The Future of Autonomous Driving

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Deeshraf Elias: In recent years, the mobility field has seen an increase in companies delving into autonomous vehicles due to a confluence of heavy investments as well as significant technological advances. If properly harnessed, autonomous vehicles have the potential to massively change the way we live by providing us with a safer, more efficient and accessible transportation model.

However, according to Deloitte's 2020 Global Automotive Consumer Study, public perception regarding the safety of autonomous vehicles have remained generally split, with many consumers expressing concerns. Why is this so and what needs to be true for AVs to be implemented successfully? Today, we discuss the evolution of autonomous vehicles.

Hi everyone! Welcome to another edition of our Future of Mobility series, bringing you the top voices from the sector - decision-makers, innovators and shapers pushing the envelope on future ideas for transportation and beyond. I am your host, Deeshraf and today, we are joined by Tony Han, Chief Executive Officer and Founder of WeRide, China's leading autonomous driving company focusing on L4 self-driving technologies as well as Niels de Boer, Programme Director at CETRAN, Nanyang Technological University of Singapore. Tony, Niels, thank you for joining us today!

Tony Han: Thank you.

Niels de Boer: Yeah, thanks.

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Deeshraf Elias: First off, Tony, as the CEO and Founder of WeRide, can you share with us more about WeRide's core business and operations?

Tony Han: WeRide, as the name of the company suggests, you can see this company has some relationship with mobility or transportation. So, WeRide is a smart mobility company, our vision is to really revolutionize or change the way people travel and we want to apply the cutting-edge autonomous driving technology, more specifically L4 autonomous driving technology to human transportation. We want the first application we roll out to be a robotaxi service. In the year of 2019, in November, we rolled out our fully, open to public robotaxi service in Guangzhou and made Guangzhou the first city in the world that has a completely open to public robotaxi service. Everybody in Guangzhou, Huangpu district, in the area of 144 kilometres, you can pull out your cell phone, download the app called WeRide Go app and (request for a) car hail service. And, if you (are) just in the right position, you can hail a robotaxi car and the car can just (pick you from) that area and travel around. So far, we have, you know, finished the testing and the operation period of 900 days, and we have given rides to almost 90,000 passengers and we have finished like 2.7 million KM, autonomous driving kilometres. And we haven't (been) involved (in) any accidents that is due to our problem. So, this is what we have done and in (the) future, we really want to continue to sharpen our technology. So that, you know, as you have seen from the futuristic movies, like the car can drive by itself, that's our dream and I think we plan to lead this kind of full driverless robotaxi service within three to five years. That's our vision and goal.

Deeshraf Elias: Niels, you lead the Centre of Excellence for the Testing & Research of Autonomous Vehicles (CETRAN) in NTU. Can

you briefly share about CETRAN and its role in supporting the Land Transport Authority of Singapore for the deployment of AVs in Singapore?

Niels de Boer: Yeah, so CETRAN has been set up first in 2016 as the Centre for Testing and Research in Autonomous Vehicles. And the reason that was done is, it's so nice to develop the technology but regulators like the LTA wants to make sure that any testing on the public roads are done safe. And once the technology is matured, it actually can be rolled out commercially and the regulations are there to support it. When it comes to the legal side of the regulations, I'm not involved in that, that's all internal, but we (are) working, really on the technical standards to support that one. And TR 68 which we developed, is one of the first technical reference, a predecessor to standards in Singapore. We're working on the updates, but we (are) also working very closely with the LTA on their milestone test framework, which is for the R&D phase, as well as what comes after that. So, we actually do testing on behalf of the LTA for autonomous vehicles, for the

purpose of allowing an AV authorization, which allows you to test (autonomous vehicles) on public roads. And by doing that, we've looked at many different vehicles by now. We've seen robotaxis, seen shuttles (and) we've seen buses, so we know that there are a number of 12-meter city buses being tested. Lately, we're looking at utility vehicles, like road sweepers and because of COVID, we've been starting to look at the delivery robots and logistics. So we see a very wide range of vehicles, and (it is) quite interesting to look at all the aspects on that because we do see that developers and regulators are looking at the technology from different angles, and then we're in the middle, in between and that's (an) interesting position to be there.

Deeshraf Elias WeRide identifies itself as a market leader in L4 autonomous driving technologies. The industry normally defines vehicle autonomy as occurring across 6 different levels, from L0 (no automation) to L5 (fully autonomous). Tony, can you briefly explain the other levels of autonomy in AVs?

Tony Han: So, from L0 to L5, I have tips (on) how to memorize these different levels. So L0 is just (not) intelligent at all, okay, so dumb car. So L1, we already call it foot-free. What does that mean? That means like you do the cruise control, right, you drive on the highway and you want to lock your speed like at 60 miles per hour, and that's why it's called foot-free. So, you'll release your foot and (for) that one you can just do this kind of cruise control, that's L1 level. L2 we call hands-free, that means you keep in the lanes. When you drive on a highway and there's some functionality (of) all kinds, for modern cars, you can release your foot and you can also release your hands (on) the steering wheel (and still) keep (within) the lanes, that is called L2 level, (also) called hands-free. And then L3 level we call it AI three, what does that mean? So, like traditional ADAS car, you don't need to put your hand on the steering wheel (and) you don't need to put the foot down on the pedal or the brake pedal. And also, you don't need to actually, always (be) staring at the front, but you have to pay attention to the surroundings. So, if it's anything that, you know, the car cannot handle (by) itself, you have to get into the mode and take over the car because you are still responsible for that car. You still need to own a driver's license to drive that car, that is L3 level. So, L4 level means man's free. So, there's a concept called ODD, if that car is inside your operational region and the car accepts your request to pick you up at point A and deliver you to point B, you basically can fall asleep in a car. You don't need to own a driver's license in order to take (an) L4 level autonomous driving car. And if there's any emergency, the car or the remote operational centre should be fully responsible (for) handling emergencies. Basically, you can fall asleep, that's L4 level. L5 level is just like everything. L5 level is the highest autonomous driving level of car. That is, any place, any situation, any human can drive the car (and) the car can

drive itself, that's L5 level. So basically, you don't need to pay attention to anything. So L5 level to my mind, still, maybe have 15 to 20 years to come, at the highest optimistic level. And I'm also hesitant to say it will come in the year after 20 years, I don't know, but L4 level, I am pretty sure it will come to reality in three or five years. That's my explanation.

Deeshraf Elias: Niels, for our listeners who might be unfamiliar with the concept of AVs, can you walk us through the typical technologies behind most AVs, from the front-end sensors to the back-end data analysis? Perhaps you can give us some examples of real-life applications?

Niels de Boer: Yeah, when you look at the technology, the level of technology depends a lot from vehicle to vehicle, you see, basic components are pretty similar. Every vehicle has a perception system. So, perception system is the range of sensors which effectively look around, see the environment and actually classify the environment around it. Most vehicles have LiDAR or optical cameras, radars are often supplemented, and you perceive your environment around it. And you do your sensor fusion, combine the information from various sensors, and recognize what is around, where are your objects, where is your road (and) where are you located. Once you've got your vehicle, you go into effectively depart planning and the depart planning is effectively replacing the driver. It is determining where you go and that has both of the routes planning, whether it is, how to get from A to B, or even routes planning can be dependent on, whether an AV or not. So, for example, if you run an AV and you know that with your certain technology, you have challenges at certain difficult traffic intersections, (you) can actually route it so that you take the lowest risk route rather than the shortest route, with the technology in mind. Then you actually do your path planning and

that is really the (navigating) - where do I drive the next 100 meters, 200 meters and which lane do I pick? Where do I do, how do you affect obstacles? Then you give it over (to) vehicle control and that is really giving your instructions to the vehicle - "I want to drive at this speed over there and break", and that is your more traditional vehicle control electronics. That said, the level of complexity depends a lot on (the) vehicle. So, if you see, we've seen simple delivery-type vehicles that (we) have on footpaths, they have, sometimes a single radar, and they operate on that. A robotaxi is already getting pretty sophisticated, also taking into account the level of assurance they need to provide and what they need to do, so the perception system is very different. If you go for a bus, it gets actually very complex because not only do you have to deal with the fact that you need to look at traffic, the bus itself is big, tall, square and very long. So, if you have a 12-meter bus, its 3 meters height (and) it's 2 and a half meters wide, it's very big and you really start with a lot of sensors. I've seen one vehicle which had almost 60 different sensors

in and around the vehicle. So LiDAR, cameras, (and) radars to look around, but also ultrasonic sensors around it to detect any pedestrians because for one of these buses, one of the main risks is actually the fact that because of the vehicle dynamics and how it moves, you can sideswipe pedestrians quite easily if they stand close to the vehicle, at the side of the vehicle. So, the application is going to determine a lot to what the number of sensors you have and the complexity of the perception system, but the rest is all pretty standard.

Deeshraf Elias: Speaking of real-life applications, Tony, would you be able to share with us some real-life applications of AVs, aside from robotaxis?

Tony Han: There's actually a wide spectrum of applications. Robotaxis are definitely the most profitable and the most impactful applications, but there are others. For example, as Niels has mentioned, robobus, like a bus (that) can drive itself, and also maybe robotic trailers, you know, we can drive autonomous driving to logistics.

And there are actually several companies doing (a) pretty good job in that area, like TuSimple and plus all the AI. And also, some other applications, like quick cleaning machines, like you can (also) apply autonomous driving technology there. And there's also in China, very, very popular, we call the last mile delivery. You have this kind of, very small robotic cars, like you can just, the car can drive itself and deliver the goods in between the range of 3-5 miles. And I know like (a) very good company called Neuro.AI, they are doing this kind of things (in) US. And in China, like Jingdong, Alibaba and Meituan, they all developed such kinds of platforms. So that's why I think autonomous driving is kind of revolutionary, it will totally change our way of living and it may be as important as (the) Internet. So, I think definitely from policy wise, from capital wise, we need more resources to develop this kind of technology.

Deeshraf Elias: Tony, how do AVs account for the unpredictability of road conditions and pedestrian behaviours? Can you perhaps share some examples from WeRide?

Tony Han: Sure. So, I think, you know, unpredictability is the nature of human behaviour, you know. You can, even as human beings, it's difficult for us to predict or project (what) others will do, right, like we call that squaring around. There are always some people, like totally out of the normal distribution curve - outliers. Some of them are really geniuses. That's the nature of the world. But the real natural question is the safety. How can we, you know, I don't need to predict your behaviour to really make the travel really safe? So, the essential problem we are trying to solve is the safety, and then we can make the autonomous driving more efficient (and) more economic. So, to us, we want the first step, like during our trial operation (and) during

our real operation, how can we make sure (that) the car don't hit anything? And actually, in this aspect of autonomous driving, a hybrid has (a) very, very big advantage. For example, with the sensors which (are) designed by WeRide, we have WeRide sensor suite 3.0. It is integrated (with) one high definition (LiDAR), the six peripheral mid-range cameras, three long-range cameras and five electronic scanning radars. These, all of these sensors, we call the sensor power, (it) is actually synchronized by a specific hardware. These kinds of sensors are triggered to a precision of milliseconds, and we can do a centimetre level resolution within 200 meters. You know, think about this, this is just far beyond the capability of human eyes. Therefore, we can see all the obstacles and we can stall (them). So even (if) there's some unpredicted behaviour, I can stop a car, safely stop a car and let (the) passenger out. Therefore, that's why we say, during our 2.7 million autonomous driving miles, we don't have any accidents. Our car may not drive as skilful or as kind of, so unpredictable (as) human drivers, but it should be safer than human drivers. That's our goal, that's the beauty of autonomous driving. We want to supply safer, more economic, more efficient transportation ways to human beings. That's our goal.

Deeshraf Elias: The huge amounts of data autonomous driving solutions produce create a natural synergy with another emerging technology that's popular these days: 5G. In your own opinion, how has 5G affected the development of AVs? Niels?

Niels de Boer: Yeah, we're about to start on a test track. We're getting a 5G installation early next year so we're looking at 5G. In Singapore, people don't really take much advantage of 5G yet. And I see also that some of the earlier proposed applications that don't take real advantage of some of the benefits of 5G, but I

now see some developers looking at what 5G can do and how it can help. So, we have quite a nice demonstration on our test track, it's not using 5G yet, it is using DSRC, infrastructure-based sensors and senses (the) perception information, or more or less (the) occupancy map of an intersection to an autonomous vehicle, and that helps really the performance of the vehicle quite significantly. So, I think that kind of applications, you might see more in the future and that is something we haven't traded. I think we need to look more at it, is the trade-off between making the vehicle smarter and (making) the infrastructure smarter. I know that some people believe we'll make the car as smart as possible and (not) rely on infrastructure. I have people seeing the other extreme, looking at, we are making the car relatively simple and the infrastructure very smart. To me, it's a hybrid and it's not only a matter of capabilities, but also financial trade-off. And where do you put your investments? How do you get on a system level (with) the best performance and optimization for costs? I think we haven't really looked at that one good enough yet and more work needs to be done.

Tony Han: So, for 5G network, I have something long to say. First of all, 5G is very expensive. Okay, 5G is really, really expensive. Why is that? Let me tell you some statistics. The base station range of all the 4G base station is roughly 1 kilometre and the range of 5G base station is 300 meters. What does that mean? That means the radius of 5G station is around one third of 4G base station. And we know the area of a circle is pi times r square. What does that mean? That means any area you cover (with) one 4G station, you probably need 9 or 10 times of 5G station to cover the same area. So, if your area is a very populated area, very advanced areas like Singapore or like Beijing, Chicago, San Francisco, that's do-able. What if my area is in Midwest of US? Will we invest that

amount of money, to use 5G to cover the whole area? It's very challenging. However, you know in big cities, I think we really do need (to) cover the whole area with 5G, because with 5G network, we can add another layer of redundancy with V2X technology- it can make autonomous driving safer and more efficient. But it's kind of an optimization problem, you have to balance between the benefits that 5G can bring to us and the huge costs of building 5G networks. This is kind of an economic problem and you have to take really, the suitable position amongst this whole curve, you find the most optimal operational point to do that. So, definitely, we benefit a lot from 5G networks, but we need to find the most cost-effective way to do so. That's my opinion.

Deeshraf Elias: Price is one of the factors in influencing consumer decisions. Given the various technologies required for AVs, how do you see companies in the space providing affordable services to commuters?

Tony Han: I think I'm very, very optimistic about the cost, you know, if you have been working in our autonomous driving field, in the year 2017, the price of 64-line of LiDAR, is roughly 750,000 (yuan) and in the year 2018, (it) is roughly 250,000 or 300,000 (yuan). Now (it) is coming to the range of 200,000 (yuan) or even lower price, so you can see every year there's sort of like something, like a Moore's Law- every year the hardware prices drop by half. On the other hand, human labour is you know, because of all the developed countries except US, most of the East Asia countries like Japan, Korea, China and also Hong Kong, and I'm sure even in Singapore, all these countries, they are facing a problem. That is the ageing of the society, humans are growing older and older. We don't have enough young people to drive cars (or) to drive buses. Therefore, the human labour costs of driving a car is growing every year. On the other hand, hardware (prices) drop. The difference between these two curves is your profit margin. Therefore, you just keep on pushing on the technology (and) I foresee

a business with a growing profit margin. What a nice business model, so we need to focus on that and continue to develop it.

Deeshraf Elias: And Niels, what about you, from an industry point of view and you know, from your work at CETRAN, could collaboration or partnerships play a contributing factor in this?

Niels de Boer: Yeah, you need to do partnerships because this whole area is just too big and too complex to do all by yourself. Of course, the partnership needs to make sense too, but I do see a need to form partnerships. I see a lot of smaller companies making the mistake of trying to save costs and is trying to save costs by doing things themselves, but I think in the long run, in some cases, it is counterproductive. So, for example, I see small companies trying to do their own mapping of an area and if you do a small area for a trial, it is cheaper. But if you want to do commercial services, you need to go with a mapping specialist who has multiple customers to make the costs lower. You need to find out also what (is) your core selling point and what is (the) technology you need to make your core selling point work, rather than trying to do everything yourself. So, I think partnerships are very important to go forward, for the whole of the industry because there are more than enough problems to solve for everybody combined. If everybody tries to do it individually, I think yeah, you bite more off than you can chew.

Deeshraf Elias: How will collaborations with existing mobility players help in realizing the new era of autonomous driving? Are there any examples you can share?

Tony Han: Okay. So, first of all, I want to add that I fully agree with Neils' point of view about collaborations. I think there are more problems than more available engineering resources or scientific resources (can) solve. Therefore, we should collaborate. But on the other hand, you know, in autonomous driving industry, there are competitors (and) the competition is very intensive, right? So, give an example, Waymo and Cruise, will they go through collaborations? Currently the likelihood is very, very low, but at different layers like say, will Waymo collaborate with Nissan? Very likely. So, we have to find out, we call it the value chain, and we need to foster this kind of collaboration environment. No company, I mean, no company can build up (an) autonomous driving vehicle on his own. So, you know, if you want to produce from LiDAR (to) cameras, (from) CPU to GPU and to cars all together by yourself, even giants like Google and Apple, they are not able to do so, we have to collaborate. And actually, that is the beauty of industrialization, right? We see the job and also the "can't solve" part of (the) job, and then we collaborate together. So, in that way, I think autonomous driving industry do need to collaborate and to collaborate, I would say, the most important factor, (from) my personal view, is the influence of the capital. The capital has to get involved, to foster these kinds of collaborations. Previously, we have big giants like SoftBank Vision Fund, they actually helped to integrate all kinds of companies together to develop the autonomous driving technology. These days, I think a capital needs to do more things to really make these kinds of collaborations strong, and to make these collaborations happen.

Deeshraf Elias: According to our Deloitte 2020 Global Automotive Consumer Study, there has been increasing consumer pessimism regarding the safety of AVs. How should companies approach safety to potential customers, especially in Southeast Asia?

Tony Han: I think you know, the trends kind of oscillate a lot, right? There are many factors affecting public views, and it's a very, very complicated social, psychological problem and one accident may change the view of

the whole society. So, first of all, we have you know, not only WeRide but every leading company in autonomous driving industry have to try their best to keep the safety not only during operations, but (also) during the technology development. Well, we actually publish our operation report every month and every quarter. And from our statistics, we can draw the conclusion easily, you know. With so many miles we have driven, there (are) so many rides we have given (and) we haven't got any accidents involved, that's excellent record, WeRide, as a company is quite proud of our safety. So that is one thing and in (the) future, the other things, like we have to make sure to convince people to try to take a ride in autonomous driving (vehicle), with more and more people. And think about (this), let me explain (it with) the human commercial plane, right? You put like 200 people in a barrel of steel, and there's some combustion engine that keeps on doing this kind of controlled explosions, to change the energy from gasoline to push (power), and then you put people in the air and then land on the ground. It's very, very scary. But do you feel like extremely scared when you (are) taking the aeroplane? Probably not. First of all, from basic science and engineering perspectives, we prove (that autonomous vehicles are) safe enough. Secondly, we gradually let people try it. And if you do (the) first time, you are going to be nervous but if we successfully give you like 1000 trips safely and you know, (by the) 1004th time, you (will) probably feel like it's just normal. So, we have to take this growth gradually, and in a very, very patient way and we need to publish our reports. And so, we start from low speed and gradually to higher speed. Start from very amenable regions (and) gradually grow to the more challenging regions. That's our way to gradually expand and gradually convince the public.

Niels de Boer: I think Tony explained this quite well, it's very important to first start gradually and (then) expand. So, people always ask me, "when do we see autonomous driving?" and my first response is, "what do you expect?". I think it is important to start and grow it over time, in terms of ambitions (and) challenging areas. That's why it's level four, you have an ODD and the ODD will expand over time. What we see also when we do demos and trials with external parties is, we see actually, in general, quite a positive response to autonomous driving and autonomous technology, especially from people you don't expect it from. I see a lot of elderly people; they find it interesting. They seem to be less worried about the technology than certain younger people because some of these people see the opportunity, being able to get around, they're getting older (and) they're not as mobile anymore. And they can see, hey, if this technology really works, I can go out more and I can go to other places more. So, if we give demo rights to elderly people, they are in general more positive than people in the 40s. So that's why they say it is very important to let people be exposed to the technology and grow it over time. Because I think a lot of the negative feedbacks are actually coming from people who have heard about it, but don't really know what it is like to sit in an autonomous vehicle.

Deeshraf Elias: The COVID-19 pandemic has brought transport to almost a complete standstill in many cities. From your viewpoint, how do you think COVID-19 will affect the roadmap of AV development?

Tony Han: I personally believe like COVID-19 will actually make people think deeply and may in, to some extent help us to accelerate autonomous driving technology. Let me tell you a real story. During the COVID-19, (when it was) first coming to our attention in Wuhan, I asked our engineers a deep question. I said, "are we capable of delivering goods in the streets, for Wuhan?" At that time, you know, the city was extremely short of hands to deliver goods (and) to pick up passengers. At that time, sadly, we were not mature enough to deliver goods (but) today we may be able to do so. So, I just asked them, if such kind of crisis happens again, can we do something for the whole society, for the whole world? And the answer is definitely yes. So, I told my engineers, okay, drive full speed, okay, develop our technology (at) full speed. So, in (the) future if this kind of crisis happens, autonomous driving technology can definitely help because simply using human drivers, that (is) kind of too dangerous, sometimes inhumane to do so. So, if we can use machines to do so, that's great. Second of all, let's put it in the (context) of robotaxi. If this kind of global pandemic happens again, taxi driver is a very important source, actually (a) convenient source for the virus to distribute itself, right. But if you use machines, between trips, they pick up passenger A and finish the first trip, and then we can sterilize the environment. And then, pick up the passenger B and we cut off this kind of transmission, we cut off this kind of virus propagation. That will be very, very helpful. Therefore, I think we really need to think about this kind of problems deeply. And if we can, we should accelerate the development of autonomous driving technology. We, as humankind, gather just like, (to) launch a rocket to Mars. You know, what SpaceX (is) doing, is trying to help us to explore the universe. What we are trying to do is actually on this beautiful blue planet, we want to make human transportation more efficient, safer, and if this kind of crisis happens again, we can do something to stop the propagation of the virus. That's my personal thinking.

Niels de Boer:
So, I think, is it going to accelerate or be slowed down, I don't think it's a black or white question, but the whole COVID situation shows really, why some of these technologies were being developed and pushed in Singapore, in the first place. One of the reasons for diverse technologies, originally from the LTA was manpower concerns, manpower constraints and the fact that we have 55% of our best captains coming from overseas, either Malaysia or China. The other area I can see changes is logistics. We went a lot to online ordering and ordering online is the easy part, but it still needs to be delivered to people's homes. There was one big online supermarket (where) they almost had their delivery system collapse, and it was for a while very difficult to get delivery slots in online supermarkets, so, it's now resolved. I know from some feedbacks that some of these players are looking now, from hey, we had the problem (and) we need to find a long-term solution. Can autonomous technology and autonomous logistics support in resolving this in the long run? So, I see logistics definitely accelerating. Before that, Singapore was a little bit lower in terms of activity on logistics. I expect logistics to accelerate quite significantly after this because there were severe challenges in the logistics area during COVID and due to manpower constraints. So, we're looking at it, I don't think it's an immediate effect but more or less in the medium range, I see a lot of activities speed up because of COVID, because the technology will help to mitigate some of the impacts of a broader society.

Deeshraf Elias: In your opinion, what needs to be true to accelerate the adoption of autonomous driving technologies in Southeast Asia?

Niels de Boer: I think places like Singapore (and) China (are) actually already quite well positioned. We have quite a lot of technology players developing solutions. We have the environment which can absorb autonomous technology. You need to have reasonably structured cities (and) reasonably structured environments, because if you're going to deploy it in Jakarta, some areas (in) Jakarta can handle autonomous technology, but bigger parts of Jakarta are just too congested and too chaotic to deploy the technology. I think one thing still needs to be done more, especially on regulations and infrastructures, because people still have problem grasping the concept

of what it means to go fully driverless. So, we have a lot of old thinking and old regulations, which is really framed around having humans as a driver in the future. And it takes time for all the people around it, regulators, legal, everyone else to say, okay, what does it take? The automation is not a one to one replacement of the human driver, there are changes and the technology that hasn't change, so that's going to be very challenging.

Tony Han: I would love to go to some countries like Singapore. I spent like two summers in Singapore (and I) love this beautiful city. So, first of all, for all Southeast Asia or maybe other countries, there are two profound questions, we need to think about it together. Number one, can some countries, let's say, for example, Singapore, Malaysia or, you know, India, and I'm thinking about, (how) can we develop this kind of technology overall? And think about like the 5G technology (and) think about the cell phone. So probably, you know, some countries developed this kind of technology and share it with all humankind, (in) all countries. So, what we need to do is actually, maybe, we don't need to reinvent the wheel. For example, if I count driving as the wheel, it is a very, very complicated wheel (and) not all countries are capable of developing this kind of thing all on (its) own. So now the question becomes like, if we import this kind of autonomous driving technology, what's the impact it will make to the society? Will that jeopardize my country's social security? You know, this is autonomous driving machine, as a two tons of autonomous driving machine. And if the answer is yes, what kind

of regulations, what kind of standards should we have? Currently, I think especially at the International Organisation for Standardisation, we should actually think about this you know. If we want to import, suppose like (in) Singapore, I want to put WeRide autonomous driving robotaxi, to apply in Singapore. What kind of monitoring we should have, to what extent should WeRide open the mechanisms of autonomous driving to the government? All of these kinds of questions, we really need to solve (them) before we apply (for) it. I still believe (that) in (the) future, WeRide may extend to Southeast Asia. And you know, to us, just like Thomas Edison invented the light bulb, not only (the) Americans use light bulbs, all humankind uses light bulbs. If we develop this autonomous driving technology, fully from my heart, I want all humankind, every (person) in every country, can use our technology. This is something we try hard to benefit all mankind.

Deeshraf Elias: Lastly, what is the one thing that gets you up in the morning and excites you the most about the Future of Mobility?

Tony Han: So, this type of question, my answer is always like this. If you have in your life, just one, just only one chance to define the future, won't you try all (your) best, use all your energy (and) all your resources to do so? I think the answer is absolutely yes to me. So, if in your life, you have (the) chance to define the future, for the good of all humans and benefit the whole society, can't you just spend all your time and all your energy (on) it? I think the answer is very natural to me. So, every morning when is very natural to me. So, every morning when

I wake up saying, if we can put this kind of (autonomous vehicles technology) into reality, and you know, (for) people (to) travel safer, that's what I need to do.

Niels de Boer: Maybe a history first, of why I ended up where I am. I worked for quite a long time in automotive, in tier one suppliers. And in around 2008, I left automotive, I went to another area. And the reason I left the other area is actually (because) the automotive had become very stale, it was all about costs. At that point in time, we wanted to do something very new and we wanted to do something new, (that is) not even safety related but for infotainment. We wanted to look at the open source stuff, and more or less I got told by my bosses, "you cannot do open source, we only take approved suppliers and that's the way it is. Stop it, kill the project". (The) only thing was costs, and we were only allowed to work with a limited number of suppliers. That's been completely turned upside down, all the car manufacturers at tier one, they're all scrambling to get to work with start-ups and new technology providers because they realize that if they stay where they are, they're going to go the way of the dinosaurs and they got to leave. So, to me, automotive got exciting again. And I got back into automotive when CETRAN came up, I was really involved from the start in defining what CETRAN should do and starting (it), so that made it interesting. It got exciting again, and especially, it feels good in the moment to be involved not just making an electronic box, which is 20 cents cheaper, but it's really defining the way people move around, defining the way how cities are being

designed because it actually is affecting city designs, and it is just exciting again. There's a lot happening, and you get the feeling that you're actually changing something, and with fishable results.

Deeshraf Elias: Well, that's all the time we have. I would like to thank both our guests, Tony and Niels, for joining us on this episode. From AV development roadmaps to consumer concerns, this has been an enlightening conversation about the future of AVs in Southeast Asia and beyond. In the meantime, if you want to comment on this podcast or the topics covered, you can send us an email at seapodcast@deloitte.com. That's spelt S-E-A podcast @ deloitte.com. Also, don't forget to subscribe to our podcast to get the latest episodes – we are available on Apple Podcast, Google Podcast, Spotify, Soundcloud and Stitcher. I am Deeshraf and until next time.