Realizing the Full Potential of Truck Platooning

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Overview

Three quarters of the total inland freight transport within the European Union (EU) travels by road . This equates to approximately 1,750 billion tonne-kilometers (tkm) of freight. In some EU countries, the amount of total freight traveling by road exceeds 90%. The impact of this has a significant effect on fuel consumption, CO2 emissions, traffic congestion and traffic safety.

One solution that could help alleviate these issues is platooning — having two or more trucks driving in close formation. While it is possible to achieve fuel savings and improve safety with just two trucks in line, platooning formations with more than two trucks realize much larger benefits. Air drag accounts for up to twenty-five percent of a truck's total fuel consumption. The closer trucks can drive to each other, the greater the fuel-saving potential. Carbon emissions on a five-truck platoon can be reduced by ten percent on the highway when a platooning system is in place .

Truck drivers, or lorry drivers in Europe, have been driving in formation for years. Doing so provides advantages such as fuel efficiency, safety and camaraderie. When truck drivers are supported by technology to drive in closer platooning formations, even larger benefits will be achieved in the area of CO2 emissions and fuel usage, safety, and efficiency of transportation .

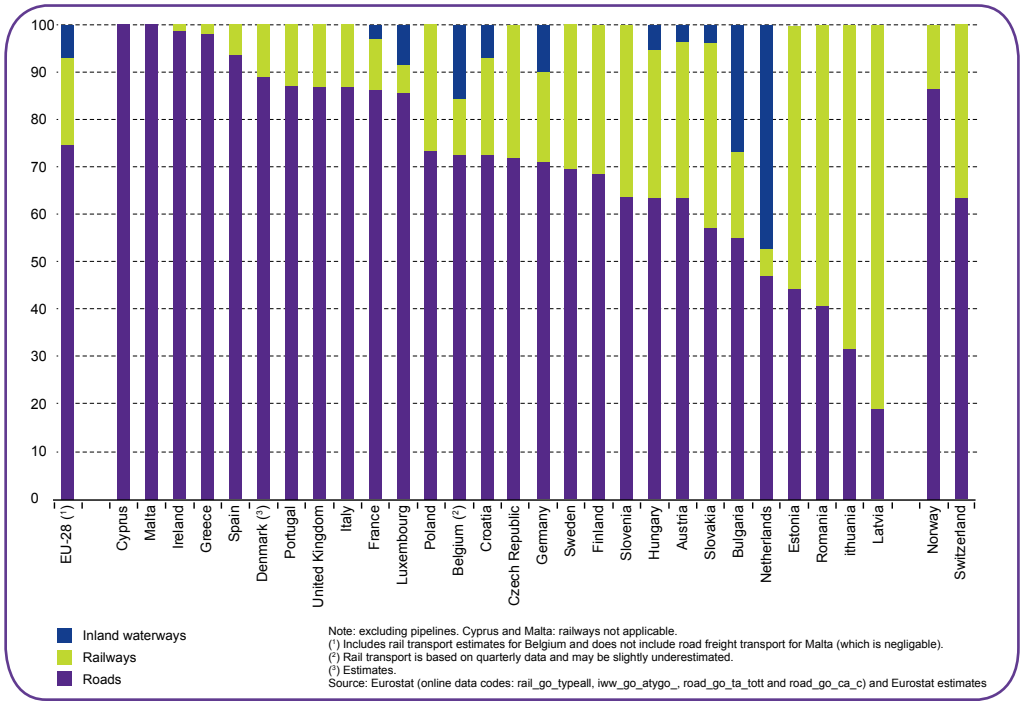

Figure 1: Modal split of inland freight transport, 2014, Source: Eurostat.

Improving Safety Through Communication

Through the creation of a safe, interoperable wireless communications network, trucks and other vehicles will be able to "talk" to each other continuously, sharing safety, mobility and environmental information when platooning. Connected vehicles can also use wireless communication to "talk" to traffic signals, work zones, toll booths, school zones and other types of on-the-road infrastructure. Additionally, these connected vehicles could alert drivers when a potential hazard arises, such as when another car is too close or in the driver's blind spot, thereby giving the driver time to react and avoid a potential accident.

Platooning systems use advanced self-driving technologies, such as those used in autonomous vehicles, to achieve a faster than human response rate. Vehicle-to-vehicle (V2V) communication technology, when paired with radar, sensor data and actuators, reacts 25 times faster than a human driver. This might afford drivers greater peace of mind and, in some instances, keep their hands off the wheel. However, with today's platooning, systems require they stay alert and be ready to take control at a moment's notice. Maneuvers such as changing lanes or exiting the motorway require manual driving of each truck in the platoon. The system, in communication with the infrastructure and all vehicles, alerts the following drivers to take the wheel if and when necessary.

Figure 2: Trucks platooning on the roadway

A Better Way to Platoon

To allow for platooning at close distance, proven technologies need to be combined with recently introduced ones to create a secure and safe system-solution:

1. Reliable, secure and low latency V2V communication is paramount for driving at much closer distances than human reaction time can handle. IEEE 802.11p, also known as Dedicated Short Range Communications (DSRC), has proven to fulfill these requirements.
2. Radar and Global Navigation Satellite System technologies are essential for determining distance and detecting when other vehicles are cutting in.
3. Camera technology is required for accurately aligning and centering trucks in the platoon. Through communication technology, the lead truck can also provide a see-through view to the trucks behind.
4. Information from sensors (radar, camera, etc.) and the navigation system needs to be collected through a sensor-fusion platform which sends the necessary maneuvers to the self-driving technology.
5. Self-driving technology needs to be installed in the vehicle to automate functions such as accelerating, decelerating and steering.

6. Cellular communication will facilitate platooning planning services, such as bringing trucks from different operators together for platooning on a certain highway. Together with the V2V communication, a hybrid vehicle-to-everything (V2X) solution will therefore be implemented that provides connectivity to the platooning trucks, as well as internet service providers, fleet operators and infrastructure to make green-wave driving possible.
7. The ideal platooning system is based on a safe and secure architecture and an implementation of hardware electronics and software that fulfills high functional safety and security standards.

Maximizing the Potential of Truck Platooning

Truck OEMS are embracing the idea of launching platooning into the market as early as 2022-2023 . NXP is a market leader in the automotive semiconductors segment with a large portfolio of solutions for advanced driver-assistance systems (ADAS) and automated driving. NXP actively supports the development of platooning by providing the appropriate technologies and co-creating the required solutions .

Through its RoadLINK® V2X solution, NXP provides the ideal core communication technology for platooning. RoadLINK uses the IEEE 802.11p (DSRC) WiFi communication standard, which provides latency as low as a few milliseconds across two wireless links[6]. The solution also allows high density platooning by incorporating the distributed congestion control standard DCC[7]. NXP's RoadLINK incorporates a secure element, holding the credentials and cryptographic algorithms for authentication and de/encryption, both for symmetric and asymmetric cryptology. NXP anticipates that both will be required in the multi-brand platooning protocol soon to be proposed in the EU Ensemble project . In anticipation of this taking place, NXP has devised multiple security schemes keeping latency to a few milliseconds during secure communication, showing it can handle the required performance for platooning.

For example, the distance between platooning trucks during road tests was reduced to just 7 m (23 ft.), or 0.3 seconds traveling at 80 kmph (50 mph). While the average human response time is around one second, the RoadLINK solution-- together with the full prototype electronics system behind it (networking gateways, sensor-fusion and path-planning ECU, low level control ECUs) -- reacts 25 times faster, a response time that is critical to achieving such short-distance platooning.

IEEE 802.11p technology is being designed in by major vehicle manufacturers, including General Motors, Volkswagen and Toyota, and is far ahead of the upcoming 5G LTE-V Rel 14[9] cellular technology just specified by the 3GPP group. It will take several years for manufacturers and module makers to validate LTE-V for later implementation in production models.

A Closer Look at Tomorrow's Platooning Technologies

As previously mentioned, radar and camera-sensor technologies are essential for platooning. NXP is a leader in these technologies, both with SiGe-based technology and small form-factor, highly economic RFCMOS-based technology, targeting short and medium distance "surround" view. The latter is especially useful for detecting cars that might be cutting into another vehicle's path. NXP's vision processor is based on the principle of an open platform supporting OpenCV, together with dedicated hardware acceleration pipes.

NXP's sensor-fusion platform combines the various sensor information to create the world model, path-planning and maneuver control. NXP's BlueBox development platform for autonomous vehicles can support an architecture consisting of a nominal mode, safety mode and arbiter (EcoTwin III co-operation with DAF , TNO and Ricardo)[10]. This versatile development and prototyping platform allows for direct cross-compilation, for example, from Simulink model-based designs on PC , supports the Baidu Apollo autonomous driving platform , and consists of heterogeneous computing processors including ASIL qualified processors to allow customers to evaluate the safety concept before committing to product-development. These technologies are supported by NXP's security expertise and the NXP functional safety program, SafeAssure .

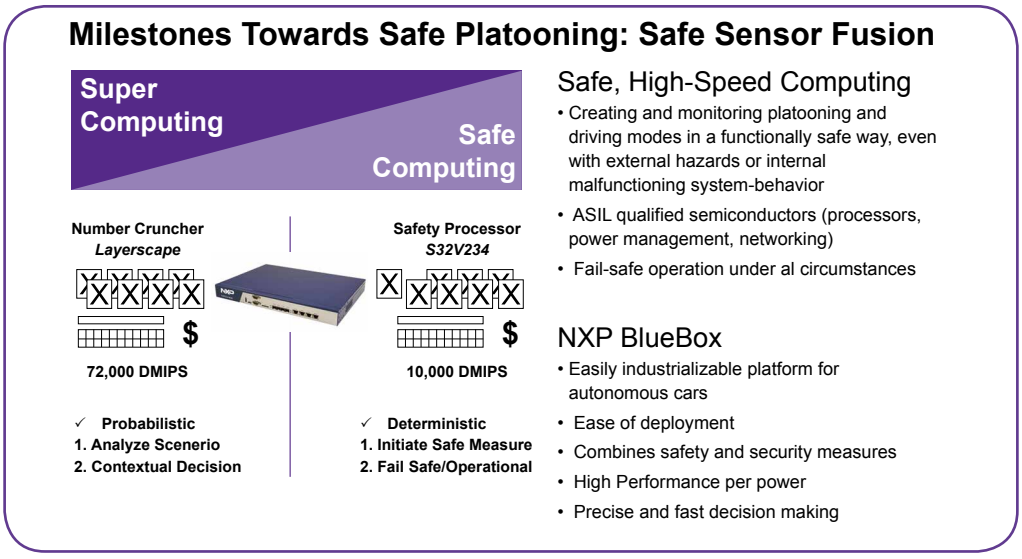

Figure 3: Safe Sensor Fusion

Conclusion

The technology to enable truck platooning at the high performance and functional safety level described above exists today. It requires a combination of 802.11p based V2V communication -- sensor (radar, vision, GPS) -- and sensor-fusion technologies, underpinned by functional safety and security design.

By reducing the gap between truck combinations and making the most of slipstreaming, double-digit fuel savings can be achieved along with an equivalent reduction in CO2 emissions. According to the EU-funded Companion Project , if 25% of the 1.5 million trucks in Europe engage in platooning (assuming a 5% fuel reduction per vehicle), nearly 1 billion liters of fuel per year could be saved, not to mention the corresponding reduction in CO2 emissions. Do note that with increasingly small headway distances between the trucks, even larger savings will be achievable during platooning . It is strongly expected that traffic safety and flow will also be enhanced due to the less fluctuating, synchronous driving-behavior of the trucks, combined with the built-in advanced driving assistance technologies.

Melanie Schultz van Haegen, Minister of Infrastructure and the Environment in The Netherlands, said at the end of the European Truck Platooning Challenge[16] 2016: "We've shown that platooning technology is ready for use and that we're at the beginning of a new era in mobility. By working together, we can gain full benefit from the opportunities smart mobility offers. That's why I want smart mobility, intelligent transport systems and connected and autonomous driving to be high on the EU agenda."

NXP's Automated Driving and V2X solutions, coupled with its BlueBox development platform, provide the main building blocks to enable safe and secure truck platooning.

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