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TomTom

MapMaking in the Era of Big Data

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List of MAIN speakers	Company	Job title
Alain De Taeye	TomTom	Member of the Management Board

IMAGE Slide #1

Alain De Taeye
Member of the Management Board

Hi, good morning. I'm Alain De Taeye. I'm a member of the management board, but more importantly, I make maps. I have been making maps for over 35 years. I'm still very passionate about it. And especially because the evolution over the past five years has been tremendous. There's a lot of technology that came in our mapmaking world, technology that has one aim only and that is to make our maps better, to make sure that we can deliver them faster and to make sure also that we deliver those maps at low cost.

MAPMAKING IN THE ERA OF BIG DATA Slide #1

What you see here on the screen is not an animated map and it's key for my presentation to explain briefly what is this. This is probe data. It's the amount of probe data that we collect. And in this case it's Amsterdam. You see actually the map building up of Amsterdam and this is played a bit faster than in reality. This is normally 24 hours. And in 24 hours you've covered the map of Amsterdam multiple times. We are in an age of big data. And big data is hugely important for mapmakers like us.

IMAGE Slide #2

As you know, the applications that use maps have grown tremendously in number, in nature, and so on and so on. We're not talking only about navigation applications. We have application fleet management, it is also pretty traditional. We have applications that are developed by developers that are using our maps' APIs and those can be any kind of location applications that you can imagine. And on top of that, we have new kinds of applications where the map is not necessarily used by the humans as such, but by robots. And I'm talking about ADAS, advanced driver assistance systems, and I'm talking about autonomous driving. The self-driving car.

Now all of that has made sure that there are a number of things that have changed. First of all, the quality of the map needs to be much higher than it used to be in the old days. Secondly, the time by which the map is updated needs to be much faster. We sometimes call that the cycle time. We want that cycle time to be as limited as possible in time so that you have always the freshest data that you can have. And to do all that you need an amount of resources and because of the cycle time that is so limited you need to have a very high level of automation, so that your cost per modification in your database is pretty low.

And I must say that we do that all quite well at TomTom and that's one of the reasons why we, as an independent map maker, one of the few companies that do that at scale.

IMAGE Slide #3

There's a couple of things which I would like to discuss with you and that I think is worth remembering. First of all, mapmaking is complex. It's not that complex to us because we have the expertise, we have the technology to deal with it. But for any company in the world it would be very difficult to produce what we already have in-house. It's not that difficult to make a map of Amsterdam. But if you imagine that there are 68 million km of roads in our database, and then you imagine that you have to keep up with street names, with the speed limits, with house numbers, with postal codes with TMC codes and I can go on for quite a while, and all those things need to be updated quickly and without that many mistakes; with the least mistakes possible. That makes mapmaking at scale very difficult and that's also the reason why we're one of the very few companies that do it.

And how do we do that? Well, we actually created a number of very specific technologies. In front of the building, you see one of those technologies: that is the moma van, that is the mobile mapping van. Actually pull up l'histoire , it's very important to understand that moma van didn't come out of nowhere. And it wasn't invented by Google, it was invented by us. In 1989, there was the first mobile mapping van and it drove around in Amsterdam, in this city. So in the meantime, I don't know which version we have today – it's version 50 or something like that – but we perfected our moma vehicles and they are very instrumental to capture images, to capture lidar data, which in turn is instrumental to make our HD maps and our navigation maps. That's one of the technologies we used.

I will later on tell you more about artificial intelligence, machine learning, which we apply to automate our mapmaking and I will also talk about transactional mapmaking system. It's quite a unique system that we have developed and that was taken into production in the year 2016 and we developed before that for a number of years and I think that's a unique system and I will explain you what it is all about.

And Harold also already mentioned that we go beyond that and we make actually sure that we create a map ecosystem with our customers. So our customers demand fresh data, high quality data, but they also imply that that data is used by their users, and their users give feedback. And because of that feedback, the map can be improved and we actually enable our customers to do that themselves so that we create around TomTom, a number of very important customers that actually contribute to our map database.

We live in a world driven by big data Slide #4

Let me go back to the world of big data. Probe data is definitely one of the examples. More and more cars are equipped with sensors. That sensor information is incredibly important for us to make our maps better and to do that faster and at lower cost.

600 Million CONNECTED GPS DEVICES IN USE GLOBALLY Slide #5

In that world of big data I'll give you one example, which is – I know you like numbers, right? – and so here are a couple of staggering numbers: So we collect probe data from 600 million devices daily and those devices include mobile phones, navigation systems, telematics systems, you name it. Six hundred million.

IMAGE Slide #5

Now, if you want to have kind of an idea what that means in terms of how much data we get on a daily basis, we cover about 3.5 billion km of road every day. I don't know if that rings a bell, but it's about one time around the earth per second. So that data is incoming and actually enables us to use that data to compare it with our map and to do all kinds of stuff.

IMAGE Slide #6

Here you see the probe data of number of cities and you see differences in the build-up. And New York, for example, we get the data about 50 times a day. Fifty times enough data to cover the whole of New York. Singapore's even worse. It's more dense traffic. There, it is about 600 times a day that we can actually cover the whole of Singapore per day. What we do with those data, is we take that probe date, we compare it to our map and we can find a number of things. We can find where there are new streets. We can find where the turn restrictions or the one-way restrictions have changed and in this way we can update the database. We can also compare the probe data of today with the probe data of yesterday to find out what has changed. So we can really play ball very quickly with regard to updating our map database.

Transactional map making system Slide #7

Let me get back to the subject, I promised to explain a little bit more what is transactional mapmaking system and why is it unique. Most map makers in the past and most map makers today produce maps in a batch system. What that means is you take a map, you store it in a map database, you make all kinds of edits in that map database and then once every month or once every week or once every quarter you basically make a release of that map database. So you have stored all those edits and in the release process, you quality check all the edits you have made. And that is done in a batch process. There is fallout. You correct the fallout and you go back to the release process and at the end of the day, you release your map once a week or once a month or once every quarter. That's the traditional way of doing things in mapmaking.

The transactional mapmaking system works differently. What happens in the transactional mapmaking system, is that any change in reality can be taken through the whole process, including the quality checks and immediately be available as an update of the map to the application, which means that your database is actually continuously releasable and what that means is that with every change of your database, you create a new release. And it happens continuously, so you don't have to wait for a week or a month or quarter. It happens continuously and your applications can immediately use the freshest information that is in your database. That's quite a difficult system to make and we were very successful doing so. As I said, we introduced it in 2016 and I will show you what the results of that introduction are and what that did to our database and to our productivity.

Automation delivers better maps faster, and at a lower cost

Here's what we have today and it is again a staggering number, but we broke the record in August with 2.35 billion modifications in our database in one month. That's an enormous amount of modifications in our database. 85% of those modifications were automated. So 85% of those modifications went into the database in an automated way as a result of what we sometimes call fusion. Fusion is actually nothing more than combining all different sources, that can be probe data, that can be aerial pictures, that can be images and lidar data from our moma van, and fusing those to create transactions that in itself have multiple modifications that are applied to the database.

Now in 2016, we were at the level of 250 million. Roughly. We are now at the level of 2.35 billion, which is almost tenfold. And what happened with the costs, because that's even more important. In the same period, we lowered the cost by a factor ten, which means that with the same amount of money compared to 2016, we can do ten times more upgrades of our database; ten times more modifications in our database, which is kind of a fantastic result and the foundation of that is our transactional system and a much higher level of automation, driven by the usage of machine learning.

Mapmaking transformed through artificial intelligence

How do we use artificial intelligence? Now I can give you plenty of examples, but I'll give two examples which are highly relevant. In the HD mapmaking world but also in the ADAS world it's very important that we capture the sign posts. And the sign posts are captured by our moma vehicles. They drive, they have lidar information and they have visual video information. That lidar information and video information is checked for reflectivity and, as you know, the signpost reflect a lot. We identify those signposts fully automated and we can actually recognise whether it is a speed restriction, whether it is a one-way restriction, whatever. So we have a number of signposts that are in the catalogue which are by machine learning detected in our database. That is one example.

Another example is, through the probe data we will know, for example, where there is a new road, but then we need to pick up the geometry of that road. Well, the way we do that is, we use our satellite images and with machine learning we can actually pinpoint first, based on the probe date, where that new road probably starts and then the new road is fully automatically created in terms of geometry. Those are two very simple examples of how we make higher level of automation in our mapmaking world possible.

Map editing partnerships enable shorter cycle times

Let me come back to the map editing partnership. So what that does – all the previous things I talked about – what that does to our database, indeed, that we have a higher quality database that we can deliver very fast to our customers, which integrate that database in their applications. Their applications are used in some cases by thousands of people, take Uber as an example. Uber is using our maps and there are many drivers that basically know whether there is a mistake in the map or see where there is a mistake in the map, and traditionally what happened is we got that feedback through Uber towards us, we put it in our production process and then basically we provided them with an update.

The way it works today with those map editing partnerships is that they don't have to return us all that information. We actually have given them the tools and the training to, on their own, be able to correct immediately the database. So you can imagine what that does.

It increases the quality and again, it lowers the cycle time. So it makes sure that we have better maps faster. That's what we do with the editing partnerships. It gives shorter cycle times and it makes the map better, which is crucial for all the customers that we have and so they are more than glad to be able to increase the quality of the database and reduce that cycle time.

Making better maps faster, and at a lower cost

So I think as a conclusion, I hope I have given you a glimpse of all the technology we are using in the process, we are using with one goal in mind: To make maps better, higher quality, which in robotic world is even more important, and Willem will talk about the HD map in more detail, but also for navigation and other applications, the quality is increasingly important. The cycle time reduction, which means that you can have much faster updates, that you can incrementally update the applications is crucial in an online world. And as Harold talked about, we are more and more going in the direction of online applications only and that means that the expectation of the end user is that your map is just continuously up to date. With that transactional system we can make that a reality. It's not true for all the attributes we have currently in the database. But as you know from our traffic for example, that we already have online information available and we can do the same thing for many attributes and content in our database. And at the end, we do that all for much lower cost per transaction and per modification than in the past.