm wondering if you're doing any thinking in terms of transportation workforce and the impacts on them, particularly with respect with high quality unionized jobs.

MR. WEST: Maybe I can respond to that, and if you have any responses, we can go from there. So, in terms of the workforce consequences, I actually have a new book that just came out entitled *The Future of Work: Robots, AI and Automation*, that looks at the implications of many of these technology trends. But on autonomous vehicles in general, I'd say most countries around the world are expecting this to be a real growth area in terms of the overall economy, as well as a part of the economy that is going to create additional jobs in terms of the future.

But I think it's also true that the kind of workforce we are going to need is going to be different. We are going to need people with more advanced skills, design skills, and so on. It's not just going to be entry-level jobs, but jobs with more technical skills involved with them.

We are already seeing consequences in terms of manufacturing, factories are getting more automation built into them, there are more industrial robots that are being deployed, AI is becoming important in a variety of different sectors. So, I think we do need to, as a society, think about the workforce ramifications and the need for worker retraining.

And is there anything either one of you would like to add?

MR. YU: Yes. I would just like to add a few words. Obviously, I feel that my colleague, Darrell, here has way more experience than I do in terms of this area, and I know he has done lots of research, he gave me a book this morning. I'm going to go back and read more about it.

But I will just briefly talk about how I see it from China's point of view. So, it is true that automation, AI and robots are going to have a huge impact on workforces. We haven't really had a very thorough research done in this regard, and I do believe that this is going to become the major challenge.

And I also want to talk about my personal observations. So, this is actually a very complex issue. And I will share it from two points of view. So, the first thing is that how automation has entered the manufacturing industry. So, I've actually visited Foxconn before, I'm not sure if you know Foxconn, it is the company -- or the factory that makes iPhones.

When I visited Foxconn's plants I realized that there weren't a lot of people working there at all. It's mostly robots, or automation that's really doing the job. So, if you really think about this, the population in China is, in a way, decreasing the labor, the working population is decreasing. So, perhaps it's not going to have that huge impact on them.

However, on the other hand, if you really think about it, sharebikes, sharebikes is a huge thing in China now. I think the last time I read, we have more than 20 million sharebikes on the road now. So, because we such a huge amount of sharebikes on the road, more and more people decide not to own their own bikes, and this actually has a huge impact on the repairmen, the repairman that repair bikes.

So, because people started giving up their own bikes and just use shared-bikes, then the repairman doesn't have -- repairmen don't have jobs anymore. And so in this way we also have to think about: how can we replace the lost jobs? How do we provide more training for the people that lose their jobs because of this new technologies and new trends?

MR. WEST: Okay. I think we are out of time. But I want to thank Mr. Yu and Mr. Ge for sharing their thoughts. Those who want to see our paper, *Smart Transportation in China and the United States*, visit Brookings website, at Brookings.edu. And thank you very much for joining us. We really appreciate it. (Applause)

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