European best practices in safe transport of dangerous material supported by GNSS

Gianmarco Baldini – IPSC - JRC – EC
Antonella Di Fazio – Telespazio (Finmeccanica/Thales)

Disclaimer: the views expressed are those of the authors and cannot be regarded as stating an official position of the European Commission or Telespazio.
Table of Contents

• Transportation of Dangerous Goods
• Regulatory Context
• The role of GNSS in the transportation of Dangerous Goods
• MENTORE project
• EGNOS
• Vulnerabilities of transportation of Dangerous Goods based on GNSS
• Mitigations techniques and best practices
Table of Contents

• Transportation of Dangerous Goods
  • Regulatory Context
  • The role of GNSS in the transportation of Dangerous Goods
  • MENTORE project
  • EGNOS
  • Vulnerabilities of transportation of Dangerous Goods based on GNSS
  • Mitigations techniques and best practices
The transportation sector is one of the most relevant elements in the economy of Europe.

It is responsible for moving millions of passengers and billions of tons of goods through infrastructures deployed for thousands of kilometres both inside and across nations.

The transportation sector includes many different modes of transport (maritime, road, railway, aviation and pipeline) and a wide range of applications.

Transportation is increasingly dependent on ICT components and services.

GNSS is particularly important in the transportation sector because of the mobility of its components.

The knowledge of the position of the transportation vectors is an essential functionality to ensure the overall security of the transportation chain.

We will focus on the application of transportation of Dangerous Goods by road
Why we are interested to the transportation of Dangerous Goods?

- Improving safety is an EC priority (2003-2010 European Road Safety Action Programme, the European Road Safety Charter, eSafety initiative launched in 2002 by the Commission).

- Thousands of trucks circulate every day within European roads.

- The transportation of dangerous goods involves risks and potential harm to the drivers of trucks and the population.

- We should identify any action or technology, which can reduce accidents and improve the safety.
## Goods transported in 2004 (in 1000 tons), per mode and per type

<table>
<thead>
<tr>
<th>Type of Goods</th>
<th>Road</th>
<th>Rail</th>
<th>Inland Waterway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>9,850.000</td>
<td>719.000</td>
<td>211.000</td>
</tr>
<tr>
<td>Perishable</td>
<td>1,978.000</td>
<td>34.000</td>
<td>25.000</td>
</tr>
<tr>
<td>Dangerous</td>
<td>1,199.000</td>
<td>500.750</td>
<td>122.410</td>
</tr>
<tr>
<td>Others</td>
<td>1,570.000</td>
<td>231.000</td>
<td></td>
</tr>
</tbody>
</table>

In 2004 16 billions tons of goods were transported in the EU25 (road, rail, inland waterway). Road accounted for 89% of this total, rail for 9% and inland waterways for 2%.

source: Eurostat
• Transportation of Dangerous Goods

• Regulatory Context

• The role of GNSS in the transportation of Dangerous Goods

• MENTORE project

• EGNOS

• Vulnerabilities of transportation of Dangerous Goods based on GNSS

• Mitigations techniques and best practices
The objectives of the regulations:

- To classify and describe which goods are considered dangerous
- To identify the categories of goods, which are too dangerous to carry
- To define the requirements and necessary activities to transport dangerous goods, including identification, packaging, labelling and documents
- To identify the duties of the main categories of participants including carriers, consignors and drivers
The international transportation of dangerous goods is mostly based on UN Recommendations on the Transport of Dangerous Goods. Model Regulations.

The UN recommendation has been implemented by:

- *European Agreement concerning the international carriage of dangerous goods by road (ADR)*

- *Regulations concerning international carriage of dangerous goods by rail (RID)*

- *European Agreement concerning the international carriage of dangerous goods by inland waterways (ADN)*

Almost all EU countries are signatories of ADR and RID.
## Regulatory Context

### Specifically for Nuclear Transport and Dangerous Goods

<table>
<thead>
<tr>
<th></th>
<th>International Regulation</th>
<th>European Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(requirements during transport)</td>
<td>DIR. 2001/7/EC and DIR 2003/28/EC;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DIR. 2001/7/EC and DIR. 2003/28/EC;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commission Decision 2002/886/EC; DIR. 1995/50/EC (on uniform procedures for checks on the transport of dangerous goods by road), emended by DIR. 2001/26/EC.</td>
</tr>
</tbody>
</table>

**Future priorities of the EU agenda will include a proposal for an EC directive for real-time tracking of dangerous materials** (source: European Commission DG TREN/MENTORE workshop June 2009)
• Transportation of Dangerous Goods

• Regulatory Context

• The role of GNSS in the transportation of Dangerous Goods

• MENTORE project

• EGNOS

• Vulnerabilities of transportation of Dangerous Goods based on GNSS

• Mitigations techniques and best practices
The knowledge of the position of the transportation vector can be an essential element in preventing or resolving, in an efficient way, an emergency crisis related to the transportation of dangerous goods.

- Passive Tracking where the tracking device stores the vehicles location, through a positioning device (i.e. GNSS terminal), and other data (i.e. vehicle condition or container status) and stores this information in a data storage systems. At the end of the trip, the data can be collected and examined.

- Active Tracking, where the tracking device stores and the vehicle location, through a positioning device (i.e. GNSS terminal), and send it through a wireless communication system to a control room for real-time update and monitoring.

In both cases, GNSS is essential to identify the position of the truck.
Truck can be equipped with OBU (On Board Unit), which collects the position information using GNSS (now GPS) and they transmit it to a central control center through a wireless communication system. Additional information can also be collected by the OBU (status of the truck or conditions of the material).
Role of GNSS

From SIMAGE project
Role of GNSS
• Transportation of Dangerous Goods
• Regulatory Context
• The role of GNSS in the transportation of Dangerous Goods
• MENTORE project
• EGNOS
• Vulnerabilities of transportation of Dangerous Goods based on GNSS
• Mitigations techniques and best practices
MENTORE: iMplemENtation of GNSS tracking & tracing Technologies fOr Eu regulated domains

Project duration: 24 Months, started on July 2007

MENTORE Team: 17 partners in 7 EU countries and Canada

service providers, industrial groups, telecommunication providers, market operators, transport authorities, regulatory bodies and agencies
MENTORE for Radioactive Transport: EGNOS T&T services for regulated control of fissile material transport (M-TRADE enhancement)

MENTORE for Regulated Freight Transport: EGNOS T&T services for
- Customs procedures
- Urban logistics
- Heavy goods vehicles
- Special traffic
- Food traceability
• Transportation of Dangerous Goods
• Regulatory Context
• The role of GNSS in the transportation of Dangerous Goods
• MENTORE project
• EGNOS
• Vulnerabilities of transportation of Dangerous Goods based on GNSS
• Mitigations techniques and best practices
The European Geostationary Navigation Overlay Service (EGNOS) is Europe’s first large project into satellite navigation. It augments two military satellite navigation systems: the US GPS and Russian GLONASS systems.
The added value of EGNOS in comparison to GPS relies in the capability to provide “guaranteed positioning”, thanks the exploitation of its integrity function.

The main application of EGNOS is air safety but many other applications can benefit from EGNOS.

Regulated Tracking and Tracking of dangerous goods is one of these applications.
<table>
<thead>
<tr>
<th></th>
<th>APV-1 requirement</th>
<th>Measured at Toulouse (France)</th>
<th>Measured at Warsaw (Poland)</th>
<th>Measured at Brussels (Belgium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Accuracy</td>
<td>16 m</td>
<td>1.07 m (95% HNSE)</td>
<td>1.82 m (95% HNSE)</td>
<td>1.11 m (95% HNSE)</td>
</tr>
<tr>
<td>Vertical Accuracy</td>
<td>20 m</td>
<td>1.07 m (95% VNSE)</td>
<td>1.78 m (95% VNSE)</td>
<td>1.60 m (95% VNSE)</td>
</tr>
<tr>
<td>Availability</td>
<td>99%</td>
<td>99.9999%* (worst day: 99.999%)</td>
<td>97.2231%* (worst day: 96.551%)</td>
<td>99.989%* (worst day: 99.924%)</td>
</tr>
<tr>
<td>Continuity</td>
<td>1-8.10^{-6} / 15s</td>
<td>Not measured</td>
<td>Not measured</td>
<td>Not measured</td>
</tr>
</tbody>
</table>

About 1m accuracy
No Loss of Integrity event
Opportunities of EGNOS for land applications rely not only on the signal coming from the satellite (OS), but also on the distribution of EGNOS data via EDAS (CS).

EDAS is a server that gets the raw data directly from the EGNOS system and distributes it to service providers in real time, within a guaranteed timeframe and in a secure and reliable manner.

- Raw GPS, GLONASS and EGNOS GEO observations and navigation data collected by the entire network of Ranging and Integrity Monitoring Stations (RIMS) and Navigation Land Earth Stations (NLES)
- EGNOS augmentation messages, as normally received by users via the EGNOS Geostationary satellites
- EGNOS ATC messages: containing EGNOS, GPS and GLONASS status information and almanacs

Source: http://www.egnos-edas.com/
• Transportation of Dangerous Goods

• Regulatory Context

• The role of GNSS in the transportation of Dangerous Goods

• MENTORE project

• EGNOS

• Vulnerabilities of transportation of Dangerous Goods based on GNSS

• Mitigations techniques and best practices
Vulnerabilities of transportation of Dangerous Goods based on GNSS

- Continuous tracking and tracing
- Control of shipment in a specified route (according to the plan and authorised path)
- Incident prevention, thanks to the monitoring of status parameters
- Alarm raising in case of anomaly condition detection
- Recording and logging for regular roundup of reported incidents
- Informing the emergency response forces for the emergency management arrangements.
## Vulnerabilities of transportation of Dangerous Goods based on GNSS

<table>
<thead>
<tr>
<th></th>
<th>GNSS</th>
<th>Communication Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unintentional</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionospheric interferences</td>
<td>Errors in the accuracy of the truck position. May impact a large geographical area.</td>
<td>Minimal impact.</td>
</tr>
<tr>
<td>Unintentional jamming from communication and broadcast systems (e.g. Digital TV)</td>
<td>Loss of GNSS signal and errors in the accuracy of the truck position. Impact a medium geographical area. Potential impact from innovative technologies (UWB, flexible spectrum management)</td>
<td>Reduce quality of the communication</td>
</tr>
<tr>
<td>Lack of coverage</td>
<td>N/A</td>
<td>Potential problem with GSM/UMTS or more with WiFi. Minimal with Satellite Communications</td>
</tr>
<tr>
<td>Lack of signal availability due to obstacles</td>
<td>Potential vulnerability in urban areas or tunnels</td>
<td>Minimal impact</td>
</tr>
<tr>
<td><strong>Intentional</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jamming</td>
<td>Loss of GNSS signal and errors in the accuracy of the truck position. Area of impact is based on the power of the jammer.</td>
<td>Loss of communications. Area of impact is based on the power of the jammer.</td>
</tr>
<tr>
<td>Spoofing/Injection of Misleading information</td>
<td>Misleading position of the truck. It may be difficult to achieve but it is also more difficult to detect.</td>
<td>Misleading position of the truck. Depends on the level of security of the communication.</td>
</tr>
<tr>
<td>Meaconing</td>
<td>Misleading position of the truck.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
• Transportation of Dangerous Goods
• Regulatory Context
• The role of GNSS in the transportation of Dangerous Goods
• MENTORE project
• EGNOS
• Vulnerabilities of transportation of Dangerous Goods based on GNSS
• Mitigations techniques and best practices
<table>
<thead>
<tr>
<th><strong>Mitigations techniques and best practices</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GNSS</strong></td>
</tr>
<tr>
<td><strong>Unintentional</strong></td>
</tr>
<tr>
<td>Ionospheric interferences</td>
</tr>
<tr>
<td>Unintentional jamming from communication and broadcast systems (e.g. Digital TV)</td>
</tr>
<tr>
<td>Lack of coverage</td>
</tr>
<tr>
<td>Lack of signal availability due to obstacles</td>
</tr>
<tr>
<td><strong>Intentional</strong></td>
</tr>
<tr>
<td>Jamming</td>
</tr>
<tr>
<td>Spoofing/Injection of Misleading information</td>
</tr>
<tr>
<td>Meaconing</td>
</tr>
</tbody>
</table>
EGNOS increased stability and accuracy

Source: ENI
Mitigations techniques and best practices

Recommendations & Best Practices

• Evaluate and validate the use of EGNOS in live operations and real commercial deployments.
• Promote harmonization among national best practices.
• Promote technical standardization.
• Provide feedback to the regulatory process.
• Increase the synergy with the public sector (Public Safety organizations) on the basis of the consideration that the transportation of dangerous good may have a strong impact on the security and safety of the citizen.
Thank you for your attention

Questions?