Transport analysis

Self-driving cars – potential development and impact on road capacity

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Summary

Self-driving vehicles can double road capacity of an inner city environment. Similarly, the capacity of a heavily trafficked stretch of motorway may increase by roughly 70% if all vehicles were self-driving.

The development of self-driving cars is advancing swiftly, and several car manufacturers (including Swedish Volvo) are expected to have models that are fully or partially self-driving on the market by as early as 2020. This evolution is placing demands on government authorities to keep pace. In 2014, Transport Analysis launched two studies of self-driving cars to expand our knowledge of developments in this area. These studies were intended both to provide some idea of the possibilities to systematically monitor developments, and to examine the potential impacts of self-driving cars on the capacity of the Swedish transport system.

Currently, no definition of self-driving vehicles is generally accepted, whether nationally or internationally, nor is there any globally accepted taxonomy of vehicle automation. Many different terms, such as “self-driving”, “driverless”, “intelligent”, and “robotic”, are currently used to describe different types of operational control performed by a technical system. The lack of an accepted definition of vehicle automation makes it problematic to monitor the development of vehicle fleet automation. Nevertheless, we believe that Transport Analysis, within the framework of our current vehicle fleet status reports, should provide a short-term estimate of the proportion of the fleet that is equipped with certain automatic functions. This should provide a rough idea of the development status until a more accepted classification scheme is in place.

The starting point of this study has been to look into how a breakthrough by self-driving vehicles could affect the capacity of the Swedish transport system. According to the relevant literature, it will take a long time before self-driving vehicles achieve a breakthrough of sufficient magnitude to have pervasive consequences for how we use the transport system and plan our cities. Nor does the literature provide a consistent picture of how self-driving vehicles could affect how we travel. It instead indicates that future views of car ownership will likely play an important role in shaping how self-driving technology affects the capacity of the transport system. If we continue to use cars in the same way as we do today, this will likely lead to increased mileage driven by motorists and a dramatic increase in demand for parking space. On the other hand, if the technology leads to more forms of shared ownership, such as car sharing, carpooling, and taxis, it will then be possible to dramatically reduce the demand for parking space and the number of vehicles, despite any increase in the number of person/kilometres driven.

One key issue regarding self-driving cars concerns the extent to which the technology can help solve future capacity problems on the Swedish road system, assuming that we will still use cars in the same way we do now. According to the literature, self-driving vehicles will help increase the capacity of the transport system. However, for this to occur, the time intervals between vehicles must become smaller than they are now. If vehicles are simply self-driving, but otherwise behave as regular vehicles do today, then the capacity gains will be minor,

resulting mainly from more uniform traffic flows and fewer accidents. To achieve truly sizeable capacity gains, it will be necessary for vehicles to form convoys and for the time intervals to decrease from the current 1.5 seconds to 0.1 seconds. For this to be possible in practice, the vehicles will need to communicate with one another via so-called V2V communication, and with the infrastructure via V2I communication.

The results of our traffic simulations indicate that, if this does occur, then the capacity of an inner city environment can be doubled if all the vehicles are self-driving. The calculations for motorways indicate that the through-flow in the case of Essingeleden (an important and heavily trafficked stretch of motorway in downtown Stockholm) could increase by roughly 70% if 100% of the vehicles were self-driving. (Effects on capacity due to reduced accident risk and related disturbance is not included in the calculation.) However, this example is not necessarily representative of all parts of the motorway and inner city road system.

It is presumed in the literature that the authorities will, in many cases, assume a passive role in the development process, at best responding to the technological progress and providing infrastructure and regulations. However, in practice, proactive policy in this area could steer the development process in various directions, affecting its consequences as well. Financial incentives and legislation offer major means of influencing the composition of the vehicle fleet and how we use cars. If, for instance, society believes that an increased share of self-driving cars could offer gains in terms of traffic safety and capacity, more financial incentives will be offered to stimulate their development. Such incentives could include, during an introductory phase, permitting driverless vehicles to use public transport lanes or offering them free parking, exemptions from congestion taxes, subsidised insurance, etc. In a later phase, specific lanes or streets could be reserved for such vehicles.

Funding and facilitating research in this area offers another means of supporting the development process. One advantage favouring Europe and, in particular, Sweden is that we do not have the same preventive insurance tradition as does, for example, the USA. In Sweden, we share the costs that arise in connection with, for example, the need for hospital care in connection with accidents. This can contribute to significantly lower costs in carrying out pilot projects.

In the long term, once self-driving vehicles have a major impact on the transport system, there will be reason to start looking at the marginal cost of allowing non-self-driving vehicles in the system, and to consider regulating this through the tax and fee system and through legislation. As we move toward that point, the regulation of non-self-driving vehicles in hazardous environments, such as mines, or in environments where compliance with traffic regulations is essential, such as downtown areas, could be considered and serve as a means of advancing demonstration projects.

To maximise the benefits of self-driving vehicles, financial incentives that regulate how the vehicles are used will probably be necessary. Assuming that the development process moves forward in a manner consistent with our simulations, traffic will be able to increase a lot without major investments in new infrastructure. If we use cars in the same way as we do today, this will entail a dramatic increase in the demand for parking space. One way of addressing this would be to site large parking facilities in peripheral locations and let the cars pick up their passengers as needed. The drawback of this approach is that it would result in many trips of empty cars. Another alternative is car sharing and carpooling, in which each vehicle is used more efficiently, resulting in high numbers of passenger/kilometres per parking place. Such a development could be stimulated by taxing vehicle ownership heavily, for example, via vehicle taxes, while various types of car-sharing services would be exempt from VAT.

In summary, the development of self-driving vehicles raises many issues that will need to be addressed, some in the long term, others in the short term. It seems highly likely that this development process will affect the capacity of our transport system. How it does will also depend on how the development process is handled at the transport policy level.

Transport analysis

Transport Analysis is a Swedish agency for transport policy analysis. We analyse and evaluate proposed and implemented measures within the sphere of transport policy. We are also responsible for official statistics in the transport and communication sectors. Transport Analysis was established in April 2010 with its head office in Stockholm and a branch office in Östersund.

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