GNSS Training for ITS Developers

Exploitation of EGNOS and EDAS for road applications
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- Road Traffic Management – Main Issues
- EGNOS/EDAS and Road User Charging
- Increasing Road Safety
- Improving Fleet Management and public transport
- EGNOS/EDAS for driver assistance
Issue 1: Road Safety - Status

25845 people died on the roads of the European Union in 2014.

Source: European Commission
Issue 1 – Road Safety - Status

Percentage change in road deaths between 2010 and 2014 (Source: ETSC – June 2015)
Issue 1 – Road Safety - Status

Road death per million inhabitants in 2014
(Source ETSC)
Issue 2: Pollution - Status

Air pollution:

- Transport is one of the main sources of air pollution, for which evidence on direct effects on mortality as well as on respiratory and cardiovascular disease is firmly established.
- About 100,000 premature adult deaths attributable to air pollution occur each year in the WHO European Region. Emissions from road traffic account for a significant share of this burden.
- Some 40 million people in the 115 largest cities in the European Union (EU) are exposed to air exceeding WHO air quality guideline values for at least one pollutant.

Source: WHO, June 2015
### Issue 2: Pollution – Most Polluted Cities

<table>
<thead>
<tr>
<th>Number of days of PM$_{10}$ exceedances of EU limit value of 50 µg/m$^3$ (daily mean)</th>
<th>Number of days of O$_3$ exceedances of EU target value of 120 µg/m$^3$ (maximum daily 8 hours mean)</th>
<th>NO$_x$ annual mean concentrations in µg/m$^3$ (the EU limit value is 40 µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plovdiv, Bulgaria</td>
<td>208</td>
<td>Turin, Italy</td>
</tr>
<tr>
<td>Pleven, Bulgaria</td>
<td>185</td>
<td>Campobasso, Italy</td>
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<tr>
<td>Sofia, Bulgaria</td>
<td>176</td>
<td>Bologna, Italy</td>
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<tr>
<td>Krakow, Poland</td>
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<td>Bergamo, Italy</td>
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<td>Timisoara, Romania</td>
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<tr>
<td>Turin, Italy</td>
<td>106</td>
<td>Reggio nell Emilia, Italy</td>
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</tbody>
</table>
Issue 2: Pollution - Measurements

Nitrogen dioxide ($\text{NO}_2$)

NOISE

POLLUTION

TEMPERATURE
Issue 2: Pollution – CO₂ emission

Carbon Emission:

• Transport = fastest growing source of carbon emission (largest contributor to greenhouse effect and climate change)

• +20% net increase of greenhouse-gas emission in 10 years (source: WHO, June 2015)

• Indirect effects, such as the wide range anticipated from climate change, are becoming increasingly evident.
Issue 2: Pollution - Forecasts

- Transport accounts for over 30% of final energy consumption and about one fourth of CO2 emissions
- CO2 emissions from transport are projected to be 1% below their 2005 level by 2030 and roughly stabilise afterwards
- The share of CO2 emissions from transport would continue increasing, to 38% of the total by 2030 and almost 50% by 2050

(Source: PRIMES)
Issue 3: Congestion - Status

- Over the past 30 years, the number of car in EU doubled and the distances covered tripled.
- 10% of EU roads are congested on daily basis.
- Most congested countries (source: INRIX – June 2015):
  - Belgium
  - UK
  - The Netherlands
  The most congested local road links in Europe.
  Source: Transtools 2010
### Issue 3: Congestion - Status

**Congestion Classification:** Average Delay per km during one hour peak period (Source: Transtools 2010)

<table>
<thead>
<tr>
<th>Country</th>
<th>1 to 5</th>
<th>5 to 10</th>
<th>10 to 20</th>
<th>Higher than 20</th>
<th>Higher than 10</th>
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<td>United Kingdom</td>
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<td>25.7%</td>
<td>11.1%</td>
<td>8.8%</td>
<td>19.9%</td>
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<tr>
<td>Belgium</td>
<td>42.7%</td>
<td>35.1%</td>
<td>12.6%</td>
<td>6.4%</td>
<td>19.1%</td>
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<tr>
<td>Netherlands</td>
<td>46.3%</td>
<td>32.0%</td>
<td>11.6%</td>
<td>6.4%</td>
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<td>Luxembourg</td>
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<td>36.2%</td>
<td>9.6%</td>
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<td>Germany</td>
<td>46.7%</td>
<td>36.8%</td>
<td>9.5%</td>
<td>4.3%</td>
<td>13.8%</td>
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<tr>
<td>Italy</td>
<td>50.7%</td>
<td>25.2%</td>
<td>7.9%</td>
<td>4.7%</td>
<td>12.6%</td>
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<tr>
<td>Hungary</td>
<td>65.7%</td>
<td>19.0%</td>
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<td>Poland</td>
<td>60.8%</td>
<td>21.7%</td>
<td>6.4%</td>
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<td>10.9%</td>
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<tr>
<td>Slovakia</td>
<td>57.8%</td>
<td>26.6%</td>
<td>7.6%</td>
<td>2.6%</td>
<td>10.2%</td>
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<tr>
<td>Ireland</td>
<td>61.8%</td>
<td>18.7%</td>
<td>5.2%</td>
<td>4.1%</td>
<td>9.3%</td>
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<td>Czech Republic</td>
<td>52.8%</td>
<td>28.0%</td>
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<td>2.5%</td>
<td>8.8%</td>
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<tr>
<td>Austria</td>
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<td>28.4%</td>
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<tr>
<td>France</td>
<td>61.1%</td>
<td>19.4%</td>
<td>5.3%</td>
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<td>7.9%</td>
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<tr>
<td>Portugal</td>
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<td>21.0%</td>
<td>5.5%</td>
<td>2.3%</td>
<td>7.9%</td>
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<tr>
<td>Denmark</td>
<td>62.8%</td>
<td>20.9%</td>
<td>5.2%</td>
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<td>7.5%</td>
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<tr>
<td>Sweden</td>
<td>70.7%</td>
<td>13.6%</td>
<td>3.5%</td>
<td>1.5%</td>
<td>5.0%</td>
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<tr>
<td>Spain</td>
<td>68.2%</td>
<td>16.8%</td>
<td>3.7%</td>
<td>1.2%</td>
<td>4.9%</td>
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<tr>
<td>Lithuania</td>
<td>78.6%</td>
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<td>Estonia</td>
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<td>8.3%</td>
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<td>1.2%</td>
<td>3.2%</td>
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<tr>
<td>Finland</td>
<td>74.8%</td>
<td>13.4%</td>
<td>2.1%</td>
<td>0.8%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>
Issue 3: Congestion - Cost

Mean Cost: 1% of the Growth Domestic Product – 111.3 B€
• Main issues:
  – 1/5 of trucks travelling around Europe are carrying nothing.
  – 20% of all truck journeys in the EU are run empty.

Waste of Fuel and money
Push Up carbon emission and air pollution

Final Energy Consumption
(source: European Union, 2011)
Issue 4 – Fleet Management -Distance

Road freight transport by distance class – Source: Eurostat, 2011
The main objective of road application are:

- **Safety Improvement:**
  - situational awareness through vehicle-to-vehicle and vehicle-to-infrastructure communications, enhancing the safety and comfort of the driver.
  - Improvement of emergency assistance
  - Insurance telematics: increase the fairness of motor insurance for both insurers and subscribers.

- **Carbon emission reduction**
  - Better usage of roads and vehicle thanks to Road User Charging
Road Application Challenges (2/2)

– **Regulation**
  - Better road traffic monitoring through collection of location data from vehicles through PNDs, IVS and mobile devices.

– **Fleet Management**
  - Better management through OBU.
  - Digital Tachograph for better control and Safety
  - Fuel and Maintenance Management

– **Innovation**
  - Connected Vehicles
  - Autonomous driving
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EGNOS/EDAS Added Values

• **Better Accuracy**
  – To localize vehicles and accidents (in particular in urban areas)

• **Better Reliability**
  – To trust the positionning and use it in complex systems

• **Integrity**
  – To detect problems quickly
Reducing Pollution

- **EGNOS/EDAS simplifies Road User Charging (RUC) system:**
  - **Definition:** Systems where the driver pays directly for use of a particular roadway or road network in a particular city, region or nation.
  - **Objective:**
    - To reduce pollution (limitation of roads usage)
    - To reduce rush hour peak and congestion
    - To finance roads infrastructures
    - To reduce noises due to traffic
RUC Existing projects in Europe

- Existing projects:
  - Germany
    - MAUT
    - ViaPass
  - Czech Republic
    - myto
    - HU-GO
  - Belgium
  - Hungary

[Logos of MAUT, myto, ViaPass, HU-GO]
Operating principle with DSRC tag

Taxation points with a DSRC beacon

Specific collection infrastructure

IT Systems

Archives

Truck with a DSRC tag
EGNOS for Road User Charging - Principles

Extract from "Egnos for Road" - GSA
Operation principle with satellite

Satellites

IT Systems

Archives

GPRS

None specific infrastructure

Taxation points by GNSS (& DSRC)

Truck with a GNSS receiver (& DSRC)
Points of taxation

Wrong taxation

Measured Trajectory

Real Trajectory

Point of Taxation

Taxable section

Collect point

TAXABLE SECTION
RUC Performance

EGNOS/EDAS reduces:
- Infrastructure
- Incorrect charging

and increase trust in the system.
EGNOS Performance

Absolute positioning error (All configuration)  Absolute positioning error (Motorway Only)

Source: Inside GNSS, April 2011
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Safety Improvement – Example of Applications

EGNOS/EDAS provide better positioning to improve:

**eCALLING**
To know where the accident is.

**ADAS – Advanced Driver Assistance Systems**
To avoid collisions

**PPUI - Pay-Per-Use Insurance**
To localize vehicle
Example of ADAS: ERSEC Project (FP7)

• Collision Avoidance System Project leaded by EICAS
• Automatically deviates the vehicle trajectory just before an impending crash.
• **Objective:** Accuracy on the order of 0.1 meter at a sampling rate of 100 Hz.
• Intelligent data fusion of the EGNOS/GNSS sensor positioning measurement, the Road-GIS digital local map data and the measurement data obtained from an instrument set installed on board of the vehicle, including vehicle dynamic sensors and environmental sensors.
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Road Traffic Management – Main Issues

EGNOS/EDAS and Road User Charging

Increasing Road Safety

Improving Fleet Management and public transport

EGNOS/EDAS for driver assistance
Fleet Management Improvement

DIGITAL TACHOGRAPH – DT
To providing reliable data to any ITS application

ROUTING
To optimize truck journeys

PREVENTIVE MAINTENANCE
To prevent breakdown by analysing truck usages

FUEL MANAGEMENT

16/06/2014
Example of Project: TACOT

- FP7 project granted in 2012 (End of Project: January 2014)
- TACOT: Trusted Multi Application Receiver for Trucks
- This project aimed to prepare the introduction and promote the use of EGNOS and Galileo in the road transportation industry through the realisation of a Trusted GNSS function to be used by the Digital Tachographs (DT)
- PVT reliability rely on multi sensor:
  - EGNOS/GALIELO, GPS and GLONASS
  - On Board Sensors (odometer, secure clock)
  - Other Sensors (time sources, accelerometer)
Architecture Overview

- Telecom Station
- Camera
- Accelometer
- CAN BUS
- T°
- Odometer
- Telecom Antenna
- GNSS Antenna
- Other Sensors
Fleet Management Improvement

LIVESTOCK

DANGEROUS GOODS

PERISHABLE GOODS
Eg. Cold Chain
• **SeCUring the EU GNSS adopTion in the dangeroUs Material transport:** European best practice for the operational adoption of commercial services based on EGNOS.

• Wide adoption of EGNOS in Europe for tracking & tracing of dangerous goods transported by road.

• 300 ENI trucks are equipped with GPS/EGNOS (OS and CS) tracking & tracing devices.
Reduce Congestion by traffic management

PERSONAL NAVIGATION DEVICE (PDA)

ROAD TRAFFIC MONITORING

ROUTING
Pay-Per-Use Insurance

• The costs of the insurance depends on the driven distance, the place, the time of driving and the behaviour of the driver.

• **Objective:** to differentiate and reward "safe" drivers, giving them lower premiums and/or a no-claims bonus.

• Some systems use GNSS signal (e.g. Metromile in US).

• Privacy concerns hinder the development of such systems.
Reduce Congestion by public transport management

PUBLIC TRANSPORTS

EMERGENCY VEHICLES

WASTE COLLECTION VEHICLES

STREET SWEEPERS
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• Connected Vehicle:
  – **Objective:** to provide situational awareness through vehicle-to-vehicle and vehicle-to-infrastructure communications, enhancing the safety and comfort of the driver.
• **Autonomous Driving:**
  
  – **Objective:** replace the driver to reduce traffic accident, improve traffic flow and driver comfort.
  
  – Coupling of several sensors allowing to identify the optimal path of action.
  
  – EGNOS/EDAS provides accurate and reliable position and speed.
Existing Technologies

**Mercedes S-Class Sedan**
- Active Lane Keeping Assist
- Active Blind Spot Assist
- BAS PLUS
- Pre-Safe Pedestrian Recognition
- Intelligent Drive

**Audi Q7**
- Presence City
- Exit warning assist
- Adaptive cruise control with Stop & Go and Traffic Jam assist
Existing Technologies

- **Tesla Model S - Autopilot**

Source: Tesla web site
Google Self-Driving Car

- HW: LIDAR, Cameras, Radar, Odometers and GPS.
- Used preprocessed journeys data

New Cadillac

- To be released in 2017
- Advanced cruised control on highways
EGNOS – Driver Assistance

Extract from "Egnos for Road" - GSA
Conclusions

• Intelligent transport systems for road transport represent an important segment of the GNSS market.

• EGNOS/EDAS signals allows to enhance existing application and to create new application to settle down the main issues dealing with road management.

• Using GALILEO signals, the performance of new application will be even higher.