Intelligent Vehicle Testing Symposium Global Policy, Regulation, and Standards

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Full Symposium Transcript

[00:00:00]

Kevin T. Kerrigan: Good morning, everybody's gonna take their seats. We have a few stragglers coming in so while they take their seats. I'll tell ya a story that happened. I almost didn't make it the conference this morning. I got struck in my hotel room. I had to call the front desk. You know, there's three doors in my room. There's one to the bathroom, there's one to the closet. And one said "do not disturb." I could not get out. *audience laughs*

Welcome to the ITS Montreal. Welcome to the Intelligent Vehicle Testing Symposium, it's a discussion today about global regulations and standards. The symposium today sis sponsored by the Michigan Economic Development Corporation and Planet M. Has anybody seen the Planet M anywhere around, by any chance? We have 26 speakers today, from ten different countries. Ten different test environments represented. So we're gonna have five panels. Four of these panels are regional panels. Including North America, Asia, Europe, and United Kingdom. The fifth panel, which will be straight after lunch, will be about new and future technology. Each panel will give about a five-minute speech from the presenter about their individual test facilities, test environments and then we'll have a panel discussion that will be moderated. We want to discuss the current state of the topics of intelligent vehicle testing and development with a focus on policy regulations and standards. We want to discuss that and come to a common agreement, if possible, and turn that into purposeful collaboration. As I've said, we have a lot of people here today. One thing I'd like to see is at lunch today, please don't sit with your folks. Sit with the other teams, the other groups from the other countries. Let's start the dialogue.

[00:02:36]

Kevin T. Kerrigan: I think if you can invite 9 other test sites to visit your test site without We'll have quite an interesting start for collaboration. So, our first Speaker today, let me introduce Mr. Ray Tanguay. Ray is the automotive advisor to the minister of innovation, science, and economic development Canada and the Ontario minister of economic development and growth. Previously served as chairman of Toyota Manufacturing Canada, among other leadership roles within the

company. Mr. Tanguay's main role as automotive adviser is to provide advice to the governments of Ontario and Canada on strengthening the value proposition for growing the automotive sector and advancing a strategy to secure further investments in Canada. My biggest compliment to Ray is that he's a car guy. And I'd love Ray to join up here on the podium for a few words. Thank you.

[00:03:46]

Ray Tanguay: Good morning. Bonjour. Bienvenue à Montréal. Uh, we're going to go from a British accent to a French-Canadian accent but that doesn't mean we don't get along. We manage to work very well together. So, in my career I've spent about 19 years in the electronics first, and then about 25, 24 years in the automotive. Now the two together are merging together. So, my value is just coming up to now, but it's a bit late. So, Ben Franklin said you know "the tragedy in life is that you get to work too fast and wise too slow." So maybe that's my case and that's maybe the reason why I decided to accept, to be an auto advisor for the government for the past couple years.

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Ray Tanguay: Bienvenue à Montréal. Montréal c'est une ville très historique, c'est vraiment une très belle ville, c'est une plus belles plus vieilles villes d'Amérique du Nord. Elle célèbre son 375e anniversaire. In Canada, we are celebrating 150 years as a country but Montreal is celebrating 375 years, so it is one of the oldest cities in North America. It is the cheapest ways to see Europe without going to Europe. *audience laughs* so it's right here. So, I welcome you to Montreal. But Montreal is more than just a place where there's fine arts and sports and architecture. It's also a hot bed for innovation. And recently they've made a commitment to really electrify their urban transit. So, there's electric taxis and electric buses. They are trying to deploy a lot of autonomous vehicle testing right here in Montreal area. So very progressive, and when Montréal, Quebec decide to work together, they are very good at working together and they can make things happen. So, I am very impressed with the evolution that they come with. They also have one of the famous AI researchers, right here in Montreal, Yoshua Bengio. And Yoshua Bengio is renowned for in his case, he is a pioneer in deep machine learning. And as result of it, there is a lot of startup companies coming into Montreal. He started a company, co-founding with two other investors, called AI element. Well it didn't take very long for the tech companies to discover that he was having value in deep machine learnings and he received $135 million dollars (CAD) from companies like Microsoft, Intel, and NVidia. And so, this is becoming a real hot bed for artificial intelligence. This is one of the things that I discovered when I became an auto adviser, when I was running the company I was focused on running the company and I didn't know what was going on around me, and now what I have realized with the industry is you need to find out what's around you. I've discovered then that we, indeed, have an AI power in Canada. So, I discovered that Toronto, for example, Dr. Hinton he was the leader researcher for artificial intelligence in google and he worked with other companies like Apple, Twitter, small companies like Facebook. But now he's back in Canada and he started, he's the chief scientist advisor for a

group called Vector. And the government is also committed to make sure that Vector will be a major presence, and an AI hub. So, they've put in a hundred million dollars to support this Vector Institute. And there's another partner in that group, her name is Raquel Urtasan. And I've had a chance to meet with her, she's amazing. What she's doing right now in Toronto, she's a cofounder of the Vector Institute. She's digitizing the streets of Toronto, and if you think Industry 4.0, you always have to compare the digital image to the real image. And what she's doing is she is digitizing Toronto, with cameras it will be able to detect whether that image matches. If it doesn't match, then maybe bring some artificial intelligence to make decision on what you need to do in that situation. Well, Uber also discovered that she has something to sell. So, they decided to create an office in Toronto, ATG. I think, advanced technology group. They wanted her to move to California, but she said my team is in Toronto. So now they've committed to making Toronto a major global AI hub. So now I said, wow that's two pioneers of artificial intelligence. Dr. Hinton, he's the one that is promoting neural network. Neural network is the one that scares a lot of people because the computer mimics human brains and it keeps learning. So, I think you'll have to find out when to pull the plug when it gets too powerful. So, then I said well okay, that's pretty good. Then I found out that we have another center in Edmonton. Edmonton is where the oil sands are, the energy. Then I discovered they have deep machine learning, basically it's called reinforcement learning. And one of their big feats recently is they defeated [China] in the Go game. And then there's a UK company, called Deep Mind, that Google and Alphabet bought back in 2014. Then they decided they need to set up a lab and really try and leverage that expertise in Edmonton. So, the reason I'm talking a lot about AI, it will be in many situations one of our solutions to try and deal with the testing and also, how are we going to deploy the technology. So, where I live in Ontario, I also discovered we have much more talent than I knew. We have 20,600 IT technologies in Ontario. About 286,000 IT specialists. We're the second-largest IT cluster outside of Silicon Valley. Many Canadians don't even know that, and we definitely don't do a very good job at marketing ourselves. I think we need to learn from Michigan. Planet M is everywhere. We need to find out how we can showcase. And that's the job that I have. To really discover what we have and how to deploy that. And so, I had the pleasure to meet Governor Snyder back in 2015. In Traverse City, every year we have about a thousand automotive leaders that gather in Traverse City. And we started talking about the need to collaborate. The fact that Michigan is really branding themselves as a major hub for testing, such as Mcity and Planet M. And the development facility. And we have that kind of expertise in Ontario. And we said, why don't we join forces. And his response, "Absolutely." If we want to bring the center of gravity to the North, we need to pull our resources together. In 2016, the premier of Ontario, Captain Win, and Governor Snyder from Michigan, we signed an MOU. An MOU is worthless unless you put an organization behind it. Kevin and I have brought two economic development groups to work together and try to come up with some activities. To celebrate our first year of MOU, this year we had two autonomous cars went from Detroit, went underneath the tunnel and went to Windsor; so, no signal there. And then they go to Customs, they drove across Ontario, went over the Blue Water Bridge in Sarnia to end up in Port Huron, go to Customs again, and then drove all the way to Traverse City; over 300 miles. 92% hands free. It shows when we work together, we can bring the resources together, we can make things happen. This was the first international,

cross border autonomous driving experience done. And that can only be done when we start to collaborate together. So now, we're just starting to put our work together and we need to continue to find opportunities to strengthen ourselves. So, this morning we're here because Governor's leadership says we need to validate our technology. It is great we have talent, because talent is what's going to bring investment, and talent is what enables us to do things. But we also have to have standards, we have to able to validate what's a level two, three, four five. How do we make sure there is some consistency? So, thank you for organizing this symposium, I think this is absolutely important that we have these kinds of collaborations. So, without any delay, I will let you introduce the governor. So, I found out the governor speaks like a businessman, he was a businessman. He's also, he was also a venture capitalist. He knows about money, he was an accountant. But he's also self-proclaimed nerd. In my days, being called a nerd wasn't a good thing. But when the governor calls himself a techie-nerd, that's pretty cool. So, it tells you how his mind works. Always, he talks about his customers. And on July 1st, 2011 he became 48th governor of Michigan and then we all know that there was a very tough ride with the economy in 2009 and 2010. But I must give you credit for the major recovery of healthy Michigan, the fact that you addressed the brains and the bodies of Michigan, and the fact that Michigan is now a major force. And I think in your seven years about 500,000 jobs have been created. And also, if you see Detroit today, versus Detroit of the past is amazing. Just amazing, this is going to go in history as one of the historic recovery of a city. Detroit today is amazing. The people want to live in Detroit. I went to school in Windsor and I tell you didn't want to live downtown Detroit in those days but now Detroit is cool just like the governor. *audience laughs* so without further ado I would like to introduce Governor Snyder. Thank You.

[00:14:43]

Governor Rick Snyder: Well thank you for that great introduction, thank you for talking about Michigan. So, I can save that part of my talk. I think you did a great job and it's wonderful to be with you today. I want to thank Kevin and Ray for coming together, they're a great team. But in particular I want to say thank you from Planet M to ITS Americas for coming together to say let's have this symposium. As we go through history as we look at the evolution and what will happen after this I hope this is one of those things, people step back as this being a landmark kind of event coming. In terms of saying we have ten countries coming together today to talk about intelligent vehicle testing and how to set standards and this is an opportunity to get us on the path to making a real difference in something that's going to transform our world. What better opportunity to be on the ground floor of it. So, I want to thank you for taking the time to be here today. The real question I would tell you is not what we just talked about today, but the commitment we make to do more, to actually take tangible action. To turn the talk into substantive things, just like Ray gave us great illustrations of what we've done between Michigan and Ontario taking an MOU and making it tangible. Not only with that drive but with other stuff we're doing together so I'd ask you to think about that all day today, is how do we really take a next step coming out of this to say is there an agreement we can come up with the 10 countries? Is there something we can say, it's not just a document but here are action steps that we can take

to move things forward. That's what we should be aspiring to do. I tell people back in Michigan, I don't like nice meetings. And people always look at me a little strange, how can you say something like that? I said let me explain it to you, if you have a meeting where everyone walks out and when they run into someone else, someone comes up and says "Hey, did you go to that thing? And they go yeah that was a nice meeting." That's not a success.

It's a success when you see something after you walk out of that meeting and you go up to him, I was at this cool meeting and we got this work to do it, so let's get to work doing something. That's the aspiration we should all have today, to make this a landmark event. So, to put it in perspective I'm going to step back a minute because in many cases I know I'm singing to the choir here because I mean no one's here that's not into this topic. The question is what do we do about it? So, there are a couple stages to that. One is I think it's important to keep our eye on the big picture cause quite often you can get too close to a topic and you can start to forget the overlying reach of what needs to be done. And the way I described the whole topic of mobility to people is I say it's the convergence. It's the convergence of information technology into the auto industry, into the mobility industry. We're creating a whole new industry here, folks. It's going to have attributes of both, and it needs participation from both. So, we need to approach it that way. But in particular when you get down to the level we're talking about, there's a couple more convergences that I want to share with you, that I think are important we recognize. When you think about this, on the testing front itself, how do you do testing? How do you put that together? Well, I think it's a convergence of 3 kinds of testing that needs to come together and we need to put that overtly out there is how do we balance these? How do we put it all together? How do we have all that make sense? And the 3 types are, first of all we're actually going to drive these things on the road. That's obvious. The second one is computer simulation. There's no way we can do all the scenarios in all these test facilities. We're going to have to simulate a lot of stuff but simulations by themselves are not the answer. And I don't believe on the road is good enough. We need your facilities, we need controlled environments where you can do real testing. That's really the synthesis, the convergence of all three of those datasets into something that makes sense; that's safe, that's efficient. And that's why we need to gather together to figure out how do we blend all of that. And the best answer is not to blend it from one set of dataset, not one group, not one test site doing simulations, doing on the road, doing it one country. Cause think about that, is that near as good as if we have people in other places, other countries, coming up with different scenarios, in environmental conditions, in different ways. That's not only going to make us stronger and better, it's going to make us safer. If you think about between North America and I'll pick the UK and Japan, where you have left-hand driving. And you say, well they should be the same but until you actually test it out, is it the same thing? No, you have to validate it. You need to find out and if there's something that doesn't work right, shouldn't we know? Cause the greatest threat to the adoption of this is going to be somebody getting hurt. To be realistic, I mean the great risk is something goes wrong. Some event happens anywhere in the world, and it doesn't have to be just in your country, that will hold back the adoption, the development, because it will scare the public. So, there's a big responsibility that goes with this, so the question is how do we do this convergence of all these different datasets, all these places data's coming from, and pull it together. And the next thing is, there's another convergence we

should be working on. And that's the convergence of technical standards and legal and regulatory standards. How do we bring those things together in a rational model? And if you stop and think about that's not an easy thing. In my view, to be open with you, I think the technical piece is easier than the legal and regulatory piece. I know you guys believe that because you think digitally. It's like, engineers can figure this out. God help us from the politicians. They're gonna mess this up. But what I can tell you is that the degree that technical standards come together and develop, that helps the political case because the easy one for someone if you're in the political world is that you can't agree with these other people on how this works, even on the technical piece. If they see disagreements, arguments, and displays. That's an excuse to take no action. And we need to encourage action. So, we need to work on the convergence of technical and legal standards. And how to move those together. And again, many of you are from the industry, and you know that one of the great things that can either make this happen much faster or slower is to have common standards between as many places in the world as possible. When I talk to the OEMs, and I've talked to probably more than half of them about this topic, at the highest levels, their greatest concern is they could end up with at least 10 different standards. That's a bad answer. That's just going to slow everything down versus just saying it would be best to have one standard. I don't know if we can get to 1, but let's good to as few as possible and you're on the ground of helping influence how many standards there will be. How well you work with the person sitting to the left or the right of you, in front or back, is going to help determine is there one standard? is there 10 standards? or are there 20 standards? And I sure recommend to you that you work towards the 1. It will make a huge difference. Now back on context of these two convergences is really important but one of the other most important things I would recommend to you, and I'm not going to get into all the benefits. I'm going to talk about that in another session later today, I talked about it yesterday. I'm not going to preach that same thing to you guys at this moment. But what I would tell you is one of the things we got to remember is we're talking to a lot of people that don't get this yet, that this is scary stuff. That their eyes glaze over. I mean how many of you have gone home, and if you have a spouse or one of your kids or relatives, and you go home and they ask how everything's going and they ask what you're working on. And you start talking to them, do they check out after a little bit? They get excited at first, I mean they'll get excited because this is really cool. Then they'll go, okay, can we talk about sports, now? So, we have to recognize that, and one thing I want to share one story with you that was kind of interesting reference point for me is I had some of this even from some of the highest-level execs in the auto industry. When I was talking about testing and we have two fabulous facilities, you know that because we've marketed the living daylights out of this conference which is awesome, and we're doing the American Center for Mobility but when I was making some of the calls to get people to sign up for one of these. I talked to probably the number two person in a global OEM and they said why would we want to do this. Why would we want to use your facility? We got her own, we don't need you. And I said, well let me tell you why. I said, think about, again I'll use a Michigan reference, think about what you do on the emissions side. The EPA test lab for the United States is in Ann Arbor. And I said, you can't sell your vehicle unless you go through that lab. And I said, how do you do that testing. Cause you wanna talk about you doing this all on your own. I said you put it in a secret van, you drive to the EPA lab. It's like Fort

Knox. It's like this big bank, guarded place. It goes in, in secret. And they go in and do their secret testing and if it fails no one ever knows. And if it works, you go sell your car, right? I said how's it gonna work with intelligent and autonomous vehicles. The question is, not if you can go in secret and see how well it works. It's how well you play in the sandbox with everybody else. I said it's not dependent on you. You may be doing a lot of good things. But if you don't interact well, if you don't figure out how to engage with the rest of the world, it's a failure point. And I said, do you believe that public officials, the general public is gonna believe that it's really safe, it's really gonna work, unless you have some place that's a controlled environment. Just like a scientific experiment. You know, you have your control and you have your experiment. If there's not an environment like that to really validate that it works, you can talk about all the road miles you've drove; all that. But can you tell them that you've gone through every scenario that you do in that controlled test environment, and know the conditions and know the answer. And he said no. Then I said, you need this. It's gotta be part of the equation. And so, I recommend to you that you not over assume a level of knowledge or level of buy-in from either the general public, or people in this industry. And then you should be very careful when you talk about these things and that you listen to who you are talking to hear what they're saying to you. And then calibrate what you're saying to them based on where they are on that acceptance curve. Are they an early adopter of this? Are they a fast follower? Or are they somewhere in the middle like most people? Are they a laggard? And make sure you tailor what you're saying to not what you want to tell them, but what they're hearing and what they're listening to and what outcome you're trying to get them to. Because that's where this is really important is that we all talk a common language. So, you're at the ground floor of this, so again that's why I skipped a lot of the other stuff I'd cover with most people. I know that we're all into this together, our goal is to get this one standard as fast as possible. TO have Technical and legal standards that all work. TO have this really safe and to have this being used by people because we'll save lives. And we'll make the world a better place for the economy, but we have a higher level of responsibility when you face that to say the best way to do it is to do it together and to do it in a way where we're bringing people with us rather than risking leaving people behind. So, I really encourage you to engage in this today. This is a huge opportunity. Certainly, think hard about how we make sure this is not a nice meeting, but a meeting that's a reference point; a landmark for the future to say now we're showing, we're taking a step today to show the intelligent transport system world can work together to do good things, faster and better. So, thank you for the opportunity to open today, you're stuck with me for a close. So I'm going to turn it over to these people so we can start these panels and I want to thank it, cause if you have any doubt how important this is just look at all these flags behind us. How much of the world we have represented here. There's a chance to have this make a big difference. Thank you so much.

[00:29:17]

Kevin Kerrigan: It's very difficult to be an auto adviser when your governor knows more about the auto industry than you do. I wanted to point today that the ITS daily publication today, the daily news, there's an article here - the New Era for Mobility. This is a publication. A new paper,

put together by the Center for Automotive Research. It was commissioned by the State of Michigan. The author of that document is our next moderator. So, we're very happy to have Adela Spulber here. Let me give you a little bit of Adela's background. She's a transportation systems analyst with the transportation systems research group at the Center for Automotive Research in Ann Arbor, Michigan. She focuses on connected and automated research on new mobility services and contributes to efforts in economic development, supply chain, and logistics. Adela, thank you.

[00:30:30]

Adela Spulber: Aright, so we will start with our first panel today as you've seen today in our agenda. We're gonna have these panels with these sorts of regional geographic logic. So, our first panel focuses on continental Europe initiatives. And I will invite the first speaker to come. We will all have five minutes for a short presentation. And because I want to give the other speakers a chance to see each of the presentations, we will join afterwards. Our first speaker is Álvaro Arrúe, he is from IDIADA and he is a R&D manager in their electronics department. And he is responsible for connected and automated driving activities. He is actively involved in several international working groups and taskforces, such as ERTICO, C2C-CC, and he's participating in the European Commission's C-ITS Platform. Alvaro is also chairman of EARPA's taskforce on electronics and communication systems. And he represents the European Commission in the road automation trilateral group between the EU, US, and Japan leading the discussion on roadworthiness testing. So Alvaro, you have the floor.

[00:32:11]

Álvaro Arrúe: Thank you very much, Adela. Thank you very much for the opportunity of presenting our capabilities in our headquarters. So I guess this will work, perfect. So a small introduction of who we are because maybe some of you are not aware of what we are doing. We are the Applus+ IDIADA, we part of the Applus+ Group. So we are a company, we have over 2,500 professionals, half of them in our headquarters which are based South of Barcelona. We mostly provide services for the automotive industry for design, testing, also type approval which is for our Canadian and US colleague is what we're doing in Europe for admittance of vehicles to the roads today, as well as facility design. Moving on this overview of our main test track, proving ground. This is as I said before, our headquarters, South of Barcelona. 70 km South of Barcelona. What we provide is state of the art test tracks, it's over 370 hectares. And we can perform, we have very nice weather conditions in the Mediterranean coast so we can provide all year-round testing in very stable conditions. So say, *inaudible* [00:33:34] test tracks. So this is what is on the ground. This is not enough for the challenges that we have to face with connected and automated driving so we need to improve in a digital way what we are providing for *inaudible*. We need to provide our clients, we need to provide our engineering services with for example accurate positioning. Providing the GPS full coverage. We've recently digitized our test tracks with HD maps. In several formats because it is not clear which is the standard there. And we are

also working on the communication layers, just to have an overview. We are right now, we will be complimenting real world test track replicable with fine lab test. But for this we need communications. So we are currently on the deployment of several technologies around the proving grounds that will allow us to test this kind of connected vehicles, which is as we know is a basis for automated driving. So the main idea is here we can repeat the scenarios on the road that are challenging for the communication systems. Based on cellular technologies we can repeat this on real environments, to see the performance and application of running on those units. And this is also complimented with the DRC network. So we have a hybrid environment in which we are able to merge these technologies and work out which one works best, or worst, or the performance of which one. We also have test tools coming from different areas. Here you will see more of the four classic advanced systems testing. I wanted to highlight, for example, that we have a connected crash lab. So we had a crash facility and now we have a full connectivity capabilities which is quite interesting for testing emergency calls and this kind of thing. But it is not just test tracks. Around our test tracks we are working now with the industry. And coordinated by the regional government we've set up what we call the Catalonia Living Lab which is an overview comprehensive approach from the industry and academia about what different facilities, smart cities, network of smart cities, as well as different areas logistics, industry, city, environment, highway, that can provide support for testing on public roads which as was said is one of the things that needs to be addressed for connected and automated driving. Also, in Spain and just to finish, right now, we have a legal framework that allows this kind of thing. So this is aligned with the efforts that are being taken by several member states of Europe as well as the European Commission to have a legal framework to be able to test these vehicles. And just to finish, this is our new proving grounds which is based in China. It is starting operation right now we speak. It is proving grounds between, it's in Shanghai and Beijing. The main idea here is to replicate the services we are having in our main headquarters but in China mainland. So thank you very much for your attention.

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Adela Spulber: Thank you very much, Alvaro. It's very interesting what you're doing with the Catalonia Living lab and I hope you can tell us more about how, what are the benefits of having such a network. So our next speaker is Gwen van Vugt, from task International. Obviously, I didn't drink enough coffee today, but now I can clearly see your name on your tag so Peter Janevik from AstaZero I am very very sorry. So Peter is the CEO at AstaZero, and AstaZero is the world's first full-scale test environment for tomorrow's road safety and before he joined AstaZero Peter held a number of positions in Volvo cars. Chiefly having a vehicle Dynamics and active and passive safety focus. So Peter please tell us more about what you are doing AstaZero.

[00:38:27]

Peter Janevik: Now we can see how it works with the order now. AstaZero – that's where I'm the CEO of and where our proving grounds are just like in IDIADA located in Sweden we're fairly fresh.

We started intense planning in 2011, Construction in 2012 opened in 2014 on budget and on time, actually. and immediately started research into standards research end-of-course testing as well our first standard has been released it's about test objects standards and our first research deliveries as well. Yesterday, we started working on our first added test environment which is a stretch of highway it which is what will be adding next year we have a special ownership structure or an effective PPP the owners are rice Research Institute of Sweden and also Chalmers we have competence regarding ITS deep learning things like that. Very close by and actually I'm the appointed division manager for safety and transport for the research Institutes of Sweden so if you would like to talk about that competence, as well, then we can speak.

What are we doing we are a test environment for connected in automated vehicles. we don't have any classical Dynamics or anything like that so we can work as an analysis and verification partner for active safety` in connected in automated vehicles and I can only attest to exactly what the governor said previously it's not a defined field yet. So we need adaptation and implementation of new technologies and methods to support this emerging field. We work together with Academia and Industry to among other things to look into verification of advanced connected an automated transportation and make them possible. Because without regulation it will not work. This is what it looks like, we have a small City, a piece of rural road. We've already got a stretch of highway down left picture and finally a very big area what we call the high-speed area can be used for flexible testing. Of course, we've got all the trimming the equipment, the workshops, the test equipment, and so on. So, some examples of development projects that I've been working on our certification for level 2018 protocol. Of course, we've already got connectivity without 4G since about a year ago we are opening up 5G court right now and of course IEEE 802.11p naturally where convenient for a group that works with targets like I mentioned previously but also developing a standard for test control this is very important otherwise we can coordinate test with more than like three objects or something in it and we will need more for the future as you will see shortly I'm finally around test equipment it's quite successful I'll give you a row So these three vehicles are on our high-speed area they are controlled so if we did not coordinate them in the painted on intersection there they would crash it's a resort project that our minority owner Chalmers has been looking into and it's about coordination again so we got to coordination vehicle that coordinates the other three vehicles that are approaching the painted intersection of this is what it looks like from one of the vehicles approaching in the instrument panel down left you can see that it's on cruise control and down the start coordinating it gets into a time slots continues coordinating and then it can blend through the intersection in a very good way if we hadn't taken control over it of course it gets a little bit hairy when you sit inside the vehicle and we can't show you the parts this is what it looks like from the top and of course once you start trusting the technology and it works thank you Proving it for three cars of course you could move on to something like this and then of course probably we would need to have some Behavioral Sciences to actually make people want to go through that intersection. Okay so that was just a glimpse of what we are and we are doing. Thank you from AstaZero.

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Adela Spulber: Thank you very much , Peter and I hope you can tell us more about what are your next steps on that project and especially when are you going to introduce to that intersection pedestrians and bicyclists and see how everyone will work there. So our next speaker is Dr. Risto Kulmala. He is a principal advisor of ITS at the Finish transport agency. He is and has been a coordinator of many major national and international R&D and deployment programs in projects with more than 300 Publications. He is also a member or chair of various International ITS bodies as well as scientific and technical committees.

[00:45:24]

Dr. Risto Kulmala: Thank you very much and good morning to all of you. So What I'm going to tell you about is what we do in Finland, with road vehicle testing and especially an action that we call the Arctic Challenge and this is a type of testing activities that are currently carried out in Finland. Starting with the winter testing in Northern Finland where really the emphasis is on how automated behaviors can cope on icy and snowy roads. And believe me Alvaro they had stable climate conditions. We also have stable climate conditions in the winter time because they're in that period, in that part of the country, it could be 5 or 6 months when the roads are covered with snow and ice so it is quite stable. We don't put salt on the roads because it would be test field drivers because there would be snow anyways. Ten we also have urban testing facilities in the, especially in the city of Tampa Bay, with the focus on the urban test ground, and there we try to develop testing tools and requirements for automated vehicles and then we have had the automated buses testing in different cities in Europe. Finally, and perhaps quite importantly we have tests on all of our open roads. First of all, national legislation that allows for automated vehicles of a kind. The law says every vehicle has to have a driver, but it doesn't say where the driver has to be. They can be outside the vehicle, or they can be at the office of the manufacturer where they manufactured the car. As long as there is a driver who has been designated to do it. So whose responsible for the movement of the vehicle. And we have the transport safety agency traffic who can grant this test space to validate one year at the time with quite, quite simple procedures. But to go to more detail on the Northern Finland testing ground, and it's located at the very North of Finland by the Arctic Circle. The main, it's on a main road, so E-8, which is a two lane road. And connecting Norway to Finland. And there we have a 10 km test section with the providing electricity and fiber optics with connection access every 300 meters, equipment cabinets every 900 meters, we have the 4G, and 5G connectivity, on that road. We also have land stations for the satellite, this is a specific problem on the arctic latitude. There the satellites are so low they are clouded by the hill, and it is quite hilly part of the country, so we do need these land stations to provide satellite positioning on the streets. Of course, we have the HD map. Also, control room facilities, road weather stations, traffic monitoring stations. And we also are working together with Norway on the same road that goes to Norway. There’s also a Norwegian test section on the other side of the border. So this is not just a Finnish project. And of course, we call our part of the project the borealis, we have the borealis corridor. And what we are trying to actually now do, to study over there. Looking at landmarks, so as you can see there are some

landmarks already because the snow plow vehicles, they need to have the landmarks so they know where the road is there supposed to plow. I took myself this picture, this is an picture of the road over there. So we look at what sort of, should those land marks, should they be, where should they be located. And then, what sort of, should they have some sensory reflectors. So we try with different sort of, alternatives of doing that. One of the as I said is the accurate positioning of vehicles. How do we accomplish that on those roads? And especially when the roads are totally covered with snow and ice. And then, we also look at remote control of vehicles. By using cellular communication, we have had to first test with 4G and it seems to work reasonably well. So we look at both 4G and 5G with remote control. We have in our hopes that Winter maintenance of the snow plow vehicles could be automated so that could do the work during the night and when the snow, nobody else about. Except for reindeers, of course especially a big problem in that area for automated vehicles, as well. And of course, we look at the back of several different systems and related interfaces so that we can provide the extended electronic horizon to the automated vehicles. Again using the cellular network as the main communication medium. Okay, that's it. Thank you very much for your attention.

[00:51:53]

Adela Spulber: Thank you very much. Myself, I'm definitely interested in hearing about your cooperation with Norway cuz we know the Nordics have a great history of cross-border cooperation so maybe there's an opportunity there to have an exchange of best practices between Finland and Norway Michigan and Ontario as we go forward. So, our last speaker is Gwen van Vugt, finally. Comcast International he is the director of their mobility center where he focuses on building TASS Knowledge Center and test Center in automated and connected driving. He is also responsible for Global Business Development and Technology projects in this field of expertise.

[00:52:54]

Gwen van Vugt: Thank you Adela. So yeah, I would like to give you a small introduction about our company we are a company which is headquartered in the Netherlands and we are offering software and testing services in three domains. Our first domain is safety that is also where our company started you see the software suite that is used all over the world to make vehicle safe. and the other area that we are talking about today which is my responsibility is the automated and connected driving area where we have our simulated driving software and we are also very active on the vehicle Dynamics area especially on the tire side with Della Tire which is actually a simulation package for tire Behavior and we all understand that tires are actually the real physical interface between the vehicle and the world two automated Vehicles can figure out how to steer but but in the end with the tires that have to make it happen especially with winter conditions or just quite challenging and then these three domains we actually offer besides the software

engineering services and testing services up to *inaudible* that's actually our methodology we are a company that's offering support for the Auto industry throughout the entire development chain from research and conceptualization until development engineering testing and finally promulgation to get these fields to the streets of legally. As I said we are headquartered in the Netherlands but we have global offices at basically all the automotive centers in the world. And fairly recently we have been acquired by the global company Siemens. which I'm actually quite proud of to say because it is synergy by Nature we're now in the process of integration for about 8 weeks and I feel very similar Siemens is an engineering company like we are, and one of the most important things is that they also have the vision they also share the vision of simulation and testing activities and one cannot do without the other.

This is actually one of the slides from Siemens to show how we fit in their enormous portfolio, this is actually visualization of the entire product development process. It goes from mechanical design to electrical design, software design, fluid design, so you can imagine you can build an entire vehicle virtually and that's actually even goes into production and Logistics. If you look where TASS fits we fit on the softer simulation side. We have very good sensor modeling in pre-scan and that is something they did not have in their portfolio. We also have loop testing activities and facilities. They are very active on that especially on the vehicle dynamics domain and TASS actually adds now connected and automated driving to that. And last but not least we have our own test track in the Netherlands for technology that we are expanding for attachment to 70 km on open roads and that's something that fits well in the portfolio of Siemens. This is a small video that actually shows the broadness and wideness of all the activities we are doing at TASS. As it says we are making the connection between virtual physical testing and that's one of the topics we are talking about your today as well I think it's one of the main areas that we need to talk about everybody understand that simulation is indispensable part of automated driving but still and maybe never we can do without physical testing to validate simulation models. we're also helping in the design activities of the proving grounds like in this case the American Center for Mobility that you see, we have already visualized in our virtual software before the test track actually even exist but very soon you can see the real thing. So basically you can see here how the proving ground is modeled in pre-scan and how people can use them to prepare for the test track before it is even available. This is to show that we have also the latest and greatest test equipment that can be even questionable. And this is actually a nice video that I like to show that Peter will probably like because it is happening on a AstaZero test facilities but what I really like about this one is that it shows how our customers like Volvo trucks are using the software simulation and the physical testing on the test track these drugs that you see here are actually programmed here with our software. So they prepare the test trajectory completely offline and the software is actually secured by Prescan and the second one of course has to brake just in time. So luckily that happens so that's good. this is our test track in the Netherlands it is quite a unique environment for a testing in the open road, it's an area of about 10 km long is completely equipped all kinds of test and measurement equipment on the public Road. We are allowed to drive the vehicles between the public and this is an example we have to work together to test in the European project 10 different automatic vehicle projects similar to what Peter showed automated vehicles can merge together and completely automatically negotiate with each other

to make a left turn. So this shows the wideness of all the activities that we are doing. And yeah, to repeat again our vision is really that in this development chain in autonomous vehicles we are seeing this integration of virtual activities and your hardware and loop facilities, and finally your test track facilities, and field test activities. this is also a sequential thing going back and forth over time updating your models your virtual models with the data you get from The Real World you are finding out that your system might not work and shows the area where you are updating your system performance that you have to bring back to the real world again so this is continuous back and forth and like the governor said standardization, I think is a big thing. And I can tell you one thing this change, this tool change, is not standardized yet. I think we have to think about that to make sure that you can actually seamlessly use the data on that you acquire on the real road that you can bring that back into the virtual world, and the other way around. So this is our last slide, it shows actually a bit of the activities that we are doing from a Services perspective. We're doing a lot of automated driving validation especially on the positioning and sensor referencing also connected and the hybrid Communications with 4 and 5 G is a topic that is currently quite old. We are also doing all kinds of certification and approval of services for example we are the technical service for Tooling system in Belgium and also the connected traffic light system in the Netherlands. We do also test program consultancy, this is a big part of our consultancy effort. Because a lot of OEMS and tiers, they actually really struggle to set up a structured testing methodology over the different domains like virtual and physical testing. And we are helping them setting up testing programs and last but not least as I showed you we are doing together with IDIADA the design of Test Facilities and the governor also mention that and I truly believe in that, that each Regional area in the world needs its own test facility because the world simply looks different in the United States as it does in the Netherlands which is different than Finland as we have seen and not even to think about countries like India. so I truly believe that there are room for lots of testing facilities and we want to help the world to build them in a standardized structured relationship so that we can connect these things together so thank you.

[01:02:48]

Adela Spulber: Alright, thank you for all those good points on how to integrate simulation with real world testing. so now that we have all our great panelist here let's open it up for some questions and I myself I have many questions already; dying to know more about so many things. But we will also be taking questions from the audience so Susan there is is ready to to relay your questions. I guess the first question I would like to start with is related to the main topic for today's symposium. So we're talking about policy regulations standards, so just to set the stage maybe can each of you talk about maybe the most important legal or regulatory or standard creation efforts in your country and also about the EU level and how we connect the two.

[01:04:03]

Álvaro Arrúe: First of all, since we have an international audience I think it would be wise to to introduce how we are organized in Europe in this way. Something we spoke about in our

presentation about type of approval so this is something that has worked out at European Commission level as well as you UNECE, United Nations for economic development, so this is more related to type approval testing and so on and then we have the other side from the member states side. That we have our own traffic laws and traffic legislation so it's sort of similar to the US federal and state level. Each member state in Europe can define their own traffic laws, turns, so on. So unless I'm not wrong. The Spanish government, for example, two years ago they published a license exemption procedure. But this was just for testing purposes. And from what I know now things are moving on also in other members states. So now we need to go to deeper changes, changes that go to legislation and parliament, and so on. This is like work going on in Germany.

[01:05:20]

Peter Janevik: From a testing perspective a lot of regulation and standardization work is not actually coordinated right now so for instance the ISO group that I mentioned is just that it it's an ISO group dealing with standardization of test targets control because if we don't start right test targets we cannot compare results between the various sites it's that simple so it's really important that this is also complimentary to initiatives taken by the SAE There are initiatives coming that way as well.

[01:05:56]

Dr. Risto Kulmala: OK maybe I can highlight that yes we have the regulatory framework is there for the testing but I think that we know that when we will have level three and also level four vehicles on the road maybe in two years' time or something like that and we are really ready for that. Are we really ready for the consequences of that? I don't think so I think that we need to do some a lot of work in the next two years to be able to respond to that.

[01:06:34]

Gwen van Vugt: You know I actually agree with Alvaro with that in Europe. There is indeed two layers you have the national layer and the European layer. And actually I think I was thinking about two. Topics there's the automated driving topic and there's the connected driving topic I think the connected driving topic is something that we have been working on in Europe already for many years I think that this progress in quite a while of course it could be facile with that this is how things work in politics. But what we've seen is there's a lot of initiative in Europe to have cross border initiatives there's a lot of corridors defined. The first one was between the Netherlands Germany and Austria but also that's a myriad of corridors between the U.K. and Europe and between France and the Netherlands and so there's a lot of activities going on that side I think that's progressing quite well. On the other major sites you see that it is very much on a national level quite so there's a lot of countries that exemption procedure that you can test

your vehicles and gets vehicles on the roads I'm in discussion with the Dutch government to see and I've also examples in Germany where the national governments can actually do type approval of a vehicle but that is only valid for that country. I mean today if you buy a Mercedes E-Class in Germany it has more features automated driving features than when you buy the same vehicle in the Netherlands simply because the Germans have approved it and the Dutch did not approve it. Yeah of course that's all the good thing but I think we're moving forward.

[01:08:24]

Álvaro Arrúe:: Just one thing for example but means regulation we have European countries that don't allow distances between vehicles on the highway less than fifty meters that by default doesn't allow tuning and continents and Europe we are all connected so we have up a country that doesn't allow this to be I would have been nice but in some countries that will have to dismantle themselves when going to a country isn't going to be there so for example these up road needs to be harmonics but again we're speaking about lot of these need to go through Parliament and it does take some time but we should happen. You know for this kind of things to enable European wide.

[01:09:17]

Adela Spulber: Very very interesting point so because we have a good mix here of private and public sector. The other thing I was curious to know about maybe let's start with you, Peter, so in your experience what would you recommend that legislators do at the national level and then the European level to create this good framework of legislation that strikes a balance between enabling technology innovation but also protecting the consumers.

[01:09:52]

Peter Janevik: In my view I think there's a new type of legislation development that has not been taking place for a lot of years and that is actually research into how to design the legislation. In my view the legislation has been developing in a very step by step way and that has served us well but now we're facing a disruption in many ways and transportation system and that needs that that requires a new way of working when it comes to legislation unless we change and increase the pace of policymaking, technology will continue moving along and it will move along without the legislation or with it, preferably with it so I'd like to push for that type of work when it comes to policymaking that is not present today.

[01:10:49]

Gwen van Vugt: If I can add to that I completely agree. I think the government understands that you that you should not specify too technically in the laws and regulations. I mean a very nice

example actually is the back of the mirror that you can look back I mean thirdly it is described in in the European laws that you do that in to be a mirror so you can't have cameras that are looking backwards and the screen you know it needs to be a mirror those are the type of things that of course we should not want so I think governments understand that these days so you really need to have a much wider framework. That allows for future technologies to arise and another example is for example the over the air days I know that our Dutch type approval authority is really struggling with all the Tesla for Europe are approved by the Dutch government. And now one of the first things that they were struggling with this if Tesla provides a new software update does it needs a new vehicle type of basically they can make their vehicle from two wheel drive to four wheel drive with the software upgrades there's a new type and the big question is when one is the software upgrades minor enough to not need to type a new type of problem when there's great significance enough to do that there is no reference for that we don't know and that's the type of things that we need to start yeah understanding.

[01:12:00]

Álvaro Arrúe: And it's not just a for market deployment what is just for testing but there's some minor change and so where should you asking for a new license or whatever this is one of the good questions and these are the things that we might learn by doing this kind of test in the next.

Gwen Van Vugt: It's actually not even in type approval I think it is even if you look to the OEMS. We all know about software regression tests I mean what when are you going to sweep your new software versions through the what is it billions of physical models that we have to go through. And when do you say OK this is just a minor days and we check you know like I don't know thousand scenarios and if it works well then off we go I mean I don't know the question and I think nobody really knows at this moment.

[01:13:26]

Peter Janevik: You know this is also made worse by the fact that some of the standards that are used to design vehicles like ISO 26262 it's quite hard to say that one but I practiced. So ISO 26262 requires you to design. Electronic Systems in a way that you actually understand them from. From an identical standpoint but machine learning algorithm can't be understood that way so we already have conflicting. Frameworks between how we actually work in the industry and how what the requirements are laid down by standards and so on.

[01:14:08]

Adela Spulber: All right so I'm really curious because we talked a lot about the European level and the relationship between national and European I'd like now to bring it to the international level you've already said that in Europe we have the type of provable system with mutual

recognition between the member states but as you know the U.S. has the self-certification process so with that in mind how is that a challenge going forward for testing and deployment and basically what is the right level of convergence and harmonization between the way we test vehicles and we validate them so far.

[01:14:56]

Gwen van Vugt: You know maybe I can say something on that I have not figured out myself what actually is the best system. Because if I looked at the American system. What is good there is that it allows the industry to move relatively quickly with new technology to the road because you do not need the vehicle type proof from the government it is basically your own responsibility to make sure that the technology is safe. So that I think it initiates innovation whereas on in the European side I mean you first have to prove that it is safe before you're allowed to go on the streets so I mean it might hamper innovation on the other end. If you as an OEMcan get a type approval from an authority in Europe. Your responsibility actually is moved towards the government so your liability is also decreased and that actually improves and speeds up the deployment of the activities so I think both systems have their advantages and disadvantages I think the American system has the advantage to speed up the innovation I think the European way of doing is speeding up the deployment So yeah it's I still don't know what Rich I did used by the way.

[01:16:31]

Álvaro Arrúe: Probably this is also something that needs to be changed at the United Nations level how to adapt to all these changes in a much faster way I'm not saying that they are doing it wrong but it needs to have mechanisms to partially adopt these new technologies as a way or at least set the framework about how these new technologies could be handled by regulation and this is what ongoing work that's already groups in United Nations dealing with or did update cyber security as well as new topics that need to be addressed at some point you want to keep this scale.

Adela Spulber: Risto, I was curious to know if what is your opinion on that because we've heard a lot from private actors. Because you represent the Finnish transport agency, what is your stance on this discussion on the European way of doing it, doing testing and validation in the U.S. one are you are you in talks with American partners on what is the best way to go forward?

[01:17:52]

Dr. Risto Kulmala: You know well we haven't really looked in that this way, I think that we have tried to reap the full benefits of the European system in a way and then to utilize the corporation especially we have had well decades cooperation between the Nordic countries and without you know not so much borders within our countries so I think that this is that, this has really benefited

us to be open and as much as possible and do things together in the same way so you know in a way that's a good thing of the European system, you know taken away the borders more or less from my so we can really do these cross border trials extremely.

[01:18:42]

Adela Spulber: And I wonder when you are talking with your other European counterparts do you talk about. From the government's point of view how safe is safe enough when we. When we start developing these vehicles, testing them and finally approving them for market deployment. Is there a consensus between European countries? Are some more strict than others and what is the flow of the discussion so far?

[01:19:31]

Dr. Risto Kulmala: I think this is still on the table I think this is a really crucial question and and how to solve this we still do have major differences in the road safety levels between the European countries so the ones who are the best I think the risk of fatality is still seven or eight times lower than in those which are the worst so so this is really a tricky tricky discussion at the European level.

[01:20:00]

Álvaro Arrúe: Probably there's not a fixed answer to that because the answer to that. I don't, I don't have it. I don't know if anyone in the room has it, yes share. The answer is we can give the microphone, *laughs* but it's it's difficult and probably there is not a clear and fixed answer and this will have to evolve with time. We can set up a minimum safety level somewhat in the near future but these will need to evolve because they are the situations that will change the higher introduction of the from a say level two, three, four function are going to change the baseline and the difficulties and the scenarios and everything that needs to be taken into account so we were speaking about flexibility before and this is a clear example about how flexibility to be taken into account for years to come.

[01:20:50]

Gwen van Vugt: And I think it's not even something between the European states it's actually also within the states that the vehicle type approvals are looking at the vehicle and they're not looking at the infrastructure and I think actually when you think about all the major driving it's a combination of infrastructure and vehicle and actually I think for level three for example it's even the interface between vehicle infrastructure and the driver. I mean we all get driver's licenses but maybe we should get another driver's license for level three or maybe I mean, I've heard people talking about driver's license "light" for people that are only allowed to level three or four

vehicles; I don't know but the one thing I do know is that it's not only the vehicle it's the vehicle in combination with the infrastructure and that's actually does not exist I mean if you go these roads in Sweden or in the Netherlands I mean a lot of roads are able to do level for automated driving but if you go into Greece for example or Romania, I mean also part of European Union, I mean most of the roads there are not capable of doing that. So currently the industry does not have systems where you are allowed only can enable your automated driving pilots on those roads that are certified to do automated driving. And I have not seen anything happening on that side, on the infrastructure side, to say these roads are safe for automated driving. I would expect that the government also says if this road is safe for automated driving and we certify automated driving [then] we make sure that the infrastructure is kept to a certain level; that the lanes are always visible, that's I don't know that there's maybe cellular infrastructure or these capabilities I don't know exactly what is needed for automated driving but but at least it's a combination between vehicle and infrastructure.

[01:22:51]

Dr. Risto Kulmala: Yeah, I could maybe complement on that way having the CIDS platform now for last one and a half year working group on physical and digital infrastructure where we have exactly looked at the question then and who does determine which is which road sections that can be used for different types of automated driving years cases and we came to the conclusion that first we need to agree on the attributes that are related to the operational designed domains of the different use cases and while and as well and when we have agreed on those attributes then we can discuss that what sort of levels or thresholds that we need to determine this in the correct case we are in the place that for instance in the Swedish test now around Gothenburg that this was pulled back to the OEMs, so that Volvo themselves determined what roads would be the, could be used for the level four or three functionality.

[01:24:03]

Peter Janevik: One thing that you also might forget is that once the vehicles can go automatically without a driver then probably there will be a lot of driver cars and other vehicles like pods or drones without any driver that can actually take place in the vehicle. Now you can place the intelligence depending on the sort of certification level of a city network or a road, you can choose to place the expensive parts either in the drone or some intelligence maybe in the infrastructure if it's reliable enough. So depending on how fast the infrastructure moves when it comes to certification and also the reliability and how good it is. This allows for faster rollout of drones and pods in the future but we'll have to see.

[01:25:01]

Álvaro Arrúe: Just a little bit to be controversial here. I don't feel so much comfortable on having to rely on the status of the infrastructure that has to be maintained by the public authorities because of course they can make a great effort to have this prepared every day but things happen and you cannot control your network. So right now we've got functional safety ISO 62626 in place. You can define the operation and domain But I mean at least in the beginning this should be the approach, maybe in the future you can rely more or whatever but trust with the statutes to be able to go level four is a tricky situation.

[01:25:48]

Adela Spulber: Yeah, if I can also recommend because I'm Romanian. Can you please do an operational designed specifically for Romanian roads? That would be great it'll save a lot of lives. So because I think we need to wrap up here - I have a final forward thinking question for you. So, because we're here to talk about international collaboration, what are our next steps to ensure continued collaboration? To ensure that this is a dynamic going forward and it's not just a one off event here, and a one off event organized by another organization? How do we leverage the talent in in this room, and the leadership, to make an impact on global cooperation? Can you each share your thoughts?

[01:26:45]

Álvaro Arrúe: OK. It hasn't really been introduced by one of the things that it's going on and it's the trilateral group. This is a group that particularly meets and shares information and it has sub-discussion groups within this tri-lateral automotive road transport group and this a way to put together mostly, it's US Japan and Europe but right now it's also growing with other observers. So, there are other countries that are participating in these meetings and it's a good forum to foster development at the governmental level but also with the input from academia and industry.

[01:27:29]

Peter Janevik: So, the business is still also small enough especially when it comes to testing and that initiative on an individual level makes a difference so our communication here in Europe and also with the U.S. and Asia makes a difference and we can find topics on the issues that need the legislation and standardization faster that way, and it's actually working, I think. So by working in the spirit of what the governor said previously today that that can make a difference as well.

[01:28:06]

Dr. Risto Kulmala: Well I fully agree with the previous speakers. One thing that sparked in my mind listening to Governor Snyder saying about these sort of workshops where we share

information; they're quite nice, yes but if we want to get something done I found out that doing things together is really the best vehicle. Having broad sense projects where we try to really do something together and to accomplish, to take steps forward together that's the best way of learning to work together and sharing information.

[01:28:45]

Gwen van Vugt: Yeah I agree to that. I think we have to use existing collaboration. And entities like ISO and UN, you name it. But I think indeed that we have to see especially on the testing side how we can collaborate more. There's a lot of initiatives going on for example building scenario databases and these type of things. I think that that we have to define these type of topics where we say OK let's here we together and I completely agree with you that actually doing things together really makes progress so let's let's find a few topics where we say these are important let's define a few projects around it and move forward.

[01:29:38]

Álvaro Arrúe: Just to add one more thing to what you just said, we don't maybe, we should start doing this not waiting for standards. So let's start collaborating right now even if nots - *audience applause*

[01:29:51]

Adela Spulber: Thank you, thank you for all those great points and I'm sure we can talk more about this during the day, thank you.

[01:30:02]

Kevin T. Kerrigan: Thank you, Adela. Thanks gentlemen, it was a great panel a lot of interesting discussion. A quick summary some of the best test facilities I've seen I really enjoyed the presentations and I now truly understand Brexit. *audience laughs* We have a break now until 10:50. If everybody can be back in the seats at 10:50 that would be great. Our next panel will be the North American initiatives and we're going to start right on time. Thank you.

[01:30:37]

Kevin T. Kerrigan: Some late breaking news this morning the governor mentioned one of the complications of autonomy being driving on the left hand side of the road or on the right hand side of the road. We have a very diverse group here that do both. It was announced this morning that California is going to change, they're going to move from driving on the right to the left. They just announced at the ITS booth. The good news is they're going to do it, they're going to

transition and they're going to do trucks first. *audience laughter* OK. And our next panel is North American initiatives and moderator is Kirk Steudle. Kirk is the director of the Michigan Department of Transportation. He oversees the agency's more than full billion dollar budget, and that was billion by the way. And he's responsible for the construction maintenance and operation of over ten thousand miles of state highways and more than four thousand state bridges. Steudle is a national leader in the development of connected vehicle technology; he served as chair of the Intelligent Transportation Society of America board of directors from 2014 to 2015. He's also a member of the ITS program advisory committee to the U.S. Department of Transportation. Kirk has received many awards and honors throughout his career. In 2015 he was named one of America's top twenty five government innovators by the Government Technology magazine. It's my honor to introduce Kirk, and have him come up to the stage.

[01:32:40]

Kirk Steudle: Thanks Kevin. Well good morning everybody. It's great to see you all I know the first sessions went very well and I think this next one will be the best ever. You know you, know hey you know pressure panelists but step it up, eh?. Although I don't know that I'm going to have to the witty jokes that Kevin does. Especially that first one this morning to kick it off and if you didn't hear it you don't need to. Alright so how is this not advancing how do we... It's advancing here but it's not advancing there so I could see what my presentation is. As you can see on the screen. It's time for a break oh you just did that. *pause*

[01:33:46]

Kirk Steudle: Great, so we have distinguished group of individuals with us and we're going to have a little roundtable conversation. We're going to start with each of them giving some comments about their particular testing facilities; where they're at what they're doing. And then we're going to have a roundtable conversation up here and before we get started I want to talk a little bit about what's happening in Michigan. You are in a planet M room so you can hear a bit about Planet M so one of the key pieces that has enabled a lot of research and development happening in Michigan is the fact that December 2015 Governor Snyder signed really groundbreaking legislation that blew open the whole opportunity to test and operate automated vehicles in Michigan. One particular piece eliminated the testing restriction so it is now completely legal to operate in an autonomous vehicle or a highly automated vehicle, whichever you prefer on any road in Michigan any time, no special driver's license or operators license; no special license plate on the back. If you could buy one of those today you can take it to our Secretary of State. Get your white and blue license plate that looks like every other one in the state, put it on the back and away you go. That was very far reaching and then there was a number of other bills. One that allowed, didn't do testing allows for truck platooning. We've already approved one company to do operations to basically, the law says company sends us a their proposal of what are they going to do, how are they going to test it. The State Police Colonel and I have about thirty days, in fact not about, we have thirty days to either approve it or deny. If we deny it we have to really

say why. And at that point they are approved so there is a company that has been approved to operate not just test platooning vehicles in Michigan and in Michigan's case the law was pretty simple. We just changed the definition of the following distance before it said there was a specific following distance and now it says, "comma, unless you are electronically connected then you can violate that following distance." so we're working with that company on some demonstrations with some OEMs here, hopefully in the next six months. They get a little bit antsy about winter weather and I said well why weren't we doing these in June but that's OK. I said look, I think we can have all the snow plowed, we can have the ice cleared any day you pick. I think we have a little bit of say over how we clear those roadways off. It also created the American Center for Mobility. You heard John Maddox to talk about that. I created the Council on Future Mobility and I've got a slide that talks about that and then one of the the last pieces, there's actually there two pieces. It also allows for on-demand automated networks to operate in Michigan, not just test. Which means driverless lift or Uber is completely legal on any street in Michigan. Now there's two parts of that law one says manufacturers can do this, another one says manufacturers of systems, which would be technology companies can do this, as well. There's been some confusion in the media that says oh, this is just manufacturers and that's not true. There's two parts of the law, if you have an automated system you can operate an on-demand automated system in Michigan. I have to tell you a personal note with that piece as it was going through and it was suggested by by some companies we add this was April of 2016 and I was at my head around what are you really talking about and that's how fast this technology is moving. Now, everybody's like well of course we do that. Well then it was like what do you really mean? Well my son was graduating from college so he and a friend were over at our house. It was a Saturday night and I said, "hey, what would you guys do if a driver shows up today to take you guys out to the bar tonight?" They both looked at me like I had three eyes and said we'd get in it. It got here, it got here, and they went yeah, OK I guess so. It got here so it's going to make its way back to my house. It'll make its way back. That was a turning point for me. This is yeah, we with less hair think a lot different and we need to think differently about it. And then the last piece is about mechanics liability and this was really important that what we're trying to do is protect the public from somebody that's got a really great idea but they're operating out of the garage and they modify a go cart or they modify even an OEM vehicle and change it and they change a safety system you know it's one thing to tweak the engine. I suspect Kevin probably tweaked the engine when he was a kid to get a little more horsepower out. That that's one thing, but you start tweaking a safety system and there's other people who are going to be impacted by that and that's really not, that's not acceptable. So, what this law does is basically provides protection of liability if you've repaired that system back to the original OEM specification and you haven't tweaked it, you haven't changed it, if you want, go ahead but then your liabilities on the line.

[01:39:10]

Kirk Steudle: A piece about Michigan, it was the 2014 World Congress that we had the great opportunity for General Motors C.E.O. Mary Barra to announce a partnership with GM and Ford

in the state of Michigan that's since been expanded to include Toyota and other OEMs and suppliers to instrument 125 miles of smart corridors in southeast Michigan. Well, we beat that and we're expanding beyond it so by the end of next year we should be at 350 miles and by 2019 at 500 plus miles. Now what does that mean? That means the infrastructure is in place, the brains are in place. There's roadside units in many locations, some of those are connected to traffic signals, some of those are standalone. It doesn't mean it's ubiquitous all the way around it. It means where we're testing and where we have people that are engaged with testing, we work with them. And say what is it you need and let's put those in place and then we'll fill in the gaps as well. But by 2019 this is the network that should be in place over all the southeast Michigan. We also moved forward on a number of partnerships and the governor is really keen on collaboration and partnerships. And we've done a lot with the U.S. Army Research and Development Engineering Center in Macomb County. We've done truck platooning a year ago on Interstate 69. And about a month ago with our friends in Ontario we did a TARDEC, a U.S. Army coordinated event over the Blue Water Bridge into Canada and turned around and the last two vehicles were in complete autonomous mode. I was driving in the last one and that is a bit unnerving that you know, they're not driving at all. It's a pretty big vehicle. The other one was a partnership with 3M and we said are we going to create this environment. We had a big construction project on Interstate 75 and 3M came along and wondered what what else could we do with this. And we had a couple of companies that came forward, one of them was Magna and they said we want to look at the infrared technology to traffic signs and say well what can we do with machine vision and embed that in the sign? So, if you go to the exhibit hall you can see the signs. You can see the 2-D barcode that's in there. We viewed it as highly successful. We've looked and said OK we have a communications link. This was a very successful opportunity between the state of Michigan and Ontario. We did the first international border crossing in North America of two autonomous vehicles. So, they started in beginning of August, they started in downtown Detroit then they went under the Detroit River and the tunnel where you lose all GPS signals. Then they pop up in Windsor, and drove from Windsor to Sarnia across the Blue Water Bridge and then continued up to Traverse City for the Center for Automotive Research Management Briefing Seminar and 95 percent of the time they were operating in autonomous mode. When they went through the customs booth they put their hands back on the wheel. But interestingly enough another partnership, Customs and Border Protection agencies on both sides were very interested in this development and this trial because they said they know they're going to see those and they need to understand how they react, how do they interact with a car like that. And so, we're looking forward to the next version of that, as well. And I mentioned that law created the Council on Future Mobility; here some logos across the bottom. The long and short of it is private companies helping advise the State of Michigan and the governor and the administration about what you would be looking at going forward. What barriers are in the way to allow technology to advance. They've been meeting since March. They're focusing on cyber security issues, insurance and liability issues, talent issues, and then communications communications and strategy. So stealing Kevin's piece we've got all that it takes right here planted out so. That's the end of the sales pitch let's move on to the our panelist members and the first one *asks question to other moderator* - John Maddox from their American Center for

Mobility is going to give ACM overview we're going to go right down the line with all of the facilities and then we'll get to that conversation.

John Maddox: Good morning. Yeah, I don't I also don't have any anybody jokes like Kevin but you know maybe I'll try. But of course I'm very proud to live in a state where our political leadership can talk technology. Of course, he always steals my talking points. Governor Snyder already talked about was this idea that we need these three key environments. I'll add one piece of information to think about. You know it's hard to ship vehicles across the world to test in different places. It's relatively easy to ship data and that simulation piece is critical and we can think about that perhaps as low hanging fruit for ways to work together. We also talked about the process if you will for and the need for voluntary standards. I won't go into a great deal because it's already been covered I think we all get this. There's already an existing process in place where industry and government can collaborate on standards you know testing leads to voluntary leads to regulation but it's a relatively slow process and that technology is moving so fast even the voluntary standards really can't keep up. Proving grounds especially the automated vehicle proving grounds can accelerate this process and we think that that's a critical piece also maybe a low hanging fruit for collaboration between facilities. So, that's really why we have established the American Center from Mobility. We are a not-for-profit DOT designated test facility focused on three main areas which I'll come to in a bit but we are really keen on continuing the spirit of innovation at Willow Run in Michigan and seeing a place providing a facility for product developers to develop their products in a very rapid fashion. You know when we talk about automated vehicles I think it's also intriguing to think about all types of vehicles; we're not just talking about passenger vehicles or even trucks we're also thinking about these new types of vehicles like the second one I call it like a dorm refrigerator on wheels. It can bring your lunch to you your groceries to you, but more importantly it can save you the human of having to take a trip yourself that will also revolutionize transportation. When we think about automated vehicles connector on the vehicles we need to be thinking about this whole range, including even UAVs. We're trying to, we're going to deploy these at our sites so that we can develop the product but also we can educate the public. I'll talk about that a bit too here are three pillars of activities: testing, standards, and education. I'm sure we're going to hear that you know varying pieces of that across all of the all of facilities today. On the testing side you know where I'm a I'm a reformed product development engineer myself fifteen years worth at Ford Motor Company and I've been to a lot of test facilities, I've used a lot of test facilities around the world, and what really is interesting now is that we've got the ability, the opportunity to create and design something something from scratch that's purposely built to focus on connection automated vehicles. We've got a nice blank slate, five hundred acre campus canvas, if you will, to do that on. I won't talk about the history of it. You know our facility, the concept, and I think Glen had showed a slide of an early version of this and TASS has been involved really since the get go. The good news there is that our concept has remained true. We are building a series of environments that look like the real world to the vehicle but importantly are controllable and we can control the experiment to actually develop these products. Highway loop, urban area, rural area; very important and maybe

that's another opportunity to collaborate. Residential areas, commercial areas, a technology park, all of those physical test areas are all needed and probably more. You know we're building this out in two phases over three years with the understanding that we're going to have to change it. Product development will occur and someone will come back and say, "oh well we now we need a blank. Can you help us build a blank?" But very importantly, and in addition to the physical test environment, is communications test environment. Critical and maybe also an opportunity for collaboration. We are, well these pictures are now four weeks old. Paving is complete, the tunnel is complete, the bridge is complete; we are moving rapidly. We will be open in December of 2017. I think AstaZero led the way in terms of speed and Mcity, also. We're trying to keep up. We're also going very fast and the governor likes to remind us to work in dog years and we call it dog days sometimes. Our next step while we're building phase one, the highway loop, we're also concentrating on the design of this urban area and I mention it because also it's an opportunity for collaboration across facilities, I believe. I think you and I are going to try to find some time later on to talk about that and we'd welcome other kind of people to join us in that conversation. But these urban areas are going to be critical and they will become, our facilities will become, the defacto standard that industry uses and government uses to design and certify. On the standard side you know I won't talk in great detail but we have forged MOU partnerships with S.A.E. and ITE and very importantly our perspective is you know back to that existing process; that's working. What we want to do is work with these partners to accelerate it we do not want to replace SAE or ID or IEEE or ISO or anyone. We want to help them do their job faster with industry and government involved. One of the, we had a couple workshops so far. One of the key next steps maybe also another area for right for collaboration is this idea we want to build a shared catalog of scenarios. It helps everybody that helps product developers and helps certifiers or helps sell certifiers if you will and it's an underlying foundational, I'll call infrastructure. It's not hard infrastructure but it's critical infrastructure. I want to mention the 10 U.S. D.O.T. designated sites because we're also, and John you're getting up, I thought you were getting up before me, but you are going to have described but we see huge opportunity within the United States. There's a huge variation in weather and geographic and to topographical conditions here in just this one country. We see the ability for this group to come together to do some of the same things that we're talking about here internationally. Lastly, on education, and we're going through this very fast, but you know education is critical. If we do just project development and standards, we haven't finished the job. We talked about public acceptance and that is going to rely on education. We formed an academic consortium and two of those schools, Washtenaw Community College and U. of M are in the room. There's some others, but really focus on these four key areas: workforce training and workforce up training for those who might be who might be displaced in their current job, public and K-12; we have to get the public acceptance. We need to develop the stem talent for the next generation. Of course, higher education, you know turning out engineers, lawyers, and product planners, etc. that have a basic understanding of what we're doing here. And lastly, R. and D. and this is kind of conveniently distributed. Industry wants workforce and public and some higher ed. Acadeia wants R and D, higher ed and so there's a combination here. We're trying to fit those two things together with again, without replacing the activity that's happening in each one of those schools. Here are the fifteen schools, all from

Michigan. And we've had requests from other places to join our consortium so we're thinking about that. Aquick quick update so we are moving fast. We were formed in March of 2016, will be open in December, and also moving fast on the investment side so happy to say that right now we're about 108 million dollars of committed money to build the facility and that's no small feat, in and of itself. I did want to leave with some ideas here because I think we want to leave here, the governor's going to come back to five o'clock or whatever and say, "what did you do?" He's already told us that and then he's going to say, "work in dog years." I can tell you. Here's three possibilities that I'd like to think about this discussing. You know working on a shared simulation environment, back to that concept that we can move data quicker than we can move vehicles. And underlying that is maybe even a common data structure. The second one I've already talked about, is a common scenario catalog that will underpin all of our activity. And then lastly and I think AstaZero and TASS talked about this, also. We have a need for common test procedures and common test targets. That alone is no small feat and we were talking yesterday about the, you know, the analogy that those are us who are old enough to have developed airbags. We developed the procedures and the facilities along with the technology, we need to do the same here but now on steroids and a lot faster. So with that just like to say we've got a lot of support from industry, certainly AT&T, Hyundai and Ford are our named investors. We will have more announcements coming. We have a lot of support from organizations, including academic and others. But really we are Planet-M, this builds, this is painfully slow. We are Planet-M and these organizations that have founded A.C.M., if you will. The state of Michigan, of course, business leaders from Michigan, Ann Arbor Spark, the university, and our township that we live in, are all focused on delivering this for Planet-M. So, with that I'll turn it back over to Kirk. Thank you. Thank you.

[01:54:02]

Kirk Steudle: Thanks John. All right John, you're not next up. Whoops, Mr. Mayor you're Next up in a slide deck. So the mayor of Stratford Ontario, Mayor Dan Mathieson, please join us and and tell us about Stratford. *asks for technical assistance*

video with music plays

[01:55:06]

Dan Mathieson: All of that, for that. There we go. *Voice-over from the video*

Video voices: In the early 2000s we started to lay fiber in this town. And I think that was the burgeoning of really the vision of Stratford being a little bit different. We certainly talked about being a smart community and we talked about the knowledge economy and the creative class but what's different about us is that the creative classes arts and culture. The creative class is entrepreneurship. The creative class is technology. We can do things from here now that we couldn't dream of even ten years ago and you can do them from, you know, your favorite cafe downtown. We have three hundred access points out in our system today. This will give us higher

speeds and more reliability on our Wi-Fi network. We've also laid about seventy five kilometers of fiber backbone throughout the city of Stratford. This allows us to interconnect new Wi-Fi points or DSRC communication points to our backend system. We see bringing that service to our citizens as a must. It really is that basic infrastructure need that everyone has, like electricity, like water, data is that next element that people really need to survive. We are wired and connected and yet we're still small. You know, we may not be big but we're small as the late great Stuart McLean said. And it's an awesome feeling, I think the city of Stratford again, just having the forward vision that it has and just the alignment that I see between citizens and council and the businesses within this community; that's kind of the secret, the secret sauce here and I'm glad just play a small part. *video ends*

[01:56:48]

Dan Mathieson: Well good morning I'm Dan Matheson, I'm the mayor of Stratford, Ontario. Governor Snyder, thank you so much for including me today. Kevin just an interesting stat, if there's 9,600 miles of Michigan-State controlled roads that means there's almost 18,000 miles of ditch, so you keep that in mind OK. It's interesting the city of Stratford is a small community just a little over 30,000 [people]. Our challenge is, you saw one of our actors, Colm Feore. We welcome a million visitors a year to our community. We're about seven square miles so we have a great opportunity in the summer. We have so many people come through our community but we also have that great winter that so many people in Michigan and Ontario come to appreciate, and Kirk I know you would understand that from the plowing of roads and to getting ice off them. So our challenge is we sit in this community, we're an arts and culture community, but we decided we wanted to do something different and to differentiate ourselves we decided that being a smart city really mattered and back as you heard there we started to lay fiber a number of years ago. We have a complete ubiquitous network over our entire city it's one gig up and down. We actually have our own internet service providing opportunity so that our residents can buy internet services cheaper than what they can from the big multinationals and international companies. And we do that because we want to make sure that nobody gets left behind in the digital divide. But we also have taken that through a number of different things, the University of Waterloo, of course, a great school. WatCAR, the Center for Automotive Research; they are a great partner of ours and they built their digital media campus in Stratford. So we're now looking at how the digital economy is going to make a difference. Now if you know a little bit about Stratford, you know probably two other things are important one is agriculture. Perth County where we're located is the most productive agricultural county in the entire country, two million dollars a day in farm-gate receipts leave the farms in Perth County. The second piece is that manufacturing, and predominantly auto manufacturing, is huge for us. We have eight assembly plants within a four hour drive of our community. So we have quite a few people working in auto manufacturing. So we really are that, where industry and arts combine. And so what we tried to do is make sure that we didn't leave anybody behind so as much as we're striving towards post-secondary education and working with the theater and arts and culture we thought it was important to find a way to bring our manufacturing along. And in doing so we started looking at autonomy and connected cars a number of years ago as we started to investigate smart city

initiatives the IoT, the Internet of Things and products. And we quickly determined that there was a void coming in the Ontario side of the equation of where we could actually start testing these cars. We put our hand up with the Automotive Parts Manufacturers Association and we had said through the encouragement of Ray Tanguay and Sam Eliseo and Flavio Volpe that we would actually start to move in this direction. And Stratford next Wednesday will be announced it was announced in the budget that would be official announcement that we are the only demonstration hub test city in the province of Ontario for connected and autonomous cars. And what does that mean well for us, it means that we are now moving forward. We've started to put a DSRC network around our complete city. We're looking at 5G networks to put over top of the city as an overlay. We're now working on data collection and we're working with Miovision out of Waterloo to not only collect the data but also then things such as the simulation that John talks about is important. Because we feel that that data when we put it into maybe a cooperative between ourselves and American Center for Mobility and Mcity there's an opportunity for us to start sharing information and to really come at this as a holistic way of protecting the relationship between Michigan and Ontario, which was formalized by Governor Snyder and Premier Wynne two years ago if I'm not mistaken. And so for us we see this is an opportunity for our community to step forward a little bit and differentiate ourselves. As a small city you're always worried about how are you going to find how are you going to be able to afford the infrastructure that's going to be necessary into the future. Well the million visitors a year, as well, we have to be that forward looking community. Forty percent of our guests come from America so we want to make sure that we're not only good neighbors but we also have the experience that will be replicated not only in Michigan but across North America and that's what we're striving for. Some of the interesting things we found along the way is that there really is no playbook on this, we've just started to put some infrastructure in and sometimes unintended consequences. And when we first put the ubiquitous Wi-Fi network in it was to backhaul smart meter data for our electric utility to keep in compliance with Ontario regulation. I can tell you they paid for that through the energy rates but that is just the tip of the iceberg to what we are going to actually do as it comes to connected and autonomous cars and other network opportunities. I think what you're going to see over the next number of years in Stratford, five to be exact as the province announces next week, that you'll start to see more companies come to our community. We've actually been to the American Center for Mobility and Susan Proctor here and Kevin were great hosts for us there last year in April or earlier this year I should say. And we have actually started to look at how we could cooperate fully work together between our demonstration and test facility and the two in Michigan. We've also been able to attract some international investment so Renesas, of course, is a Japanese company, largest ship manufacturer for automobiles based in Tokyo but has an office in actually in Michigan; research office and and sales. Has actually taken over and built a four acre test track in Stratford and they opened it just six weeks ago and we are starting to work with them and other companies that are involved in the infotainment and sensor systems within the automobile to define how we are going to actually do the testing in Stratford. We've looked at everything from unmanned snowplows on the streets, to unmanned buses, and to look at the city's own fleet and how we could try to do some of these things. And I think the only reason we're really striving to do this is because we want to stay relevant. Most communities and I think

if anyone knows that Michigan who has had its fair of ups and downs but always comes back stronger than the time before, and we're seeing that now. We want to be that resurgent story that we're not the small community that people forgot and that technology will play a part in how we define ourselves going forward. And I look forward to the collaboration that we're going to have between not only our government but also our community and the work that's being done in Michigan. I think Michigan has really set the gold standard right now for many of us and we're just happy to work with you and look forward to hearing more about the panel but also how we can collaborate to make this a very productive relationship cross border and it's just not about the Red Wings winning the cup. It's about actually bringing jobs and protecting automotive investment in Michigan and Ontario so thanks so much.

[02:03:34]

Kirk Steudle: Thanks Mr. Mayor. OK so we're going to roll the dice through the next. All right Huei Peng, you're up. The director of Mcity is going to tell us a bit about the the first autonomous asset in the state of Michigan so Huei Peng.

[02:04:03]

Dr. Huei Peng: Thank you Kirk. Mcity test facility opened in July 2015. We have accumulated more than 2,400 hours of testing of connected and automated vehicles. So if you are here to find out who started the arms race of building connected automated vehicles look no further than blaming Governor Snyder, Kirk and University of Michigan for doing that. OK So Mcity is not just operating Mcity test facility. It's actually a public-private partnership. We focus on research and development deployment and removing barriers for a sustainable ecosystem of connected automated vehicles. Under the support from the state and our leadership circle companies and affiliate members; we have sixty five strong companies supporting our activities. We operate a lab, so we call Mcity test facility a laboratory. We call the city of Ann Arbor a with the connected environment, a living laboratory. We also support research; we also engage in education and outreach activities. So, here's a quick view of the Mcity test facility so I would like to argue that the arms race for civil engineering has finished and now the race for electrical engineering, mechanical, automotive control engineering, artificial intelligence has started. So, if you look at the Mcity test facility, yes, we designed it to have reach urban highway test environment. But also it's important to note that it has been model into popular simulation software you already saw a picture of pre-scan model of Mcity. We also have been modeling another very popular software and we are working with another software company to have Mcity included in another software environment. We have connecting infrastructure; we have eight *acronym* supporting 802.11P and news about other capability will be forthcoming. Also, it's important that we develop our own so-called open CAV. The reason we call that open is because we hope these vehicles with muscles and sensors, eyes and ears, are able to be available for our students and professors so that they can put in their brain software localization and their perception decision software in those vehicles. We are also pushing for possibly making our software environment open like Android system so that's working in progress. Mcity also has its own traffic control center,

interestingly the city of Ann Arbor doesn't have a traffic control center but Mcity has a traffic control center. We are developing augmented reality capabilities so that we don't need to really use dozens or hundreds of real vehicles and many of these vehicles can be simulated in Mcity and we are deploying driverless shadow, the learning experience there I think can be shared with all Mcity members. So this is a very busy chart but I'll lay the features of Mcity I guess. This is on the website for several years so I guess many of you must have a seeing a copy of this. So, what happened inside the Mcity test facility he saw over the last more than two years 2,400 hours of testing. Many of our company members come to test their autonomous vehicles or connect the end automated vehicle capabilities; pedestrians, bicycle, driving in snow. Also, you can see video clips showing the two software CarSync and copy of Mcity. So this is a typical day of testing, so this is again has been a beautiful fall day. I think about a year ago a company coming with many cars and you can see Mcity is all fenced and people typically coming with multiple vehicles [and] they study the interaction between autonomous vehicles and pedestrians, bicycles, and so forth. We also develop our own open CAV. So it is very important to recognize that car doesn't just crash in the test track. It is where it is challenged with other vehicles so the other vehicles are posing challenge to highly automated vehicles and what we plan to do is we are developing our own instrument, not only for research, but they will serve as precisely controllable challenging vehicles making dangerous lane changes at the intersection. Just similar to what has been shown at AstaZero. Vehicles will need to be precisely controlled to come across the intersection interacting with the AV being tested.

Yes I have to show video, too. We can see autonomous driving. We can see that our vehicle has visualized, so it will detect the traffic signal status and stop for a red light. And you also see the interaction with simulated BSM so the dots that you are seeing, they are not real people so the vehicle will stop for red signal or start going for a green light. We also in the next intersection see another vehicle running a red light. And this is a crash avoided because of DSRC. Obviously doing this kind of experiment is somewhat risky and time consuming so what we do is we also demonstrate the fact we can do this red light running intersection motion assist function testing using simulation. So, we are not really running a vehicle running a red light but a simulated vehicle running a red light. This is our traffic control center so you can see that you can monitor the status in Mcity this is of course all the equipment technology provided by Mcity members in particular I recognize Econolite. So this is basically the architecture of broadcasting simulated BSM. So we will be running a traffic simulation software simulating dozens or hundreds of vehicles in the Mcity test facility and the roadside unit will play the role of OB unit simulating those BSM signals. And this is another video just in this time you can see the video of autonomous vehicle driving in an empty Mcity test facility but in the virtual world you see dozens of vehicles. So, this is so much cheaper, faster and safer to do things in a simulated world and we are now working not only faking BSM. we're working with companies to fake simulated sensor signals. Mcity also wants to deploy level four autonomous vehicles on the road so with our government passing all the these CAV bills allowing Michigan to be one of the most forward looking states that has law that balances between safety and innovation; why not taking advantage of that? So, we are actually

this week we are testing Navya shuttle on north campus with all riders we want to make sure that every seems fine before we take riders but they are being tested outside of Mcity on North campus of U of M and what will happen is maybe by that March, if I put something reasonably conservative, March also of 2018 if you come to U of M campus you'll see these two Navya shuttles running and they may be taking riders at that time. Alright, thank you. So, that's the end of my presentation; thank you very much.

[02:13:25]

Kirk Steudle: Alright I think Huei gave it away. Next up is Habib Shamskhou. Right, I mispronounced that, I have a name that is the same way; apologize for that. Habib. He's from GoMentum Station in California.

[02:13:45]

Habib Shamskhou: Thank you, thank you, thank you for your California joke. I will save my Michigan joke then all of you come to California and you are all invited March 29th to come to California and on the serious note for a change we are going to have Jerry Brown in our program for fifteen minutes and he's going to deliver a lot of jokes. I make sure that they include the Michigan joke, as well. So I'm the co-founder and program director of the GoMentum Station facility in Northern California. We are also one of the designated US DOT proving grounds among others; the other nine are here. So GoMentum station is a 5,000 acre facility and our vision is to build a connected vehicle autonomous center where the convergence of technology and innovation take place in one of the largest testbed in the world, but in fact what separates us from the crowd, we are trying even in short term, meaning in next ten years or so, address some of our serious congestion problems in Northern California specifically in Contra Costa County. We are losing too many people, 45,000 in North America is very too many people that we're losing per year and 130 billion dollars in lost productivity. Huge number, this is the problem that we are trying to solve specifically by this program. So, as I said this is a 5,000 acre facility with twenty miles of the existing roadway, tunnels, bridges all kind of the environmental condition which is going to, which it costs about 100 million dollars to replicate. We are about forty five minutes north of, north east, of the San Francisco. That makes it highly desirable for the companies in Silicon Valley to test over there. And we are multi-modal so we have got the Honda auto truck is testing at our facility. We do have *inaudible,* we just announced Toyota yesterday and our FCA announcement comes next. We have maxed out in number of car manufacturers that they could test at our facility but we are in negotiations with the city of Concord and Navy to add additional as we have a high demand for testing facility. We also have got the easy that completed testing at our facility and now we have moved it to the real world scenario in the bishop ranch. So what is GoMentum Station? When I heard the governor talking this morning, I wish he were here, I thought he actually wrote our strategic plan, a vision a statement. Everything that he said it was a music in my ears. It is a platform for transforming the future and redefining the mobility, our motto is collaboration and facilitation with everybody on the board and we will deal with all of the C.V. applications and we have beside the test facility, we have ten different projects in their real world hat have a demonstration project. Obviously like any other facilities testing out research, center for innovation, and the largest one of the largest test bed in the world. So macro

environment that we work at the GoMentum Station includes our entire program. It covers practically all of the issue; we inherited all this issue from the time of the automated highway system consortium, AHS-era. We deal with all the technologies, all the application, and we work with all the influence from the private sector to public sector in the industry. So, we have a very large ecosystem. We are in discussion collaboration and some agreed of the 160 different entities in a short period of time of our existence which is about two and a half to three years that we exist. We are a very young nonprofit, a startup, like your facility here in Michigan but because of our close vicinity to Silicon Valley where all the research activities, for whatever reason, that our talents are there that is taking place over there that it is highly desired by all these startup companies to all 800 pound gorillas in the marketplace that they wanted to test at our facility. We have several announcement that you should expect to hear in the next couple of months with the major companies and as we speak, as I said that there are six companies testing at our facility. I know we are also are an international entity so we think this only can be happening in collaboration with our international partners learning from the European experience, Asian experience, and just yesterday we have an announcement for country agreement with Singapore, Australia, and New Zealand because we have got the similar demonstration project that they are interested in our activities. I will talk in a moment about that there, but these are the countries that now we have a signed agreement with them. From here I'm heading to Denmark and Netherlands, then there's Japan and we want to sign agreements with Denmark in the near future or so. And we are expanding our international partnership as we go along. So, having said that as I said that we have about ten demonstration projects in their real world outside our facility. So, one of the, I'm just going to talk about one of our notable projects, is our first mile, last mile project; this is our own project so we brought for the first time two of the EasyMile cars fourteen months ago and many, many other jurisdiction follow suit after that and this is a seven million dollar demonstration project that is well advanced into the third phase. So, we just received the NHTSA approval in order to be able to test on the public road and then we are about to get our DMV license plate to test it in their public road. This is a true collaboration between the public sector and the private sector. So, we've got the several private sector entities that are contributing to this demonstration project. Stantec, which is my company, EasyMile is contributing to what this program. First Transit is the operator of the units and they are also giving us the free insurance for this trip [to] LA. We just added and had an announcement with them lately EasyMile is providing the software and more importantly the owner of the business part is contributing to this programs. Our public sector entity they all are contributing differently to this program. Every one of them for different goals and objectives. Obviously, Contra Costa County Transportation has to address the issue of the mobility and congestion in our most congested corridor. BART, or Bay Area Rapid Transit, contributing because they've got a parking problem at their stations that they cannot add the patronage. Bay Area Air Quality Management district they are contributing a couple of million dollars to our demonstration project because our project is a green project and save, reduce their emissions. Now we are adding *inaudible* connection and San Francisco Transportation Authority. With that said we are just, as I said this is a real project, we want to go implementation 2019, 2020 and deploy 150 of these throughout the county. Again we just want to address the key problem which is transit accessibility with this

pilot project. Having said that I want to invite all of you to join us at our fourth annual redefining mobility summit at the Bishop Ranch on March 29th, Thank you.

[02:23:33]

Kirk Steudle: Habib, thank you. All right so we need to reload John's presentation so I'll bring the IT folks up here to do that and in the meantime we'll move the microphone over here and you can just chat from here. John Barton, from Texas A&M, and those of you that were at the opening ceremony you heard John do the plenary discussion and he's got some great things going on in Texas. I'm looking forward to that, as well.

[02:24:03]

John Barton: Thank you Kirk. So, I appreciate the opportunity to be here with you, bonjour, or as we say in Texas, Howdy. As Kirk mentioned, I currently am employed with the Texas A&M university system as an Associate Vice Chancellor overseeing the development of the RELLIS campus. And as most of you that might have worked with Texas A&M in the past know, tradition is important to us and we name everything after some famous military hero; and so I'm often asked, Governor Snyder, who is General Rellis? And the answer is well there is no such human, RELLIS is an acronym for the six core values that we at Texas A&M embody and I think that most of us in this room do, as well. Which are respect, excellence, leadership, loyalty, integrity, and selfless service. And so, it's just an acronym to remind us how important it is for us to understand who we are and the things that we embody each and every day. I think as Habib mentioned the reason that most of us are involved in this is not only to improve the mobility of our growing metropolitan areas and to increase efficiency of the transport of people and products across the globe, but it's to save lives and that's really why all of us are inspired and motivated to get up each and every morning to take advantage of an opportunity to be involved in this. Governor Snyder, honestly, we at Texas A&M I retired after thirty years with the Texas Department of Transportation and I was asked to come to work at Texas A and M to try to help to form a collaborative environment that would be value added and supplemental to the great things going on in the great state of Michigan. Director Steudle and his team, John Maddox, others we've had a great working relationship with for many, many years in the Texas A&M Transportation Institute and the A&M system, at large. We wanted to continue to build upon that. And so, I came on board in January of 2016. Our chancellor, also John, counts things in dog days and so he said let's get started; let's find a way to build upon the proving grounds and test beds that we already had at the Texas A&M. University system to enable the same types of technologies and innovations and solutions that many of you are involved with. We're also very fortunate to have been designated as part of one of the U.S. Department of Transportation's Autonomous Vehicle Proving Grounds. John Maddox mentioned that earlier and showed those locations across the United States. Ours happens to be a multi-institutional proving grounds and not only involves the RELLIS campus that I'll show a video on in just a few minutes to share with you some of the things that we're doing there, but also includes the Southwest Research Institute in San Antonio, the

University of Texas in Austin Texas, and about thirty four communities all across the state of Texas; where we can take technologies and improve them in a controlled environment on these proving grounds and test beds and then deploy them into real world policy all across the state of Texas. We are very proud of the partnerships that we've enjoyed with all of the presenters so far and Matheson I look forward to continue to be able to explore how we can help collaborate with the great things you're doing there in Stratford, in partnership with the great state of Michigan. We're excited about that. Our proving ground is focused in, just like all of the other presenters have shared, on helping do three things that are important to all of us, but in a university environment. They are slightly different than the way John Maddox mentioned it but it is to do education, research, and service. And so that's if you think about it that's really you know testing standards and education. The RELLIS campus, and the video will describe some of the things we're doing there, is a 2,000 acre property. It is in Brian College Station near our Texas A&M university campus in College Station which is home to 68,000 students about 18,000 of them are engineering students it's one of the largest engineering colleges in the United States of America. And it was an old army air base commissioned in the 1940s to train pilots for World War II and then the Korean War. Texas A&M. took it over in 1962 and has been using it since then to do crash testing, innovations, product development, technology development. And in May of 2016 our chancellor said we've got to do what we can to be a partner with people Governor Snyder in the state of Michigan. So, let's think about how we can develop this campus, and he's cobbled together a commitment of about 350 million dollars to redevelop this campus. We'll be opening up our first new facility at the campus about the same time that John is opening up the facilities at ACM. in December of 2017. We started construction on it just a few months back, it seems a long time ago, but it was in October of 2016. It's an infrastructure renewal and resiliency lab. And we're building out not only our proving grounds but also research facilities to help support those things so that all of our academic investments and interest can be involved that our public and private sector partners can be involved, as well. It will be home to about 25,000 college students that are seeking degrees from all eleven Texas A&M. University institutes across the State of Texas as well as Doha, Qatar. So, it's collaborative research in education environment focused on product development, technology, testing evaluation, and demonstration, education, and workforce development. So, let me play this video and then anything else I would say would be duplicative of what has already been shared by the other panelists. And then we'll get started with the rest of the session. *starts video*

[02:29:40]

Video: The Texas A&M University system is creating America's newest epicenter of innovation the RELLIS campus, close to major metropolitan areas in minutes from a tier one research institution, Texas A&M University. Located on 2,000 acres RELLIS will be home to two education centers and seven new engineering research and laboratory facilities including the state headquarters for the Texas A&M Transportation Institute; the largest education-related transportation research institution in the US, and the Texas A&M Engineering Experiment Station. With more than 300 million invested, the campus will house university and industry

research labs, testing grounds, and rapid prototyping facilities, as well as workforce training in two and four year degree educational facilities. We know the transportation challenge before us. America's population is growing faster than the infrastructure we rely on, making our transportation system work more efficiently, smarter not just harder, is essential and we have already started. TTI and T has led the way in making autonomous vehicles safer, smarter, and more efficient. Texas A&M Engineering has developed a fleet of light duty vehicles buses and heavy duty trucks to test different levels of automation and interaction with infrastructure on and around RELLIS campus TTI is leading a research project to develop pavement marking criteria that will provide reliable detection within vehicle camera systems. The results will help agencies to maintain highways to a level that provides reliable machine vision detection. Without it, automated and connected vehicles become less effective and less safe. Our research is trying to reduce the risk of wrong way drivers by developing a detection and warning system that alerts both drivers as well as the nearest law enforcement officer. With RELLIS expansive proving grounds TTI has created a first of its kind comprehensive freight platooning demonstration in Texas. The study demonstrates the safety benefits and fuel savings that can be achieved by adding automation to platoons of freight trucks. Finally, with connecting and automated vehicles moving closer to reality can signalized traffic intersections be made safer through communications between vehicles and the controller? By integrating real connected vehicles communicating wirelessly with realistic traffic simulations, TTI researchers and partners have developed an innovative testing environment. The potential of combining our proven track record in transportation research, and the state of the art facilities at RELLIS campus, is quickly being recognized. The private sector has responded. *Companies* and Western dairy transporter already participating at RELLIS, or have confirmed future participation. The federal government has responded; the U.S. Department of Transportation has designated Texas as an automated vehicle proving ground. That partnership includes the Texas Department of Transportation, the Texas A&M Transportation Institute, the University of Texas at Austin Center for Transportation Research, Southwest Research Institute, and more than two dozen municipal and regional partners. Research and testing at RELLIS will be instrumental to the partnership success. And the state of Texas has responded with the Center for Infrastructure Renewal. A 73 million dollar facility that will allow researchers to develop advanced and sustainable materials and structural systems to reduce cost and extend infrastructure life, safety, resiliency and durability. Other facilities are being built at RELLIS to focus on robotics, cyber security, and industrial distribution, to name just a few. A state of the art data center is in the works. RELLIS is already more than a fourth of the way through its initial four year construction phase. Our transportation system is on the precipice of great change. The technological innovation coming out of RELLIS will test our imaginations, and at times disrupt our daily habits. There is no place better equipped, no experts better qualified, and no organization more committed to defining the future of intelligent transportation then RELLIS. Come see for yourself. Thank. You.

[02:33:36]

Kirk Steudle: Well all of you, that was tremendous I got to tell you. I've been in this area a lot and frankly I learned a lot in the last hour about what all of you are doing, which is frankly the reason this whole session was put together. So, we're going to have just a little, we've got about less than ten minutes or so, and I'm kind of behind you, so I'm going to be lofting questions behind you that... Oh, we can run another ten minutes. Kevin just gave us permission to push your lunch off ten minutes. Kevin did that. OK but, clearly place the blame on Kevin. All right so question cards.

[02:34:25]

Kirk Steudle: So let's start with, this is an easy one so I want all of you to remember our time constraint so don't get too windy me to get to the point so this whole symposium is about collaboration and your presentations, I think everybody learned a lot about what's happening .What do you each of you think what should be the next steps in collaboration and whoever wants to go first, or give everybody a chance, whoever's got the microphone. What's the next steps in collaboration? What should we do next? Don't all speak at once.

[02:34:55]

Dan Mathieson: What I would say is we should develop an inventory of what we're all doing. Make sure that we don't double up on the same research in two different places and make sure we share all the data points that come out of the research we do and then on a quarterly or semiannual basis re-evaluate and see how we're moving the yardsticks.

[02:35:15]

John Barton: But I would just add what the mayor mentioned that in our conversations with a lot of the private and public sector partners that are working with all of us they're interested in how these different test beds can be additive rather than duplicative. How they can take what their investments are here and M-Planet and leverage them against you said, GoMentum or at the RELLIS campus, at VTTI, or other places and so in addition to that inventory I think we need to work together to convene those research and private sector partners and find out how we can take advantage of what they want and leverage it with the collective assets that we all have.

[02:35:52]

Dr. Huei Peng: So Mcity has identified removing the barriers of an affordable, sustainable connected and automated vehicle technology as a key area so we can remove barriers easier together.

[02:36:11]

John Maddox: I think really I talked a little bit earlier but a common data structure. If you're a product developer or an OEM or maybe a communications company, you want you need, to go visit, to go do your work in many different facilities. You don't want to have to recreate the data wheel every time you go, in fact you might even want to drive from one facility to another from Texas to Michigan to Stratford and so having a common data, at least a common data format and common data basic set, will go a long way towards accelerating the technology and safely.

[02:36:46]

Habib Shamskhou: I've been in this particular subject for over twenty years and I heard this collaboration, collaboration all the time. I think we are way too far apart if in the private sector and public sector we need to get a lot closer. And I give you just one quick example 80% of the companies that I've work with in Silicon Valley, they never heard of ITS.

[02:37:13]

Kirk Steudle: So I have one to offer for you, every one of you talked about some significant date you have in the next six, eight months. We ought to have a common one and when you have your openings you all ought to be at each other's openings. Here's what's going on, that talk about showing collaboration, you know whoever's there. You know look, here's your partners from across the the U.S. and Canada. So this is a question as I look out here there are some tremendous leaders and some thought leaders and some technical minds; some of the best in the world. So, how do you all take advantage of their expertise? How did they all get engaged with all of you and again, collectively, how would we do that so thoughts from any of you.

[02:38:02]

Habib Shamskhou: The best way is that the way that we started our our strategy, vision and a strategy to plan to be 100 percent in closer. So, we are to facilitate everything that we do, all other facility every entity that want to come and collaborate with us and work with us and moving forward, That's just the first sentence of our strategic plan that is hundred percent inclusive. GoMentum station it does but it doesn't belong to Contra Costa County in Northern California, It belongs to America, it belong to entire world and we welcome whoever wants to come and collaborate.

[02:38:46]

John Barton: I would add that in addition to that the one thing that we all have in common is this interest and I say Mission Statement to do education and so workforce development or our education or K-12 are all things that we're very interested in. And this group of professionals and

technical experts can help inform what that workforce development that K-12 STEM program, our education program ought to be can help develop the content. And in doing that can help us better build out the testing grounds and proving ground facilities that would be value-added to their industry so I think an easy tactical way is to collaboratively work on some of this education content.

[02:39:29]

John Maddox: And I would add, you know there are a lot of players in this area; developing automated vehicles, developing facilities. We've tried to reach out to as many. We also have open an open door approach. Our facility will be used by everyone, all comers will be able to to use our facility for testing but that's just the one pillar. Then there's standards and education. So, we reached out where we know others are working and and that's not a full, it's not a complete set, yet. There is so much activity, there's not one organization that can really try to corral it all. You know, perhaps, an outcome of this discussion could be a beginning of a continued awareness and that that will breed us, that will that will breed working together

[02:40:18]

Kirk Steudle: So, so I'm going to, and I know you probably both have a question but I want to throw in another question, we're going to get a couple of questions. So, here's here's a real funny one. So, the three hundred pound gorilla in the middle middle of the room is we're all talking about collaboration. Well how do we, this is a question from somebody, everybody preaches the virtues of cooperation... how do you balance that with the inherent sense of competition? How do you do that?

[02:40:45]

Dan Mathieson: Well it's co-operative and I think is the first thing we've agreed on a number of things. First of all, we have an agreement in Michigan and Ontario. It's not going to reach its potential until we actually sit down and understand it. NAFTA is a good example and I think that's a little under threat but we've been able to link our industries together, collectively, and we have to find a way to do it I think. To be quite honest there's so many goods that passed across the border in Michigan and Ontario, in unfinished value added state, going back and forth. It behooves us to make sure that we start working on that and I think that's what we may be lost in this. And I think we need to take the same partnership using the OEMs and of course the and the manufacturers to to talk to us and figure out how we do it. And I think that's what we're missing probably is a holistic approach with industry. I call it the triple helix. Government, business, and academia together figure out how to do it.

[02:41:39]

Kirk Steudle: Very well. One person wanna add something in? Anybody?

[02:41:41]

John Maddox: I'll add one thing which is a little bit of a competition is not a bad thing. The technology is moving so fast the facilities, our efforts need to move fast. Now I mean you know, I come from both an industry and government and academic background. There's always competition, even certainly it's tightest amongst the industrial players, but it's really there amongst every, I guess, bottom line is you know we need to move fast. Competition will help us do that but really we need to solve the problem and so if we can get after we move fast we come back together to figure out the best way to collaborate. I like the idea not building two of the same thing or unless there are different ones in the hot area ones and cold areas. That's actually helpful.

[02:42:23]

Kirk Steudle: So, here's another question. How do you protect the data from the private sector? You know, your partners that are working with you how do you protect that data. What of that data becomes common that you share. I mean as I sat in many of your leadership team meetings I think about how do you do that? Anybody got a, who's got the silver bullet for that?

[02:42:49]

Dr. Huei Peng: So so in terms of autonomous vehicles, we think the autonomous vehicle is probably somewhat sensitive. A lot of companies want to protect something there, but if we're talking about the behavior of data or behavior or data for other vehicles or from pedestrians or from bicycles, there's no confidentiality and sharing of those information will be beneficial.

[02:43:19]

Dan Mathieson : One of the things I've stressed is that IP, intellectual property and proprietary data for the companies involved, they have to be able to protect it, but anything outside of that I think needs to go into a data cooperative. I think the only way cities are going to be able to afford, governments are going to build afford to pay for this, going forward is if that data goes into a cooperative and there's a royalty stream, sort of people take it off of there, then there's an opportunity for them to share in whatever commercialization happens and it helps us keep the infrastructure fresh. Remember when I talk about roads, we build one every forty years and you maintain potholes, we're talking about data collectors, sensors, which will turn a life cycle of five to seven years pretty quickly. And we can't keep up the infrastructure we have now, so I don't think we can turn away an opportunity to find a way to revenue, turn this into revenue.

[02:44:06]

Kirk Steudle: So what's the biggest challenge, Mr. Mayor, this may be for you. What's the biggest challenge to true international consistency of regulations? And that's really going to lead to another question here, and regulations on a follow up. Mr. Mayor, what do you think?

[02:44:19]

Dan Mathieson : well I think what we need to probably do is take the framework we have between some of the agreements already on safety standards and try to find a way to actually turn them into data standards, as well. And to make sure that we except those early on between the partners and the regulatory bodies that are in fact whether it's U.S. D.O.T. or the Department of Transport in Canada, or down into the state-provincial level here. I think we have the opportunity to actually have a bilateral agreement and I think we start with North America and we build our way out.

[02:44:51]

John Maddox: I would add to that also, having been a regulator myself, regulators are people too. But really, we have a golden opportunity. The real, the real thing that inhibits cross border harmonization is the fact that there's already an existing standard in a given country, it makes it very hard to change that standard. Now is the golden opportunity; the standards are not yet created. So now's the time, if it's ever going to work, it's going to have to work now.

[02:45:21]

Kirk Steudle: All right so I got one last question and this is a round robin, fast. What are you doing for UAVs and freight? We've talked a lot about cars. What do UAVs and freight.

[02:45:33]

John Barton: So at Texas A and M we're spending a lot of time exploring the benefits of UAVs for all kinds of data collection. Most recently in the wake of Hurricane Harvey and how we can understand what happened and how we can understand how to rebuild better. In freight you saw the truck turning, it wasn't really platooning in the front vehicle was driven by an operator. The second vehicle was autonomous. So it's really more freight shuttling. And then we have created the freight shuttle system which is an induction motor-driven rail-guided system that we believe will be revolutionary in terms of moving containerized freight from ports to other locations, and taking that traffic off our roadways.

[02:46:12]

John Maddox: We are very aggressively looking at UAV operation over our site. We believe that's a that's a key component of future transportation to do that. We are luckily and unluckily directly next door to a very active airport. The lucky, unlucky side, of course, that there are prohibitions on operating UAVs within X miles of an airport. However, those have changed recently. The opportunity is that we are working with the airport. We have a company at Willow Run literally, our direct suite neighbor who builds drones, programs drones, operates drones at Willow Run and they fly them in Madagascar and other places. That 'll tell you about our regulatory structure, right there. That's right, I just last night, we were, we actually have a map of where the FAA will allow us to operate now. So, we're getting very, very close.

Dan Mathieson: To be quite candid we're not trying to be all things, to all people. We're in the connected and autonomous vehicle space. We're going to look at how we can do it with snowplows and others. The connected corridor and the highway 407 ringing the top of Toronto is looking to be a connected route that would be great for fleet vehicles. And as far as for drones, or UAVs, the Department of Transport Canada is working on pilots but they won't be taking part in Stratford. They'll be in other centers.

[02:47:29]

Dr. Huei Peng: So, Mcity studies connected and automated vehicles, moving people, and freight. So, we are not excluding freight or trucks or drones. However, the focus is ground vehicles at this moment due to the membership. University of Michigan is also building an M-Air similar to Mcity to test drones.

[02:47:50]

Habib Shamskhou: So, in order for us to be successful we have to predict a little bit about the future what the future holds. We are very bullish about the early winter, It's going to be truck that's why we have that auto truck testing of that facility. Both platooning, as well as an autonomous and we'll also adding the second trucking company that is going to test out of our facility and we are opening up also a highway if we get that legislation passed to do the testing in California. UAV leave it to others because we think that then we can find a lot from Aberdeen and major site that are active in that market.

[02:48:33]

Kirk Steudle: Great, so here's the last question. This is a one word answer for each of you and we're going to move on to lunch. When is the first time you're going to drive in or ride in a non-demonstration CAV. Level five; So, OK, so level four. All right so let's say Level four. All right. We'll qualify level four, what year; what year if you want to get to a specific date that'd be cool, too.

But when and just and if you could just give me a year, you just round robin, you don't have to qualify it.

Habib Shamskhou: Yes, I think we are fifteen years away.

Dr. Huei Peng: So, I signed up to test Navya vehicle this week, so Thursday, I will riding.

Kirk Steudle: Is that non-test mode? Non-demonstration mode.

Dr. Huei Peng: March next year.

Dan Mathieson: 2030

John Maddox: 2018, low speed, urban.

John Barton: 2025.

Kirk Steudle: All right, with that we're going to go to lunch and I think our keynote speakers at the back ready to lead us into lunch, Kevin, thank you.

Kevin Kerrigan: Thank you everyone that was actually awesome.

[02:49:55]

Kevin Kerrigan: So, if everyone could take a seat we're going to start the afternoon sessions. Thank you. So our panel after the lunch is called future technology: what happens next? We thought that it would be good to take a break from the exciting world of policy, regulation and standards and talk about some technology. And so we have a great panel here today. We've got three industry experts and we're going to have each one of those folks come up and make a presentation then we'll do some questions and answers. So please start putting together your questions. We're going to do this a little bit differently than in the morning we more audience-based interaction. So, our first speaker is Dr. David Atkinson from Continental. David is the head of systems and technology and chief research scientist for artificial intelligence Continental Automotive. He works principally at the company's Silicon Valley research and development center Before joining Continental, David worked at the Florida Institute for Human and Machine Cognition where he lead projects in the area of trustworthy autonomous autonomous robotic systems. He also spent twenty years at NASA where he founded the agency's artificial intelligence program and made significant contributions to spacecraft autonomy, planetary exploration robotics, and spacecraft control center automation. In recognition, NASA awarded Dr. Atkinson the exceptional service medal so please give a round of applause to talk to David Atkinson.

[02:51:50]

Dr. David Atkinson: So first let me just qualify that title there. Continental's a huge company. And so I work for, my boss is the head of systems and technology for North America in the Chassis and Safety Division. My purview extends in the western part of the United States and also to our disruptive Mobility Group customers. So that's just, it doesn't make it any less important what

I'm going to tell you but don't think I run the show. OK so this morning was really excellent; lots of good questions. I know there were some particular points I'm going to try to adapt my remarks to things that Governor Snyder said and a few others that came up. First let me introduce Continental though. We're a global company; fifty four countries; 192 facilities; roughly a quarter million employees; 43 billion dollars a year in business. We make parts. If you go out in the parking lo, or in the street probably, nine out of ten cars that you see will have Continental parts. They won't have the same parts but they all have some of our parts

And therein lies one of the challenges that we have here is that our parts are used by lots of different automobile manufacturers to deliver in future intelligent behaviors and so we have, one of our challenges is understanding the contribution that our part of radar perhaps contributes to the overall behavior of the vehicle and depending on the manufacturer they may want more or less intelligence in that sensor itself so our radar, for example, can output a list of targets their distances, their bearings, their speed. It doesn't have to be a radar image. Other companies want the radar image, same for our cameras, same for our Lidar. There's lots of variation not only in what we make for any company but how they're using it right now because Continental is focused on parts, all, much of our automation artificial intelligence is pushed into the level of the components. So that's an important consideration. We've talked a lot about test tracks; we've talked about simulation, about scenarios but the real world is messy It's very messy, OK? And we always have this question, how can we capture enough of that dynamic nature of the world so that we understand that our intelligence vehicles can deal with the uncertainty that comes from that that variation. We're also going into a new realm where we have different modes of control, shared control, co-driving between the vehicle and the driver. And that is going to be huge for overall performance so this is how our strategy works right now. I'm going to use the acronym automated driving; it's a sign of how new this industry is, that everybody has slightly different acronyms on their charts but I'll talk about automated driving. So as I said many functional variations, many different kinds of requirements our focus is on the holistic ecosystem of automated driving and we want to prepare our parts and be ready for all the different ways that they're going to be used. And that's pretty hard to imagine, right. If you look back at the origins of the smartphone. Who could imagine all the things you can do with a smartphone so we can only our imagination only go so far. So, the other factor that really affects us is that our strategy has to dovetail with our customer processes and we also have to do that in a way that, of course, meets the the regulation, the rules or the expectations of the domains in which they're going to be used. So, we build that basic level here on good systems engineering; drawing on the safety reference and the requirements that come from multinational safety boards. Multi meaning they all have a different one, not that they're shared, but in Europe especially. And that's where a lot of the focus is and the independent sensor technology. We've talked about the field operational tests; the objective there is analytic objective proof and the scenario-based. We don't really know what the envelope is for the behavior, the constant, having confidence in the behavior of the intelligent vehicles. So, we have to be creative and try to identify the edge cases and we believe we have a methodology for do doing that. The final aspect of our strategy is how we introduce this technology and I'll tell you a little more about that. So, following up on the scenario test coverage. There, for the scenario based right now, I don't know of any and if I did I probably

couldn't, it would be us, and I couldn't tell you but it's all done by hand; it's manually driven by experts. What kinds of scenarios are likely to break this particular kind of automation? Variations in weather, variations in street geometry, variations in traffic patterns; imagine all the different factors that you can and if I handed you the list you would say well that you missed these and someone else would say well you've missed these, and the point is you can go on all day, for a long time, without repeating yourself coming up with challenging cases. And if you think about it, given that the world is uncertain and constantly changing, we can see there are realistically near-infinite number of potential scenarios where we wanna know will the machine do the right thing? Will make the right decision? Will it not do something dumb? Another challenge we have: data; massive floods of data, not just from the sensors but from all of the telematics, the engineering on the vehicle. From our testing we might add special harnesses. For example, telemeter new types of sensor data. What is the most relevant for testing the behavioral side, the intelligence side, of the V&V. I think we know how to do vehicles, non-automated vehicles or modestly, OK you know, assisted braking. We know how to do those kinds of things but how do we use this data now to evaluate behavior? That's come up earlier today. So what we know from working in this technology area is that features are really important. What do you pay attention to in the environment? The fact that that panel truck is purple doesn't matter. The fact that that panel truck is halfway through the intersection does matter. There are infinite number of features. So, we have to do two things: we have to say what's ones are really important. Some of those will be chosen manually because if there's you know that they're sort of obvious these geometrical ones. Other ones we don't really know. There's sort of the features that you as an experienced driver feel in your gut that says this is getting to be a risky, high threat traffic situation. You know, that truck is a little too close. So, there are these knowledge based implications of features and we may not know them all but we have the vehicle that has to know as many as possible. So, we need to have the right kinds of sensors in the right combinations mounted on the vehicle in the right way, collected in the right way, processed in the right way, that we Continental can say, with confidence, yes you can detect those features of a situation that lets you distinguish what's going on and what you need to do. So, moving on to the introduction part. Certainly some risk, and uncertainty. So part of our approach we call shadow mode. So we may have this level two automation which will be what is advertised and sold but the capabilities for level three and level four will be there in the software, in the hardware, but they'll work quietly on a non-intervening basis and serve over time to give us data on how well they're performing. We collect data during regular maintenance checks and so forth. So, they're none interfering but nevertheless they're actually there; not the driving part. That would give us some confidence. That's step one. Probably use that with whatever comes from the cruising chauffeur project, for example. To manage uncertainty we have these, what is it again. It's a new new acronym for me, the operational design domain, is that it, OK yeah? I think of it as an envelope. Here is the use case. Everything inside that envelope is OK, and then outside that envelope... no guarantees. You know, we don't know how it's going to work so we have to, we have to make sure we understand how to define those boundaries. And how to bound them in a way that lets us have very conservative statements as possible about the behavior of the vehicle within that boundary The odd thing about, I think, about intelligent systems, artificial intelligence

is they tend, it tends to be brittle at the edges. They don't fail gracefully in many cases. An AI will be very happy giving you an answer for something it's not competent, yet. So as you come up to the level of its competence things are fine, fine, fine and then broken. OK, so there are other things you need to add to give you that confidence and then we have to bound those envelopes in a way that lets us give the hard numbers that are required by these national acceptance principles. So, for the future this is what keeps me up at night. And hopefully you'll start worrying about some of these, too. Safe driving I mean we heard this at lunch, too; I hate going late. So, so we're entering these this new era of different driving modes. Automatic driving on the highway, manual off the highway. Maybe a dual driving. I mean, when people, when I press the brakes right now in my vehicle I may only go up, even in emergency situation, only go up to sixty percent of the braking power of the vehicle. But the brakes are smart enough now, and they know, the brakes know, our brakes know; I don't know about the competitors. If you are pushing the brake fast, it's an emergency stop but people never go beyond sixty percent, so the system automatically goes the rest of the distance; gives you the maximum braking power. So, I think of that as a case of co-driving. Who has authority to do what in the vehicle, and right now that balance shifts between equipment and human. And it will continue to shift and I don't think we'll get clear answer for quite some time either. We need to enforce this operational design domain. We need to have an ability in the vehicle to detect when it is getting near the limits. Now if it's a geographic limit, we can use geo-fencing. You know, you can only be on these roads these particular roads or this particular region and that part's not hard to do. It's a little harder when you have other factors like weather and traffic congestion and so forth. You need to test those. Reachability; we must insist that an intelligent vehicle is always within reach of a minimum risk maneuver. Now we have introduced that in a recent auto show for the cruising chauffeur that if the operator doesn't take over in time it will execute a minimum risk maneuver to safely bring the vehicle to a stop but it is possible for intelligence system to stray beyond that point and we need to understand how to manage that. So. When are you done testing? Never! You're never done testing. We are going to have machines that learn even after they're delivered. Not just over the air updates, but machines that get better. And I give my car keys to my sixteen year old; he is barely competent to drive and I know that, I know he's going to get better. And I think we should have some of the same expectations of our machines as well. It can be done but that means we have to verify the machine learning process, as well. We have to be able to make guarantees that what it produces are also good we talked, we heard a little bit, a couple times today about multiple vehicles interacting with each other. We should expect emergent behavior. We already know manual vehicles driven in certain levels of congestion give rise to that stop and go behavior. That is, that is emergent but we don't know what will emerge from the mixture of automatic and manual or all automatic. And then, of course, the c in connected, it also stands for cyber security. There are a lot of new vulnerabilities and this will entail quite a few changes to the electronics the software of the system and that's it. Thank you very much.

[03:07:27]

Kevin Kerrigan: Thank you. Thank you, David. The next presentation is from Pat Bassett from Denso. Pat is vice president of Denso's North American Research and Engineering Center in Southfield Michigan. He is responsible for overseeing the company's North American technical planning, engineering planning, intellectual properties, creative design, and North American research and development activities with offices in Michigan and Silicon Valley.

[03:08:02]

Pat Bassett: Thanks Kevin. I guess we can skip this page; just gave you the introduction. First thing I wanted to do is talk about Denso's long term vision and there's two things: protecting life and preserving the planet. So when we do anything at Denso, the environment and safety are at the, you know, two pillars of what we do. This is going to be similar to what David had said. We're a large company. I'm assuming, I don't know if everybody knows about us, forty billion in sales. The top three in the world, over two hundred subsidiaries, thirty six countries, 150,00 employees. So, we have global coverage and we're broken up into business units: power train electronics, thermal, info, safety, small motors. So, we carry a broad spectrum and it allows us to work faster, but one thing we're broken up into business units but on the other hand, in the future mobility now we're starting to get cross pollination. We're working cross functionally, much more so in the future. They'll be a lot of cross functional activity as well. So. Denso, you know, we see this as a once in a century shift in the automotive industry; it's a paradigm shift. And we use a term called CASE which is Connected Automated Shared and Electrification; all four of these things going on at the same time and we're facing drastic structural changes, I think is all of you know. And you know, we're competing with nontraditional competitors right now, in non-traditional fields; so very, very challenging times in this and the pace of innovation, social change accelerated drastically. So it's an exciting time but on the other hand it's definitely a challenging time. And I just recently, I just wanted to talk about some investments and partnership. In Tennessee and Michigan, we made large investments in these case activities. In Tennessee in manufacturing, but in Michigan in engineering. We're doing a lot of work with startup activities in our Silicon Valley office and we're doing a lot of work with universities in consortiums; Mcity we signed up yesterday for that, again. The key point is in this environment one company cannot do everything themselves. So partnerships are a really important important topic. So I wanted to talk about what is the future mobility society, when somebody this morning used the word you ubiquitous. And that's how we see it, right? Anyone, any time, any place should enjoy these services right so we have to interface with all these different areas whether it's you know widespread use of the IT services in the smart grid, automated driving, of course. We're here today and then mobility management the total transportation system should be looked at. So all of these areas are, you know, critical for a new mobility society and a lot of your jobs are related to the infrastructure. We have to work with the infrastructure to make this successful. So, I mentioned CASE and I knew my colleagues would talk about autonomous drive so I just didn't want to repeat the autonomous drive. We were doing similar things as Continental, so what I wanted to talk about was electrification and it's part of the future mobility; right? Especially, electrification and charging right now you know we know cars they are are already electrified but

soon the whole pipeline will be electrified eventually in the future. So, how do we deal with this, I think from an infrastructure point of view, you know we're expecting natural energy for wireless charging in the infrastructure and even autonomous drive lanes these types of things to really make it more smooth integration into society. I wanted to show a video we showed this last year at CES so there's no sound so don't worry but a lot of cities and even transportation companies are going to electric-type bikes and the infrastructure you could you could ride in the streets or in bike lanes with this. The other thing is what autonomy, a lot of people working on drone delivery stands. We won't make these bikes but we need a lot of the components that go into these types of bikes. So I think a lot of people have seen this for drone delivery. The other one I think for convenience, I know a lot of people probably are familiar with wireless charging, but the infrastructure for this; very important. Instead of a charging you know plug it's, we need to work on that as well. So, with electrification to the range is very important, you know everybody has range anxiety. So what some of the things energy management, we're working on is recovery and reuse. How to take the energy back from some of these areas and how to conserve energy. As I mentioned, we make all different types of products: high efficiency air conditioning, safety systems, inverters, motors. The point I was trying to make here, though, is these things should be encouraged and high energy efficiency products should be encouraged. And like EPA offers off-cycle credits for using some of these products. This type of promotion should be continue to be promoted. And everybody mentioned you know collaboration we're no different, we see it the same way as most people in this room. There's everybody needing to collaborate together right industry, academia, government to make future mobility successful we all have to work together and that's that's why we're here. So, in summary the paradigm shift is started in future mobility as we know. We have huge opportunities here and you know the time is now to work together. And of course, we have to work collaboratively. Thank you.

[03:15:11]

Kevin Kerrigan: Thank you, Pat. Thank you. Our next speaker is Dr. Ryan Eustace; Ryan is the vice president of autonomous driving at the Toyota Research Institute in an Ann Arbor, Michigan. Ryan received a PhD. from the Massachusetts Institute of Technology Woods Hole Oceanographic Institution, joint program in ocean engineering in 2005 and was a post-doctoral research scholar. Johns Hopkins University. He joined the faculty at the University of Michigan in 2006 in the department of naval architecture and marine engineering where he additionally holds joint appointments in the Department of Electrical Engineering and Computer Science and the Department of Mechanical Engineering. He remains the director of the Perpetual Robotics Laboratory at the University of Michigan a round of applause for Eustice. Thank you.

[03:16:12]

Dr. Ryan Eustice: OK great. Well it's a great pleasure to be here today and a chance to speak with you about some of the work they're doing within Toyota. Towards basically you know what's next in autonomous driving, you know how do we realize this technology and importantly I think have

an honest conversation too about what's hard. So actually trying to bring this technology to market. So there's a lot of excitement both in industry within the public-private sector right? And we hear a lot about autonomous technology and what's coming down the road and there's many challenges that still exist in terms of how we actually bring this to be a reality. From the adoption challenges, right, in terms of both you know economic, employment, and legal, security, ethical. But also many technical challenges that remain on the engineering side of this, as well, so how we use maps and maintain them. How do we handle adverse weather scenarios? Interacting with people is actually a very challenging problem you know, the lot of the social grease of driving is actually making eye contact with somebody or doing this you know at a four way stop. To better sensors, and then I think, what human factors. What does it mean to have a human and machine and have them co-exist together? So I think to kind of help have a common language for talking about some of this technology is kind of useful to use this SAE reference. Where we define these five different levels of automation and let's just kind of step through it quickly, I think sometimes this language gets used a little bit loosely and so I just want to try to give some context for these different levels of automation and what they imply. So you know a level zero system is basically a dumb car today right, the humans fully responsible for the driving; both lateral and longitudinal control. Once you get to a level one system and the example of this was like adaptive cruise control and basically you have a system that's regulating the longitudinal speed control of the vehicle. With the humans you know basically doing the steering. Level two systems, and we're starting to see some of these systems fielded today, basically the car actually takes on the task of both lateral and longitudinal control. And with a reliance here, is that the human basically needs to serve a vigilant role in the system basically playing both a supervisory role, in such that when the system gets in a regime that it can't handle the human should be aware and disengage it, to also when the system recognizes it's in a situation and can't handle it and basically hands it back to the human, then the human has to be ready and attentive to basically take on that driving task. There's a number of human factors challenges there and how that humans are able to play that level of vigilance in these types of systems. A Level three system basically builds upon that level two scenario where basically the system though, the automation, needs to be able to guarantee basically this handoff back to the human within a minimal, acceptable amount of time. So, in the industry sometimes we talk about is that eight seconds? is that fifteen seconds? It's a definition that needs to be defined but the idea is that the when the car's going to transition basically back control to the human there's a guaranteed minimum amount of time that it can do that. And there's actually a number of technical challenges and being able to actually feel level three system because what you're saying is that automation's able to do is essentially guarantee that it is able to handle all the driving task beyond what it can actually physically sense with its sensors. And so the amount of technology actually goes into fielding truly a level three system might presume that actually the system has actually has to be smarter than what it is and actually be a level four system. Levels four and five in the spectrum, the main idea you should get across here is the human is always a passenger and that's the mindset of a level four and five system. Really the key difference between level four and five is that level four, we have a limited operational domain so you can think about whether it's geo-fencing or weather fencing and a level five system, basically, the car can handle the driving task anywhere any time, any type of

weather. It can drive as good or better than a human today under all conditions. And it's really with these level four, level five systems and we think with that level of automation this is where we get amazing new potential here. In terms of access, right, for people who are unable to drive today so you think about who might be the passenger in this vehicle. You know might be the blind might be the disabled, it might be my five year old son being whisked away to school and the level integrity we need to have in these systems, we need to realize that is a challenge that we are taking fully head on. So what is TRI's approach to this autonomy. So, as we talked with these different levels of automation internally within TRI, we have two kinds of internal code names of projects that we work on we talk with Chauffeur and Guardian. Chauffeur's really geared at this idea of access and convenience, so in chauffer we think about the human as being a passenger. Chauffeur, our ultimate goal is to get to a level four system where the system is fully responsible for the driving task, and the human entirely remains a passenger at all times. Now I think one of the ways that within TRI as we as we are working on this amazing technology push to realize this future. Where we see tremendous opportunity in terms of where we can use that same backbone of technology that goes into Chauffeur is with our Guardian application. Where in Guardian, it actually doesn't fit o to the SAE levels of definition of level two or three. In guardian, we actually think about an application where you are the primary driver hands on the wheel, eyes in the road, but the way we think about using AI is we use AI to guard the human; we think about how we can actually augment your driving capability and make you a better driver. So in our guardian system we actually think about our technology backbone in chauffeur in terms of having a sensor rich competition rich car is trying to parse the world around you at all times and our goal with Guardians actually to build an uncrashable Toyota in the sense that it's a vehicle that will be incapable for being responsible for causing a crash and importantly we're working within Toyota, this is part of our mobility team, a concept where we bring this technology to market beginning as early as 2020. So next I'm going to play actually a a recent video that came out from us just a last month, that actually showcases what we mean by guardian and chauffeur and kind of some of the technology we're proud to kind of show we're at.

[03:22:40]

Video playing: Today you're going to see four different demonstrations the first two of them are going to be in show firm of what chauffeur means is that the car drives for you you would use a chauffeur car if you can't drive for instance if you're disabled if you don't want to drive if the traffic is very bad or if you're taking a taxi cab ride like mobility as a service the other two demonstrations are going to be in Guardian mode this is for people who want to drive it's a safety net against having it crash we have designed a special test car which has dual steering wheels dual brakes can dual accelerators the reason for this is that we need two different personnel in the front of the car one is a safety driver the other driver is a test driver they are there to interact with the car as if they're the actual driver in a production car but for our development this is a tremendous advantage because it lets us test the Guardian system with a actual test driver while still having a safety driver there just in case the wrists are up for the show for most of the car where the car is going to be doing all the driving for us so you can basically set back the action

enjoy the ride all right you ready Sure yes I mean are you ready I'm ready. And one of the real world things that we have to handle in self driving mode or all the randomness that occurs every day and actually in this lab we recreate a scenario where we've had a pickup truck drive on the track and she jumps in the bells of the background only. So we're going to see is our car senses does it safely change. Since the next one also changes from. So we're going to show you in this live knows how those cars it will interact traffic the robot so coming around the bend here you'll see that there's another car on the track with us to our senses a sight so we get our share of pickup trucks parked in our lane locking us she's here vehicle slow down. Talking behind the people in one spot. And smoothly change back that's critical Yeah. Now we're going to demonstrate our guardian system we're going to emulate what happens when a driver falls asleep guardian can tell me I'm using a camera that's part of the dashboard camera can even see through sunglasses in order to see what the driver's eyes are doing or if their head is moving into a position that indicates they're not paying attention to run whenever you're ready when you go ahead and pretend falsely. Now starting to step dance and striving the car for you and now the offered someone to give it back to you just take it. One of the most frightening things that can happen on the highway is when a car in front of you switches lanes to avoid debris you have very little time to react because your view is blocked by the car in front of you we have sensors that can see significantly better than a human driver can see the guardian is going to take over where car switches lanes in front of us in order to avoid debris or that cars which is named guardian decide lead us to switch lanes also and we avoid having to cross. Now Guardian has offered to hand back control. Has taken control back of the car. So today you seem demonstrations of two basic technologies that the Toyota Research Institute is doing research on this is all part of your eyes work to eventually build cars that can never be responsible for a crash regardless of what the driver.

[03:26:30]

Dr. Ryan Eustice: So that gives you a little bit of a preview of how we think about this problem what we're trying to bring into the technology that we will come to market with. Next I just want to kind of quickly step through a little bit just a reality check in terms of what's hard for a time the striving in fact is many situations right most driving is easy but the hard stuff is hard so you know from the social interactions that need to happen right when you make eye contact between people to a meeting what maps and how do we maintain them so if you when the roads get paved over night or remapped, to interacting with say crossing you know police officers based their intersections to you know handling adverse weather so here's an example you know just green always being goes in this case knows it's a red light there's an officer actually waving us through it and then you'll see that as we come up to the next intersection is going to be a green line. And so this is actually in Boston. Red Sox game just got out so that the T.'s basically over is taking off there you see right there after stepped in the traffic right just put their hand up and immediately the context of the green light changed right now it's not beyond our capability actually right if you're is not going that can detect somebody doing this OK but do you want to stop for every teenager that comes on the road and does this is you know right it's all the it's all

the top down context of understand scene scene the police cruiser of park to the side of the road that you know that you can actually interpret and trust us. Secondly you know we think with the social dance of driving so this is an example when we were a vehicle vehicles in Boston again just trying to make a left hand turn Ok into traffic. And what does it mean right to have the vehicle interact with other people of agents out there you could solve this problem actually by just doing right hand turns all the time if you want to do what basically U.P.S. like Fed Ex does where they're at their delivery vehicles purposely and how they program the routes but if you really want to be all interact and kind of drive in everyday traffic these are some challenges to solve and then also important a member I said will talk with Level four low five driving humans always a passenger Here's an example of you know the individually rare but collectively common thing that happens every day in America a water main broke on Main Street OK I'm driving into work one of the days and I see a man I can make a right hand turn to the office why there's a fire truck there police cruiser to the side what happened basically a water main busted and I was cited and so that road had turned into a river and when we talk a love for a little five system we're talking about the car has Bill handle these types of scenarios all the time because who's going to be in the car versus me not be able to drive maybe my five year old son OK So this is the mindset that we have to have when we think about this technology we try to bring it to market. So just a few closing thoughts you know I I'm a huge believer in this and really excited animate about you know the potential for this technology is great I think there's some issues in terms of challenges that we're trying to solve to actually get there to bring it. I think you know the idea of human factors and in particular the way we're thinking about guardian is purposeful in terms of how we think about some of these human factors what's the right interface between human and machine in terms of how do you, how do you overcome basically some of the level of vigilance that might be required by a human in terms of how they interact with the vehicle? And so this is basically to your eyes two prong approach to this of how we think about billions back out of technology that realize the chauffeur but also how we think we can apply it in a unique way with Guardian to really make a difference and basically saving lives now.

[03:30:01]

Kevin Kerrigan: if you can get an autonomous vehicle to drive through Boston then you're a better man than I am. The question cards are going to come around if we can take a look at those I think there's some. Three great presentations, by the way guys so let's see if we can still some discussion here. Ron this is for you, we are here discussing tech test facilities and I'm curious how does Toyota view physical testing in today's environment?

[03:30:48]

Dr. Ryan Eustice: Yeah. Bring the technology to market and some of the what types of testing do we need to do I think there's work that needs to happen both in simulation soon nation is one of the ways that we'll get to scale in terms of testing I think the role that physical test facility provide for us is actually two fold so one in a physical test environment we get to be maximally equal to

the technology so we can basically reproduce the difficult driving events that would otherwise you'd have to drive a lot of miles on public roads the kind encounter you know the kind of weird wacky kind of stuff and what allows you to do at a physical test facility is to repeatedly and in a statistically meaningful way recreate those types of scenes and scenarios I think another aspect for us that you know vitally important is that as we think about you know if you look at chauffeur a sense of the cars trying to do the driving task it's basically trying to act like a median driver and we can test that on public roads with the safety driver concept fairly well but we think about a system like guardian where guardian is basically trying to step in and avoid you know high dynamic driving events and prevent crashes from ever happening, close course facilities actually play a very important role in terms of where we're able to field those systems and do a lot of engineering development on them safely.

[03:32:11]

Kevin Kerrigan: Right. Denso is one of the world's largest suppliers as you showed. How are you dealing with the rapid changes, the record change of pace in the industry? You touched on it a little bit but just like to expand upon that a bit things are moving so fast and you were in charge of planning.

[03:32:33]

Pat Bassett: I think I did touch on a little bit I think you know being a Japanese company usually we were very vertical before and we wanted to do everything in our house and we just realize you know at the pace we're going right now it's impossible to keep up so looking for startup companies or university help or consortiums we've really shifted how we're looking to outside partners to help us because the pace we can't be experts at everything we used to think we were and we'd like to be but that's the biggest, really the biggest change. And I also mentioned a little bit of cross functional activity when we talk about future mobility we have some really strong product groups but a lot of these products should be interacting more. If I talked about electrification thermal and power train there's a lot of sharing there or electronics and thermal how the passengers comfortable we talk about total relaxation so when you're in the car driving autonomous tirelessly it's about thermal comfort it's about safety and peace of mind so that type of shift is what we're focusing on.

[03:33:53]

Kevin Kerrigan: Okay, great. David, Continental is a leader in autonomy. What do you think is coming next? What do you think is really going to open our eyes and may us say wow?

[03:34:06]

Dr. David Atkinson: This is the, this is the timeline question right now. So I know for you know it I know of companies who are very aggressive and reasonable to be placed technologically to achieve a level five autonomy in geo-fenced areas by 2019 so I would say in initially select urban areas we'll see shared rides we'll see urban transport using some novel kinds of vehicles that are fully autonomous with your own route but within very circumscribed areas and probably sensitive to weather and other traffic conditions and they'll be in the kind of environment where there is a traffic management or manager who is monitoring and dispatching these vehicles as well but the autonomy driving that will be right away I think we'll see that an increasing trend in the rollout of new capabilities in existing products the the big change recently is that now machines can sense and perceive their environment and was has been very difficult for a long time to do that and so most of AI has concentrated on reasoning automated reasoning. But they haven't been, we have many able to apply it in certain situations that are very much driven by situational information but now we can perceive machines can see they can see in multiple wavelengths they can see much better than we can which means now we've unlocked the potential for decades of research machine reasoning which has been on the shelves in universities and research labs so we'll see that technology come into components first I think for general for general automotive and basically for Continental we think of mobility. If it has wheels there are customers and each one has poses different challenges but so it's not just automotive for us that's the bread and butter for sure. So much depends on the major OEMs but now they're telling us faster, faster faster which is fine because the disruptive new companies which of the ones I pay most attention to, like Tesla, still very small company terms of what they buy and there's dozens others coming on very fast. They want to go even faster faster faster and tell us all the time we need samples we need this we need that and so. It's going to come really fast as soon as we learn how to do it it's more the speed of delivering then it is the technology maturity in some cases.

[03:37:06]

Kevin Kerrigan: So speed of speed all right of trying to have technology implementation.

Dr. David Atkinson: Processes within the company.

Kevin Kerrigan: what about speed, period? Why can't I get a car that drives two hundred miles an hour? I mean is that something that is even you know being talked about right, what are your thoughts on that?

[03:37:30]

Dr. Ryan Eustice: I guess I hadn't thought about that. You know I think well. It's autonomous right it could potentially I guess yes you're right already you know fourteen challenges in terms of sensing technology range at the seventy mile per hour range so. I think I'll keep us going for a while.

[03:37:54]

Dr. David Atkinson: So this, may I comment, this relates somewhat to that question of of driving style and customizing to somebody who drives two hundred miles an hour is in aggressive driver. Driving two hundred miles an hour in the snow is a little reckless we don't want to do that but that said there are a lot of different preferences for how you want to be driven. And some people really like a sporty Boston taxi driver and others would want to chauffeured limo where they don't even feel the road so this level of personalization of performance maybe not going to hundred miles an hour but personalization is another aspect where the artificial intelligence will come in and we're seeing the first of that now with some of the capabilities.

[03:38:46]

Dr. Ryan Eustice: Yeah, and in particular just when we think about worldwide I mean driving is a worldwide activity and so driving in the U.S. is actually very much different than say driving in India or even trying to drive in Rome where I feel like driving there's a sport. So yeah exactly so I think a lot of that adaptation will come from a lot of machine learning. That will allow it to be, basically adapt to the environment right that the system becomes deployed.

[03:39:15]

Kevin Kerrigan: It's a question from the audience is what areas are ripe for collaboration on the hard challenges? Can agreement on what is hard scenarios we talked about scenarios be the style of anything?

[03:39:34]

Pat Bassett: I think some of the more common items maybe where we talk about legal issues or regulation where. If there are some guidelines or some standards that could be set then it might some we mention this morning help the deployment. Because the liability is still unclear right right now who would be liable if there's a crash so if we at least set some minimum standards and the auto companies clear those then it least you know the designers like us we're not held liable or things like that. So I think that type of that's an industry thing that this group especially this group here if we could work on some common you know minimum guidelines would be I think one of the bigger things to speed things up.

[03:40:25]

Kevin Kerrigan: Again which I have a bit of fun with this one what is the hardest scenario Ron that you see what is it that you can figure out or is testing?

[03:40:40]

Dr. Ryan Eustice: Yeah I don't in terms of specific challenge I mean just the number examples I gave today right are situations are really hard thing for any time as car to handle in terms of the well as the construction worker of the or the police officer at the traffic light to when the road conditions with why there are the you know when the water main breaks and Main Street becomes a lake so much stuff right now it's going to beyond where our systems are able to handle in a general purpose of a way I think where you'll see some flexibility in terms of how so many systems that get fielded when you think about applications like mobility as a service those offer opportunities where when you think about integrated system there's there's more. Technology levers we can pull that problem to try to get the reliability up so when you think about saying countering that that broken water main on Main Street, right. Zones of vehicles that can able to detect that anomalous configuration maybe come to a safe state you can think about using say like a call home function almost like a center right where somebody could basically teleport into the car and help disambiguate and help figure that out so I think there's different avenues I think I bring this technology and field it in a reliable way.

[03:41:54]

Kevin Kerrigan: David, this one's this one's right up your alley, I think. Drones, UAVs, what is your perspective on when they enter the picture or have they already

[03:42:09]

Dr. David Atkinson: Yes. This is now. We're looking at for example freight yard operations logistics operations within closed areas with large trucks for example where visibility is sometimes difficult for the driver. We have three hundred sixty degree view camera approaches plus overhead drone that might be launched from the truck to give yet another perspective. And those are useful whether the driver is in the driver cockpit or standing to the side so there are multiple driving modes there. I think you'll see the I'll see the drones. People have a lot of ideas but this is the first one you know constrained spaces go take a look where otherwise you can't see and that adds to safety and performance so that will be the first place comes out in my opinion.

[03:43:14]

Kevin Kerrigan: Anyone else wanna comment on that?

Pat Bassett: I think in regards to drones I think that also will be the next thing it then so we're talking right now we're moving people to places right in you know with Amazon and everything else now packages are starting to come to people so people have to move less. Next would be the drones coming we see that definitely coming and then even after that if you're talking different technologies with 3-D printing and some of this type of thing, maybe packages won't have to move, people won't have to move, and actually people will be staying, could stay home

a lot more, so even that type of activity probably is a little bit farther out but it's a natural progression I think we see., think there's always going to be things to do but that type of progression you know it's going to take some time but we can see that that happening.

[03:44:14]

Kevin Kerrigan: OK. And this is the last question and it's the same question Kirk asked the group, earlier. Fully autonomous and this is a one word answer from everyone. OK. Fully autonomous level five vehicles, not test vehicles, you know in test environment, when are we going to see those on the road. And we will hold you to this.

[03:44:40]

Dr. Ryan Eustice: Yeah so I think you qualify it right there with a level five. So I think it's a decade away because level five basically assumes that the vehicles able to drive anywhere anytime any kind of weather condition I think the first systems that we're talking feeling are going to be level four systems where there is a limit operation on the in scope but ten years at least I would say it's on the order.

[03:45:06]

Pat Bassett: I would agree, I mean it's not up to Denso so really it's up to the OEMs but yeah we just have to supply the components. But. Like Brian said the weather in handling every condition is so difficult so it's going to take some time.

Dr. David Atkinson: It's not my nature to be conservative about the technology but I think in this case I will be, I think we will believe we're ready long before we're actually ready and then we'll learn. I think they're very difficult challenges to still to solve in the interaction of multiple autonomy sphere goals in a city that offer some smart infrastructure there's just, there are lots of unsolved problems. It's much easier for us to make a mobile robot go over rough terrain in a desert or on the surface of Mars than it is to drive safely on a city street. If you if you want fully autonomous off road driving we can do that now. If you demand it complies with traffic regulations you know then it's a little different thing so, so I'm going to I'm going to say twenty fifteen earliest, sorry twenty years, in ten years, ten years, fifteen years, sorry. Fifteen years. OK, my wife says you've lost a decade you know, it's the first sign.

[03:46:41]

Kevin Kerrigan: Gentlemen, thank you very much. Appreciate it.

[03:46:58]

Kevin Kerrigan: Yeah, thank you that was was outstanding. We have our next panel if I can find it, which is Asian Initiatives. The moderator for the next panel is Qiang Hong. Qiang is a senior research analyst with the Center for Automotive Research in Ann Arbor Michigan. His research focuses on the planning and policy implications of transformative automotive from transportation technologies included connected and automated vehicles is work also focuses on personal mobility trends automotive industry development and transportation impacts in China. Qiang serves as a project panel member and chair of the Transportation Research Board and the National Science Foundation; a big round of applause for Qiang.

[03:48:00]

Dr. Qiang Hong: Thank you, Kevin. It's an honor to be here. We have three Asian countries participating. Before I introduce the panelists I'd like to provide a few facts. Asia is big, forty eight countries. Fifty eight percent of population or four point four billion people are living in Asia. Asia is also a big automotive market sixty one percent of vehicle production; passenger vehicle production. Traffic is a problem; is serious. Three quarter million or sixty three percent of road way fatalities happen in Asia, and in terms of vehicle penetration levels, varies significantly. Like Japan a mature market, six hundred per one thousand people but in Myanmar, like seven vehicles per one thousand people. That means the mobility needs requirements are diverse and that's why we're here to discuss solutions, opportunities. First panelist, Charlie Cheng, has been representing the government of entering Anting, Jiading District, Shanghai for four years. His company has represented to multiple multi-national organizations around the world. This year Charlie was honored to be able to represent Shanghai International Automobile city (SIAC). Let's welcome Charlie.

[03:49:58]

Charlie Cheng: Thank you. Thank you also MEDC For hosting and letting me speak. And I look young, you guys have probably worked at the company longer than I've been alive. So, I'm not a technical person. I'm just, I'm not a technical person; I'll just go over what I see and what I've done so far and then if I have time I might play a video you guys can see. I don't know if you've seen the video or not. So, I want to clarify so we're not "psych" Motors we're SIAC it's a bit confusing, I understand, but it's Shanghai International Automobile City. In my terms, they're kind of like an economic development corporation but they do more than just economic development. They actually run fleets and things like that, as well. The name is also confusing and the governor is not here but he totally bombed the marketing for this with the nice, you know nice meeting. You know so I get it. So, I'm going to tell China that he didn't like it. But the A stands for, it's first letter in the alphabet, it also stands for Anting which is the town, which people get confused with Shanghai; it's basically Shanghai but it's not. Also, national intelligent connected ecosystem the e's ecosystem and electric and then obviously we took it from Mcity so thank you for that. I'll go brief there's a lot on the slides and I don't want you to read it all but basically I'll give an overview of what China, and then what we're doing in Nice City and what we

think upcoming events and things like that we're going to be hosting. So, in China it's a little bit of a different situation as you guys are probably aware like Mr. Hong said. You know we've huge population, huge traffic congestion so those are really our focus areas. You know in other places like Smart City Columbus you know you're serving the under-served areas. Were more focused on transportation safety, erratic driving, unreasonable bicycles carrying huge amounts of boxes but we do expect a fifty percent auto sales growth in the next ten years and that's going to happen along the west side of the country. On the coastal region is very much developed which is why Shanghai was the first out of the awarded testbeds from the Ministry Industry and Information Technology and we hope to continue that development so those are the kind of applications we're looking at. But I say these are our six platforms; I don't want to get into it again. I think it's more promoting and developing the whole industry as a whole rather than just focusing on specific areas. Obviously standards is a big part; data is a big part; security's a big part; they're all things we're looking at and we're going to be putting it kind of on a foundation of three public service basis: talent, a lot of what people talked about today; systems innovation; and then obviously international cooperation. Which I think is a big topic for the reason why we're here today. Here's the history of what we've done. We were awarded the event, the official badge let's say for the testbed in late 2015 and then we officially opened in June seventh of last year. So we've been operating and running test consistently now for almost about a year and we've also hosted one of the first China intelligent vehicle competitions. Now I want to be clear we actually weren't the first in the country to host this competition but we are on a bigger scale looking to do more. Here's a development phase and we're currently in phase two. So right now we have three square enclosed areas that we do testing, five square kilometers. We're expanding now on the open roads and that red line right there is exactly the open road that we're going to be putting the DSRC and communication equipment on to and you can kind of see also what kind of vehicles we want to have in the background running, as well. Some of the equipment, some of the applications road side units, the three zones include an urban area, a countryside area, and what I would say is more of a smart quarter. Data is obviously an important, looks a little weird, but we want to have a very comprehensive data center on everything from simulations to what happens on the public roads to what happens in the close test zones to the vehicle environment to the driving simulator and we're going to package this all together. And we have actually close to two hundred different scenarios right now that we've we've kept records of this is our most famous F-zone. It stands for the Formula One zone because if you've ever been to Shanghai, we're across the street from the Formula One race track. Again, that scenario application has increased to two hundred now. You've seen we've had three hundred days of testing and we've posted a lot of events so it's very much a collaborative environment that we want to facilitate not only in Shanghai but throughout the country. What we then did is when we were first founded in 2015 to 2016, that period of development, we had sixty founding members. You can see anything from universities to telecommunications companies to automakers to standards to parts manufacturers. It maps the whole suite, we're all part of it and then what we did is we said OK we need to be close together so we put them under as an Auto Innovation Park and then we created an office and then automation, a part for all the think tanks to house under one roof and it's called the United Innovation Center. So if you've been there recently this is the area where

you'll see all these companies housed and then obviously we're working very closely with all the standards like CATARC, SAE China, Tsinghua University, and Tongji University.. This is a very important slide I think because it really explains why Shanghai International Automobile City might be crucial for China. This is our second pilot zone that we developed; the first one was the EV zone which was then again similar promoting the development of the electric vehicles in new energies and renewable energies and then what we did is we were an asset based company; it's government-owned Shanghai International Automobile City is government-owned but we built a fleet. So the EV cars, we used a vehicle manufacturer, SAIC, and other manufacturers to build these battery electric vehicles that are provided free to the citizens we bought a fleet of about eight thousand and we have over four hundred fifty thousand members who are using this service all throughout Shanghai, as well as the rest of the world. But then through that we're able to collect data consistently on what these drivers of these vehicles are doing in this car and then we're able to then take that and now test AI onto it now. And then what we've moved on to is buses. So, we have now, if you've been to China recently you've seen dedicated bus lines throughout Shanghai. There's twenty of them and also in Anting and we have close to three hundred full battery electric vehicles and you see the members and this is all going to grow and it all feeds back into the data center. So real quick I'll show you a little bit about what we have coming up. Now it's a lot, I don't expect them to complete all of it. I would say the most important ones are the vehicle simulator, as well as the public integrated data center. And we're working very closely with some couple partners to develop it and obviously international exchange is a big big piece. But I kind of want to give my opinion. By the way this is the open road that we're going to be developing. You can kind of see how many DSRC equipments. I know it's in Chinese but you know Wi-Fi positioning systems, everything, cameras, and that is the data center. So, if you've never been, you'll recognize it.

[03:57:21]

Charlie Cheng: The upcoming events... so we have a lot of events I would say the entire November there's events all over the country so I highly recommend coming to visit and taking a look, and meeting some new partners. Most important, I think, is the second China Intelligent Vehicle Championship. We're going to be hosting that December 11th through the 13th. Sixty teams are going to be participating. We'll be testing fully automated driving, information security and assisted driving. And then we have a bunch of events and forums, everything. The bus is probably the first application that we're going to see come out and be used on open public roads. And that bus is built by us along with some partners but we put all the cameras on obviously we use the bus manufacturer for the vehicle itself and obviously we work very closely with MEDC and Kevin obviously has a great picture and that is the chairman. He was unfortunately not able to come because it's very difficult for these government officials to get out of the country and he exceeded their outside travel limit so he apologizes for not being able to attend but hopefully next year he'll be able to attend and speak clearly on what they're doing. And I also wanted to give you an idea on what the competition, what will really have involved in, and what kind of teams, multiple research institutes are going to be there, almost nearly all the technical universities. Various auto

makers and we're going to do a full comprehensive test so we're including information security. So we're actually going to hack the vehicles and see if the teams can regain control of the vehicles. They'll be simulations testing. There will be a fully automated one, as well. We're really seeing can you maneuver through our two hundred different scenarios and then through that test there's competition. We're going to take the data and jointly together, come together and see what was produced and what was analyzed, as a group; all sixty teams along with the universities and everything like that. Last thing. So I'm going to, if I have time, can I play the video? I don't know how many of you have seen this. This is fairly new. A lot of people asked me about the open road part of it and what I what I say is the Department of Transportation, we've talked to them about this and they didn't give us a very clear no you can't do it, or yes you can do it. So we're going to do it anyways and that will really prove, or show, to them that what the technology that's out there can do. *speaks with A/V guy* I got it, yeah, I got it.

[04:00:34]

Charlie Cheng: So you see I'm very good with technology. That's because my generation grew up with this so we don't have any problems with you know, I'm not, it's not to be mean. *video plays, voices are in Chinese*

So, I know it's in Chinese. I'll try and help you translate a little. You might not be able to see the words. Our F-Zone, this is exactly what it looks like so when you go visit you'll see this. We actually run 24/7 almost the only couple days throughout, couple of hours throughout the day that we're not running. And in fact it's actually completely booked. The only time that, we only have about twenty percent utilization, is the night time. Otherwise we're actually completely booked and sent off for a year I believe. Just you know and there's consistently testing going on; pedestrian crossings. I don't know why it did that but you know, you can see anything from like losing connections which in tunnels in Shanghai, they're everywhere As well as onward systems, navigation, speech to maps, and we have various sets of HD maps like everybody can't just have one; you have to be multifaceted. I think here is getting better. This video is also playing on the booth in the ITS China. So if you want to come see it I'd be happy to play to you. This is going to take forever. OK, I'm done, thank you.

[04:02:46]

Kevin Kerrigan: Thank you Charlie a lot of content and I'm sure there will be questions for clarification or for that understanding. Our second speaker is Dr. Han Geom Ko. Dr. Ko is a research team leader at K-City Automobile testing and research institute. His research interests include traffic operation and management, automobile and transportation safety evaluation and ITS. He's involved in research on development of assessment and safety technologies of autonomous vehicles and also management off construction of K-City. Yes, welcome Dr. Ko.

[04:03:40]

Dr. Han Geom Ko: Thank you. Welcome and good afternoon. My name is Han Geom Ko. I'm in charge of K-City construction. I am not team leader, I'm instead of my team leader unfortunately. Today I present on overview of *inaudible*

[04:08:19]

Dr. Han Geom Ko: K-City a test bed for autonomous vehicles will be constructed on the premises of the proving ground of the Korea Automobile Testing and Research Institute. K-city is divided into five sections for the test environment it will model the actual transportation environment for roads, traffic facilities, and communications. In the urban area a real road transportation environment including signalized intersections bus only lanes and buildings is simulated. The signalized intersection perceives the intersection or traffic signal and receives the traffic signal information with vehicles in regard to buildings and an assessment will be made for the influence of environments where buildings of various heights are located. At the community section pedestrian center transportation environment is simulated. In the school zone the car would decelerate receiving the information on school zones and speed limits. The warning system guides the car to recognize bicyclists and jaywalking pedestrians and avoid collision situations. Motorways are designed to carry traffic at high speed with the lowest possible number of accidents. Various systems of automated driving assist are evaluated. It evaluates the supporting functions of the merging section. On the main lane it is evaluated whether the vehicle keeps its lane in distance by using an advanced driving assist system it evaluates the functions for forward collision warnings and emergency braking. At tollgates an assessment will be made on the perception of told gates and the handling of situations where vehicles are in conflict with each other. The outer road simulates the road transportation environment of rural areas with unmet infrastructure. At the roundabout it evaluates the ability to decide on the priority among entering vehicles and to deal with possible collisions. At tunnels, an assessment will be made on environmental perception capabilities when driving through tunnels. At the autonomous parking party facility. The parking environment for autonomous parking is simulated. It evaluates the parking function, the ability to cope with collision, as well as autonomous valet parking function. The K-City data support center, an integrated support center for the technical development and safety assessment of autonomous vehicles will carry out an integrated control of the center with such on site systems as CCTV and advanced signal controllers. A system for assessing autonomous vehicles will be constructed in a connected environment where center systems, test cars, and road infrastructure are integrated in an organic manner which will ensure the constant safety control of test cars. K-City will be expanded to enable the overall assessment of autonomous vehicles by utilizing all the test routes of country including the high speed circuits, the handling instability circuits etc.

Our research and assessment will be conducted in various locations and in various months. 4G and Wi-Fi. We are planning five tests in the motor way section at of this month, November. We are collaborating with S.K. Telecom. Our telecommunication company. Their research center

controls autonomous vehicles with platforms. K-City will be used for autonomous vehicle. K-City is not constructed for Korea domestic. I thank you very much for your attention. Please send me an email for questions. Thank you.

[04:13:16]

Dr. Qiang Hong: Thank you very much for bringing us the latest information on K-City. I saw an article on Traffic Channel, previous issue, describing K-City activities. On our agenda, we have speaker from China Automotive and Engineering Research Institute, Xia Qin. Because of VISA issues she cannot make it and will try next time to have her or other representatives. Our third speaker, Dr. Nobuyuki Uchida, he has been a researcher at the Japan Automobile Research Institute since 1994. His research interests include understanding of accident causation mechanisms and some relation of the common accident scenarios for developing better preventive measures. From 2016 he is Japanese co-leader of the trilateral EU-U.S.-Japan impact assessment sub-group for automation in road transportation place. Here he is.

[04:14:39]

Dr. Nobuyuki Uchida: Good afternoon everyone. My name is Dr. Nobuyuki Uchida, I'm from Japan Automobile Researching Institute. First, I'd like to say thank you to all of you for giving me such kind of great opportunity to introduce our new facility called J-Town. It's opened just seven months ago and now it's fully booked and we're very happy to this have type of facility. And this J-Town consists of three areas and I will explain each of them one by one. At first, specific environment area and the length of this facility is two hundred meters and OK, and wide is sixteen point five meters. And inside we simulate such kind of tough condition and simulate such kind of very difficult situation for sensors or detection system for autonomously driving, ADAS. And this is pretty much you, OK. Trouble.

[04:18:32]

Dr. Nobuyuki Uchida: Very difficult sunlight and no snow, sorry. Yeah, people it's very difficult the temperature is really high. Let's talk about, and this generation system keeps certain condition at least one hour. And the visibility can be changed from fifteen to eighty. And the raining system, it also keeps the rain. So it's very high. And thirty meters per hour to eighty. And you can choose the rainy part from two hundred meters. And you can also use the lighting system at the same time, like this, and sometimes that kind causes critical situation in the program. And the second one is V2X of an area. This area has three hundred meters of straight road and four-signal road intersections. And also equipped with communication devices and we use it, seven hundred sixty MhZ. We use it for already served vehicles. We use this area for testing driver supported systems or greenway traffic right systems. And this is example with this case, somebody already said, the timing across oncoming traffic it's very critical also in Japan. In this situation infrastructure

sensors can detect oncoming vehicles and also pedestrians. And also we can put simulated buildings around intersections. And last one is a versatile area. The biggest advantage of this area is having 100 m x 100 m test area. It's pavement area and you can make any kind of road marking, something like this. Kind of, any type of intersections, by using the movable white lanes and you can also simulate road construction area and you can make, intentionally, you can intentionally make a difference between map and actual road markings. Finally our objective and also the future goal. We want to create an international open innovation environment for connected and automated vehicles. And we are preparing a proposal for the international standards for technologies concerning connected and automated vehicles. OK. Thank you very much.

[04:23:52]

Dr. Qiang Hong: We still have twenty minutes for Q. and A. Sorry about the glitch showing the video but we made it. I'd like to follow the last slide. Uchida you mentioned about international collaboration. And that's a really the theme for today's event. Three different testing sizes may have different levels of international involvement I believe. So if you, three of you could explain more, describing what type of international participation and collaboration, especially for foreign companies or government agencies, that would be great.

Charlie Cheng: I'll go first. So, it's a core pillar of Shanghai International Automobile Cities to collaborate. I mean it was the first pilot zone, the EV zone, was founded with six other countries together, jointly. So we apply that same concept, same philosophy. We work really hard and try really hard to cooperate internationally. So far we've had signed agreements with Mcity, TRC, we're working on ACM right now and working on a couple others GoMentum, MIRA, and a few others that hopefully will come soon. But we're open to all collaborations because we understand different environments, different cultures, different scenes, different driving mechanisms and all those things. And we are participating in international standards. So I see China, USA international standards, as well as any other standards that we can be part of, European, etc.

Dr. Han Geom Ko: At K-City we are conducting now you're conducting these but we don't have detailed ones yet. But we investigating with government to open that. Thank you.

Dr. Nobuyuki Uchida: We're also open for foreign companies and universities but so far our facility is fully booked. And in the future, we've got to especially test scenarios is the most important. But also we are very, we investigate what kind of scenario should be ready for automated driving.

Dr. Qiang Hong: And I'd like to follow up with Charlie because Chinese auto market really is a global playground. And there's great opportunities for sure, but some specific challenges I believe relate to CAV. For example, you know communication approach or mapping approach standards those areas right now still are protected area for the Chinese market.

Charlie Cheng: Yes, very much so. So no public roads, there's no legislation in place right now where you can drive autonomous vehicles at all on public roads. Now it's different for connectivity and anything related to kind of communicating or assisted driving. Those are

definitely things China is promoting now. You know I'll give you an example some of the people, colleagues that I work with they're from China and they've lived in the US maybe five or six years. They are very scared of driving on the highway in the US and that's because it's just a different environment; they're not used to it. She she said you know when I'm on the highway I'm on the right lane in the slow speed and hands like this and I'm close to the wheel so, so it's just a different environment. And then turn it around, I mean I'm trying to get a license in China but I would never really be safe or feel safe as I am in the US driving in China. And it's erratic behavior and it's a big automotive market and there's some thirty five, close to I would say even fifty or more vehicle manufacturers; all different types from low and to high end and extremely luxury to low speed electric vehicles to three wheelers that are running on public roads. So and there's a bunch of new startups popping up that are independent electric vehicle manufacturers and the government is now starting to say well we can't have these random rich people starting their own vehicle manufacturing. I's just too hectic. So I think as it develops, it'll shrink and things will become more regulated and more standard. But it is, I definitely agree with you, that it's a big, big market. And you know if you read on the studies online you can look people like my age and the millennial generation in China actually accept. It's completely opposite in the U.S., I think it was something like sixty, seventy percent, you know say they would never get into an autonomous vehicle and China is the opposite. It's they are willing to get in an autonomous vehicle because technology has moved so fast that they expect change to move so fast. So it I think it will become more likely.

Dr. Han Geom Ko: One of our aim is to make flexibility test bed so we can test AISIN, European, or UK site. So we can test facility using lane tape or move over some place. So we will, many countries come to our country, and they test all the, maybe I think, all the testing.

Dr. Qiang Hong: Since you have the microphone I'd like to ask you about potential for 5G. You are probably the only person mentioned 5G. How significant that was to support the AV development and even after that, and since vehicles driving themselves, so with 5G and faster data transformation so people can entertain in the vehicle. So what do you comment on that.

Dr. Han Geom Ko: 5G is not standard yet but Korea has next year connected and telecommunication company develop 5G technology and the service more earlier. So I think we can service using 5G network for safety function and we can deliver entertainment service. This is our servicing to test at the end of November, this month.

Dr. Qiang Hong: OK. I'd like to ask Dr. Uchida, you mentioned about testing scenarios and you're also our safety expert. When the computers driving the vehicle basically it will depend on perception, analysis and decision making. Three big components and I believe your safety background is smart about human factors so transitioning from human factors to computer-driven What do you see the likely failure or liability in those three different steps of automated driving.

Dr. Nobuyuki Uchida: From my point of view I think decision or is judgment it is most difficult for us driving because in an actual situation the critical scenario is not so simple. Several participants related one very short video and its very tough decision making.

Dr. Qiang Hong: Are machines better than humans?

Dr. Nobuyuki Uchida: We need more data in public road situations and we should have much more. What kind of things might happen or kinds of good vehicle behavior would happen. We need to learn much more.

Dr. Qiang Hong: Yeah that's true. Back to Charlie. As I understand, China is developing eight or nine, even nine, different testing facilities simultaneously so what is the relation between these testing facilitates and how they collaborate and probably more importantly for the regulators, policymakers at this central government level, by the way, I'm confused the Minister of Information Technology, Minister of Science, Minister of Transportation, which one is leading this effort. I'm still not clear but if you can give me the answer that would be great. The internal coordination in China. `

Charlie Cheng: From my knowledge so when they first announced, MIT, when they first announced these test beds they came out with six and then they expanded and then expanded it. I think there's way more than eight actually now and there's unannounced and there's everybody looking towards it. But I think the thought behind it was you know, in China there are six motor vehicle inspection centers all around the country Pinjing, Beijing, Shanghai. I think it's kind of the same concept is that each different city government let's say has their own different perspective on how things go for their area. So you know, I think it's actually even more competitive than in the US even though in its nature it was set up by one entity and everybody follows that one entity which is the Ministry of Information. But you know, for example, the Shanghai International Automotive City, they want to collaborate with other testbeds and we've approached and even the infrastructure designers, the information, the communication designers, they've all gone out to Beijing and other cities to say we want to submit a bid to the proposal to help build. And so far to my knowledge no Shanghai has ever built for Beijing, Beijing has ever built for, they're all different organizations so it's kind of like a competition. The Ministry says here we authorize people to start doing testing, we're giving the funding to help provide for the testing, but we want to see who can be the best or who can be the most forward thinking who can collaborate internationally. Who can work with others and really prove to show the public that this technology can work on closed, open and public roads. So it is very much in like Mr. Hong said, we're not even sure which organization is really the decision maker in all of this. But I can tell you from my knowledge, it's more important on the connectivity side which you see promoting more because they want to see bandwidth increase throughout the country once the bandwidth increases then you have everything connected and it leads into what they're looking for which is technological advancement, R&D, increase their R&D capability of the country. And that's very much the focus of this. You hear Made-In-China 2025 autonomous vehicles is part of that plan but it doesn't go too far into it because everybody so new about it.

Dr. Qiang Hong: Yeah, final question I believe. Actually, I have two. So timeline, I know Japan and South Korea maintain very high level of IT and infrastructure already so that there from there will be a plus to the AV deployment. So it's Kirk's question, so give me a sense of which year you will see level four or above deployment in your own country.

Charlie Cheng: I can give my personal opinion, I can give you what I think China is thinking of. I think electric vehicles, the planet and everything, that they want to get gasoline vehicles away. But when it comes to autonomous, you know, China really looks to the Western world for how you guys are doing all of this. So you guys are really setting the standard for trying to, in my perspective, it's the same thing with why, you know, China loves Hollywood. They love movies. All the movies you see now, artificial intelligence, space Martians, it's all going towards that field. And when China thinks of the Western world because of this great internet firewall, they think of Hollywood. So naturally there already attuned, especially my generation, attuned to all this stuff. So I think it will happen, I think China could happen way before the Western world to adopt this, at least see it on the public road, but I cannot give you an exact year.

Dr. Qiang Hong: China is complicated, I know.

Dr. Nobuyuki Uchida: I think the key is Winter Olympics, 2020. Social acceptance will be increased.

Dr. Qiang Hong: We look forward to that.

Dr. Han Geom Ko: Unfortunately we have not heard. We have not to show autonomous vehicles in Olympic, more higher levels. We just show our internet service. I think what was said, I agree. Technology is more higher, social production is more important. Many Korean, or many, we have many people thought AV car. It's more important.

Dr. Qiang Hong: OK I think that's all the questions I have. Yeah, really thanks to the three speakers from three Asian countries and I will look forward to future collaboration on this important area.

[04:42:04]

Kevin Kerrigan: Now the next panel is United Kingdom initiatives the moderator is Ella Taylor. Ella Tylor leads on innovation connectivity and data for the Center for Connected and Autonomous Vehicles, a government unit which pulls together the U.K.'s activities and policies on connected and autonomous vehicles. Ella joined the team when it was established in 2015, previously working on connected vehicl policy, looking at issues ranging from connectivity and communication networks to creating an ecosystem for connected vehicles to be developed. She's worked for the Department for Transport for five years and originally joined the U.K. civil service as a government statistician. So, Ella please join me. Ella Taylor.

[04:43:06]

Ella Taylor: Great, thank you. So, as mentioned, I'm from the Center for Connected Autonomous Vehicles. The Center for Connected Autonomous Vehicles was established in 2015. We're a joint unit where both transport business energy and industrial strategy essentially that was because when we were established we thought that it isn't just about making sure that we can get our transport systems ready but it's also about making sure that we have a really thriving industry in the U.K. Since we started, you'll excuse me for being a bit reflected, I had my two year anniversary

the other day and I was thinking back around what we've learned since we first started and I I remembered joining and thinking genuinely the most interesting question in connected and autonomous vehicles is whether or not you hit the granny or the pram and since then we really have learned a lot. One of the first things that we learned was that our theory that there was a lot of industry capability in the U.K. was absolutely correct. We have one hundred million pounds that we called our intelligent mobility fund and when we first started we worried that we might actually kind of have a bit too much money and we might flood industry and that has been totally proven to be incorrect. All of the different projects that we've been working on have been of an unbelievably high quality; super exciting. But what we wanted to achieve was a kind of self-sustaining kind of ecosystem. We didn't want to just put money out there, we wanted to make sure that we were attracting industry internationally and that we were, our ecosystem was, kind of, feeding itself and developing across time and one of the things that we got told was to be able to do that you needed to make sure that you, kind of, also got the testing infrastructure there, as well. And this is the next thing that we massively learnt and thanks to industry really. So we said to industry what what would our testing infrastructure look like? What we need to do? And they said you need to do something that's genuinely unique to the U.K. Don't try and build another Mcity or build another Autobahn; that's already happening and they're doing it really, really well. So what does the U.K. have to offer? And what we have to offer is already a kind of massively exciting and massively advanced set of world class assets we already have the Millbrooks, Myers. You just need to make sure that those are ready for the arrival of connected and autonomous vehicles. They also said that you risk, you risk spreading yourself too thin and that's absolutely something that we have to hold our hands up for central government. Pick a winner and this has to be an area where you can expect companies to fluctuate in between so you can't say that some of your testing infrastructure is going to happen in Scotland and some of it's going to happen in kind of, sorry that's not going to work. The next thing that they said is that this is for you and the UK in particular. This is about making it so that there is an equal playing field, you aren't catering to organizations which already have their own testing infrastructure. They need to be able to guarantee that they don't have to build their own test tracks because they can just go and easily access what everybody else has. So, we look to our existing trials and excuse the map as a bit of a sherry map but if you can kind of see slightly that there is a kind of cluster of activity. So that's where you need to start focusing your energy. Industry said to us was there are loads of different environments that you want the kind of connected and autonomous vehicle testing to happen in. You want it happen in urban megacities, urban regional cities, parking into urban and high speed and handling and these need to be both in a controlled environment and public environment other than high speed and that's not very appropriate. So we said we've got a hundred million pounds again. We're going to do a series of different competitions looking at these so if you'll see. Different competition each of those is going to be a collaboration between different industries. Kind of offering that up and this is all going to be coordinated with one central hub and that one central hub is Meridian. So we announced our winners and by wonderful chance the four winners are your panel speakers today. So I'm not going to, there was a real, you know, like if it hadn't happened the way I would have been off hiding in the corner but we didn't need to because their competitions were fantastic. So I'm going to hide and let them talk about

what they've won and why it's really exciting. So the first person I am handing over to is Alex Byrnes. Alex joined the Williams F-One team in 2002 as general manager with responsibility for the test facilities, car production, and operation and all the support services. He was later promoted to chief operating officer and in 2010, to chief executive officer of Williams Grand Prix Holdings P.L.C. He established Williams' advanced engineering to apply F-One technology to hybrid electric vehicles outside the sport. In February 2014, Alex took up the post of chief executive officer of Millbrook shortly after General Motors sold the business. He has led the transformation of Millbrook into an independent automotive test services provider working with customers around the world. Millbrook is now part of the test and measurement business segment of Spectris SLC. Thank you Alex.

[04:49:02]

Alex Burns: Good afternoon everybody and thank you very much for for making it thus far through the day. I think we've saved the best for last definitely. I think U.K., the U.K. actually is quite a hotbed of collaboration in this area at the moment as you'll hear from colleagues from the U.K., as well. We've been working under the U.K. Automotive Council for many years collaborating in all sorts of areas of research and development within the automotive industry and now connected and autonomous vehicles and all of this is going on around us now is just the next phase of that. So I think we are here as natural collaborators and very open to discussions about how we can take a more international stance and what we're trying to do even though we ourselves working together with the U.K. When I talk about the U.K. I will very well, I'm here to talk about Millbrook Company that I'm very proud to lead. As you just heard Millbrook is part of the test and measurement business segment of Spectris PLC, if you don't know Spectris don't worry it's one of the biggest companies that most Brits have never heard of. Actually but it's about number one hundred twenty on the London Stock Exchange by value and has about nine thousand employees in thirty countries around the world, and the revenues of the business are classically split about one third North America, one third Europe, which I still include the U.K., by the way, and one third in Asia; so it is a global company with very much a global outlook and they acquired us just over a year ago because they wanted to add test services to the companies they have and their test a measurement group who are into test hardware and test software so we kind of round out the piece in what we offer to our customers. And what do we have to offer our customers? What we offer is quite a range of services very much focused around testing. General Motors founded Millbrook Proving Ground in the late sixty's because they wanted to do more testing of vehicles as fundamentally our heritage and over the years we've grown to offer a broad range of testing services. Powertrain is our biggest and heavily regulated, of course, like this space will be in the future but is not yet. Safety is the next biggest, vehicle testing alongside that, and these are the areas really where we put connected and autonomous vehicle testing. We see it principally as a safety issue and it also impacts on the whole vehicle attributes, as well, so it's important from those areas so as I come back to the details of what we do in a couple of minutes. Principally, we see as a safety issue moving from offering passive safety testing to offering passive and active safety testing. We also test tires, principally actually in Finland where we have many

thousands of acres of Winter proving ground so if you want snow and ice we have lots of snow and ice. I have to tell you we actually have snow twelve months of the year in Finland. We have some very innovative indoor facilities when snow falls in February or March, we bring that indoors into to two huge freezers one that's a straight line and one is a closed circuit and actually we have people today driving on snow that fell last February which I think is quite a technical achievement. We are refilling those facilities over the Christmas break. We do various other pieces of testing as well particular type approval testing so we have an investment into doing type approval work as you heard earlier. That's the European way of certifying vehicles for the roads and I think it's very relevant to some of the discussions we have to have around connected and autonomous vehicles for whom we provide these services. Automotive is our biggest market but actually by no means dominant, you'll see most of this is really around transportation generally but we are heavily invested in trucking off-highway, the larger vehicles partly because of the GM heritage that they are meant for trucks in the U.K. when they set up an older part of because we've recently taken on the label and technical center as well which is just average for buses and trucks, originally. So we are heavily invested into into the transportation industry and I do think that particularly some of the larger vehicles are the ones that are going to be early adopters of some of the commitments on most technologies that come through. So what are we doing in that in the CAV area, we have are a range of services that we offer just heard are expanding significantly as a result of the of the current competitions and grants that are going on through the U.K. government. It's part of our collaborative efforts to go on within that I think that I won't go through all of them in detail but I think the thing that we really want to highlight today is our award of being the controlled urban test environment within the U.K. So we're doing that in partnership with another site in Oxfordshire about fifty or sixty miles from main site in Bedfordshire, and between the two sites we're going to create a number of different urban simulation environments. So physical simulations of urban environments. We'll do that mostly at Millbrook proving grounds which is a tightly controlled safe multi-user environment that has been has learnt how to operate as a multi user community over many many years of operation. We would then be doing that in partnership with this other site in Oxfordshire which is actually slightly less controlled it's not a proving ground per se, it is a collection of businesses on a site; it's a government site. And we'll be able to take our customers really through doing virtual simulation into then testing in the very controlled environment of the proving ground and then into the slightly less controlled but still relatively safe environment on the Oxfordshire site before that and they go on to the public streets to the to public environments which I think you're going to hear a little bit more about from from Paul and Peter when when they speak later on. So I think you know the fact that we are connecting all of this together, I think what's really important I think it goes to some of the theme of today really is that we are already quite connected in the different streams that are running under the meridian umbrella within the U.K. I think we're very happy to talk about that. I'm very happy to talk about ways that we can expand that to generate more international collaboration in this area and that's something certainly so in the my owner inspectors are pushing me towards because they are a very international company and the same why you're just doing this in your little corner of Europe, Alex? Why aren't you doing it across the rest of the globe so I think that's it for me. I'll close with actually was supposed to be just a nice

picture of Finland. We can never tell if that sunrise or sunset because they happen in both happen in the south in the winter but actually if you drive through that as an autonomous vehicle I think quite a testing environment as well but one of the many tests you know as the we operate for many months of the year OK. That's a quick summary of where we are thank you very much.

[04:56:07]

Ella Taylor: Thank you. Thank you, you know it's fascinating and you just put platooning out there as well and I think that's important to highlight. While we are obviously doing massively interesting other projects but we've been limited to five minutes. So the next person I'm going to be introducing in is Tim Edwards. Tim been with Horiba MIRA 3` for more than ten years where his work has spanned driver assistance systems, automated vehicles, cooperative driving and ITS. Tim was a technical lead for a number of advanced collaboration R&D projects including safe spotwatch and safe rider and the current U.K. Autodrive project. Tim led a range of design and implementation projects for the city circuit. This unique purpose built ITS test facility hosted at MIRA and now advises international customers and have test procedure and test facility development Thank you Tim.

[04:57:08]

Tim Edwards: Thank you. OK. thank you very much. So as we've been saying it is a short introduction first of all to the Horiba MIRA. So, it is a business that's been around for more than seventy years. We have effectively a full kind of spectrum automotive service provider so we work in the vehicle engineering activity as much as we work in the test engineering activity. Our main sites in the middle of the U.K. it's based around a one hundred kilometer proving ground and supported by about thirty seven major facilities as well. So one that's obviously very relevant today is within the middle of that proving ground area is the city environment. So this was actually developed and opened in 2011 so I think we can claim a bit of a first place in Europe, not the world, for a controlled test site and obviously a lot of effort was put into not just creating the physical environment but as we're starting to see with other sites now as well having that controlled radio and wireless environment as well. But it's important for us to remember that that is only one small part of the testing ecosystem obviously we will talk a lot about simulation today various points but even when we look at other physical CAV testing it's really supported by the wider proving ground as well. Most of what we do today to meet existing regulations and standards actually wouldn't take place within that complex urban environment. It would take place on the wider circuits where you can achieve greater distances, test durations, and speeds. And so as we just mentioned with the Meridian activities, this will be extended even further. The additional space created at MIRA for exercising CAVs in high speed limit handling situations. But actually in a little bit of a break from from what we've mainly seen today I was going to talk a little bit about collaborative R&D as well. So there was already a reference in Ella's introduction to the U.K. Autodrive project. So this strikes me as a very interesting project because we've got a mixture of the traditional automotive value chain with some disruptive companies as well so we have people like Jaguar, Ford, and Tata looking at passenger vehicle applications of ADAS, all the

way up to highly automated driving and then we have our D.M. which is shown here in front of the vehicles on the U.K. Pavilion downstairs so you can see that vehicle as well. And they're actually obviously looking at low speed fully automated transport services. So MIRA has been part of that consortium to be actively working in the verification activity and the projects going through a stage development we've actually finished now proving ground trials and the vehicles are actively being tested on public roads. One thing I want to talk about a little bit through this is safety and not just safety through verification but safety through a kind of rigorous engineering process. Something that we have sort of taken beyond the state of the art within this project so we focused on trial safety and what that really means because obviously when you're not developing something to a production level it's not always viable to put all those protections in place of what other mechanisms can you put in place to manage safety when we're doing road trials today. So one of the projects I wanted to mention was SAVVY so this is a much newer collaborative R&D program so the point of SAVVY is to look at the end to end engineering methodology for automated vehicles and ADAS so we know that there's no real kind of precedent in automotive that's going to scale to the complexity of next generation cap systems so there's needs to be changes all the way through this engineering process that might include things like model based on test automation and simulation. So that's what this process will be directly addressing and it's doing it independently of a particular OEM or a specific end application. It really is trying to put the framework in place that's going to scale. So from MIRA, we're really interested in OK, the simulation capability out of the day, what do we need to do to actually be able to make a good safety argument that something is robust based on a lot of evidence and simulation. And also my slides like to get ahead of me. Also, there's an element here through a company called Metal Software who are introducing elements of artificial intelligence. So again the question is, came up a few times today, what can we do to make sure we're properly assessing the safety of artificial intelligence? It's not just a matter of brute force verification and repeated testing it needs to again look at that full engineering workflow. So, to try and make sure I finished roughly within my time, there are some other projects I would like to tell you about them, perhaps you can talk afterwards. If you point out some of the main ones actively running in the U.K. at the moment that we're involved with. There's the U.K. site project, as well. This site is focused on the more connected end of CAV and doing a lot of public road evaluation creating a test bed effectively that people can come in use for further work after the end of the project. This five star mentioned here which is specifically looking at the arguments for assurance of cybersecurity capabilities and finally human drive which is an active consortium looking at trying level four autonomy in the U.K. road network. So, thank you for your attention. It was a very quick whistle stop tour of a couple of programs. Thank you.

[05:02:58]

Ella Taylor: Thanks so much for that, thank you for mentioning safety. I think it's absolutely integral that we flag that every time we speak really. So, the next person I'm introducing is Paul Jennings. Paul is an Oxford educated physicist who has been with WMG Warwick manufacturing group. For over twenty five years leading automated research with industrial and academic

partners since 2014 Paul has led WMG's multi-disciplinary intelligent vehicles research activity which draws on capability from across the department including complex electrical systems, communications technology, experimental engineering, cybersecurity, modeling and simulation and new business models. There is a particular focus on the need for new approaches to test and evaluation for connected autonomous vehicles and led the team which created WMG's new 3 X-d simulator for intelligent vehicles. Thank you.

[05:03:56]

Peter Jennings: Thank you and thank you to Kevin and Susan for the invitation for attending today; it's really great and I'm pleased to be here. I'd like briefly just to introduce you to, to explain the simulator that was already mentioned and then a little bit more about some broad testing and our Meridian initiative, and would just like to finish with a few random thoughts on testing. So who is WMG? Well we are a department at the University of Warwick. We are a multi-disciplinary department and I think one of the one of the things that's a little different about us is that all our research is done in partnership with industry, hopefully to benefit local and international industry. So we tend to focus on real world problems working in partnership with industry and being in the West Midlands of the U.K. a good deal of that is around the automotive sector. And I think it's not only a way multidisciplinary group we're a multi-experience groups. If you look around teams probably about half of our teams have come from a traditional academic route with very significant industry experience which again helps us to deliver applied research. Also, I'd like to mention that next year I think the building opens which is the national Automotive Innovation Center which is a WMG building on the Warwick campus with a lot of funding coming in from Jaguar-Land Rover and Tata Motors but the intention is that it is a hub for national research in the automotive sector in the U.K. So it's open for other institutions and other organizations. The research agenda there is about how to make vehicles greener, lighter, and how to make them smarter. Now to start with, I want to mention I guess an innovation that we created at WMG a couple of years ago. We've talked today about different approaches to testing from the virtual world to control testing, to real world testing. And we maybe can make it maybe a fourth alternative where we thought that would be an advantage for having a real vehicle with real people inside but we actually simulate the world around. That means that we've got complete control of the operating environment and we can test any scenario or use case if we can deliver this vision so our intention was to be to create a facility where we could look at any new technology whether it was only vehicle whether it was communications technology or whether it was even a change in the infrastructure. And then we could actually test in these representative real world conditions. So our challenge is that for any vehicle, we can actually create the sights and the sounds, crucially the traffic and the people and then one aspect that we think is unique and we think is really important is that our simulator is actually built in a screened room. So our intention and where we are at the moment is to be to control the connected environment as well such that we can do that in a safe and repeatable manner; whether it's 3G, whether it's GPS 4G, and eventually 5G. And then if there's a signal drop out or a cyber attack, we can see what will happen with the user involved and actually safe, controlled and repeatable

environment. So that's a focus for a lot of our research at the moment. We are working with a number of partners. No secret here with a Range Rover but also I think you've seen the the Audi pods on the U.K. stand and we're actually using this facility to help accelerate the learning of the development of the IT. So where do we see this sitting? Well I think we've seen a lot today about the different approaches we really see the testing continuum from left to right from the digital world through to real world trials. Overseas you go from left to right, is increasing realism. But it's only one of the three right boxes can you include the real uses, the actual drivers was the actual occupants of the vehicle. And I would always stressed out human elements in those. I was interested in the presentation from Toyota really which was really stressing the importance of human factors and understanding users. However, it's only really in the left-hand areas that we have got total control of the operating environment. We can look at potentially any scenario. So there's that increasing ability to choose scenarios as you move from right to left. There's also an increasing flexibility to test different technology next and then in the reverse direction to the right you actually need to make sure that high cost; you've got the technology in the systems actually ready to go out there in the physical world. And then as you move from right to left is the potential for increased efficiency you can test many scenarios much more quickly and in fact as you go into the simulated world you can test faster than real time and really what we're trying to do I guess in terms of product development is to be able to test more confidently and more effectively earlier in that product development cycle. Having settled that and I think one of the important things here we'll be sharing and learning across this whole testing continuum in that eventually even though we're trying to move to the left there will be a need to go out into the real world for the first time. And therefore, as was mentioned, we were very fortunate enough to be able to be one of the winners of the recent competition and for Meridian Mobility. And with that we will be creating a real world test bed within Coventry and Birmingham area as part of the test bed U.K. initiative from the Meridian Mobility. And this is a project that will be developed over the next couple of years and again we'll be looking to try to complement the other activities within the U.K. So just to finish with just a few random thoughts. Firstly, I think in this space that people coming from all sorts of different backgrounds and need to be a bit careful on which in terminology even just words like tests and trials and evaluation, the living labs, I think they all got different meanings to different people so we need to be careful even use cases scenarios and test cases a very specific and fortification of validation so we need to have a little bit of care that will come in from the same direction. I think also when we think about testing we're often thinking about dependability whether things are safe, secure, robust and reliable but testing, especially when we go into the real world, is actually more maybe about demonstration involving users and looking at social acceptance and measuring whether things are becoming more efficient or safer. We also need to understand that human angle about desirability and commercial viability when we go to full demonstration of deployment that maybe other facets of testing. Recurring themes today, how do we choose these use cases scenarios and test cases. We talked about people, talked about the hundreds of millions of miles, feeling is it's very much around the edge cases in the corner cases that perhaps is where we need to focus on and that was part of the motivation behind our simulator. And then there were some really complex issues. We've talked about understanding the character for human behavior in the testing, is the

area of emergent behavior. Very often when you stitch complex electrical systems together things don't quite behave as you would expect it from them individually or in simulation and therefore at some point we need to move to the real world and be able to understand that emergent behavior. If we're connecting vehicles together into the infrastructure there's probably emergent behavior that we haven't yet experienced and then the whole way around artificial intelligence and machine learning. Even if the elements are pre-trained all especially for maybe learning when they're out on the road, how are we going to account for that. And finally, I think the theme of today; It's so important that we manage to share learning and data across that test stream continuum between different partners and between sort of all sorts of different sectors in different industries and different initiatives but at the same time I think we need to recognize that there's a lot of very sensitive IP within this, in terms of the controls in the different sense of technology as well. So we need to learn how we can share knowledge and at the same time protect the IP of those other companies who need to use these testing facilities. So I think it's not a question of if, it's when this technology is coming up. I'm going to advocate as well I think there's a lot of societal benefits, but I think this is all about making sure they're safe secure and robust, you know a really complex environment. And to do that we need the existing facilities and there's a lot of novel facilities as well which are all really exciting; we've seen a lot of those today. But I think as well as the dependability we need to think about making sure we understand the human element because in the technology going to be desirable and also commercially viable as well maybe today we've talked less about things like mobility as a service in new supply chains and new value chains. I think when we commit to deployment, vote will be on the agenda, as well. So thank you very much.

[05:13:00]

Ella Taylor: Thank you thank you so much for that. I've had the pleasure of experiencing the WMG simulator and I can say that it's fantastic and made me question the two of us. My final speaker today is Peter Vermaat. Vermaat is the principal ITS consultant for TRL. Peter has over twenty five years experience in the electronics communications and intelligent transport businesses including research and development, product development, systems engineering, integration test and operations. His principal areas of expertise are in the fields of cooperative and automated vehicles where use of charging and more recently in low carbon vehicles. He has been the technical lead in a number of C-Cap projects for both E.C. and Highways England in the U.K. Most recently as TRL's technical lead in a project investigating the feasibility of providing connectivity on road corridors in the U.K.'s strategic road network. Thank you.

[05:14:03]

Peter Vermaat: Alright so I have the honor of being the very last speaker I think of this extremely interesting day. I'm going to be talking about the smart mobility living lab in London. Which is the fourth of the competition winners for the the Meridian competition. SMLLL is providing a test bed in a very urban environment one of the biggest cities in the world, one of the greatest cities

in the world, dare I say. First of all, I'm going to tell you a little bit about TRL. You may not, you may or may not know about us. TRL is the Transport Research Laboratory. It's been around for, I think, since 1933. Originally part of the Department for Transport, we were the research arm of the of the U.K. Department for Transport. Quite a few innovations over the years have come out of TRL. Some you may not thank us for. We invented the roundabout or at least the way the current roundabout works in the world. We also designed the euro m-cap crash testing regime. And we did the initial research that led to the banning of using mobile phones while driving in the U.K. Although sadly, that was implemented not quite as according to the research and research actually says that using the mobile phone is the danger, not holding it in your hand. But the politicians decided that or the police largely decided, it was my understanding, that it's really hard prosecuting somebody for using a mobile phone but you can see him using, hand holding it it's much easier. Our current work related to this is we are running the Gateway project which is, which is one of an earlier competition looking at or to one of his vehicles and actually the Gateway project is highly relevant here because it led directly to this; to the Smart Mobility Living Lab because the test area that we're using in Gateway is the same as Smart Mobility Living Lab. So, where is it? It's in Greenwich, in the center of London, well just slightly to the east of the center of London depending on your particular desires for what you want to call the center of London. It consists of two areas specifically the area below the river is Greenwich and that is quite a nice varied area where we have a number of numbered points there, for example, point number one is the shuttle test area where we will be running a shuttle from the Millennium Dome to the metro station there to the local, two local businesses. There's a nice quiet residential area at number two, there's a historic area of old buildings that area number three. Coming in from the bottom of some major road corridors leading to Blackall tunnel which goes under the river at point one and there's a lot of industry around the whole area as well but then we've got a second area which is the Queen Elizabeth Olympic park at the top. An area that was completely redeveloped for the London Olympics. So it has a lot of very modern infrastructure. And in fact we're setting up one of our two test headquarters. One will be in Greenwich, one in Stratford. And we believe this is a fairly really unique environment for for testing in urban centers. Who is the team? We have eight major partners. Transport for London, one of the world's leading transport authorities for urban transport. Digital Greenwich, the second one along these D.G. cities is Greenwich, is very proactive in digital infrastructure and they are backing it the both the Gateway project and this project extensively. We have a big infrastructure provider Costing, a network company Cisco, which we all know about, and Cubic, a transport systems company. So we have an academic connections with Warwick University, Millbrook providing some testing expertise, and as a delivery partner is the University of Surrey who have a 5G innovation center so they will be providing next generation cellular capability. So what are we going to be doing there? And who will our users be? We see six principal areas of testing there. Clearly the one that will attract a lot of focus is vehicle validation. Where we see the clients as being OEMs and the automotive supply chain. Building expertise in creating CAV-ready cities. Transport companies or technology companies would benefit from that. Access to a flexible technology program, provision of data services, data storage analysis, integration and this fits well into the theme of big data that comes out in a lot of the automotive, I'm sorry, autonomous driving work.

Development standards, clearly, and because this is really leveraging in the the location is it's a really good high profile launch site so it makes it's very visible, it's very iconic. And is really good for that. Kind of things we'll be doing there? I think the target groups are three the collaborative innovation R&D programs. These are big, largely centrally-funded in the U.K. A lot of the funds will come from innovate U.K.. Clearly there's a market for private R&D programs of that individual companies who have something to test but we also see something what we call a shared R&D program which is companies banding together to test in systems integration. And doing all of that in a complex real world environment which we think will be very beneficial. I think that's about it for me. The shuttles you see in the middle there of the Gateway shuttle, you can actually see physically the same device down on the U.K. stand downstairs. It's painted in Westeel sport colors because they are actually the people who created, who built it for the project. So, thank you very much.

[05:22:10]

Ella Taylor: Thanks so much for that Peter, and thank you for reminding us that actually these customers aren't just the people who are building the devices themselves but actually kind of the repercussions are huge for other industries, as well. If you'd like to join me and we can start and we can throw open the floor to questions. I have a couple for myself, so I think it's very interesting and I haven't had an opportunity to ask these to you guys, yet. So my first question is really around how you keep the infrastructure current? So, these devices their still in the early stages of development. Since I think as I said, I promised I'm being quite reflective, but since I joined this team the communications infrastructure has changed; the standards are developing. How do you keep your testing ecosystems up to date and how difficult is it?

[05:23:10]

Alex Burns: First of all, I think it's expensive. I think is probably the first thing to say. I think part of our current program is to equip certain parts of our proving grounds just with a lot of trunking in cable and in order to provide an environment on which people can come and plug the latest innovation in communication and test it in a vehicle environment. That is one of the things that we're offering as a test environment is to say actually come and test the latest in communication infrastructure you know, for example, 5G. We are getting ready to emulate 5G initially and then to have 5G, for example, on site. One of the interesting aspects of Millbrook is we have a hill route which is built into natural folding hills. it means that the the cellular signal is very strong in certain parts and then two hundred meters further on drops out completely because the topography with 5G and its shorter range. What's the impact of the topography on the 5G? The sort of thing that we can test so I think we try and provide a test infrastructure. People who leave some of that get behind and their task to keep it up today

Ella Taylor: Thank you.

Tim Edwards: So for our controlled environment I think we take a very similar view to Alex that you want to kind of flexible reconfigurable in the structure and obviously that makes it a little bit more cost effective. On the flip side the thing that can make it more expensive though is that we're not just interested in provisioning perfect network coverage. We want to reconfigure the networks, create things you're seeing naturally with your landscape. There's other things you can't measure naturally that make it go in a proving grounds you need to create those artificially.

Paul Jennings: I think it comes back to collaboration. Again, I think it's having a collaborative environment. I think it's around recognizing that we are quite well beyond automotive there are communications companies, infrastructure providers. And I think it's making sure that we've got an exciting development arena for them as well so they learn just as much and then they're incentivized to actually keep the latest technology there. Just as an example with a simulator. I think because we've got automotive pack around, we started probably primarily with automotive interests of mind but since we've been up and running it's a lot of infrastructure companies and communications companies that have been very interested in using it and its potential.

Peter Vermaat: This advantage of being the last one is that I think mostly, most of the issues have been addressed and I absolutely agree collaboration is a big one. The other thing is that you need to keep in contact. And that's part of the collaboration I guess with the the cutting edge providers so that you you know what's happening out there. So you know in our case we're using 5G innovation center, who probably know as much about 5G in the U.K. as anyone outside the actual Tel-Cos themselves. The other thing is actually is being successful in being prepared to reinvest. If we don't get clients, we're not going to run a good test service and we're not going to be able to help bring in the money to keep it up to date because the funding that we've got for from you guys is there to set the system up. It's not, it's not there to keep it running. That's our job, so our job is to run a decent test center and the way we will get you guys coming back to use it is by keeping it up to date so the incentive is on us.

[05:26:44]

Ella Taylor: Thank you so much and say some of you guys have touched on this and I think we often get told that the U.K. one of our main selling points is the fact that we collaborate quite well. You know we've funded lots of competitions with different industries and testing infrastructure has got local authorities involved as well as industry as well as academics. I'd be interested to know what some of the challenges are for collaboration and whether or not you still think it's worth it.

Peter Vermaat: In the high tech environment the biggest challenge is intellectual property I think. A lot of companies spend an enormous amount of money in the figures that are talked about about what has already been invested in the technology which is not available yet despite what Tesla says. There isn't a car that you can buy that does proper, full time completely hands free autonomous driving on the road. And the numbers, the amount that's been invested is already in the billions. These companies need to get a return on their investment. They need to keep the IP safe. On the other hand, the whole system is so complex it goes so far beyond the automotive

companies that they also have to cooperate and have to collaborate. And that that tension between intellectual property and collaboration I think is one of the big big ones.

Paul Jennings: I think the collaborative R&D programs in the U.K. have been very good for being able to break down all of the various I guess in automotive research over many years tends to be the similar sort of consortium you know but I think in the recent competitions through C-Cap, kind of you're seeing quite different consortiums taking shape involving communications companies, infrastructure companies, local authorities, insurance law firms. And I think it's through that research that trust is going to, understanding is going to, so I think that's a good way of trying to bring things together.

Alex Burns: I think that we should not ignore is that competition is sometimes a bit of a barrier to collaboration. Tim and I most of the time compete for our customers business has to be said. But there are certain areas where where we do come together. I think you know as proving grounds in particular, safety is our number one watchword and we have all been collaborating for many years in terms of the safe operation of proving grounds and other test sites. I think that perhaps naturally draws us together. I think, you know, the fact is we all see the societal benefits and the economic benefits that come from adoption of these technologies and if we don't collaborate, the process will be much slower and more expensive for everybody and will take longer. So, I think there is, I think we all acknowledge that there is an imperative for us to collaborate in this area at the moment in the same way as we do on safety because it is actually first and foremost a safety related issue.

Tim Edwards: So I think there's very little left, just very good and all I would say is that autonomous systems is clearly kind of perceived as being such a big market. There's a lot of people trying to keep their hands around the valuable data they have and clearly there is this compromise to be found somewhere. I think the opportunity seems to be really in the kind of supply chain that's going to support those companies and in the test sites those would be the areas where we have to engage as we have to kind of use that leverage to open up the data a bit.

[05:30:19]

Ella Taylor: Thank you and I know from speaking to some of the projects one of the things that often gets raised is shared computer system is being a real issue and everybody being able to access everybody else's files. What advice, would you, sorry this is one of the questions from the floor now, what advice would you give the US government for guards to successful collaboration?

Tim Edwards: Yeah, OK. Not sure who asked that but it's very good question and before you get it, you can ask every one of any of the groups today. So, clearly everyone's looking at collaborative R&D. I think one of the things we've seen most of today is probably the very big expensive investments in test facilities so it's not necessarily something that would directly led in the U.K., yet, I don't think. But it's something that I'm really keen that we all try and learn from, is that the test facilities take a long time to build. They take a lot of money and really you are backing something which is not fully yet specified. You're trying to foresee what's the application going

to be, what the test is going to be, so to me that's the area where we've got to, you know, we keep the question areas. We've got to get those right between us before we necessarily built too many more high value test sites.

Paul Jennings: I guess money is good and competitive R&D is a good thing especially when the projects can only be achieved by bringing certain consortiums together. So, it's around the whole being greater than the sum of the parts so I think the competitive R&D is a good one that does bring people together and not just for the art project but it tends to create long standing relationships as well.

Alex Burns: Like I mentioned the Automotive Council earlier I think that's been a huge success story in the U.K. and the Automotive Council was set up when I think the U.K. automotive industry hit what is now seen as a trough rather than being a downward slope. Is that happy coincidence? Not entirely, I don't think. The Automotive Council is a regular meeting with very senior levels of government, with very senior members of the industry that happens behind closed doors with the intent of working together to improve the prospects for the automotive industry in the U.K. and that has spawned many subgroups that then look at different areas: supply chain, scales, technology. And all of this is now being guided by by the technology group that sits under the Automotive Council. So, having that formal structure which I think is quite unusual actually is something we would say has probably been part of the successful reemergence of the automotive industry in the U.K. over the last seven or eight years.

Peter Vermaat: I'd like to extend it slightly beyond the U.K.. I think a lot of the innovation that's come out of Europe has been because of direct investment by the research arms of the European Commission who have pumped an enormous amount of money into projects where they absolutely insist on collaboration and insist on multinational collaboration and I think that by insisting on the collaboration between organizations from multiple countries and often insisting that there must be an academic element, as well, that has provided quite a lot of productive output, in the last probably fifteen years.

[05:34:00]

Ella Taylor: Thank you. So, another question from the floor and it has made me kind of grateful that I'm not on the panel on the U.K. And I said the U.K. would like to be a catalyst for collaboration what would be the impact of Brexit.

[05:34:23]

Alex Burns: I think potentially minimal, actually. I think that if you're looking at collaborating across borders whether a country is involved in the EU or not. As a lawmaking body I don't think really has a big impact on that particularly well. I think as Peter was saying there are, you know, international collaborations that already exist, have existed in the EU but also a lot of the institutions that run those are actually outside of the EU and independent of them, so there's no

reason why those can't continue within the European sphere. I think that the politicians in the U.K. would tell you that if we leave the EU, we're much more interested in collaborating with countries outside the EU than we have in the past. I'm not sure if that's actually the case. I think we've always been pretty keen on the international collaboration but I think, you know, I do want to stress we're not turning inwards. We are actually, if anything, turning out with more as a country and wanting to to do a lot more business with countries that are further afield from the U.K. than the EU twenty seven as we now call them.

Peter Vermaat: Right, I'm not sure if I should even answer this question. I have fairly strong views on it. I do not think that there's going to be a beneficial outcome, but I think so much is dependent on what's going to happen in the next year to eighteen months because actually nobody has any idea what Brexit looks like; the politicians say they do, but they don't. Industry doesn't, industry loves certainty and they have no certainty so I'm not as optimistic as Alex. I I don't think it's going to end well but that is, I stress, I strongly stress a personal view. The TRL has no view, as a scientific organization we are entirely evidence-led. Brexit is at the moment completely evidence free.

Paul Jennings: It's a very tricky, if you want to me, I guess collaboration happens when there's a mutual benefit for all the parties and I think in the story that we're talking about today they're going to, those benefits are going to exist with, or without, Brexit.

Tim Edwards: Yeah, I think it's reiterating what's already been said really but obviously for CAV and the supply chain is entirely global. So, we're looking as much in the U.K. to Europe as we are to the US and the rest of the world. And again, and you know we're still part of the European-type approval framework; that's still part of what we're looking at the moment. We're engaged with the international standards bodies, like ISO and SAE, and other groups like that, as well, so I think it's you know just makes us all look to the whole global market.

[05:37:17]

Ella Taylor: Excellent. Thank you so much and what a question to end the day on. Thank you and a round of applause for the panel please.

[05:37:43]

Kevin Kerrigan: So thank you very much for that. Well done, Ella. Great input from everybody from the U.K. We enjoyed that. My job right this at this moment is to pull the threads from everything that we've talked about today and see if we can come up with some cohesive way forward. Before I do that I have one thing that I need to do and that is that everybody who is in this room, has been a speaker on the panel. Susan Proctor has been in contact with you, she's helped you get here, she's registered everybody, she put the information together, and she organized this event and so I'd like to give a great shout out to Susan for all of that. Absolutely brilliant job. So the one word that we've heard today from every single panel, and almost every single speaker, has been collaboration and the question is how do we collaborate? How do we

move forward? And it's obvious from listening to all of the the presentations on all of the different sites and absolutely incredible amount of technical oversight or viewpoints, that there's a great amount of duplication of effort that I don't think we need to do. I think if we can collaborate, we can speed up the deployment of these technologies, we can move forward faster. Some of the things that were talked about were shared simulation environments and data structure. I think we all agree that that would be something that we'd like to see happen. And I do go back to Paul's comments, Paul Jennings' comments about an understanding terminology between the different groups and making sure that we are talking about the same types of of simulations, the same types of scenarios, catalogue scenarios. There's some, there's a lot of work to be done. Common test procedures and targets that's an easy one. So what I'm going to suggest, what I'm going to propose now is that as we move forward I'd like to, you know, Michigan, the MEDC, the automotive office, we've taken this step forward to bring this group together. I'd like to keep this going. I'd like to propose that we reach out over the next six months. We put a group together of the thought leaders in this room and keep this dialogue going and move into something that is practical and useful. And I'm not necessarily talking about MOU; purposeful, actionable collaboration is what we're looking for and so I'm going to work with the different leaders from the different countries that were here today and see if we can bring that together. Culminating, I hope, in a year in Copenhagen that we can continue this dialogue at the ITS World Congress in Copenhagen. And as I was sitting listening I was thinking about the fact that we just heard from the U.K. and from England, in particular, and I was thinking about one of my favorite Churchill quotes. So I'm going to butcher that for you. This is not the end of the discussion about regulation and standard, it's not even the beginning, but it is perhaps the end of the beginning. So with that I'm going to hand it over to the governor for some closing comments. Thank you.

[05:41:43]

Governor Snyder: Actually I have a prop coming. So I do appreciate everyone coming together. All this has been fabulous and I don't want to be out of school but I think it'd be great if we could give Kevin and Ray and some of the other people that put this together a round of applause for your work. *applause* I'm going old school on ya because there are a couple concepts I thought that would be useful to share. I'm not sure everybody in the back can see it but it's more the point of the illustration that I want to get across to you in terms of some thoughts because this is fabulous. We've got everyone together, we've got things to do. I apologize I went in and out a little bit but one thing I can actually report to you that I thought was really cool is one of the things I had to do is I had a great conversation with Premier from Quebec and as I discussed it with him he apologized he couldn't be here but he was so excited. He's already said he's ready to sign up for an MOU with ten countries to move this forward. Because I said I'm ready, he goes I'm with you so let's go. So we've already collected Quebec. But that's the kind of approach we need to take. What I would suggest to you as I walk through this, these few comments is we have to sort of put aside our traditional ways of doing things too when you're talking about something new when you really want to innovate and so I suggest that we're from government organizations, we're from universities or from the private sector or from many different places

and now's the time for entrepreneurship. Now's the time to say let's get a vision; let's go, let's engage, let's move it forward. Understanding we will have every answer but as we go we're going to learn a lot more and be better off than if we sit around and study forever. In terms of how we work together. Again, we need to have at rigor when we're doing the testing but with respect to our relationship and how we collaborate we should just go. This isn't about hiring consultants. This is about moving things forward and I would appreciate you take that approach to think about that. So, a couple things as I want to give you some food for thought in terms of a number of how questions that I think are really relevant to do this. And at first I just hadn't I thought I could come talk about that but I thought it'd be a little more fun to come up here with some graphical format and again don't worry about seeing all the details I'm crummy at penmanship, anyway. So the first question you get, is a question of how long is this going to take? This is a topic that could take a handful of years to make major private research, could take a generation. And what this group is in the key position to do is the find how long it's going to be. And it's not going to happen overnight. Quite often when you hear people talk about this they have this sort of light switch mentality that there's going to be some switch that goes, that says "wow this world's here." That's not how it's going to happen folks. I'm going to skip ahead because I think this is one of the things that when you talk about how this gets put in place it's critically important is the adoption curve between the connected and autonomous vehicles in the current world of unconnected. The question is what's the slope going to be? It's not going to be all the sudden out here at one hundred percent. It's going to take a number of years to move up that curve. And a lot of is going to be down here or up here and the faster we make it happen the better it is this is. This is a world of increasing marginal utility. The more people using it faster has a major incremental value. And the hardest part in terms of the public reception, in terms of how people respond of and how they get this, is down here. This is the scary part. Once it's here everyone goes, well yeah that's obvious that's what neither happened. So, this is going to be the toughest sliding and this is where we're at now. And so this is why when I talk to people I say it's not just about connected and autonomous this is my point that many cases it'll be how well we communicate to the unconnected. That's where V2I, I think is going to be really important during this phase because we need to show benefits to the people not connect to the world about why connected is good. And if we leave them out, and if they're not participating in a material way, they're going to go what do I care? So, let me come back to this and continue. The first one is how long? It will start and we're going to go around a little circle. The next question is how safe? And the reason I put this here is this will not be a straight line. There are things that are going to go wrong and how well this question gets answered and how well prepared we are for that question to come up could define how long and that difference could be as much as five, ten years or more. And when I say how safe, when that accident happens or something didn't go right and in that connected and autonomous vehicle and again it could be something that we just missed in terms of a scenario. It could be because of the weather being that bad. People are not going to automatically assume it wasn't because of the equipment or the logic. The other one is this is where that cyber risk thing is huge. People are afraid that someone could weaponize one of these. You can turn it the other way and all of that. We had the terrible tragedy in Manhattan. If it would have been in Guardian mode, as we saw from the Toyota presentation it would have

been able to go on that bypass. That truck would have shut down automatically. So should we be viewing it as an opportunity to stop those things from happening or is it creating more threat? The answer is both. So, this how safe when the things will go wrong and how well we are prepared to respond to that and understand those issues will materially affect how fast all this happens. The next question is how real is it? The more we can make this real instead of theoretical the better off we are. And that's why having this collaboration of all these test facilities all of us working together is critically important. Believe me when I became governor of Michigan we were the most messed up state and nation; we were fifty out of fifty. And I campaigned on reinventing Michigan. I said fixing Michigan was not good enough. We had to reinvent our entire state and people like that and then I did my first budget and it was a really good idea until I came out with my first budget to deal with a billion and a half our deficit because now I asked somebody to change. Everybody likes change until it affects you and then you go, "wow that's a really good idea, you're talking to me." And the best way to overcome that is to show how it can really be done in a safe fashion. This gets back to not just the online but using those facilities as places they have tours, the visits, to present them to get that on TV the great work you're doing some of the videos we saw today. We need the general public to see that stuff. We need to make it real instead of theoretical. Theoretical tends to be scarier. When people start seeing real things that makes a huge difference. Now what's one of the keys that needs to go with that is how exciting? And you can say well why is it exciting. Again the average public is going to glaze over with this stuff. I had a great, I had an interview in between with one of the automotive publications, and it was great. I love the stuff you know I'm a nerd. So, I love going to all these exhibits but he walked in, it was great the reporter walked in sat down and said, "Yeah I was just in a booth having a discussion about LiDAR." And I looked and I said, "wow, that sounds exciting." And it's exciting to us. How many people that are your friends and neighbors, if you walked up and said well I had a great discussion on lidar. This is where we need to get back to selling the benefits, safety going to zero deaths, that US going to zero accidents; aspiring to that opportunity to help the blind person, the disabled person, the person with economic challenges, have an opportunity get the training to get a great job. Efficiency, making that traffic jam go away, getting rid of congestion, saying we don't need to spend a billion dollars on another lane of highway for so many miles because we have a Smart Highway now. That's, those are the words that should come out of each one of our mouths every time we talk to someone not in this world. To start with what's the value proposition. We're already at work. We're the choir, we were singing to the choir today but the key part that brings us back around the driving force and help a lot of us is this how well we collaborate. And it came up more than once today no single organization can do this. Whether be a government, whether be a company, whether be universally. And the best way to do it is to have us do it together. That's how we can speed it up, we can make it safer, we can make it real faster, and we can promote how exciting is to the whole world. So now hopefully you see why I did my little circle here. I didn't want to just give you a linear vision; these are interdependent and it's a gratuitous cycle of success. It's dependent on how well we work together. So let me take the comment that Kevin made about collaboration and working together. My view is he knows I'm crazy and he always worries what I'm going to make up anyway. My answer is, we just need in addition to getting people doing real work

together, we should do an MOU, we just should sign up. I mean where's the document to say it doesn't have to be rocket science, it doesn't take a whole bunch of attorneys. It can be exciting if we did an MOU without attorneys. I can say that because I am an attorney. But to do an MOU to say let's get as many provinces, as many states, as many countries as we can and again if you have some jurisdictions in your own nation sign us up. The more the merrier. And what I would say is again don't get bogged down in the legalities. Let's get excited about the progress on all of this and it has to be as simple as, how do we make all this happen? So I would suggest to you is I'm happy to have Michigan take the lead of putting something together. I got Quebec signed up already and they didn't even see the document. That's pretty good. So think about that and think about what you're going to do and how fast you're going to do it and let us know. Let Kevin know. Let me know. Let our team know. And let's go because you've made a tremendous investment already. You wouldn't be sitting in your this room if you're heart, in addition to brilliant heads, we've got a lot of I.Q. points in this room, but I'm more excited by your heart. If your heart sees value in this about making the world a better place. So let's put your name on something to say you're signing up. Not to do a nice meeting not to do a nice event but to change the world. And we can make this a landmark event today by saying that. And following through on that. So, I want to thank you for coming today. This has been great. You can see I'm signing up. I ask you to join me. Thank you so much.

[05:55:16]

Kevin Kerrigan: Thank you so much. Thank you Governor. Thank you everyone for being here. Drinks are served.

END [05:55:21]