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ISO-23795-1: Nomadic Devices for Low Emission Zones and Green Navigation

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Abstract

In June 2022, a remarkable standard was published after being voted by 21 National Standardisation Bodies worldwide: ISO 23795-1:2022, Intelligent transport systems — Extracting trip data using nomadic and mobile devices for estimating CO2 emissions — Part 1: Fuel consumption determination for fleet management. The key message of this ISO-Standard is the fact that Newtonian Physics using speed profiles per second relative to the speed profiles of WLTP leads to reliable and quantifying results with regards to fuel consumption and CO2-Emissions caused by any vehicle in motion driving on road networks. In the EU-Project 5G-Loginnov it was found that such indirect %-WLTP measurements also allow to quantify other pollutants such as NOx and PM10 / PM2.5. By avoiding Stop & Go, example given indicating the Time-to-green information to drivers in a platoon, the field trial in Hamburg found significant savings in fuel consumption, acceleration, and standstill.

Keywords: Data processing and energy efficiency, Policy, Standards and Harmonization

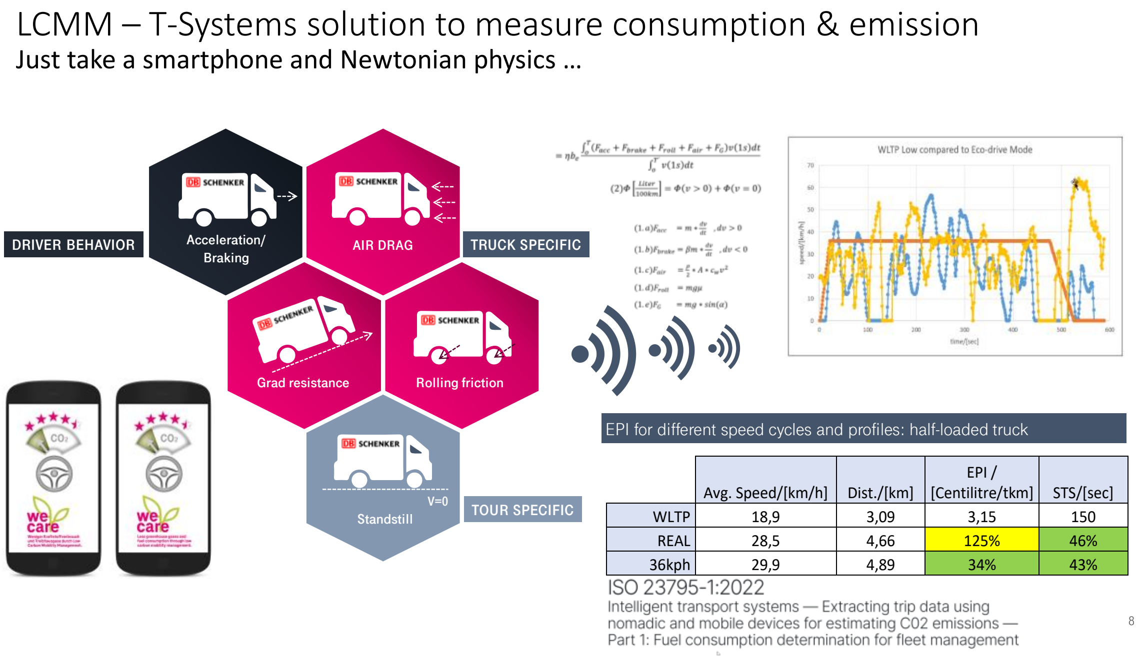
Nomadic Devices – A Game Changer for Green Navigation and Low Emission Zones

When Probe Car Data was considered ideal in the early 1990ies to optimize navigation systems by dynamic traffic information, engineers were dreaming to have a minimum of 4% of all vehicles driving equipped with telematic devices. The statistics behind this, was based on the reliable forecast given during election campaigns with sample data in the range of few percent. The 2020ies generate an amount of traffic data nobody ever could imagine in the early times of telematics service deployment. In October 2022, GSMA published in [1] that the total number of mobile connections has reached 11 billion compared to 2021, whereas the total number of registered vehicles has exceeded 1,4 billion. With most of these drivers and vehicles connected to mobile services all the time, Probe Car Data has become a question of Big Data Analytics and Data Privacy, the relevance of limited statistics and better sample fleets seems a technical challenge of the past.

Newtonian Physics – fuel and CO_2 emissions analysed by speed profiles per seconds

One can say that in the past 30 years, I.T.S. successfully worked out reliable solutions and standards to promote dynamic traffic information and navigation systems, thus dealing with the increasing number of vehicles sharing road networks with limited capacity. Nevertheless, environmental concerns and carbon emissions were ranked secondary as air quality measurement stations and EC regulations took some time to report NOx, PM and Ozon emissions before creating awareness of harmful pollutions since 2010. Pay-as-you-Pollute policy, city-tolling and Low-Emission-Zones, are only a few examples how to manage pollution peaks caused by road traffic.

T-Systems supported traffic authorities in many projects and helped to converge mobile communication with advanced IT to roll out adequate solutions for public stakeholders in charge of traffic management. Together with ERTICO, ISO standardization for monitoring fuel demand and carbon emissions was initiated to make use of the enormous data sources driving with Nomadic Devices on road networks worldwide. Figure 1 shows how Nomadic Devices with Satellite Receivers can be used to evaluate quality of traffic flow based on the quantity of carbon emissions. To the left the specific energy contributions and inertia forces are listed in the box, mathematical formulas are listed directly to the right [2]. By comparing the on-trip speed profile, in Figure 1 the yellow dotted curve to a well-known reference speed profile of WLTP dotted in blue, trips are classified in %-deviation of inertial forces.



	Avg. Speed/[km/h]	Dist./[km]	EPI / [Centilitre/tkm]	STS/[sec]
WLTP	18,9	3,09	3,15	150
REAL	28,5	4,66	125%	46%
36kph	29,9	4,89	34%	43%

Figure 1 – Low Carbon Mobility Management implemented by T-Systems

For the half-loaded truck presented in Figure 1, the recorded speed profile leads to an increase of 25% fuel consumption relative to the corresponding WLTP[1] reference cycle (Low) whereas average speed is

1 WLTP stands for „World-wide Light Vehicle Test Procedure", a methodology for testing engine behavior, including fuel and emissions before market introduction

higher, thus less time needed to deliver the goods. The example shows that only Energy Performance Indicators normalizing fuel and energy demand in Centilitres per Ton and Kilometres using units of [cl/tkm] can make the quality of trips comparable, thus giving dispatchers and logistics entrepreneurs a management tool to optimize operation, costs, and margins. Good results for saving fuel consumption and carbon emissions in the range of 4% up to 15% were found in numerous R&D projects in Europe and Greater China in the last 10 years with further details to be found in reference [3]. Figure 1 also shows the ideal driving pattern with regards to achieving an energy minimum, the red coloured speed profile with only one acceleration and one deceleration event driving 36 km during the rest of the trip. Compared to the two other speed profiles such ideal driving pattern would lead to 34% of WLTP.

GLOSA and Automated Mobility - 5G-Loginnov Use Cases in the pilot site Hamburg

In Hamburg, Green Light Optimum Speed Advise (GLOSA) was tested within the project activities of 5G-Loginnov. The main objective was to find out how GLOSA can stabilise vehicles driving in automated platoon mode in difficult urban traffic conditions and road networks. For this purpose, the 5G-Loginnov tests took place in Hamburg's Test track for Autonomous Driving[2] where all traffic lights are connected via roadside units and mobile communication to the Mobile Edge Server of Deutsche Telekom Group, see Figure 2.

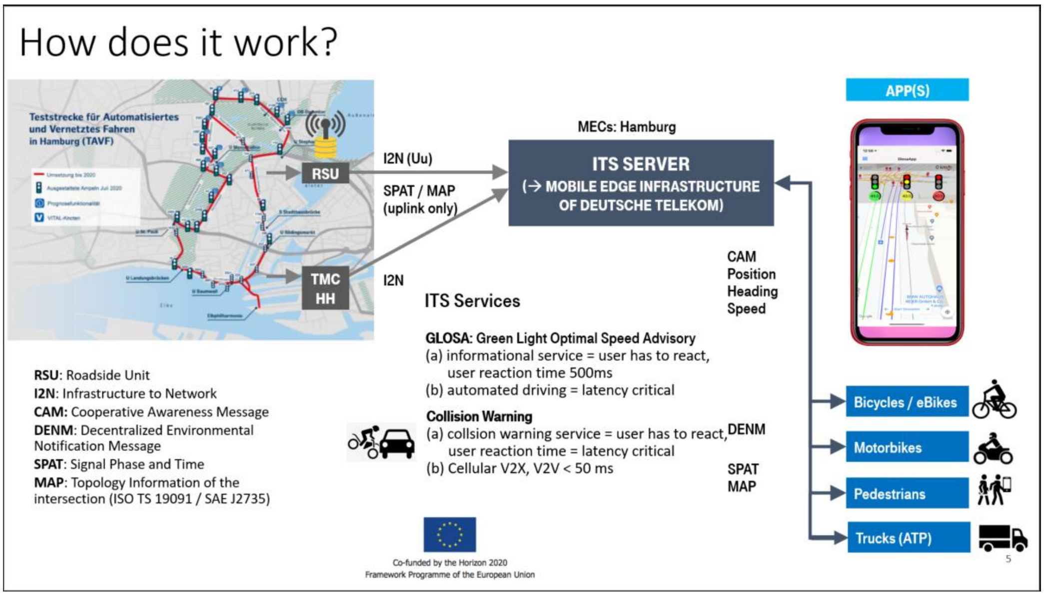


Figure 2 - Test track for Autonomous Driving in Hamburg, set-up 5G-Loginnov

The GLOSA APP shown in Figure 2 was used to give recommendations to the platoon drivers with regards to traffic light's Time-to-green information with a total of 68 traffic lights connected to the system. The responsible operators and traffic authorities in Hamburg fully supported the 5G-Loginnov field trials which were executed in the years 2021 showcasing the solution design for the 2021 I.T.S. World Congress in Hamburg and continued after full use-case and service deployment in 2022. It should be mentioned that fuel consumption and carbon emissions were measured additionally by telematics units of 5G-Loginnov project partners Continental and tec4u for calibrating the ISO-23795-1 method.

[2] See www.tavf.hamburg in English and German

2022 Hamburg 5G-Loginnov field trials and results showing strong low emission potential

In March and July 2021, a total number of 80 platooning trips were recorded along the Test field for Autonomous and Connected Driving (TAVF) without GLOSA APP or relevant Time-to-green information. During the I.T.S. congress in October 2021, another 150 platooning trips were registered giving the Time-to-green information via GPS equipped smartphones to the drivers of the platoon. For fuel and carbon monitoring, the T-Systems ISO-23795-1 APP and two CAN-Bus connected telematics devices of Continental and tec4u were used comparing energy and emissions with and without Time-to-green to measure and quantify the potential savings and the positive environmental impact using 5G cellular V2X (Connected Automated Mobility – CCAM).

1. 5G enabled Time-to-green brings an average speed increase from 15 to 22 km/h, when analyzing trips with constant distance and traffic light information for reacting on time and adequate (Eco-Driving Style)
2. Due to WLTP specific statistics in urban road networks, CO2 emissions have to be analyzed per segment rather than per urban districts with mixed road categories, as this compensates savings and losses, e.g., complex intersections with pedestrians, bicycles, etc. Consequently, Figure 3 shows no reduction in total energy demand and carbon emissions due to such compensation but a clear increase of average speed along the test track TAVF in Hamburg.
3. In combination with Green Light coordination and Time-to-green a potential of more than 50% reduction was found for the TAVF road segments Landungsbrücken to Baumwall (Elbphilharmonie) based on Single Mode Tests, results can be found in Figure 5.2 with 180 gCO_2/km and in Figure 6.3 showing an average 80 gCO_2/km.
4. Acceleration relative to the standard driving cycle WLTP was found to be reduced by -32% and braking indexed by average deceleration by -11%
5. The strongest impact of 5G enabled Time-to-Green comes with regards to standstill. The trips analyzed showed 213 seconds in 2022 compared to 631 seconds without Time-to-Green in 2021, this shows reduction in standstill time of minus times 3.

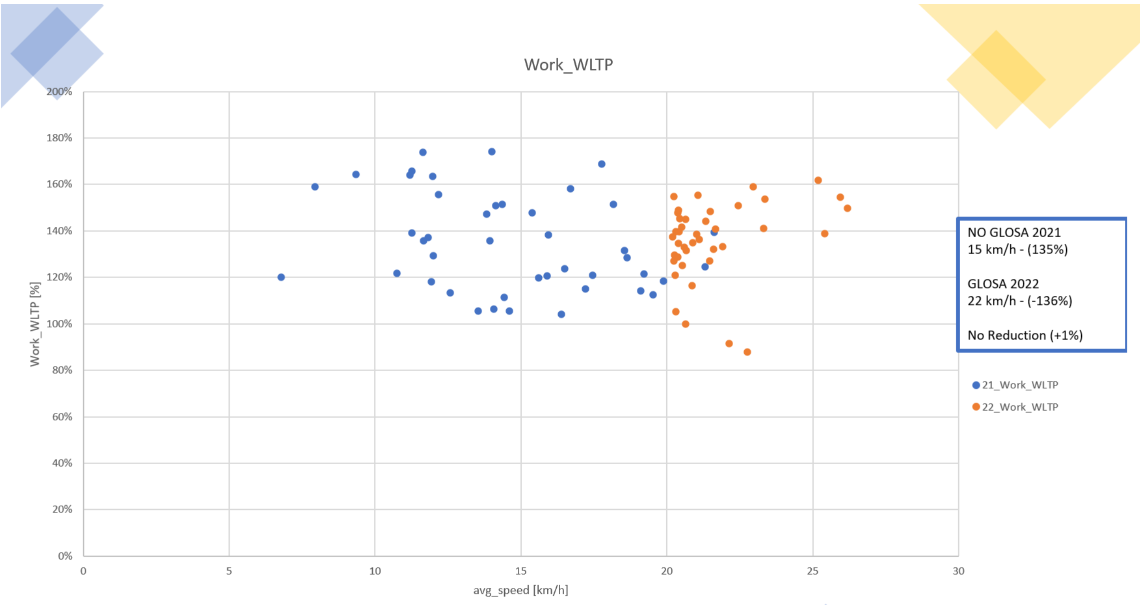


Figure 3 – Comparing speed and energy demand with and without GLOSA information

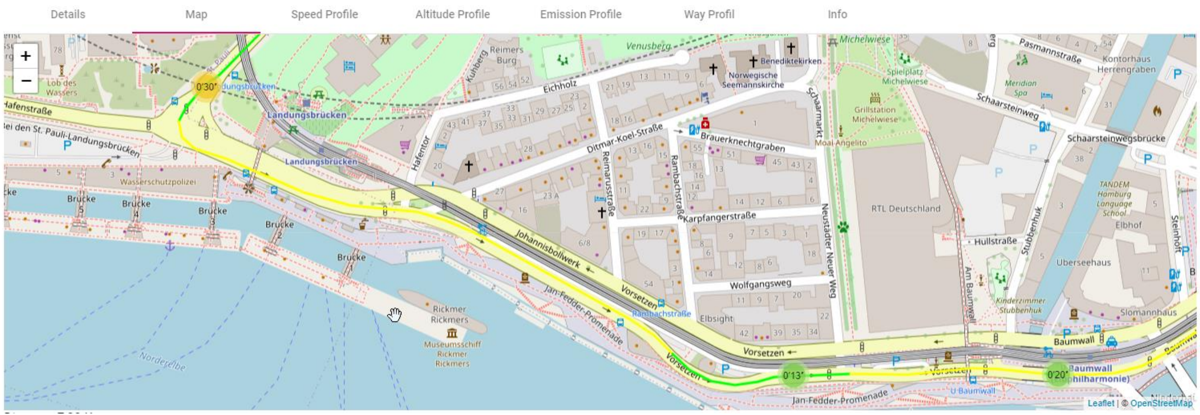


Figure 4.1 – Energy demand analysis across the TAVF road segment Baumwall / Elbphilharmony

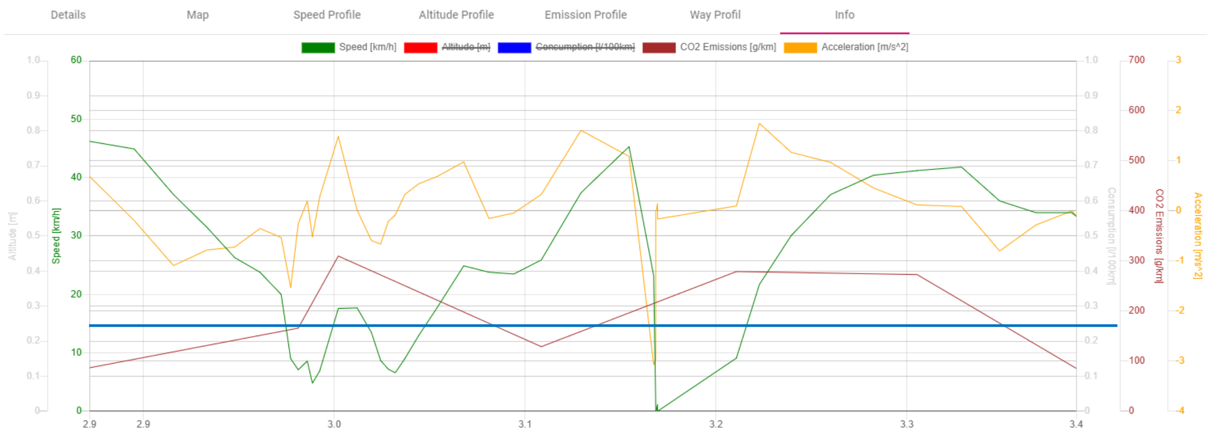


Figure 5.2 – CO_2 emissions across the TAVF road segment Baumwall / Elbphilharmony (2 Stops)

Figure 6.3 – CO_2 emissions same segment but coordinated Time-to-green (No Stops)

Conclusions – 5G enabled Impact Assessment for Green Navigation and Low Emission Zones

Figure 8 shows the Zero Emission Zones Paris and Greater Paris will introduce from 2030 onwards. The concept of low emission zones is well-known in traffic management to reduce emissions and is introduced in many cities all over Europe and worldwide. Especially, in cities with an overloaded road network, it is nevertheless very difficult to introduce low emission zones without causing challenges for the mobility needs of the urban population.

Therefore, the diesel ban which was implemented in several highly polluted European cities in the last years caused a lot of criticism and shows the need for better dialogue between traffic authorities and citizens.

Here, the experiences and results of 5G logistics innovation have the potential to seriously improve the mobility needs of citizens and political constraints of low emission and reduction of air pollution. The results from the field trial in Hamburg, especially those with the better and coordinated traffic light phases show the chance that a connected V2X infrastructure with connected vehicles can bring positive impact to low emission policy.

Figure 7 shows how speed profiles can support traffic managers targeting Low Emission Zones. The severe accident which took place on the A86 ring road caused the necessity to leave A86 and to use a deviation on the urban road network. Where A86 as pass through motorway ring road, is free for all vehicles including Diesel and other high polluting vehicles, the road network for deviation is part of the Low Emission Zone and therefore only can be used by vehicles with Environment Label. Similar bottlenecks will occur when organizing Park & Ride parking lots close to the Low Emission Zone. Here, the political pressure for traffic authorities is directly linked to the amount of parking lots and good access to Public Transport. It is evident that Connected Vehicles and Nomadic Devices will take over the Emission Zone guides for these highly dynamic traffic management tasks in front of Zero Emission Zones 2030 and onwards.

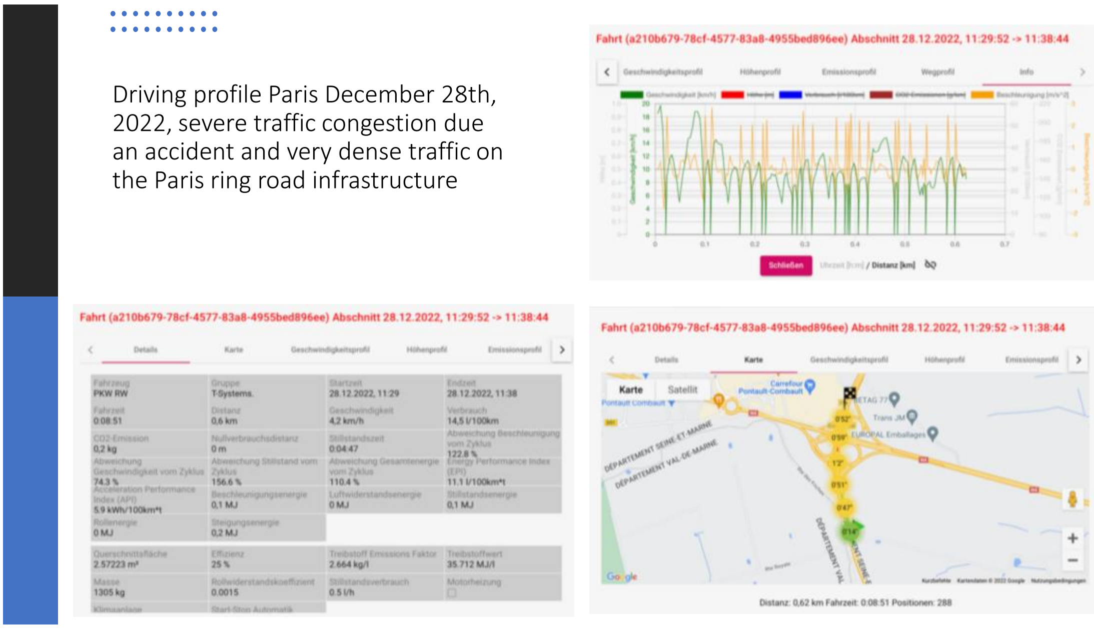


Figure 7 – Severe traffic congestion after accident in Greater Paris

Given the mentioned amount of 11 billion connected mobile devices, including all or at least most of the vehicles driving on roads with connected mobility can definitely help to improve Park and Ride or similar concepts for handover of car drivers to public transport or shared bicycle mobility. Additionally, Green navigation on mobile devices, bringing optimized and low emission routes to general information of on-trip navigation will help to bring resilient green navigation to reality. Therefore, the ISO-23795-1 standard for nomadic devices is a good start, but only the beginning of a long journey ahead for sharing data and bringing new business to markets in the next 20 years.

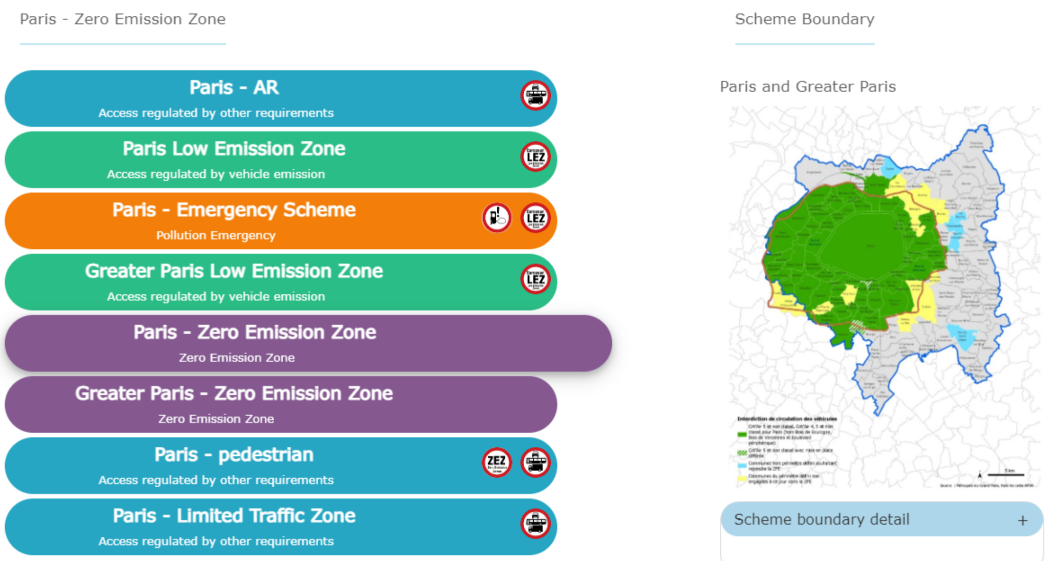


Figure 8 – Paris and Greater Paris - Zero-Emission Zones (only electric) >2030

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