Excerpt from the GNSS MARKET REPORT, ISSUE 4 (2015)
GNSS applications

- **High Density Command & Control Systems** assist train command and control on main lines, referring primarily to the European Train Control System (ETCS) in Europe and some regions in the rest of the world, as well as Positive Train Control (PTC) in North America. GNSS can also be a source of additional input, e.g. for enhanced odometry in ETCS or to support PTC.

- **Low Density Line Command & Control Systems** provide full signalling capabilities supported by GNSS on lines with small to medium traffic. These lines are usually located in rural areas, where cost savings can be vital for the viability of a service.

- **Asset Management** includes such functions as fleet management, need-based maintenance, infrastructure charges and inter-modal transfers. GNSS is increasingly seen as a standard source of positioning and timing information in these systems.

- **Passenger Information** systems on-board trains show the real-time location of a train along its route. Increasingly, the GNSS location of a train is also supporting platform and online passenger information services.

In this chapter

- **Key trends**: GNSS as a solution to increase safety and reduce costs.
- **Industry**: List of main players by value chain segment.
- **Recent developments**: European and Asia-Pacific regions leading GNSS shipments in Rail.
- **Future market evolution**: GNSS to become standard equipment within a decade.
- **User technology**: GNSS potential in Transit Signal Priority applications.
- **Focus on European GNSS**: European GNSS on the way towards safety-relevant applications.
- **Reference charts**: Evolution of GNSS devices’ installed base and revenues by segment and geographic area.
GNSS: a solution to increase safety and reduce costs

Key market trends

- Non-safety relevant applications in Rail are already widely based on GNSS.
- Safety-relevant applications are emerging with different maturity levels depending on region, e.g. in India, China and the Middle East, GNSS is taking up an important position.
- GNSS based solutions can offer safety at a lower cost, e.g. as investigated in railway signalling.

Different levels of maturity for GNSS consideration in Rail applications

The way in which GNSS is used for train applications is different from one region to another. The amount of initiatives in the world shows the consideration given to Rail and GNSS developments.

In Europe, investigations are on-going to include GNSS as a complementing system for safety-relevant operations in the frame of the European Rail Traffic Management System (ERTMS). GNSS, being an innovative solution capable of decreasing costs, has been included in the ERTMS roadmap. Shift2Rail, the first European Joint Undertaking initiative for railways, has been launched as a concrete action to accelerate the integration of technologies, including the use of GNSS, into rail solutions. The key stakeholders developing the ERTMS technical specifications are the European Railway Agency (system authority), ERTMS Users Group and and UNISIG (a member of UNIFE developing the ERTMS specifications).

In the US, PTC (Positive Train Control) implementation is planned soon. PTC combines control, communications, and information systems for safety, security, precision and efficiency of trains movements. It includes GNSS as a positioning technology for the train.

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In the Asian region, India benefits from one of the largest railway networks requiring emphasis on the safety of applications. Huge investments are planned by the Indian government, and trials are on-going to deploy the Train Collision Avoidance System (TCAS). It is considered as a cost-effective solution thanks to the use of GNSS.

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GNSS opportunities for the users

GNSS can bring many benefits depending on types of applications and specific user needs:

- For passengers, there is a strong need of getting precise travel information, which is already being widely implemented.
- For asset management, GNSS is becoming a necessity.
- GNSS enabled signalling applications provide increased safety and reduce costs of infrastructure management and operations compared to legacy signalling solutions.

In the Rail segment, safety comes first

- Introduction of rail applications must consider the constraints in the specific railway environment (e.g. limited satellite visibility, significant multipath or even electromagnetic interference).
- GNSS performance compliance to expected requirements for safety-relevant rail applications is being analysed. Accuracy and integrity requirements that are under development within UNISIG are expected to be very stringent.
- The use of GNSS should continue the growth in non-safety-relevant applications. Many rail freight cars, for which GNSS can be used for asset tracking, currently contain no power supply. Alternative solutions and their associated costs are being investigated first.
The EU GNSS industry in the global arena

The Rail industry is concentrated in Europe and North America, both in terms of components and receivers and system integrators. European companies have a market share of 38% among components and receivers, with the segment being dominated by North American companies.

The top three European companies are Septentrio, Hexagon (Leica Geosystems) and U-Blox.

Among system integrators, European companies have a dominant role with 72% of the market, and the key European operators have strong exports in North America and Asia. The top three European companies in this segment are Ansaldo, Alstom and Siemens.
Europe and Asia-Pacific regions lead GNSS Rail shipments

The existing infrastructure differs greatly across regions, as well as in use. Transport policies, as well as lifestyle and passenger habits, have an impact on the infrastructure. For instance, North America has the second largest railway network in the world, but the second lowest number of passenger journeys among the regions. On the other hand, the Asian network is heavily used for passenger transport. In Europe, Rail has been traditionally strong in terms of both infrastructure availability and usage of trains by passengers.

The size of the railway network and number of passenger journeys per year for each region in 2011

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Unit</th>
<th>EU28</th>
<th>North America</th>
<th>Asia-Pacific</th>
<th>Non-EU28 Europe</th>
<th>Middle East + Africa</th>
<th>South America + Caribbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of track</td>
<td>th. km</td>
<td>348</td>
<td>317</td>
<td>305</td>
<td>199</td>
<td>42</td>
<td>39</td>
</tr>
<tr>
<td>Passenger journeys per year</td>
<td>mln</td>
<td>7,507</td>
<td>78</td>
<td>18,873</td>
<td>2,193</td>
<td>584</td>
<td>24</td>
</tr>
</tbody>
</table>

As a general trend, shipments of GNSS devices have been constantly growing in the last years, with growth significantly intensifying since 2012.

Europe was the early adopter of GNSS and took the majority of shipments in the early years. Europe (encompassing EU28 and non-EU28 Europe) is still the leading region, especially due to high development of non-safety relevant applications related to passenger information. In 2013, the European market represented 49% of shipments.

Asia-Pacific is the other main region in terms of GNSS shipments, showing a very dynamic evolution. Rail networks are particularly important in this area. China has heavily invested in rail infrastructure and has the 2nd largest railway network, whereas India has the world’s 4th largest railway network. The rapid growth of rail infrastructure and thus applications requires enhanced means for train management to ensure safety. GNSS technology contributes to answering this need. The Asia-Pacific market represented 34% of GNSS shipments in 2013.

The Middle East and Africa regions are emerging. Heavy investments are planned in the Middle East (particularly in Saudi Arabia and Qatar) and in North Africa (e.g. in Algeria). Apart from these regions, the African market still remains behind. Although Africa’s railways are disjointed and disconnected, there is a clear willingness to connect railway networks in different countries. This will require interoperability that could partially be provided by GNSS, especially as very few legacy systems are in place and GNSS based systems are more easily deployed.
GNSS to become standard equipment within a decade

Asset management applications are currently driving and expected to continue to drive shipments of GNSS devices. For the nearly 220,000 trains in the world dedicated to freight, the number of wagons with GNSS equipment is around 2.8 mln.

In the coming years, safety-relevant applications (signalling and train control) based on GNSS will be increasingly developed. These applications require a very high level of performance and, depending on the strategy towards them, GNSS may be used as:

- Primary means as foreseen in the US with PTC;
- A back-up solution as planned in Europe; or
- Even one of the means within a hybrid solution.

In any case, GNSS is to be considered as an innovative solution allowing to cut operational costs while also increasing safety. As an example, maintenance of on-board equipment located under the trains, such as balise readers, is very costly. GNSS is an opportunity to reduce reliance on balises and therefore decrease operational costs.

GNSS penetration* will strongly increase in the coming years. The availability of Galileo also strengthens this trend.

There are many on-going activities in Europe to ensure the feasibility of Rail safety-relevant, satellite-based applications capable of being used in operation.

On-going EU-funded R&D: Next Generation Train Control

The NGTC project addresses technical interoperability of different rail systems. The main scope is to analyse the commonality and differences of required functionality for mainline and urban lines, and develop the convergence between the currently used train control and communication systems – determining the level of commonality of architecture, hardware platforms and system design that can be achieved.

In addition, the NGTC project aims to apply new technologies, including GNSS, to the new train control system.

The project is coordinated by UNIFE, the Association of the European Rail Industry, that is contributing to defining the new control systems specifications that will be further developed in the Shift2Rail Joint Undertaking. The project started in 2013 and is planned until August 2016.

* GNSS penetration is defined as the proportion of all possible GNSS devices in the market that are currently in use. In case of Signalling and train control applications, it is assumed that a train with full GNSS adoption will have two GNSS devices. For non-safety critical applications (asset management and passenger information), it is assumed that a fully equipped freight train will have a GNSS device on each wagon, while a fully equipped passenger train has one GNSS device in total. This implies a very significant increase in shipments compared to the way asset management was addressed in the previous edition of the GNSS Market Report.
GNSS potential in Transit Signal Priority applications

Despite the trend to include GNSS in safety-relevant applications, GNSS is currently used in non-safety-relevant ones, such as in passenger information and asset management, where technological innovation plays an important role.

Due to upcoming market opportunities, the manufacturers are preparing to enter the railway signalling domain, which belongs within the realm of safety-relevant applications.

The chart on the left below shows that GLONASS is already present in almost 70% of available receivers*, favourably influenced by the deployment of the Russian KLUB-U train control system, using both GPS and GLONASS technologies for train positioning. The inclusion of SBAS is considered relevant and more than 70% of available models have integrated this augmentation.

The chart on the right below highlights that multi-constellation is recognised as a valuable feature and the percentage of devices capable to track multiple constellations is c. 75%.

Future applications will benefit from multi-constellation, further enhancing their positioning performance.

It has also been demonstrated in the course of the Galileo Signal Priority (GSP) FP7 project that the integration of SBAS, such as EGNOS, is a key enabler for further enhancing GNSS positioning accuracy.

For example, in Transit Signal Priority (TSP) still dominated by conventional technologies such as infrastructure beacons, GNSS provides a new approach that applies on-board intelligence with the same level of reliability provided by the incumbent technology. TSP is an application aimed at improving service and reducing delays for mass transit vehicles, such as trams at intersections controlled by traffic signals. The fact that GNSS allows the “priority request system” to be directly located on the transit vehicle, enables relevant benefits for citizens and the public transport operators. For instance, it results in reduced expenditures, thanks to the lower cost of GNSS OBU compared to roadside equipment, as well as a reduction in delays thanks to reliable real time communication of the position with the traffic management centre (in combination with other technologies).

* For the methodology applied to the charts please go to page 15 of the Report.
European GNSS differentiators

EGNOS
EGNOS, thanks to its capability to both improve accuracy of the positioning solution and provide integrity information, permits the determination of train locations without the need for dense trackside infrastructure. Investigations are currently on-going to characterise the expected level of performance for Rail applications by using GPS and, in the future, Galileo, with EGNOS augmentation – specifically for safety-relevant applications. In the meantime, EGNOS is starting to be used for some of the non-safety relevant applications, e.g. transit signal priority.

On-going EU-funded R&D: ERSAT EAV
The main ERSAT EAV objective is to verify the contribution of EGNSS (EGNOS and Galileo) for safety-critical railway applications, in particular in regional lines, for which a safe localisation of the trains based on satellite technologies will be defined and developed. This will pave the way for harmonisation with the European ERTMS standard, by implementing the solution on a pilot line as reference.

In the first phase, the project will measure and evaluate the gaps to be filled in terms of technological criticalities and railway requirements. Then the measurements under real operating conditions will be performed, building models and analysis with the help of simulations. Finally, a system solution will be defined, developed, implemented, tested and validated on the pilot line, as reference for the future standardisation and certification processes.

More information can be found at: http://www.galoroi.eu/

European GNSS R&D Programmes support competitiveness of the EU industry

Story of successful EU-funded R&D: GaLoROI
The GaLoROI project aimed to develop a certified, safety-relevant, satellite-based on-board train localisation unit to be used on low density railway lines. In the project, a European GNSS based train positioning solution was used, instead of conventional railway localisation equipment so, to provide a cost benefit solution for low density lines.

GaLoROI delivered its final conclusions in mid-2014, finding that a satellite based localisation unit for the safety-relevant application in railways was developed and successfully tested (field tests in a railway environment of the functionality and quality of the localisation unit). Further steps after the end of the project rely on the approval of the localisation unit on a track with respective demand for it from the operator and the relevant infrastructure manager.

More information can be found at: http://www.galoroi.eu/

Source: GALOROI project