Reader

Traffic Telematics

Subarea:

RE Road

Research & Education on Road Transport Logistics

This reader supplements the ppt presentation on this topic and doubles as a script if needed.

FH Fachhochschule des BFI Wien Wirtschaft Management Finance

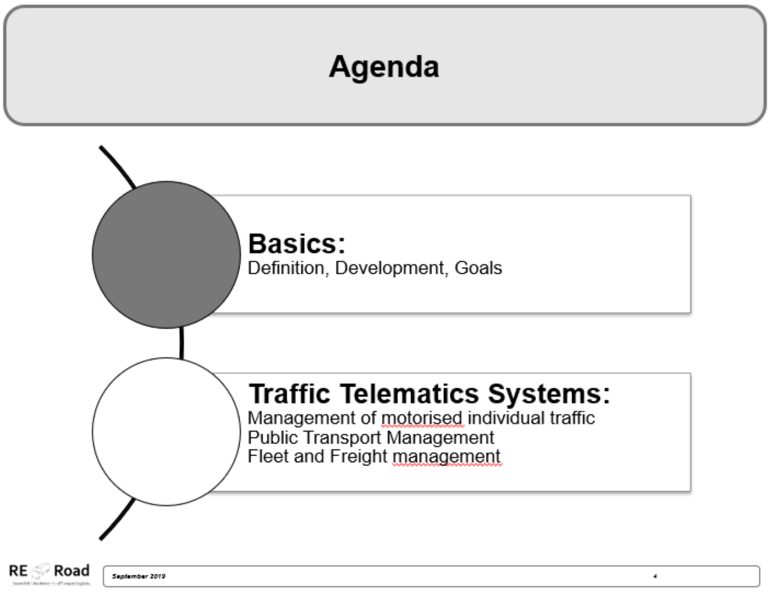
LOGISTIKUM CHALLENGE ACCEPTED

Bundesministerium Verkehr, Innovation und Technologie

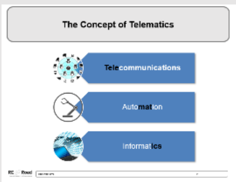
SCHIG MOBILITÄT VERSTEHEN

Overview

The ppt presentation on telematics and the accompanying reader are structured as follows:



Basics
Definition, Development, Goals



The Concept of Telematics

Telematics is an artificial word and derives from the terms automation, telecommunications and computer science. The task of automation is the acquisition of data by sensors, that of telecommunications is the transmission of data between fixed and/or mobile devices. Information technology processes the information and presents it in appropriate formats.[1]

Traffic telematics is the use of telematics in traffic. It deals with the acquisition, transmission, processing and presentation of data (for example: position, temperature, speed, humidity, acceleration). Its basic objectives are to improve transport use and

[1] Cf. Federal Ministry of Transport, Innovation and Technology (no year), online

infrastructure capacity. Transport telematics also supports coordination within or between modes of transport such as road, rail, sea and air.[2]

To use telematics, an acquisition unit, a processing unit and an output unit are usually required. Locations these can be attached to can be infrastructure, means of transport or transport objects (goods or persons).[3]

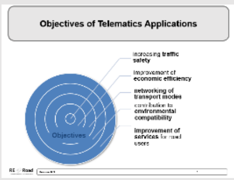
Building on these basic telematics functions, a large number of sub-applications have developed over the past 20 years.[4]

The following figure shows a categorization and examples of telematics applications.

		Attachment location		
		Infrastructure	**Transport means**	**Transport objects**
Transport modes	**Road**	Traffic control systems	Navigation systems	Congestion information
	Rail	Train protection systems	Dynamic passenger information in the train	Travel planning systems for mobile phones
	Water	River Information Services	Automatic ship identification	Tracking and tracing of containers
	Air	Instruments landing system	Anti-collision systems	Mobile Check-in

Figure 1: Categorization and examples of telematics applications[5]

Current national ITS projects of the bmvit can be found at https://www.bmvit.gv.at/verkehr/gesamtverkehr/telematik_ivs/projekte/index.html.



Objectives of Telematics Applications

Depending on application, different objectives are pursued:[6]

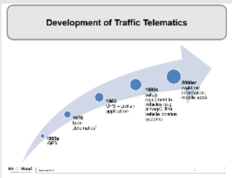
- increasing traffic safety through facilities in vehicles and on the road, through targeted traffic information, etc.
- improvement of economic efficiency

[2] See Kummer (2010), p. 51 ff.
[3] See Kummer (2010), p. 51
[4] Cf. Federal Ministry of Transport, Innovation and Technology (no year), online
[5] Cf. Kummer (2010), p. 52
[6] See Ausserer, K. et al. (2006) p. 6

- increasing productivity and capacity by making better use of existing infrastructure in all modes of transport
- networking of transport modes to exploit the system advantages accordingly
- contribution to environmental compatibility through traffic avoidance and reduction by means of modern control technology etc.
- improvement of services for road users, e.g. through up-to-date information across all transport modes

The opportunities for road freight transport include the following:[7]

- facilitated transport planning (e.g. avoidance of empty runs)
- facilitated order processing (e.g. increasing flexibility, avoiding disruptions, increasing delivery reliability)
- facilitated fleet management
- tracking of shipments which promotes customer loyalty
- vehicle monitoring, e.g. to reduce both fuel consumption and environmental impact
- Linking transport modes, e.g. rail and road



Development of Traffic Telematics

In the mid-1960s, a global positioning system, the GPS, was developed for the first time. Originally it was a system of the US Navy to be able to locate submarines with nuclear weapons during the Cold War and thus the origin of what is now understood by telematics. In 1978, the term telematics was first used by the French government in a report on the computerisation of society. Originally, GPS technology was not intended for use by the general public. However, a plane crash in 1983, in which 269 people lost their lives, gave the impetus for civilian application.

In the 1990s, safety equipment in vehicles was improved and, for example, airbags or daytime running lights were prescribed. In 1992, the EU's DRIVE programme was terminated, and an agreement was signed to promote the further development of telematics. The EU wanted to expand its competitiveness through superior transport and logistics networks. The first vehicle location systems were also invented. The

---

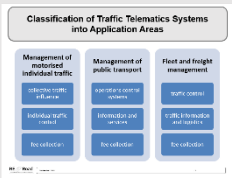
[7] See Berg/Rolf (no year) p. 2 ff; see Andres (2003) p. 3 ff.

hardware in vehicles was connected to the software installed on computers via local servers.[8]

In the 2000s a number of further information became available. This includes real-time information, for example on the traffic situation, traffic jams, construction sites and radar cameras, as well as mobile apps designed to support the driver. Smartphone apps are now also available to help fleet managers monitor their vehicles from a distance. Furthermore, they are intended to support drivers in routine tasks, such as recording data in a driver's logbook.[9]

Telematics systems provide fleet managers with information about the driving behaviour of drivers and can thus ensure that the company's fuel, maintenance and insurance costs can be reduced. Communication between office staff and drivers on the road is facilitated by telematics and leads to better cooperation. Built-in devices in vehicles provide an overview of the performance of the fleet. This allows the use and condition of the vehicles as well as their driving behaviour to be monitored and analysed, thus reducing operating costs.[10]

Traffic Telematics Systems:
Management of motorised individual traffic
Public Transport Management
Fleet and Freight management



Classification of Traffic Telematics Systems into Application Areas

The possible applications of traffic telematics are very diverse and widely spread. In principle, the use of telematics in transport is of an additive and integrative nature, i.e. no existing system is replaced, but should support the implementation of sustainable transport strategies. In the following figure traffic telematics systems are classified into application areas.[11]

[8] Cf. TomTom (no year), p. 5ff.
[9] Cf. TomTom (no year), p. 5ff.
[10] Cf. TomTom (o.J.), p. 5ff.
[11] See Ausserer, K. et al. (2006) p. 12.

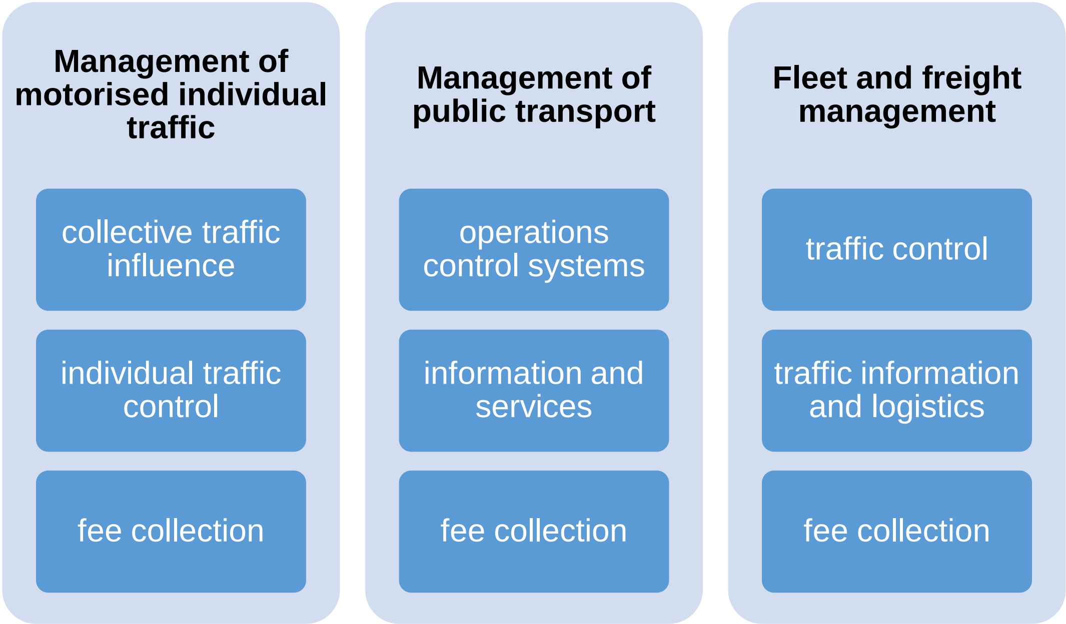


Figure 2: Classification of traffic telematics systems into application areas[12]

Traffic telematics systems can be divided into three application areas:

1. **Management of motorised individual traffic**

Collective influences on traffic are recognisable for all road users and in some cases also binding. Regulations and information are intended to control traffic depending on current traffic conditions and influence driving behaviour in a desired direction. Examples are traffic control systems (route control systems, network control systems, traffic junction/node control systems), warning systems (fog warning systems), automatic traffic controls (section control), or parking guidance systems.

Individual traffic control systems can be divided into two groups: information systems and assistance systems.[13] Information systems primarily have a warning or informational character. These include navigation systems, travel and traffic information services as well as comfort and infotainment services. Assistance systems mainly serve the safety and the relief of the driver. The degree of intervention can be not only informative, recommending and warning, but also automatically intervenes in the driving action.[14]

The following application categories can be distinguished:[15]

- lateral control (e.g. blind spot monitoring)

[12] See Ausserer, K. et al. (2006) p. 12.
[13] See Ausserer, K. et al. (2006) p. 17ff.
[14] See Ausserer, K. et al. (2006) p. 20ff.
[15] Ausserer, K. et al. (2006) p. 20.

- longitudinal control (e.g. distance-retaining speed controllers, collision warners and collision avoidance systems)
- reversing and parking assistance
- vision enhancement
- driver monitoring (e.g. eye blink sensor)
- pre-crash systems

Example: parking assistance

These driver assistance systems facilitate parking monitoring an area of about 20 to 250 cm in front of and behind the vehicle and warning the driver of obstacles. The parking assistant not only parks the car for the driver by steering the car independently, it can even find the appropriate parking space beforehand. The driver can still control parking by accelerating and braking.[16]

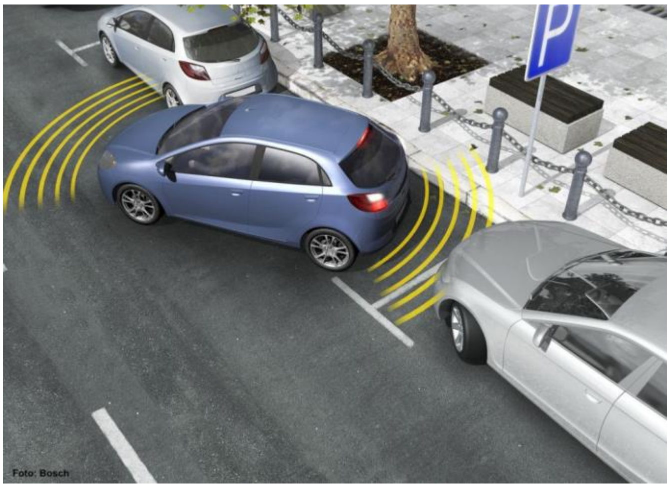


Figure 3: parking assistance[17]

Fees for motorised private transport refer to road tolls or parking fees, both already electronically billed. Such billing systems collect fees quickly and smoothly while being convenient for the user.[18]

2. Public Transport Management

In public transport, many telematic devices are often invisible and cannot be recognized as such. They are perceived by the passenger, for example, only through an improvement in comfort (e.g. denser intervals, shorter waiting times). In contrast to

[16] See Mein-Auto.de (2019), online.
[17] Mein-Autolexikon.de (2019), online.
[18] See Ausserer, K. et al. (2006) p. 25.

individual telematics applications in motorised private transport, the new technologies in public transport in principle benefit all road users equally.[19]

Transport telematics systems for public transport management can basically be divided into three groups:[20]

- operations control systems, e.g. disruption management, dynamic passenger information, automatic traffic light control
  iInformation services, e.g. electronic timetable information systems (internet, mobile phone)
- Charging, e.g. SMS ticket, online ticket, electronic ticket

For example, the computer-aided operations control system of Wiener Linien (RBL), which has been in operation since 1999, not only provides passengers with information on waiting times at the stations, but also provides the transport company with precise information on the current locations of all vehicles. Around 800 different vehicles circulate during peak traffic in Vienna. Every 20 seconds, position data is queried, target/actual comparisons are made and travel commands to drivers updated. At the same time, the waiting and arrival forecasts are sent to station displays.[21]

Figure 4: passenger information display Wiener Linien[22]

3. Fleet and Freight Management

[19] See Ausserer, K. et al. (2006) p. 26.
[20] See Ausserer, K. et al. (2006) p. 26.
[21] Cf. Vienna Mobile (2015), online.
[22] Wiener Linien (2019), online.

Telematics applications for fleet and freight management increase traffic safety, optimise goods delivery and, above all, reduce traffic congestion. This happens by shifting freight traffic to rail on the one hand, and on the other by shorter waiting times for road freight traffic, by avoiding congestion (e.g. through targeted traffic information and better route selection) or by improved logistics.[23]

Traffic control is achieved, for example, by dosing systems (avoiding congestion in tunnels) or reservation systems (booking a tunnel passage in advance).

Many European countries levy HGV (heavy goods vehicle) tolls on trucks. In Austria, a mileage-based toll on motorways and expressways applies to all vehicles over 3.5 tonnes maximum permissible weight (lorries, buses and heavy motor caravans). Toll collection takes place via microwave technology (DRSC - Dedicated Short-Range Communication) across several lanes without reducing vehicle speed. Vehicles liable for tolls require an on-board unit, the so-called "GO-Box" (see below). Vehicle owners can choose whether they pay tolls before or retroactively.[24]

With regard to traffic information, services similar to motorised private transport can be used, seeing the tracing and tracking system as a customer service. Consignments can be tracked according to criteria like the consignment number. In addition, there are various telematic systems in fleet management which monitor vehicles to locate problems when difficulties arise.[25]

Traffic telematics systems:
Examples for Motorised Private Transport Management

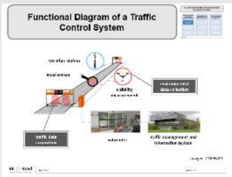
Traffic Control Systems

Traffic influencing is based on an integrated control and information system, which controls traffic depending on current conditions and influences driving behaviour. They are recognisable to all road users and in some cases are also authoritative. Traffic conditions are automatically recorded and forecast resulting in recommendations, warnings, restrictions or orders.[26]

[23] See Ausserer, K. et al. (2006) p. 34.
[24] Cf. Asfinag (2019b), online; Cf. Cerwenka et al. (2007), p. 108
[25] See Ausserer, K. et al. (2006) p. 35ff.
[26] See Ausserer, K. et al. (2006) p. 13.

Advantages of traffic control systems in road traffic:[27]

- reduction of traffic jam probability by stabilising the traffic flow
- Increase of infrastructure capacity by opening hard shoulders
- reduction of accident frequency and severity
- reduction of noise and pollutant emissions
- information generation for use in navigation systems, route planning programmes and fleet management systems



Functional Diagram of a Traffic Control System

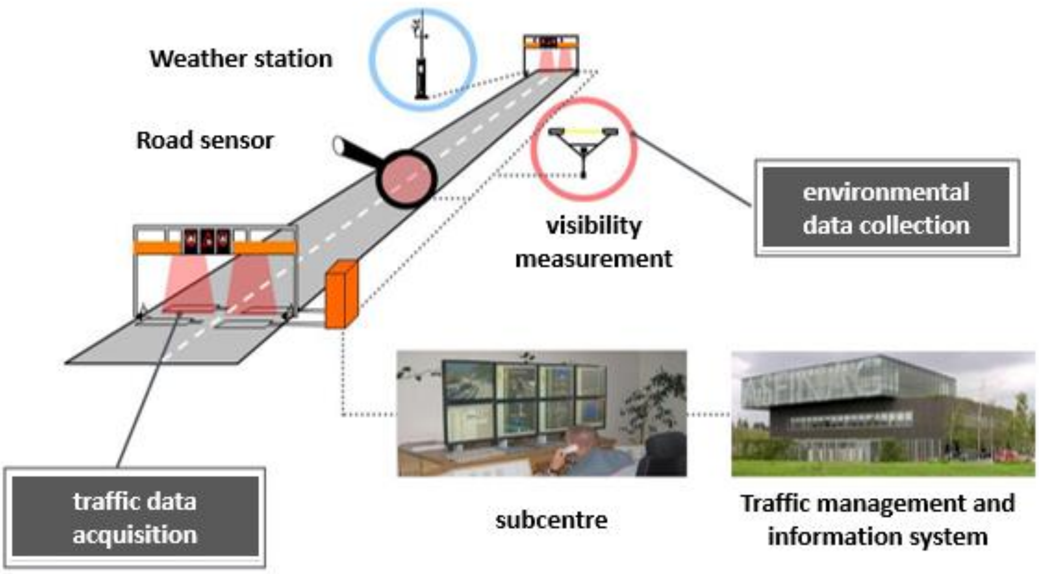


Figure 5: Functional diagram of a traffic control system[28]

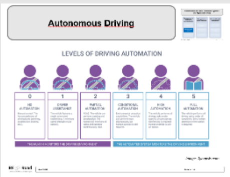
The sensors record environmental and traffic data such as the traffic volume, speeds or weather conditions (wetness, visual impairments) along the motorway. Depending on this data, speed limits and/or warnings are switched automatically. In addition, there are also operators who can use the traffic control system to display speed limits, warnings or lane assignments in the event of events such as accidents, breakdowns and lost parts on the road.[29]

---

[27] Cf. Kummer (2010), p. 52 f.
[28] Asfinag (no year), online
[29] See Asfinag (o.J.), online

Types of traffic control systems:

1. Route control system: displays speed limits, overtaking bans, lane assignments and warnings based on prevailing conditions (accident, traffic, congestion, construction site, weather). They control the speed in the motorway network. Traffic data and weather data are continuously recorded via detectors and the information is displayed with variable traffic signs via a control logic. In addition, the data obtained is used for traffic radio.[30]
2. Network control systems: provide information on events such as diversions and closures and can suggest alternative routes. A distinction is made between additive and substitutive rerouting systems (variable message signs to advise drivers of alternative routes). In the case of additive rerouting, the road user is only advised to switch to the detour route by means of a diversion arrow. In substitutive rerouting, the goals and arrows of normal signposting are exchanged.[31]
3. Junction control systems: traffic flows at motorway junctions can be controlled traffic-dependently, e.g. by temporarily blocking the right-hand lane of a continuous lane in order to make the approach for a strong incoming flow easier. A special type of adjacent junction influencing systems are inflow control systems. During peak traffic periods, cars are only let onto the motorway "drop by drop" by traffic lights at the access roads. This access metering regulates the traffic volume on the motorway and keeps it below the congestion limit.[32]



Autonomous Driving

Autonomous driving means independent, targeted driving of a vehicle in real traffic, without driver intervention. The vehicle initially obtains its input data from visual information sources that are also available to the driver. In the preliminary stages of autonomous driving, the technology supports human perception by providing information that enables the driver to make a safe decision and react quickly. However, if the reaction of the vehicle takes place independently via algorithms and

[30] See Ausserer, K. et al. (2006) p. 13.
[31] See Ausserer, K. et al. (2006) p. 14.
[32] See Ausserer, K. et al. (2006) p. 14.

associated reactions of the vehicle without the active influence of the driver, this is referred to as autonomous driving.[33]

The International Society of Automobile Engineers (SAE) has defined six levels of autonomous driving. The first three gradations describe the area in which the human driver has control over the vehicle. Levels 3 to 5 then subdivide what is understood as autonomous driving. Here the machine takes over most of the supervision.[34]

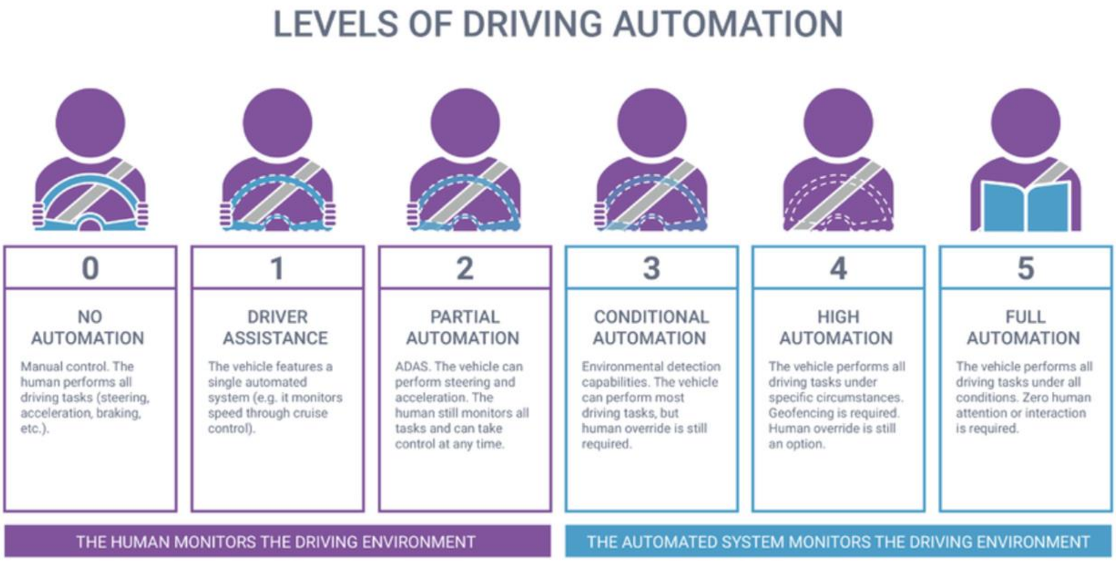


Figure 6: Development stages - autonomous driving[35]

A distinction is made between the different gradations below:[36]

- **Level 0 - no automation:** This is classic driving. Stage 0 describes a vehicle in which the driver performs all control tasks, i.e. steers, accelerates and brakes herself/himself. At no time is the driver supported by an assistance system.
- **Stage 1 - Driver assistance:** At Stage 1, the vehicle has systems which, thanks to information collected from outside, can take over parts of the "Dynamic Driving Task" in certain driving modes. An example of this would be the emergency brake assistant, which assumes the partial task of braking in a hazard context but leaves all other vehicle control tasks to the driver.
- **Stage 2 - Partial automation:** At this stage, the vehicle can perform several tasks simultaneously. Like a traffic jam pilot, for example, who recognizes the road boundary as well as the speed and distance of the person in front. On the basis of this information, the system is able to accelerate, brake and steer the

[33] Cf. Randelhoff, M. (2017), online.
[34] See Lang (2017), online.
[35] See Synopsis.com (2019), online.
[36] See Lang (2017), online.

vehicle within a certain driving mode (here: the motorway). However, taking over these aspects of the dynamic driving task only works within a defined frame, for example only up to 60 km/h. The driver must keep an eye on the surroundings and, if higher speeds are possible again, take the wheel.

- **Level 3 - Conditional automation:** At level three, the vehicle itself takes over all the tasks of the highest dynamic driving task" and, depending on the environmental situation, also carries out lane changes, for example. At this level of automation, however, the assumption applies that the human driver is ready to take the wheel at any time and thus react appropriately to a request to intervene. Furthermore, the level 3 system does not work in all driving modes.
- **Level 4 - High automation: The** main difference to level 3 is that the system executes all tasks of the dynamic driving task even if the driver does not react to a request to intervene. In an emergency, the system literally relies on itself and follows a predefined strategy, such as braking to a standstill and sending an emergency signal.
- **Stage 5 - Full automation:** Finally, all the tasks of the dynamic driving task are assumed by the system in all driving modes but can be controlled by a human being. In this stage, the vehicle moves purposefully and independently from A to B under all conditions.[37]

City Toll – a Congestion Charge for Road Traffic

The main aim of a city toll is to reduce congestion in conurbations. An increase in usage costs leads to reduced car use and a shift to alternative means of transport. As a result, congestion, the stress on the environment and city dwellers are reduced. As a positive side effect, revenues can be generated for road construction projects or the expansion of public transport.[38]

One of the best-known city toll projects in Europe is the congestion charge in London. For 11.50 pounds a day on weekdays between 7 and 18 o'clock you can make as many trips as you like. In Italy some cities have so-called "Zona traffico limitato" (limited traffic zone) in order to limit traffic and reduce particulate air pollution. In Florence, Genoa, Rome and Pisa, for example, parts of the city are closed to all traffic or only at certain times. In Milan and Bologna, you pay to enter certain zones. In

[37] See BMVIT (2019), online.
[38] See Sammer (2012), p. 480.

Norway, the city toll partly finances the expansion of the road network by levying a user charge for the route until the costs of construction are covered. In Sweden there are chargeable zones in Stockholm and Gothenburg from Monday to Friday depending on the time of day. The revenue is also used for road construction and for the safety of non-motorised road users.[39]

The Austrian Toll System GO-Toll

Despite growing discussion about the introduction of a comprehensive toll system, only use of motorways and expressways is currently subject to the Austrian toll system. A general distinction is made between the "Vignette" system and the "GO Maut" system, the use of which is primarily dependent on the maximum permissible total weight of vehicles. Tolls and user charges are collected by ASFINAG (Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft). The "Vignette" system applies to cars and motor vehicles up to a maximum permissible total weight of 3.5 tonnes and to motorcycles. Owners of vehicles covered by this scheme must purchase a vignette for the use of Austrian motorways and expressways and affix it to the windscreen at the points provided for that purpose. Vignettes come as 10-day, 2-month or annual versions for which a one-off payment is made, allowing road network use without restriction during this period. In comparison, the "GO Box" system is characterised by the opposite principle. It applies to lorries, buses and heavy motor caravans which exceed the maximum permissible weight limit specified in the vignette system. In the "GO Maut" (Engl. toll) system, toll fees depend on the distance travelled. High-level road network use (= primary road network), incurs a corresponding fee. This means that each distance travelled is calculated separately or anew and no one-off amount is charged, as with the "Vignette" system. Individual tariffs depend on the number of axles and the respective emission class. The following applies: the better the emission class, the lower the applied tariff. The distance travelled by the vehicle is recorded by a mobile device, the "GO Box", which must be placed inside the vehicle on the windscreen. The "GO Box" employs microwave technology, a form of data transmission, to communicate with a toll portal (= a kind of thin steel bridge stretched across the road), which forms the basis for toll calculation. The advantage of the Austrian toll system is that the toll debit is not influenced by the

[39] Cf. Großmann, J. (2015), online

lane used or the selected speed. This principle is also known in science as the "Multilane-Free-Flow" system.[40]

Here is an overview of current tariffs:

Rates 2019

Distance-related toll including surcharges for air and noise pollution for motor vehicles with a maximum permissible weight of over 3.5 tonnes						
Rate groups	**Category 2** 2 axles		**Category 3** 3 axles		**Category 4+** 4 axles and more	
	Day	Night**	Day	Night**	Day	Night**
Drive type E/H2*	0,18550	0,18590	0,26033	0,26125	0,39011	0,39127
EURO-emission class EURO VI	0,18820	0,18860	0,26411	0,26503	0,39443	0,39559
EURO-emission class EURO V and EEV	0,20240	0,20280	0,28399	0,28491	0,41875	0,41991
EURO-emission class EURO IV	0,20870	0,20910	0,29281	0,29373	0,42883	0,42999
EURO-emission class EURO 0 to III	0,22870	0,22910	0,32081	0,32173	0,46083	0,46199

Rates in EUR per km, excl. 20% VAT, valid as 1st of January 2019

Figure 7: Current tariffs for the "GO Maut" system“ [41]

It should be noted that special fares apply on certain routes in Austria (e.g. Pyhrn or Tauern motorways), added to the tolls already paid under the "Vignette" or "GO Maut" system.[42]

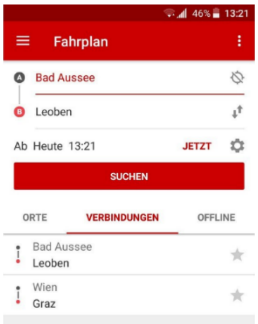
[40] See ASFINAG (2016b) online; see ASFINAG (2016c) online; see Kummer (2010) p. 272 ff.
[41] Asfinag (2019a), online.
[42] see Asfinag (2019a) online.

Dynamic Passenger Information next:urban technologies

The dynamic passenger information of "next:urban technologies" provides real-time information at stops and can therefore automatically display waiting times until the next departure, delays and the current position of the vehicles. Furthermore, there is a reading function for blind and visually impaired people and, for the night or if the ward is poorly illuminated, more light on the display.[43]

ÖBB (Austrian Rail) SCOTTY App

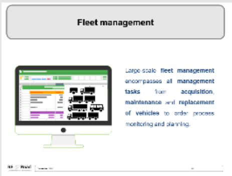
The "SCOTTY" app is Austrian Rail (ÖBB) timetable information for all popular smartphones and tablets.



SCOTTY can access the timetables of all public transport companies in Austria. This enables seamless itinerary planning. The area maps can be downloaded to the mobile device and are available offline. In addition, you can bookmark frequently used stations or frequently travelled routes as favourites. Via the Internet, all information such as departure and arrival times or delays are recorded in real time and can be displayed directly. The train radar can display on a map all ÖBB trains, or just special train types, in the Austrian rail network and provide real-time information on individual trains. In addition, all deviations or faults in the rail network can be queried via information on disruptions.[44]

[43] Cf. Forschungsinformationssystem (2019), online; next:urban technologies GmbH (no year), online
[44] Cf. ÖBB (no year), online; ÖBB Personenverkehr AG (no year), online; image source: Steirische Tourismus GmbH (no year), online

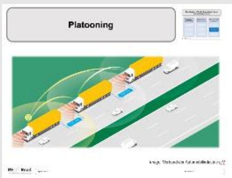
Traffic telematics systems:
Examples for Fleet and Freight Management



Fleet Management

Fleet management is one application area of telematics. Large-scale fleet management encompasses all management tasks from acquisition, maintenance and replacement of vehicles to order process monitoring and planning. The focus is on improving communication between dispatcher and driver. Without telematics, information between the players is usually exchanged by mobile phone or radio. This results in numerous problems such as time delays, information loss due to media breaks, lack of accessibility or errors during manual transfer into a system.[45]

The estimated time of arrival (ETA) can be stated in advance by determining the location and route of a truck. If there is an on-board computer on the truck, a tamper-proof driver's logbook can be created, facilitating compliance checks of the statutory rest periods. Telematics systems simplify administration thus economise personnel and material costs.[46]



Platooning

The term "platooning" is a military term and can be described as a "truck convoy" or "networked columns". "Platooning" works like a classic freight train, with trucks instead of wagons attached to each other. Individual trucks are linked through innovative technologies (WLAN, GPS, Wi-Fi, etc.) and equipped with cutting edge systems (e.g. automatic braking systems or distance regulators). The driving behaviour of the group of trucks is controlled by the first truck. The vehicles travel at a speed of about 80 km/h at a constant distance of about 5 m. In the long run such a “train” could consist of up to 10 trucks and in addition to networked vehicles, a network with the infrastructure

[45] Cf. Schrage (2010), online; by expert (no year), online
[46] Cf. Schrage (2010), online; by expert (no year), online

should be possible, too. Autonomous driving of trucks forms an important basis for this.[47]

Strengths associated with this concept:[48]

- reduction of waiting times (better traffic flow)
- increased efficiency (optimum capacity utilisation, reduced congestion, better coordination of loading and unloading)
- reduced environmental impact

Resulting weaknesses from this concept:[49]

increased road transport and stronger burden on infrastructure by more freight transport in the future

- legal hurdles
- different national regulations

Bibliography

Andres, M. (2003): Telematiksysteme für die eLogistik. Anwendungsbereiche, Lösungen, Marktüberblick [Studie], available at: http://eurift.eu/file.php/telematik_broschuere.pdf-2005-10-27/telematik_broschuere.pdf, accessed 29.07.2016

Arena, F. / Pau G. (2019): An Overview of Vehicular Communications, in: Future Internet, 11/2, 27, available at: https://www.mdpi.com/1999-5903/11/2/27/pdaccessed am 06.04.2019

Asfinag (2016a): Die Vignette 2016, available at: http://www.asfinag.at/maut/vignette, accessed 13.10.2016

Asfinag (2016b): GO-Maut für Fahrzeuge über 3,5 Tonnen, available at: http://www.asfinag.at/maut/maut-fuer-lkw-und-bus, accessed 13.10.2016

Asfinag (2016c): GO Maut, available at: https://www.youtube.com/watch?v=IwXN96LdA2s, accessed 27.04.2019

Asfinag (o.J.): Verkehrsbeeinflussungsanlagen – Für mehr Sicherheit, available at: https://www.asfinag.at/verkehrssicherheit/verkehrsmanagement/verkehrssteuerung/, accessed 07.04.2019

Ausserer, K. / Risser, R. / Turetschek, C. / Reiss-Enz, V. (2006): Verkehrstelematik – der Mensch und die Maschine. Überblick über Verkehrstelematiksysteme und psychologische und sozialwissenschaftliche Überlegungen zum Thema Verkehr und Telematik, available at: https://www.bmvit.gv.at/verkehr/strasse/umwelt/downloads/studieTelematik2.pdf, accessed 07.04.2019

[47] see Bay (2016) online; see European Truck Platooning Challenge (2016a) online; see Christof (2015) online; see Holzer (2016) online; see Scania Group (2013) 0:00-2:12.
[48] see Bay (2016) online; see European Truck Platooning Challenge (2016a) online; see Christof (2015) online; see Holzer (2016) online; see Scania Group (2013) 0:00-2:12.
[49] see Bay (2016) online; see European Truck Platooning Challenge (2016a) online; see Christof (2015) online; see Holzer (2016) online; see Scania Group (2013) 0:00-2:12.

Bay, L. (2016): Lkw-Platooning. Schön der Reihe nach, in: Handelsblatt, Online-Ausgabe vom 04.04., available at: http://www.handelsblatt.com/unternehmen/industrie/lkw-platooning-schoen-der-reihe-nach/13399630.html, accessed 29.07.2016

Berg, C. C. / Rolf, J. (o.J.): Zum Einsatz der Telematik in der Supply Chain, available at: http://www.gvb-ev.de/fileadmin/pdfs/forschungsergebnisse_07.pdf, accessed 29.07.2016

Bosch (o.J.): V2X Vernetzungslösungen für Nutzfahrzeuge, available at: https://www.bosch-mobility-solutions.de/de/produkte-und-services/nutzfahrzeuge/vernetzungsl%C3%B6sungen/v2x-vernetzungsl%C3%B6sungen/, accessed 06.04.2019

Bundesministerium für Verkehr, Innovation und Technologie (o.J.): Telematik / intelligente Verkehrssysteme (IVS), available at: https://www.bmvit.gv.at/verkehr/gesamtverkehr/telematik_ivs/index.html, accessed 01.04.2019

Christof, F. (2015): V2V-Kommunikation. Platooning: Lkw im elektronisch gekoppelten Fahrzeugkonvoi, in: futurezone.at, Online-Ausgabe vom 12.03., available at: http://futurezone.at/science/

platooning-lkw-im-elektronisch-gekoppelten-fahrzeugkonvoi/116.088.643, accessed 29.07.2016

Dolak, G. (2018): Rechts stehen, links stauen, available at: https://www.bayernkurier.de/inland/31503-rechts-stehen-links-stauen/, accessed 23.04.2019

European Truck Platooning Challenge (2016a): What is Truck Platooning?, available at: https://www.eutruckplatooning.com/About/default.aspx, accessed 29.07.2016

Forschungsinformationssystem (2019): Dynamische Fahrgastinformation (DFI) mit RBL-Daten, available at: https://www.forschungsinformationssystem.de/servlet/is/191276/, accessed 23.04.2019

Gkogkidis, V. (2017): Gamification Tools: Kahoot, available at: https://gamificationplus.uk/gamification-tools-kahoot/, accessed 27.04.2019

Großmann, J. (2015): City-Maut: Wo die Durchfahrt kostet, available at: https://www.geo.de/reisen/reisewissen/926-rtkl-city-maut-wo-die-durchfahrt-kostet, accessed 27.04.2019

Holzer, H. (2016): Vernetzte Lkw: Rollende Datencenter, in: Zeit Online, Online-Ausgabe vom 08.05., available at: http://www.zeit.de/mobilitaet/2016-04/logistik-lkw-vernetzung-digitalisierung, accessed 29.07.2016

next:urban technologies GmbH (o.J.): urban station, available at: https://www.nexturban.at/urban-station/, accessed 23.04.2019

ÖBB (o.J.): SCOTTY mobil, available at: https://www.oebb.at/de/fahrplan/fahrplanauskunft/scottymobil.html, accessed 23.04.2019

ÖBB Personenverkehr AG (o.J.): Google Play: ÖBB Scotty, available at: https://play.google.com/store/apps/details?id=de.hafas.android.oebb&hl=de_AT, accessed 23.04.2019

Randelhoff, M. (2017): Automatisierung des Straßengüterverkehrs, available at: https://www.zukunft-mobilitaet.net/113531/analyse/automatisierung-strassengueterverkehr-selbstfahrende-LKW-autonom-automatisierte-nfz-nutzfahrzeuge/, accessed 06.04.2019

Rauch, M. (2013): Autobahn- und City-Maut für Ausländer: Skepsis bei Asfinag und Stadt Bregenz, available at: https://www.vol.at/autobahn-und-city-maut-fuer-auslaender-skepsis-bei-asfinag-und-stadt-bregenz/3755358, accessed 27.04.2019

Sammer, G. (2012): Wirkungen und Risiken einer City-Maut als zentrale Säule eines städtischen Mobilitätskonzepts. In: Proff H., Schönharting J., Schramm D., Ziegler J. (eds) Zukünftige Entwicklungen in der Mobilität. Gabler Verlag

Scania Group (2013): Platooning [Video], YouTube, 03.10., available at: https://www.youtube.com/watch?v=X3fF6m4ks1g, accessed 26.07.2016

Schrage, R. (2010): Flottenmanagement und Telematik, available at: https://www.uni-koblenz-landau.de/de/koblenz/fb4/ist/AGZoebel/Lehre/ss2011-ordner/sem_asida/Seminar10Ausarbeitungen/schrage, accessed 19.07.2019

Steirische Tourismus GmbH (o.J.): Die Apps der ÖBB für Öffis, available at: https://www.steiermark.com/de/service/apps/oebb-app, accessed 23.04.2019

Synoposis.com (2019): Dude, Where's My Autonomous Car? The 6 Levels of Vehicle Autonomy, available at: https://www.synopsys.com/automotive/autonomous-driving-levels.html, Zugriff am: 30.7.2019

TomTom (o.J.): Die Geschichte der Telematik. Ein kurzer Überblick, available at: https://static.telematics.tomtom.com/_ttt/lib/assets/ttt/doc/whitepapers/de_at/ttt-history-of-telematics.pdf, accessed 06.04.2019

Verband der Automobilindustrie (o.J.): Automatisiertes Fahren. Platooning – Innovation im Güterverkehr, available at: https://www.vda.de/de/themen/innovation-und-technik/automatisiertes-fahren/platooning.html, accessed 06.04.2019

vomFachmann (o.J.): LKW Telematik – Preise und Anbieter, available at: http://www.vomfachmann.de/LKW-telematik-preise-und-anbieter, accessed 06.04.2019

Weidner, M. / Hunger, M. / Zwigl, M. / Schlenker, K. (2018): Blockabfertigung: Verkehr auf A8 und A93 hat sich normalisiert, available at: https://www.rosenheim24.de/rosenheim/inntal/kufstein-ort44506/kufstein-landkreis-transitverbot-blockabfertigung-naechste-staus-erwartet-neu-9813519.html, accessed 23.04.2019

Wiener Linien (2019a): Mobile Tickets, available at: https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66526/channelId/-4400535, accessed 23.04.2019

Wiener Linien (2019b): Der richtige Fahrschien, der passende Tarif, available at: https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66526/channelId/-46648, accessed 23.04.2019

Wiener Linien (2019c): How-To: Jahreskarte in der WienMobil-App anzeigen, available at: https://blog.wienerlinien.at/how-to-jahreskarte-in-der-ticket-app-anzeigen/, accessed 23.04.2019

Wiener Städtische (2017): Neue Risiken durch autonomes Fahren, available at: https://www.wienerstaedtische.at/unternehmen/presse/pressemeldungen/detail/neue-risiken-durch-autonomes-fahren.html, accessed 06.04.2019