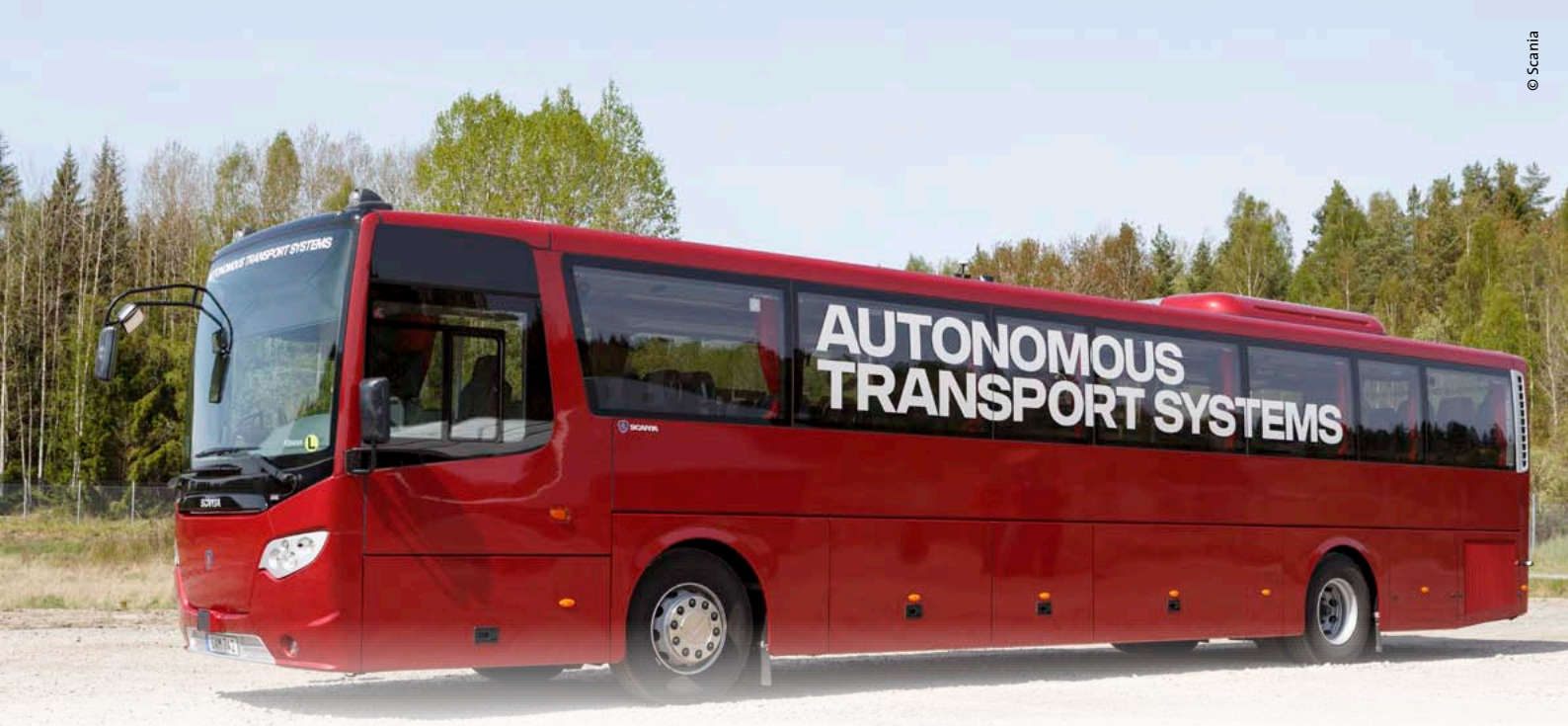

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Whitepaper

Forecasting the future of mobility

What role will autonomous buses play within efficient urban transportation?

Research project: iQMobility

Every day, autonomous vehicles are featured in prominent news items. Besides enormous efforts from private car providers, most notably Tesla, there are also substantial, gradual developments in the sector of public transit. New, more flexible solutions are being developed in the form of autonomous mini-buses, able to carry around 10 to 12 passengers. These are perfect for providing on-demand first-/last-mile transportation, or short "on-campus-like" corridors. In regards to heavy buses, however, there has been minimal visible effort, so far.

Research project: iQMobility.

Motivation for autonomously operated heavy buses

There is a common saying that money makes the world go round, but money is scarce, especially in public transit.

According to an internal market analysis by Scania, a Swedish heavy bus manufacturer, drivers account for approximately 60 percent of the total cost of ownership of a bus. Naturally, autonomous buses would have a social impact on drivers, but given the reduction of the total cost of ownership, operators could run a higher number of vehicles for the same cost while there will be an obvious increase in jobs related to servicing and maintenance. If you consider the effort and money transit authorities spend annually to recruit new drivers, the decision for autonomous buses can make a sound investment against the backdrop that over the next 10 years, 40 to 50 percent of drivers will retire.

In addition, autonomous vehicles also have the potential to drastically improve traffic safety, as they do not need to rely on the constant alertness of a human operator. Safety usually has a very high cost.

The use case of autonomous operation within depots already represents a significant cost saving. Here, the capability of vehicles to move autonomously between parking slots, maintenance and fueling stations reduces the need for time spent by human operators with appropriate driver's licenses. Due to the simplified operating environment, this is the most viable commercial application of autonomous vehicles in public transit in the near future.

Eventually, however, autonomous vehicles will likely be a piece of the puzzle in answering changing mobility requirements where on-demand services with ad-hoc routing are preferred over time-tables. This may be one way for public transit to stay in business with the competing initiatives of Transport Network Companies (TNC) like Uber and Lyft providing Mobility-as-a-Service (MaaS).

Although it sometimes may appear as if vehicle manufacturers are not focusing on vehicles serving "mass-transit", you can be sure that the prospect of autonomous public transit in intensive urban environments is being pursued. One of the first research projects worldwide studying the specific requirements of autonomously driving heavy buses within a public transit framework has now been established – iQMobility.

The research project

iQMobility is a Swedish funded project led by Scania, the Swedish vehicle manufacturer which is part of the Volkswagen Group. Its subtitle, "Automated Transport Solutions Project", refers to the scope of the project to examine the specific requirements of public transport when it comes to autonomously operated fleets. The aim is to identify what information needs to be exchanged between which components and systems, as well as their technical specifications. Not only do the "driving skills" of autonomously operating buses need to be developed, but they also have to be integrated into a fleet management system as well as other public transport managing systems to serve the needs of public transport providers.

Anders Ställberg of Scania explains: "At Scania we are developing autonomous transport systems where we put the autonomous vehicles in a context. The vehicles themselves will not be the solution – the way they are used and how they are integrated in the overall transport system is what will make the difference. In order to learn and understand the challenges involved when introducing autonomous vehicles in public transport, we needed a strong partner, which we found with INIT.

Within public transport we need to understand how our cloud-based intelligent control environment, together with our vehicles, can integrate with a current public transport control system such as INIT's, to be able to jointly meet the requirements of our customers."

The primary expected result of this project will be the development of a prototype for an automated urban public transport system. There are three main areas of interest – planning, depot management, and operation which result in examining questions like:

What specific information needs to be incorporated in public transport planning systems? How can schedules and real-time Intermodal Transport Control System (ITCS) orders be translated into driving instructions the bus control system is able to understand? How will depot management systems need to be enhanced or connected to planning and ITCS systems to support autonomous driving?

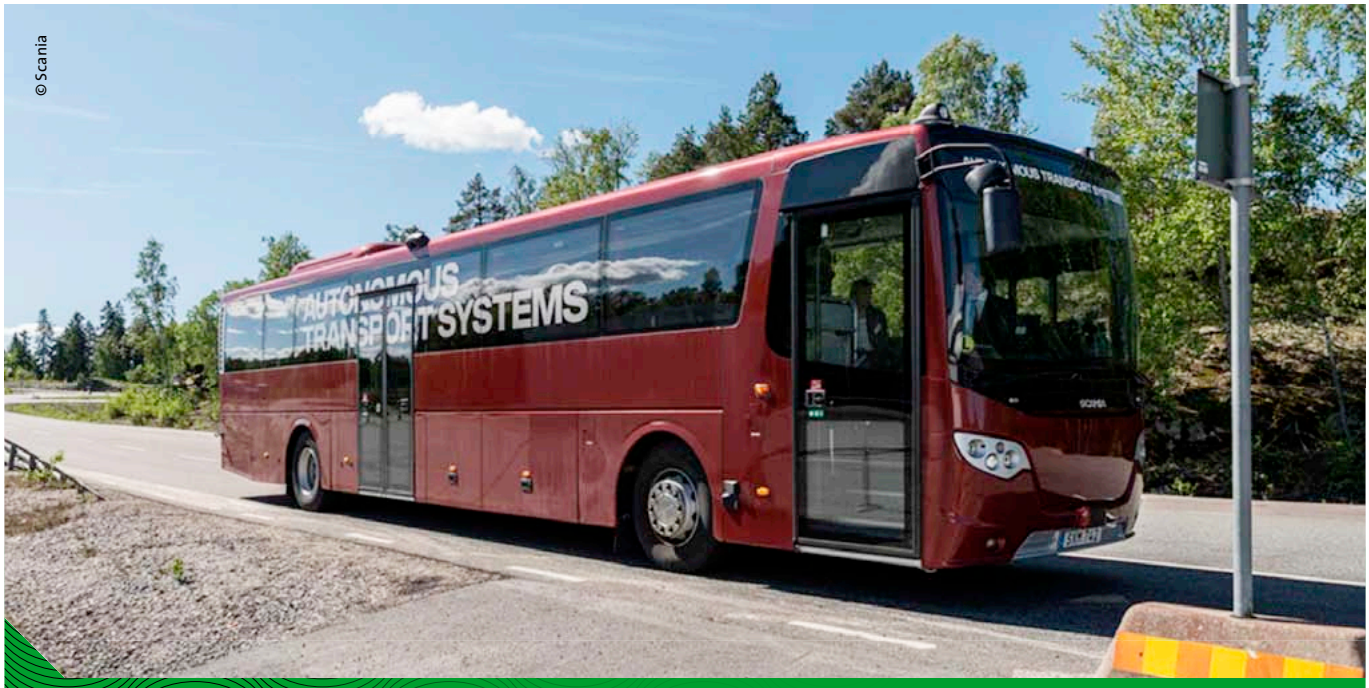
To validate the new technologies, essential and realistic tests will be performed in urban environments. For this, iQMobility will exploit the test platforms of a related project called iQPilot which specifically provides a number of autonomous city buses.

Exclusive demos have already taken place. Larger demos will be open to the public towards the end of the project (2019/2020). The scientific findings will be validated by means of proof of concept demonstrations on those vehicles. Two other partners are responsible for modeling and simulation: KTH (Department of Transport Science) and Örebro University (Centre for Applied Autonomous Sensor Systems).

Mass-transit requirements

Bus operation is traditionally coordinated and controlled directly through the driver, who receives information and instructions from an onboard unit connected to an Intermodal Transport Control System (ITCS).

When the vehicle is autonomous, the driver is no longer the "standard gateway" to set things in motion. Three main tasks are to be replaced by new IT-Systems currently examined in the iQMobility project: absolute safe driving, real-time flexible operation, and humane interaction with passengers. Since safety is of the utmost importance, bus manufacturers will make sure that their vehicles are well-connected to their back-offices. It is therefore logical to channel driving instructions and other vital measures directly to the manufacturer's back-office. For now, this is



When the vehicle is autonomous, three main tasks of the driver are to be replaced by new IT-Systems: absolute safe driving, real-time flexible operation, and the humane interaction with passengers.

also the system approach of iQMobility for the handling of measures ordered by the ITCS. They will be transmitted to the Scania back-office which transforms them into actual driving instructions for the autonomously driving vehicles.

> The biggest change we will see for the future of ITCS is the way dispatchers will work with the system, and how technical solutions will replace the information about on-site situations that now quite often are still provided by the drivers.

Kai Brückner
Head of the Real-Time Systems Department
INIT GmbH

Kai Brückner, Head of the Real-Time Systems Department at INIT, explains: "Our ITCS already incorporates many of the mechanisms needed, like traffic jam detection or ad-hoc detours. But they need to be used more extensively, and we might as well incorporate further features, which we will determine now in this thrilling project."

It is yet undetermined how tasks like travel information, ticketing, and passenger counting will be implemented, assuming there will still be a direct connection to the ITCS. Passenger interaction may turn out to be one of the tougher nuts to crack.

ITCS outlook

In addition to the fleets of traditional public transport operators, the ITCS of the future may be connected to many different back-offices of autonomous buses. It is even foreseeable that commercial fleets and individual cars might be connected to the ITCS as the former private car is transforming into a new form of public transport: "personal rapid transit." This describes small electric cars that are in shared use and ordered on demand. They might direct the driver to a transport hub selected by the ITCS.

Smart Cities will want to have control over the traffic that all modes of transport is generating. Much of the traffic can be predicted when most of it is planned. They will also want to decide in accordance with their strategy who can enter, where and when, at what cost, and under which conditions. ITCS can develop into the tool which supports them with this smart traffic management. Following the trends towards Smart Mobility and Mobility-as-a-Service (Maas), the ITCS might change its role in the future from a purely public transport operating system towards a multi-modal control system that Smart Cities may use for an integrated traffic management system.

Conclusion

The role of autonomous heavy buses in public transport can revolutionize the way we move through our cities in the future. Understanding how we can safely and efficiently manage these modes of mass transit is vital. Using integrated technologies and advanced Intermodal Transport Control Systems will be key to achieving a lasting solution. As autonomous vehicles continue to emerge, our roles, and technology will adapt to help define the future of mobility.

RESOURCES

1 The Future of autonomous driving buses: research project iQMobility

2 Karlsruhe Technology Region: Poineering ecological intelligent solutions that connect the dots between mobility, energy, and digitization

3 Scania: Autonomous public transport systems one step closer

Dirk Weisser is Director of Research for INIT. He and his team are involved in projects dealing with electro-mobility, autonomous driving vehicles and standardization of interfaces between different IT systems used in Public Transport (e.g. VDV 301 (IBIS-IP), VDV 431 (TRIAS), CEN 13149 part 7-9). The main focus is getting information from one IT system to another with specific use cases in mind.

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