TRUCK PLATOONING: AN UPDATE AFTER THE EUROPEAN TRUCK PLATOONING CHALLENGE

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Abstract

This paper provides insights in the current and expected achievements of Truck Platooning (TP). Although not a research paper as such, it provides accumulate knowledge around cross border truck platooning on public roads. The drivers for vehicle automation and mobility are identified. and placed in a Dutch, European and US perspective. We look back on the lessons learned from the European Truck Platooning Challenge (ETPC) and other TP initiatives and we look forward to upcoming TP initiatives. A timeline with technology ready levels is presented and conclusions are drawn regarding cost benefits for society.

Keywords: Truck platooning, innovation, driver support, vehicle assessment, governmental support, societal cost benefits

1. Research approach

In this section we answer the question how the investigation took place. We started our investigation by looking at TP from a birds eye view: Why, What, how and who are the drivers for TP? How are they connected to the process of policy making and what steps can be identified. Then we give an overview of current and planned TP demonstrations.

1.2 Why, What, how and who are the drivers for TP?

Increasing traffic jams cause pressure on the Dutch road network capacity. KIM[1] calculated that in 2016, approximately 3 billon euro working hours were lost due to traffic jams. At sufficient high penetration rates, TP can enhance the road network capacity by using automation. TP should also lead to energy savings and enhanced road safety. Less accidents will also lead to less traffic jams. Eventually TP can possibly lead to a reduction of driver costs by (partially) unmanned following vehicles. This is beneficial for the competiveness of The Netherlands given its ageing populations.

TP becomes more and more in reach, as sensing technologies for automated vehicles are getting more robust. Think of the developments in computer vision, radar, lidar, laser scanners, localization by GNSS, and vehicle-to-vehicle communications.

In the Netherlands the main champions of TP are the national road authorities (RWS), being part of the ministry of Infrastructure and Waterways and the port of Rotterdam. By contributing they are supporting innovations that potentially improve traffic flow. Another strong driver is the technology industry and applied research organizations like TNO and NXP, that look for application of their technology. The logistical sector, represented by transport companies, shippers, hauliers and umbrella organizations like TLN and EVO. They see opportunities for fuel saving, safer work conditions and in the long run stretching driving and resting times. And of course the truck manufactures representing themselves or by national branches like RAI. The OEM's are aiming on competitive advances like reduced fuel consumption, safer vehicles and in the longer run relive from the driving and resting regime.

1.3 Policy making and what steps can be identified

In general the Netherlands considers TP as a high potential development to accelerate Smart Mobility solutions. To that end, a national Action Plan Automated Logistics is prepared (nov 2018) in which all initiatives are bundled and focused. Joint investments are made on vision and ambitions, willingness to adapt legislations, create a large multi-million euro national funding scheme, and setup overall coordination and orchestration facilities.
The following first milestones are proposed:
2020: 250 Driver-Assistive Truck Platoons (SAE L1+) deployed in the Netherlands – over 500 trucks equipped with platooning technology and continuously connected to the cloud traversing national motorways and ITS-corridors.
2022: Highly Automated Driverless Truck Platoon (SAE L4) integrated in automated port transport system, with 1 manually driven truck with 2 automated followers – driverless followers as part of a platoon driven across parts of the Netherlands in logistics operation.

1.4 An overview of current and planned TP demonstrations.

Studies on automated driving with heavy trucks[2] were started in the mid-1990s and include "Chauffeur" within the EU project T-TAP from the mid-1990s, truck automation by California PATH from around 2000, "KONVOI" in Germany from 2005, and "Energy ITS"

by Japan from 2008, COMPANION (2013-2016) funded by the EU 7th framework program and the ETPC.

Despite many demonstrations like the ETPC [3] on public roads, truck platooning is not yet available as an off-the-self driver support system. Especially in countries like the Netherlands and the US the shippers, carriers and government are ready to implement platooning in their logistical processes. Other countries are ready for TP demonstrations, but not with cargo and on a daily base. In Europe the technology is not ready for market introduction yet. The last quarter of 2018 is mentioned by several stakeholders to become the year where regular truck drivers can start driving in small series truck platoons.

Peleton is a US company building aftermarket solution for platooning. The systems focusses on longitudinal support, like a cooperative adaptive cruise control system. The difference with Europe is that the US is already applying the technology. To maximize platooning opportunities drivers are informed of potential platooning options by a Network Operations Center (NOC). The pairings are based on their location and anticipated route. The NOC can find platooning partners while driving or can be planned ahead of time. A similar truck platoon matchmaking solution, for both scheduled as well as on-the-fly platooning, is developed in a consortium funded by TKI Dinalog[4] and led by TNO in Netherlands.

The European Commission is also anticipating on the potential benefits of platooning. Initiatives are found in DG Connect (table of Oettinger), DG Research (Horizon 2020), DG Move (C-ITS, CEF) and DG Grow (Gear2030). The initiatives range from recommendation to budgets to support large scale pilots like ENSEMBLE. ENSEMBLE is the Horizon2020 project on Multibrand TP TP is also part of the follow up meeting of the Declaration of Amsterdam[5,6]. No initiative from the UNECE, Working Party 29 on global standards on truck platooning are known. WP29 seems to focus on highway pilots for passenger cars.

2. Expected results

This section describes the major expected results of TP.   How can TP contribute to the road freight transport system that is challenged by increasing social and environmental challenges. Technological seems to offer opportunities but how robust are the revenues?.

2.1 Fuel consumption
All papers that were reviewed show that Cooperative Adaptive Cruise Control (CACC) on TP significantly reduce fuel consumption and emissions[7,8]. Reducing the spacing between vehicles reduces the aerodynamic drag experienced by all vehicles in a platoon, and maintaining a consistent speed reduces the frequency of acceleration and deceleration, thereby reducing fuel consumption and CO_2 emissions. Since long-haul trucks accumulate high annual mileage, most of which is at highway speed, the savings could be substantial. The tests and demonstrations reviewed during the study indicated a range of fuel savings between 4.5 and 21 percent. During the ETPC no research on fuel consumption was done. The yields we be lower in hilly terrain and on stretches of road were the platoons have to break up frequently. This because of for instance ramps and dense traffic flows.

2.2 Safety
Collision between trucks and truck and passenger cars are probably the most dangerous type of crashes due to the incompatibility of weights. . There are different occurrence of these accidents [9] between countries. For example due to infrastructure and climate. In Germany, rear-end accidents accounts for 40 % of all accidents involving HGVs that cause serious

injuries or fatalities to the HGV occupants. The most common type of accidents in Northern Countries are lane-departure accidents and rollover or yaw instability on the road. Probably because the traffic in the North is less dense and trucks don't follow that close.

Since November 2015 three systems are legally required in Europe that can help decrease accidents:

- Advanced Emergency Braking System (AEBS)
- Lane Departure Warning System (LDWS)
- Electronic Stability Control (ESC)

The operational design domain of AEBS systems is however limited. The national highway authority in the The Netherlands (RWS) pointed this out in an investigation[14]. Objects like road work marking vehicles and stationary trailers differ from the standard reference AEBS vehicle. There fore the driver should remain vigilant at all times.

The main safety systems that are used in TP are Cooperative connected Adaptive Cruise Control (CACC) combined with the above mentioned legally required systems. Due to the close following distance the AEBS had to be modified. Otherwise the AEBS would have prevented TP. Empirical evidence that truck platooning is safer must be strengthened. Till now the TP European was limited to demonstrators with expert drivers.

Independent of TP an increasing number of driver support systems will become available during the transition to partially or fully autonomous vehicles[10, 11]. Initially these systems will be systems that warn the driver in specific situations. In this phase it is important that information is prioritized, to avoid distraction by less important signals. In this way it can be prevented that the workload gets too high and the risk of errors increases (Cantin et al., 2009). Furthermore, it is important that the warning is given in the right manner. Depending on the situation, the driver can be warned by an auditory signal, a visual signal, a haptic signal (such as a vibration of handlebars or seat), or a combination of signals.

We know that driving a car is primarily a mental task (Gabaude et al., 2012). This means that partially taking over task leads to a reduction in the driver's task load (Timmer et al., 2013). When the task load is too low, the performance goes down and the risk consequently goes up (De Waard, 1996). Because the driving task will change from driver to 'supervisor', the task load will also reduce. It is therefore important to examine the effects of this task load reduction on the execution of the driving task, and on road safety. Especially in the case of TP were the driver task is heavily supported, the expected number of interventions is very limited and the view of the rear end of the next truck can get boring.

In short[15], with conventional trucks, critical risk factors are driver reaction time and concentration. Indeed, some 90% of all traffic accidents are due to human error. Truck platooning can help improve safety, but needs to be proven in practice.

2.3 Traffic flow effects of TP

The heterogeneity of traffic[12] is a significant if not dominant factor in accurately modeling freeway traffic flow operations. The effects of CACC[13] using simulations simulation on a part of the A15 highway (Netherlands) show generally positive effects on the traffic flow. Traffic flow effects are influenced by on-ramps, weaving sections, lane drops and bottlenecks where extreme braking is applied. CACC systems were found to have a homogenizing effect on traffic flow. Although simulation showed reasonable and credible results, the models need to be validated in real world situations.

2.4 Societal and business benefits of TP

Next to the above mentioned more societal benefits of TP like lower CO_2 emissions, enhanced road safety and positive effects on traffic, also business benefits are presumed. Platoons have the potential to make the logistic process more efficient and optimise the labour market. Currently it is difficult to hire qualified truck drivers. Platooning is a cost-saver, as lower fuel consumption means lower fuel costs, which currently make up 30% of total operating costs of a truck. For transport companies, platooning means also a safer, more efficient flow of their freight. Under current legislation, drivers are either resting or driving. With automated platooning, the drivers of the trucks following the leader in the future might have the possibility to undertake other tasks, such as administrative work or making calls.

3. Conclusions and discussion

There are many expectation of TP. In the short run stakeholders mainly look for benefits on fuel consumption, enhanced road safety and improved traffic flows. The theories are predicting the benefits, but there is a considerable margin in the theories. In Europe several demonstrations took place, but not enough data was gathered or shared to validated the theories. In next year's many European demonstrations are planned. It is a high importance that data will become available for research, so the expectations on traffic flow, safety and fuel consumption can be validated.

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