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Recently in the United States, I think many of us were a little shocked to learn how far or how much of our daily lives depend now on space; on communications coming from space, on photography... After a series of devastating hurricanes, we learned that satellite photography had enabled Houston and others affected cities, to download photographs of the damage and save the time and expense of having insurance adjustors go out to the site of that damage. It brought home the extent to which space is important to us today in ways we do not understand as well as we should. To solve that problem, we have Jean-Yves Le Gall, President of the Centre Nationale des Etudes Spatiales (CNES).

Jean-Yves LE GALL

I will start by talking about what was said regarding the events in the US and the French West Indies. At CNES, the French space agency, when there are hurricanes or earthquakes, we task all the satellites that overfly these regions in the hours afterwards to take pictures of the world. This is why, after the big floods in Texas, we got radar images from the satellites to show the extent of the damages. In the French West Indies, we got the first images of what happened in Saint-Barthelemy and Saint-Martin to organise relief efforts. As you said, satellites are very useful in many respects.

Today, I am going to speak about another use of satellites, which is for enabling autonomous vehicles, and in particular Europe's Galileo geolocation system, which will enable very autonomous vehicles in the future. Today, Galileo is a constellation of 18 satellites launched over the last few years, which are already delivering promising performance levels and much better levels of precision than any other satellite and navigation system currently available. To be blunt, if you use GPS you know that you are in the Four Seasons here in Marrakesh. If you use Galileo, you know if you are here on stage or in the audience; this is very important, and it makes a difference. We are going to continue to launch Galileo satellites, with the next launch planned from French Guiana with Ariane 5 on 12 December, to have the full constellation by 2020.

There are four points I would like to emphasise and to explain why Galileo is such an asset for autonomous vehicles. The first point is a service offering 10-metre accuracy around the globe and, as I said, Galileo is much more accurate than GPS. The second point is an authentication service that lets users ensure they are receiving the right signals, and not being spoofed. This is very important, especially when you are dealing with insurance or micro-trading, for example, so that you know exactly when an event occurs with an accuracy of something like one over 10 minus nine seconds. The third point is enhanced signals to ensure better positioning resilience in urban environments, because if you have skyscrapers etc., it may be difficult. Galileo is very useful for that. And last but not least is the close interoperability with GPS, designed into the system from the outset.

I would like to tell you in a few words some of the key issues facing autonomous vehicles where Galileo is going to be instrumental. The first issue is institutional and regulatory. Any discussion about driverless vehicles is bound to touch on the word safety. Today, safety is mostly in the hands of drivers and when you drive a car you are in charge of its safety. However, tomorrow we are going to see a new paradigm where autonomous systems will ensure safety. One of the main challenges for that may seem something of a paradox, since governments must both guarantee road safety and boost innovation. Therefore, cooperation between the public and private sectors appears vital to progressively build a regulatory framework that favours innovation, while retaining tight control over safety. Driverless vehicles are also an international issue. It may seem obvious, but today we have international stakeholders like the Vienna and Geneva Conventions on Road Traffic, and they seek to improve road safety by harmonising regulations in signatory nations. Of course, work is underway to include autonomous vehicles in these international treaties, because once we have autonomous vehicles, it will be too late to change the regulations. That is why it is so important to start right now.

The second issue is technological and industrial. Fully autonomous vehicles are not going to start operating overnight. Industry plans to roll out solutions ranging from limited to full autonomy, over more than 10 years. Today, five levels of autonomy have been standardized, level five being fully autonomous vehicles. Driverless vehicles will need to be geolocated very precisely and nowadays we are hearing that a vehicle's on-board positioning system must be accurate to within half the width of the tires, which is around 10 to 20 centimetres. In fact, it must be extremely accurate, because you must have the same accuracy everywhere on the surface of the Earth.

Positional accuracy is important, but so is positional integrity, which is the confidence we have in it. If the system gives the position but you do not trust it, it is completely meaningless. Even before technical solutions have matured, we need to address the issue of how driverless vehicles will be certified. This is another very important point and it seems increasingly likely that we will adopt a building block approach, focusing on the sub-system level. Although Galileo is a reality, we still have a lot of work to get its services into the architecture of vehicles, even if it is already very mature on some vehicles.

The last point is how the industry organises itself in this respect, because the organisation has to be very strong on the industrial side. Driverless vehicles are fuelling fierce competition to develop new technologies in the automobile sector, especially with the arrival of the GAFAs and the data-driven culture that will be a key to their development. In this context, most automobile manufacturers have decided to engage in this competition by nurturing their own ecosystem, rather than going it alone.

In a nutshell, it is clear that autonomous vehicles are coming, and it will be difficult. However, I am sure that it will bring a lot of benefits. To conclude, I would like to say that there is a strong need to conduct trials, to allow industry to design innovations for autonomous vehicles and to give governments enough data to inform policy decisions and legislation. From this point of view, cooperation between the public and private sectors will be a guarantee of success. I am certain that discussing this point, as we are very briefly today, will be helpful, but as with many other innovations, things are moving very quickly. While it may seem strange to have a car driving alone today, I am sure that within a few years we will be able to drive, for example, from Casablanca to Marrakesh without drivers. It will only take a few years. In the US, some experiments have started on social issues. At the moment, there are five million truck drivers and they clearly understand that they will lose their jobs with vehicles of this type. However, they will bring a lot of benefits and that is exactly what is at stake.

Jim HOAGLAND

Thank you very much, Jean-Yves.