Deliverable D7.5

Overview of technical developments and innovation with direct or possible future expected impact on existing guidelines

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Lead contractor

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Contributors

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Executive Summary

A number of innovations have been researched and developed in NeTIRail-INFRA, which will have an impact on the railway system. Some of these innovations will influence existing guidelines and descriptions of practical working methods, while other innovations will have an impact on existing standards, or might require a new standard in the future.

Considering the existing set of standards and technical standardised documents, the aim of deliverable D7.5 “Overview of technical developments and innovation with direct or possible future expected impact on existing guidelines” is to analyse the possible impact of NeTIRail-INFRA deliverables on future technology evolution and regulation. This deliverable also points out, in some cases, a need for developing a new standard or user guidelines where a gap was identified.

The methodological steps of deliverable D7.5 are:

1. Identification of the deliverables representative of NeTIRail-INFRA main innovations.
2. Identification of the relevant Technical Specifications of Interoperability (TSIs) / Standards / International Railway Solutions (IRSs) / Technical documents.
3. Analysis of the possible impact of NeTIRail deliverables on these TSIs / Standards / IRSs / Technical documents.
4. In addition to the analysis of direct impact on Standards / Technical documents, where relevant, the deliverable suggests some new items to be developed (EN, IRS, user guidelines, etc.).
5. Wherever relevant, the information is planned to be forwarded to the Agency (EUAR), Railway applications - Technical Committee of CEN (CEN / TC 256), Railway applications - Technical committee of CENELEC (CLC / TC 9X), UIC Rail System Forum, and to Shift2Rail Cross Cutting Activities Work Area 3.2 dedicated to standardisation. UIC is ready to draft any relevant IRS and user guidelines where UIC members show interest and have available resources to work on the corresponding topic.

The actual exploitation of NeTIRail innovations may lead to refining the list of impacted documents and the further associated actions on the standardised documents (needs for updates, revisions, additions, etc.).

This deliverable has been completed with no deviation from the task description in the Grant Agreement.
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## Abbreviations and acronyms

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<th>Abbreviation / Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABA</td>
<td>Axle Box Acceleration</td>
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<tr>
<td>CEN</td>
<td>Comité Européen de Normalisation - Standardisation European Committee</td>
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<tr>
<td>CLC</td>
<td>CENELEC - Comité Européen électrotechnique de Normalisation - Electrotechnical Standardisation European Committee</td>
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<td>EN</td>
<td>European Norm</td>
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<td>ETSI</td>
<td>European Telecommunications Standards Institute</td>
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<td>EUAR</td>
<td>European Union Agency for Railways</td>
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<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
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<td>HSPA</td>
<td>High Speed Packet Access</td>
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<tr>
<td>IEC</td>
<td>International Electronical Committee</td>
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<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>IRS</td>
<td>International Railway Solution</td>
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<td>ISO</td>
<td>International Standard Organisation</td>
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<tr>
<td>LTE</td>
<td>Long Term Evolution</td>
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<tr>
<td>OCL</td>
<td>Overhead Contact Line</td>
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<tr>
<td>prEN</td>
<td>European Norm Project</td>
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<tr>
<td>RFID</td>
<td>Radio Frequency Identification</td>
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<tr>
<td>TC</td>
<td>Technical Committee</td>
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<tr>
<td>TSI</td>
<td>Technical Specification of Interoperability</td>
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<tr>
<td>UMTS</td>
<td>Universal Mobile Telecommunications System</td>
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<tr>
<td>USP</td>
<td>Under Sleeper Pads</td>
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<td>VHST</td>
<td>Very High Speed Technology</td>
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1. **Methodology**

The deliverable has followed the methodology below:

1. Identification of the deliverables representative of NeTIRail-INFRA main innovations.
2. Identification of the relevant Technical Specifications of Interoperability (TSIs) / Standards / International Railway Solutions (IRSs) / Technical documents.
3. Analysis of the possible impact of NeTIRail deliverables on these TSIs / Standards / IRSs / Technical documents.
4. In addition to the analysis of direct impact on Standards / Technical documents, where relevant, the deliverable suggests some new items to be developed (EN, IRS, user guidelines, etc.).
5. Wherever relevant, the information is planned to be forwarded to the Agency (EUAR), Railway applications - Technical Committee of CEN (CEN / TC 256), Railway applications - Technical committee of CENELEC (CLC / TC 9X), UIC Rail System Forum, and to Shift2Rail Cross Cutting Activities Work Area 3.2 dedicated to standardisation. UIC is ready to draft any relevant IRS and user guidelines where UIC members show interest and have available resources to work on the corresponding topic.

The identification of the relevant ENs, IRSs and other documents such as user guidelines has been performed in close cooperation with the NeTIRail coordinator who has the overview of all deliverables developed by the project, as well as with experts involved in the corresponding deliverables.

As NeTIRail-INFRA is a European Research project, the deliverable has focussed the survey on the European and International perimeter to comply with a wider application. National standards were not taken directly into consideration in the study, as standards developed by Standardisation Bodies and Standard Setting Organisations at European and International level are the conclusion of an important technical consensus that consolidates the best national practices, whereas national standards apply to a limited range.

All standards mentioned below are the latest version in force at the time of writing.
2. Work Package 2 - Tailored track infrastructure, design and maintenance

2.1 Deliverable D2.2

Deliverable D2.2 “Practices and track technology tailored to particular lines” is related to the following existing relevant standards and documents, considering that the main technical objective of this deliverable is the description of the main components and functions of a railroad network, as well as a comparison of the various possible components and technologies according to the actual operation of the line (traffic type/density, etc.) and the three main stages in the life of the railway line (installation, operation and maintenance):

For track design general issues, EN 13803 "Railway applications - Track - Track alignment design parameters - Track gauges 1 435 mm and wider" is the reference standard at a European level.

For rail profile design and selection, the European Rail sector mainly use EN 13674-1 "Railway applications - Track - Rail - Part 1: Vignole railway rails 46 kg/m and above".

For rail fastening design, EN 13481 series on "Railway applications. Track. Performance requirements for fastening systems" is the reference standard in Europe.

Concerning the use of under sleeper pads:
- EN 16730 "Railway applications - Track - Concrete sleepers and bearers with under sleeper pads".
- IRS 71301 "Under Sleeper Pads (USP) Recommendations for Use".

For ballastless track system design questions:
- EN 16432 series on "Railway applications. Ballastless track systems".

To help solving some remaining TSIs open points related to Very High Speed Technology (VHST) and ballastless track systems design:
- TSI Infrastructure (INF TSI).

The deliverable could have the following impact on the existing standards and documents mentioned above:

Design of track alignment, design of slab track systems and ballasted tracks systems, and their components including rail profiles, fastening systems, concrete bearers and sleepers, use of under sleeper pads (USP) and also switches and crossings (both design and components).

Possible developments and/or actions beyond the existing standards:

A user guideline could be developed in the future to help the Infrastructure Manager choosing the type of track (ballasted or slab).
2.2 Deliverable D2.4

Deliverable D2.4 “Application of lean and automotive industry techniques to produce a step change in railway S&C life and costs” is related to the following existing relevant standards and documents, considering that the main technical objective of this deliverable is the investigation of the application of lean and automotive techniques to S&C which represents a critical component of railway infrastructure from the safety and availability points of view (such an analysis was carried out based on the results of previous projects and technical visits that were performed in the framework of NeTIRail-INFRA):

- EN 13674-2 "Railway applications - Track - Rail - Part 2: Switch and crossing rails used in conjunction with Vignole railway rails 46 kg/m and above".
- EN 13232 series on "Railway applications. Track. Switches and crossings".
- UIC Leaflet 716 "Maximum permissible wear profiles for switches".

To help solving remaining open points in TSIs:
- TSI Infrastructure (TSI INF).

For RFID technology standards for items/assets identification:
- prEN on RFID in Railway Applications as required by TC225/WG4 to be developed.

The deliverable could have the following impact on the existing standards and documents mentioned above:

- Design for switches and crossings and components, monitoring/inspection and maintenance actions, recommendations for logistics. Components do not only include the infrastructure system assets (rails, switch rails and crossings) but also elements connected to control, command, signalling system, such as actuation, locking and detection.
- Design for RFID items and assets.

Possible developments and/or actions beyond the existing standards:

A user and organisation guidelines - work management - could be developed.

2.3 Deliverable D2.6

Deliverable D2.6 “Tailoring track to avoid corrugations: Traffic dependant selection of rail cross-section, clips and pads to avoid or delay corrugation” is related to the following existing relevant standards, considering that the main technical objective of this deliverable is to determine the optimal choices in terms of rail cross-section, clips and pads, with the goal to tackle corrugation, according to
the actual traffic along the line (in fact, the choice of these components has a direct impact on the development of corrugation):

For rail fastening design for corrugation prevention:

- EN 13481 series on "Railway applications. Track. Performance requirements for fastening systems".

For the use of under sleeper pads for corrugation prevention:

- EN 16730 "Railway applications - Track - Concrete sleepers and bearers with under sleeper pads".
- IRS 70713-1 “Under Sleeper Pads (USP) Recommendations for Use”.

For ballastless track systems prevention for corrugation:

- EN 16432 series on "Railway applications. Ballastless track systems".

The deliverable could have the following impact on the existing standards and documents mentioned above:

Design of track alignment, design of slab track systems and ballasted tracks systems, and their components including rail profiles, fastening systems, concrete bearers and sleepers, use of under sleeper pads (USP) and also switches and crossings (both design and components).

Possible developments and/or actions beyond the existing standards:

A guideline could be useful to identify and give recommendations on the material to be used.

2.4 Deliverables D2.7 & D2.8

Deliverables D2.7 “Lubrication Systems And Data Available, With Estimates Of Costs And Benefits” and D2.8 “Tailoring lubrication to duty and climate: Safe, effective and eco-friendly avoidance of track wear and damage” are related to the following existing relevant standards concerning wheel/rail friction management, considering that the main technical objective of these deliverables is to determine optimal choices in terms of lubrication products (eco-friendliness, etc.) and lubrication techniques/systems according to the climate and traffic conditions in such a way as to improve the safety and availability of the track and help the maintenance operations:

- EN 15427 on "Railway applications. Wheel/Rail Friction Management - Flange lubrication".
- EN 16028 on "Railway applications. Wheel/Rail Friction Management - Lubricants for train borne and trackside applications".

The deliverable could have the following impact on the existing standards mentioned above:

Lubrication systems and compounds for wheel flanges and rails, both for train borne and trackside applications.
Possible developments and/or actions beyond the existing standards:

A guideline could be developed on which lubrication liquid to use.

2.5 Deliverable D2.10

Deliverable D2.10 “Cost effective transition zone design tailored to line type and traffic” is related to the following existing relevant standards and documents, considering that the main technical objective of this deliverable is to improve the design of transition zones in such a way to tackle the abrupt condition change in these zones, which generally require important maintenance operations:

For track alignment design in transition zones:
- EN 13803 "Railway applications - Track - Track alignment design parameters - Track gauges 1 435 mm and wider".

For rail fastening design in transition zones:
- EN 13481 series on "Railway applications. Track. Performance requirements for fastening systems".

For the use of under sleeper pads in transition zones:
- EN 16730 "Railway applications - Track - Concrete sleepers and bearers with under sleeper pads".
- IRS 70713-1 "Under Sleeper Pads (USP) Recommendations for Use".

For ballastless track system transition zones to other systems or ballasted track systems design questions:
- EN 16432 series on "Railway applications. Ballastless track systems".

To solve open points in TSIs related to VHST and also on ballastless track systems and their transition zones design:
- TSI Infrastructure (INF TSI).

The deliverable could have the following impact on the existing standards mentioned above:

Design of track alignment, design of slab track systems and ballasted tracks systems, and their components including rail profiles, fastening systems, concrete bearers and sleepers, use of under sleeper pads (USP) and also switches and crossings (both design and components).

Possible developments and/or actions beyond the existing standards:

A guideline could be developed on maintenance and how to manage transition zones. A new standard could also be foreseen on smooth tamping.
3. **Work Package 3 - Tailored overhead line power supply infrastructure – Deliverables D3.5 & D3.6**

Deliverables D3.5 “Tailored combinations of wire tension, pantograph collector strip material and upload force for optimum performance” and D3.6 “Data on system damage for different combinations of wire tension, pantograph collector strip material and upload force” are related to the following existing relevant standards and documents, considering that the main technical objective of these deliverables is to determine the optimal choices/configurations for the various components that ensure high safety level of the train overhead power supply:

- ETSI EN 300 220 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW”.
- ETSI EN 303 204 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Network Based Short Range Devices (SRD); Radio equipment to be used in the 870 MHz to 876 MHz frequency range with power levels ranging up to 500 mW”.
- IEEE® 802.15.4g PHY specifying wireless personal area network (WPAN) standards.
- ISM 868 Band for Europe.
- IEEE® 802.11 b/g/n specifying a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.

Wire tension standards and overhead line monitoring could also be impacted.

**The deliverable could have the following impact on the existing standards and documents mentioned above:**

The range of the existing tensions could be impacted by the future evolution of:
- Standards in the area of pantograph and contact line interactions.
- Standards in the area of maintenance and inspection activities.

**Possible developments and/or actions beyond the existing standards:**

- Complex applications for linking the historical long-time database with mathematical models and providing automatics optimisations solutions for current collection performance and OCL maintainability.
- Wear degree monitoring, through long time vibrations registration, for other high voltage components.
- Development of new models for further railway track upgrading, and also improvement of new designs.
4. **Work Package 4 - Monitoring and Smart Technology**

4.1 **Deliverable D4.2**

Deliverable D4.2 “Low cost track-based monitoring modules for plain line and S&C” is related to the following existing relevant standards/documents, considering that the main technical objective of this deliverable is the development of low cost trackside modules that can be easily installed and operated to monitor some special zones along the track (S&Cs, welding points, etc.):

For track inspection:
- EN 13848 series "Railway applications. Track. Track geometry quality".
- EN 12299 "Railway applications. Ride comfort for passengers. Measurement and evaluation".
- ETSI EN 300 220 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW”.
- ETSI EN 303 204 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Network Based Short Range Devices (SRD); Radio equipment to be used in the 870 MHz to 876 MHz frequency range with power levels ranging up to 500 mW”.
- IEEE® 802.15.4g PHY specifying wireless personal area network (WPAN) standards.
- ISM 868 Band for Europe.
- IEEE® 802.11 b/g/n specifying a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.

The deliverable could have the following impact on the existing standards and documents mentioned above:

Impact on standards relative to maintenance and track inspection management.

Possible developments and/or actions beyond the existing standards:
- Complex applications for linking the historical long time database with mathematical models, and providing maintenance optimisations solutions.
- Wear degree monitoring, through long time vibrations registration, for other sensitive track components (sleepers, clamps, joints, etc.).
- Development of new models for further railway track upgrading, and also improvement of new designs.
Deliverables D4.3 “Development of technology for track and ride quality monitoring” and D4.4 “Track and ride quality monitoring technology based on train-borne measurements in standard vehicles” are related to the following existing relevant standards on track inspection, ride quality monitoring and assessment, considering that the main technical objective of this deliverable is the development of monitoring modules that can be installed onboard standard vehicles to monitor track and ride quality:

- EN 13848 series "Railway applications. Track. Track geometry quality".
- EN 12299 "Railway applications. Ride comfort for passengers. Measurement and evaluation".
- EN 14363 "Railway applications. Testing and Simulation for the acceptance of running characteristics of railway vehicles. Running Behaviour and stationary tests".

The deliverable could have the following impact on the existing standards mentioned above:

No impact has been identified on the standards mentioned above.

Possible developments and/or actions beyond the existing standards:

A possible guideline in terms of inspection and maintenance planning could be developed, especially on finding small defects on the track.

Deliverables D4.5 “Development status of smartphone technology for track and ride quality monitoring” and D4.6 “Low cost smartphone based track and ride quality monitoring technology” are related to the following existing relevant standards / documents, considering that the main technical objective of these deliverables is the development of smartphone based low cost solutions to monitor track and ride quality:

- ISO 2631 "Mechanical vibration and shock - Evaluation of human exposure to wholebody vibration".
- 3G UMTS (Universal Mobile Telecommunications System) / HSPA (High Speed Packet access).
- 4G LTE (Long Term Evolution).

Neither impacts on the standards above, nor possible developments, were identified.

Deliverable D4.7 “Harmonised interface to transmit on-board monitoring data to the traffic control centre” is related to the following existing relevant standards, considering that the main technical
objective of this deliverable is the development of a common interface that gathers and combines the various information collected through the monitoring modules developed within NeTIRail-INFRA:

- IEEE® 802.11 b/g/n specifying a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.
- IEEE 802.3 is defining the physical layer and data link layer’s media access control (MAC) of wired Ethernet.
- 4G LTE – Long Term Evolution.

The deliverable could have the following impact on the existing standards mentioned above:

GSM-R could appear limited, which would lead to the use of 4G LTE and 4.5G LTE, for instance.

4.5 Deliverable D4.8

Deliverable D4.8 “Functional, operational and technical specification for simplified interlocking of user autonomous switches in low density lines” is related to the following existing relevant standards, considering that the main technical objective of this deliverable is the development of a uniform system that communicates monitored status data from all mechanical and electromechanical devices, which are involved in interlocking activities while achieving the requirement for integrating automatically operated devices into the old interlocking systems:

- ETSI EN 300 220 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW”.
- ETSI EN 303 204 “Electromagnetic compatibility and Radio spectrum Matters (ERM); Network Based Short Range Devices (SRD); Radio equipment to be used in the 870 MHz to 876 MHz frequency range with power levels ranging up to 500 mW”.
- IEEE® 802.15.4g PHY specifying wireless personal area network (WPAN) standards.
- ISM 868 Band for Europe.
- IEEE® 802.11 b/g/n specifying a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.

The deliverable could have the following impact on the existing standards mentioned above:

None. National regulations are involved for safety aspects.
Possible developments and/or actions beyond the existing standards:

- Complex applications for synchronising activities and helping interlocking management.
- New sensors interfaces for particular devices integration.
- Guidelines on acceptance of the innovation, in particular whether or not the introduction of the innovation should be considered a significant change of mechanical interlocking systems, requiring (or not) the application of a Common Safety Method.

### 4.6 Deliverable D4.9

Deliverable D4.9 “Interface definition for input of GNSS (or ground-based train odometry) location data to monitoring technology” is related to the following existing relevant standards, considering that the main technical objective of this deliverable is to create a standard interface for connecting ABA (ride and track quality monitoring) and SATLOC (localization) systems, to transfer and concentrated data for achieving a complex and complete data acquisitioning message:

- RS232 asynchronous standard communication between ABA and SATLOC.
- Standards respected by ABA and SATLOC systems, individually.

The deliverable could have the following impact on the existing standards mentioned above:

Communication standard interface does exist, impact on SATLOC and ABA (standards involved by the both systems, individually).

Possible developments and/or actions beyond the existing standards:

- Structure of messages could be standardized.
- Optimisation and automatic usage of the results.
- Real time data processing.

### 4.7 Deliverable D4.10

Deliverable D4.10 “Tailored decision support for track and vehicle maintenance through conversion of data to information” is related to the following existing relevant standards on track inspection, ride quality monitoring and information assessment, considering that the main technical objective of this deliverable is the combination of the various collected monitoring data and the generation of useful information for short, mid and long term operations:

- EN 13848 series "Railway applications. Track. Track geometry quality".
- EN 12299 "Railway applications. Ride comfort for passengers. Measurement and evaluation".
- EN 14363 "Railway applications. Testing and Simulation for the acceptance of running characteristics of railway vehicles. Running Behaviour and stationary tests".
The deliverable could have the following impact on the existing standards mentioned above:

None.

Possible developments and/or actions beyond the existing standards:

A possible guideline to select the right technology to be used could be helpful.

5. Conclusions

Considering the existing set of standards and technical standardised documents, the deliverable analysed the possible impact of NeTIRail deliverables on future technology evolution and regulation. This deliverable also pointed out in some cases a need for a new standard development or user guidelines where a gap was identified.

Concerning the potential development of recommendations and guidelines, UIC would focus on operations, maintenance and processes, and assess the needs among its stakeholders.

6. References

