TomTom

Zenuity

Tuesday 24th September 2019

List of MAIN speakers	Company	Job title
Erik Coelingh	TomTom	Technology Advisor

IMAGE Slide #2

Erik Coelingh
Technology Advisor

Can I take this one? Yes, okay?

I can confirm that autonomous driving, self-driving car, is a truly transformative technology because it will change the way you operate a car; the way you own or maybe not own a car. It will affect the road transportation system as we know it. And that's a good thing because as Willem said, the road transportation system as we know it is not efficient and it is very dangerous. A lot of people get killed in road traffic and we believe that's unacceptable.

Created by the safety leaders of the automotive industry Slide #3

And because this is such a transformative technology, our company has been founded, a little bit more than two years ago. We were created by the safety leaders of the automotive industry, that is Volvo Cars and Autoliv is a big tier one. Two years ago, these 2 companies realised that self-driving and advanced ADAS systems is a crucial part to remain safety leaders in the future. And developing this technology not only requires different working methods, but also completely new business models. The automotive industry is very much organised around bending metal and all the timelines that it has for bending metal. This technology is much more software intensive, much more data intensive and that's why we decided to carve out a development of active safety software in self-driving cars, software from Volvo Cars and from Autoliv, and build a new joint venture around it. A pure software developer focusing on this type of Technology.

And I can say that Autoliv has since then spin off their electronics business into Veoneer. And today Veoneer is 50% owner of Zenuity and Volvo Cars is 50% owner of Zenuity. And what we do is software development for sensing, driving policy via control. And we partner with TomTom when it comes to mapping. We already had the workshops before Zenuity even formally was founded. We were sitting together to understand how can we build together a complete stack for vehicle automation.

And we're working on that, full speed ahead since two years ago.

Our product roadmap – pushing the boundaries of ADAS and AD Slide #4

We have made choices on how we want to develop this technology because when you talk about a self-driving car, it can mean a lot of different things. Some people may think of a self-driving trucks or robot taxis where there is not a steering wheel at all, while we focus on automation for, let's say, privately used vehicles. That is vehicles that still have a steering wheel, they just sometimes drive manually, but sometimes drive autonomously. And we believe that it is a very attractive way to enter the era of self-driving cars, because ADAS is happening in almost all vehicles. I mean, NCAP is requiring that for all vehicles to get a good rating and we also see from the OEMs that a new vehicle just has to have at least a camera and ideally more than that. And by being able to build an ADAS business in

parallel to a self-driving car business, we can move step by step forward and deal with uncertainty around creating revenues around self-driving cars, as opposed to doing robot taxi vehicles where you don't create any revenue until you completely solve the automation problem, which is very challenging. We instead do this hand in hand with ADAS such that we can build the business over time.

Before I joined Zenuity, I had been working at Volvo Cars 18 years in the field of active safety, pioneering in the early days adaptive cruise controls, automatic emergency breaking systems, pedestrian detection systems and things like that. And during those days we actually were never allowed to use a map, because an ADAS system is being offered independently from the navigation system to the end customer and we could not get the guarantee that there would always be a map in the vehicle. Fortunately, that time has passed.

We see that you cannot build a premium ADAS system without having a map in the vehicle and we also see that if you really want to have a leading ADAS system the coming years, you need to have an HD map in the vehicle as well. And on the screen, I tried to depict what we believe we need to develop in the coming years to move forward. We will at the end of this year, early next year, launch the next generation of active safety systems at the Polestar 2 vehicle. New collection of warnings systems features level two vehicle automation systems.

During next year and the year afterwards, we will do a hands-off level two automation where we also use a HD map. And then moving forward into ’22, we will start with unsupervised automation. So that will for us be the first products where we can say to driver now you can do something else behind the steering wheel. That’s a very big task. It's very challenging. But that is what we will do.

Any then moving forward, we believe that automation for us will go— it will start somewhere in the limited so-called operational design domain. For us it will be traffic jam driving towards highway driving. And then over time we will address other use cases that are important for the end user of the privately-owned vehicle. So typically, parking is one of those scenarios that we will target. So we will do ADAS and AD hand in hand, and we will move forward like that.

Building these types of systems, as I said, is very challenging. And probably challenge number one is safety. This technology has the potential to get us to vision zero; no road fatalities at all. But we also realise that we can introduce new risks into the system by introducing these types of technologies. That is: automation can go wrong; computers can crash; sensors can get locked; map may be wrong. All these kind of aspects we have to deal with moving forward.

And that is what we do. And building these systems in order to do that consist of a few layers, and I can use the layers that Willem mentioned: The first one of that is sensing. We have to understand what is happening around the car continuously.

IMAGE Slide #5

An important part of that is the cameras, the radars, and lidars that we are using. You see some results of the 360-degree camera system that we do, where in each detection, in each frame, we detect in this case, other dynamic road users. In a similar way, we do detections of lane markers, free space, barrier signs, and a lot of other stuff and this gives us frame by frame a lot of information about what's happening around the car. We can build in a little bit of short-term memory as well by tracking these objects over time in between frames, but this doesn't give us long-term memory. I mean, the car doesn't know that it has been there before. The only way to get long-term memory into the car is to actually use maps.

The role of the map Slide #6

So sensing and getting the perception environment is really important, but we also want to know where are we in a map. We have to know that for a couple of different reasons. There are the obvious ones like when you do an automated vehicle, it has to take the correct route, so you have to be in the right lane. So that kind of planning we take from a map. We also do some operational planning based on the map. When we know things like curvature, we can adjust the speed and we can adjust the steering so that you can do smooth driving. But also other things, which are actually very safety critical like localizing yourself in a map to only activate the automated driving system when you are at the right location is very important.

As I said, one of the first applications that we work on is highway pilot, highway automation. Thereby the driver can do something else behind the steering wheel. But we have to be really sure that we actually are on a highway when we activate that and not on a road that is parallel to that highway. So determining that you are within your operational design domain is a very critical thing and that is information where we use the sensors of the car in combination with the map. We're constantly comparing what the map data says with what our sensor data says. And only if we have very high confidence that they say the same thing, we allow the system to be activated. If we're uncertain, we decide to not activate it. So there you can see that also in those kind of safety critical events, the map plays a very important role.

Collaboration with TomTom Slide #7

As I said, since even before the start of Zenuity, we started to work with TomTom. At an R&D level to do, let's say, mutual learning. Doing these kind of vehicle localisation, knowing exactly where you are in the map, in which lane you are, what's in front of you, what kind of curvatures, is there a barrier to the left, is there a barrier to the right? It's new technology and we're still in relatively early days but together, we have been exploring these kinds of models. What is it that a sensor actually can see? How can you represent this in a map? How can you maintain the freshness of the map over time?

Those are things that we've been working on together since the last two years and we're making really good progress in that. But also probe-sourcing is a very important area and probe-sourcing is a technique where you use vehicle sensors to detect for example, landmarks or lane marks or signs or something else where the car detects them. You send them to the cloud. You compile that into the map and you can send an almost real time map back to the vehicle. And this is a technique that I believe is going to be super important in the coming years.

We have built early prototypes together with TomTom where we use Zenuity vehicles, with a Zenuity camera that detects traffic signs. We detect that, we can compress the data, send a small package to the cloud and from the Zenuity cloud we sent the roadagram to TomTom, who then integrate this into map and can update the map with a traffic sign that we detected, but it was never seen before.

And this kind of mechanisms will be built into the fleet of cars in the coming years, allowing you to have real-time maps available for highway automation and for ADAS systems. And for ADAS this is important because it can really improve the performance of the ADAS systems. But for vehicle automation this is important because it will improve the availability of vehicle automation. As I said, we can only automate when map and perceived reality correspond.

So these two are key areas that we have been exploring, that we will explore, and we will learn together moving forward and those are key techniques, both to make driving safer and putting ADAS technology in more and more vehicles. But it's also a technology that is going to be crucial to enter the area of self-driving vehicles.