**Track infrastructure design and maintenance optimised for particular routes and track types**

Tailored overhead line power supply infrastructure providing solutions for low cost electrification

Low cost monitoring interfaced with railway technology to optimise operation, maintenance and renewal of the infrastructure

Assessment of economic and social impact of rail transportation to examine costs, benefits and viability of lines and their investment decisions

Developing decision support software for rail system operators outside the project to apply the methods developed to their own lines

Track infrastructure design and maintenance optimised for particular routes and track types

The key aspects of the project

**Background to NeTIRail-INFRA**

The principles behind the NeTIRail-INFRA project were conceived in early 2014 in response to the topic MG2.1 “Intelligent Infrastructure” in the 2014-2015 Mobility for Growth Horizon 2020 call. The NeTIRail-INFRA concept was based on designing railway infrastructure and monitoring tailored to the needs of specific lines to ensure the most cost effective and sustainable solution for different line types and geographical locations.

There is particular emphasis in the project on lesser used lines which are marginally economical and at risk of closure or require substantial public subsidies. As well as the lesser used lines the project also considers capacity constrained and freight dominated lines.

**NeTIRail-INFRA**

Needs Tailored Interoperable Railway Infrastructure

**Foreword**

This first issue of the NeTIRail-INFRA Newsletter presents some of the highlights from the first year of the project.

NeTIRail-INFRA started in June 2015 and has made considerable achievements within the first year, all of the deliverables due in this period have been submitted, and the public deliverables will be available on the public website shortly. Progress to date includes selecting the case study lines to be used throughout the project; initial deliverables related to the tailored track infrastructure and overhead lines technologies and recommendations; GIS mapping of failures; and baseline maintenance and cost data have been collected. With regard to monitoring and smart technologies, prototype measurement devices for on track measurement have been developed and work has started to trial the ABA high precision track monitoring system in Turkey.

The website will be updated frequently so please visit us regularly to keep informed of the latest news and progress in the project, or you can follow the project on twitter at @netirail.

**Next Events**

NeTIRail-INFRA will hold a joint project conference with the FP7 Capacity4Rail project on 4 November 2016 in Brussels.

This will be an opportunity to learn more about the aim and objectives of both of these projects and the results so far.

As further details are finalised more information will be available on the NeTIRail-INFRA website and on our Twitter feed, or if you wish to be added to our project mailing list please email j.paragreen@sheffield.ac.uk or dekeyzer@uic.org.

Website: www.netirail.eu

Twitter at: @netirail
WP1 - Contrasting market needs, and business case

**Leads Partner**: University of Leeds – Institute of Transport Studies

**Objectives**

- Establish the business case for the proposed technical innovations as they apply to the three line categories under consideration in this project (busy capacity limited passenger railway, under-utilised secondary 'low density' line, and a freight dominated route) to demonstrate that the proposed technologies will generate an overall net benefit to society, and establish the financial case for each of the line categories, to demonstrate viability for the different parts of industry.

- Propose changes needed to the (country-varying) incentive arrangements operating within the rail industry to facilitate the implementation of the proposed technologies.

**Achievements**

In the first task (1.1), seven case study lines were selected that fit the three line categories from countries with industry representation in NeTIRail-INFRA (Romania, Turkey and Slovenia).

In the next task (1.2), working with the other work package leaders, work has begun to clarify the nature of the technical innovations being studied such that the potential types of costs and benefits may be identified, and a data collection strategy adopted.

Some data on rail demand (needed to quantify any benefits to rail users, for example through improved services) has been collected and a data template covering costs and related information populated using Swedish data in order to demonstrate the types of data that will be needed in due course.

The objective is to compute costs and benefits for the scenarios with and without the innovation. The data collected and the strategy for completing the data collection process is set out in Deliverable D1.2.

In the next phase, the focus will be on collecting the remaining data, working closely with the work package leaders for WP2-WP4. The next stage will also set out the high level cost modelling framework that will be used to model the cost changes from the innovations (Deliverable 1.3.1) and begin to specify the incentives related research (related to the second main objective above). The latter will include new statistical modeling work on better understanding cost variability with traffic, climate and quality.

The demand model – needed to compute user benefits will also be developed. Work has started on that aspect within Task 1.2 and the approach is summarised below.

Transport interventions (such as the NeTIRail-INFRA technological innovations in the railway) provide two types of benefits; lower costs for maintenance and better conditions for users. To quantify and measure user benefits, it is necessary to understand the current state of the demand of the train lines analysed. Based on a clear understanding of the current situation, it is feasible to forecast future situations with and without the innovations. To achieve this goal, some form of demand analysis tool is needed. The selected tool for this project is the PRAISE (Privatised Rail Services) demand model developed at the Institute for Transport Studies, University of Leeds (Whelan et al, 1997, Preston et al, 1999, Whelan, 2002).

In order to undertake this analysis, we use an implementation of the PRAISE rail forecasting model suggested by Johnson and Nash (2006). PRAISE forecasts rail demand between Origin-Destination (OD) pairs on a network as well as for individual services and ticket type, taking account of fares, journey times, desired departure times and possibly overcrowding.

The tool is useful for considering different aspects of competition and for analyzing the impact of capacity shortages on demand. It can also be used for forecasting the impact on demand as well as estimating the benefits of service improvements.

**STEP 1**

- Estimation of the generalized cost of travel for each service and ticket combination

**STEP 2**

- Setting the sensitivity of the model to replicate known elasticities of demand

**STEP 3**

- Calibrating ticket specific constants to ensure that the base market shares can be replicated

**STEP 4**

- The final stage iterates to adjust for overcrowding on trains

**There are four stages to the calibration of the demand model:**

- An upper level of the model scales overall changes in rail demand following service level changes based on generalized journey time or cost. The package also includes a model for considering operator costs, using a cost accounting approach. This facilitates the incorporation of costs that are related to operating hours, costs that are related to train kilometres and fixed costs in the analysis.

- PRAISE yields results for changes in consumer surplus, operating profits, modal switch values and vehicle kilometres, which can be used in conjunction with external cost valuations to undertake an appraisal.
WP2 – Tailored track infrastructure, design and maintenance

LEADING PARTNER: SZ – PROMETNI INSTITUT LUBLJANA D.O.O.

Objectives

The overall purpose of Work package 2 is to develop track infrastructure solutions tailored to three types of rail lines. This WP focuses on the cost drivers of track infrastructure maintenance. The tailoring of track is further detailed in order to focus on the precise types of data necessary for the analysis. WP2 deals with track technology, switches and crossings, corrugation, lubrication and transition zones.

Achievements

Task T2.1 analysed the primary cost drivers of maintaining, collected data related to failures and environmental, created data repository in a form of a relational database, identified and presented existing datasets of failures, maintenance, costs, asset types and spatial databases.

With the purpose of preventing corrugation within Task T2.4 the following studies are being performed: a numerical model to understand the mechanisms behind short pitch corrugation and sensitivity analysis of fastening parameters on vertical railway track dynamics.

Task T2.2 described the technologies and practices used for installation, operation and maintenance of track lines at European and global level most suited to each three line types investigated on the seven case study lines.

In order to apply lean and automotive industry techniques to railway switches and crossings (S&C) sector within Task T2.3, successful cases of lean application and experiences of S&Cs collected. Analysis of this data and the application of lean techniques are intended to increase the efficiency of maintenance and repair of S&C.

Under the Task T2.5 a questionnaire was prepared to obtain information of the current types of lubrication systems under use in partner’s countries. The questionnaire also considered climatic conditions (humidity, precipitation, ambient temperature) and mechanical parameters. This task will result in the specification of lubrication strategies which are optimised to the individual case study lines.

In the Task T2.6 the transition zones and their effect on railways are being studied. For this purpose a sophisticated finite element model is being built to simulate the transition zone and identify if transition performance can be optimised through adjusting sleeper mass and spacing.

Conclusion

Work in WP2 has been carried out in accordance with time planning. The first two tasks have been completed, while the other four tasks related to research on new technologies, improvements, innovations, which will represent the results of project NeTIRail-INFRA – are in progress.

Comprehensive infrastructure data is necessary to perform the tasks and to achieve aims. Cost data of infrastructure components needed for analyses have been specified. Much of the data for each case study line has already been presented inside completed deliverables; other data currently being obtained and/or analysed.

NetIRail-INFRA delegation visit a site in Ankara to measure the health condition of the railway track

From the 4th to the 6th of April 2016, a delegation of the Section of Railway Engineering, Delft University of Technology, visited the railway track near Ankara, Turkey, to evaluate the possibility of measuring the health condition of the railway track with the axle box acceleration technology.

Jan Moraal and Jurjen Hendriks (TUDelft) were received by Elf H. Öztürk and Ali Salih Akbaykal from the Intermodal Transportation & Logistics Research Association (INTADER) of Turkey. Different meetings were conducted and track-train visits were all organized by INTADER and TCDD.

On the first day, after they were picked up at the airport, the delegation visited the main office of TCDD near Ankara Central Station. An interesting track section was selected for the visit, and different meetings with directors and personnel of TCDD were held. The track section that was planned to be measured starts in Kayas and ends in Lalahan.

The second day started earlier in the morning. A meeting was first organized with the director of the track section to be visited. Shortly afterwards, the track visit and a visit to the Roger 800 measurement car was conducted. The track is very interesting for health condition measurements. Some track segments are in very good condition, so they can be used as a “healthy reference”. In some other locations, short pitch corrugation and rolling contact fatigue are affecting the tracks. The aim of the research will be to focus on the understanding of short pitch corrugation, but the team of TUDelft will also test detection of squats. With the information of where the defects are located, and how severe they are, INTADER and TCDD will have information that can facilitate maintenance operations.

Figure 1 - (a) Having a meeting in the Roger 800: Jan Moraal, Yavuz Bozkulu, Elf H. Öztürk, Ali Salih Akbaykal, Barabara Kucukakin, and Yusuf Suvag. (b) The Roger 800 from the outside. (c) Double track segment of the track that starts in Kayas. (d) A track that ends in Lalahan.

Figure 2 - Some rolling contact fatigue examples that were found during the track visit, (e) squat, (f) short pitch corrugation, (g) joint with plastic deformation, (h) weld, (i) surface damage, (j) damaged weld. The measurements will focus on the understanding and detection of short pitch corrugation, but it is expected with the measurement to also be able to detect squats (e).
WP3 – Tailored overhead line power supply infrastructure

LEADING PARTNER: ADS-ELECTRONIC RESEARCH SRL

WP3 is a technical work package developing technologies and supplying input about their costs and benefits to the business case and other tasks requests. It focuses on the challenges which lead to delay through unreliable performance of overhead line power supplies, the investment costs which make it difficult to install overhead power on low density lines, and on the ongoing operational cost of maintaining the system. The activities conducted in WP3 are aimed at increasing passenger comfort, and transport security along the lines monitored as well as optimising the frequency for the maintenance works.

Objectives

- **Develop evidence** based links between the grade of overhead line and components installed in the traffic mix which uses them, and the life of the system.

Testing will be conducted to support these objectives. The work will support increased utilisation of capacity as well as a reduction in the recurrent costs of rail operations, and reduced power supply operational and maintenance costs.

Achievements

The main activities and results achieved could be summarised as follows:

**The activities carried out by ADS in relation with the designing of equipment and systems within WP3 are the following:**

1. **On-board monitoring of voltage, power spikes, other electrical properties that inform about state of substations and overhead line.**
   - These systems will be used to collect appropriate data modelling in order to analyze the relationship between controllable factors (line tension, materials, and upload force) and power system wearing and failures.

2. **Instrumentation of overhead line (not pantograph) to measure accelerations of overhead line.**
   - High speed video data gathering from pantograph and overhead line contact.

3. **Specify tailored solutions for improving the quality and performances of overhead line power infrastructure.**
   - Cost effective inspection and asset management to minimise maintenance intervention time/cost without dedicated inspection vehicles. New methods will be proposed based on track side accelerometers and sensors, axle box acceleration measurements and ultra low cost smartphones.

Data and information have been collected in order to the task dealing with “Tailoring new overhead lines installations to mechanicals and electrical demand”.

These data should be grouped and assigned to three categories of case study lines, so that the design can be optimized for tailoring new overhead line installations to mechanical and electrical demands.

WP4 – Monitoring and Smart Technology

LEADING PARTNER: TU Delft

Objectives

The objective of this work package is to develop smart technology solutions for three major problems faced by lower density lines:

1. Cost effective inspection and asset management to minimise maintenance intervention time/cost without dedicated inspection vehicles.
2. New methods of interfacing equipment specific to lower density lines with existing systems of data configuration, location information and interlocking.
3. Data mining and interpretation capability to convert monitoring data into management information.

Achievements

In summary the main results achieved so far:

- To understand the dynamic loading for plain line and S&C, ADS established a technical solution following a stage of system analysis. The schematic design of the hardware device was created and the experimental equipment for data collecting was designed.
- ADS created the experimental equipment for data collection of track side from accelerometers sensors. This equipment was used on AFER Stress Testing Laboratory to collect data with initial controlled conditions, at Cristianu Station from partner RCCF - for testing range of rails vibrations in real conditions, at Sabareni Station (see Figure 1) also for collecting data in real conditions.
- The ABA measurement system has been tested by TUD in the Dutch railways with a new GPS antenna. Evaluation for fitting the ABA sensors in the available rolling stock was done for Turkey. Measurements in Turkey are being planned.
- ADS defined the requirements inputs and conceptual design for the low cost smartphone sensors for vehicle and infrastructure monitoring. The physical design is ready and testing will start on end of July 2016.

Figure 3 - Data collection at Sabareni Station
WP5 – Societal perspective

**Leading partner:** Albert-Ludwigs-Universität Freiburg

**Objectives**
The objectives of this work packages are to assess and quantify possible societal and legal effects caused by the decisions made about railway infrastructure. It will integrate ethical, social and legal considerations with the economic analysis carried out in the work package “Contrasting market needs, and business case”. By doing that, WP5 aims to provide a framework that enables better choices regarding transport and railway innovations.

**Achievements**
A preliminary social impact assessment

So far a preliminary social impact assessment of the innovations planned in NeTIRAIL-INFRA has been carried out. It has identified the different stakeholders groups and the interest that might be affected by the innovations, such as those relating to health and environment, safety, employment and accessibility. Drawing on the most important ethical traditions, it also laid down the theoretical framework for evaluating the effects of innovations. Finally, WP5 has designed an on-train survey to investigate passengers’ perceptions of the case-study lines.

WP6 – Evaluation and decision support tools

**Leading partner:** UIC

**Objectives**
Objectives of Work Package 6 “Evaluation and decision-support tools” are threefold:

- Gather the necessary, network-related technical and operational data;
- Show these data via a web interface that will be used by other work packages for performing evaluations of potential infrastructure upgrades;
- Prepare the same tool and datasets for further usage outside the Project.

The considered web application shall be open source, and shall offer a GIS-based interface usable by non-specialists. The main challenges in the design of this application are:

- The data mix: the end user shall be able to use background data, e.g. from public sources such as the European Register of Infrastructure (RINF), together with his own – possibly confidential – data and hypotheses;
- The “scenario player”, allowing the end user to compare options for the future development of the network. The economic outcomes should be immediately visualized.

**Achievements**
A confidentiality agreement has been prepared: the data necessary for the development and calibration of the web application will be made available to the extent desired by the data owners.

Background data sets have been collected and examined. For a GIS-based application, a usable representation of the railway networks would be the Natural Earth 1:10m railroads public domain dataset (ne_10m_railroads files), providing a fairly complete, worldwide line-level mapping.

The main data shortage concerns passenger stations and freight yards. While these locations are well known by name (e.g. from ENEE or CRD databases), there is no single source of geo coordinates to be associated with these.

Basic information concerning line characteristics and operations will be retrieved from legacy UIC databases; these have been gathered and reviewed. Assembling all information into one single data set is the main upcoming challenge. One fundamental component for assembling the data is available since April 2016: it is the RailTopoModel, a universal data model for representing the railway network and linked assets; more information is available on www.railtopomodel.org.

The definition of the web application could stem from RailVIVID (a railway-specific data viewer, under separate development) and/or OGSI, a well-known and powerful open source GIS software solution.

Figure 4 - Part of the European network represented using QGIS and the mentioned data sources. Attempted station and halt localization is precise enough, but many stations are still missing. Only Romanian stations are shown in this sample picture.
WP7 – Dissemination, training needs and influence on guidelines and standards

LEADING PARTNER: UIC

First user-group meeting

On March 23rd 2016 NeTIRail-INFRA held its first user group meeting to obtain expert external feedback on the aims and objectives, and the current work being carried out in the project. The user group meeting was also an opportunity to better understand other national, European or international projects or initiatives past or present which may be complementary to the activities carried out within NeTIRail-INFRA or may benefit from the results of the project or provide background information or data. The user group meeting was also an opportunity to forge links between the project consortium and the wider industry to start to plan where the NeTIRail-INFRA project results may be implemented or developed further. Amongst the attendees at the user group meeting were representatives from Network Rail, RSSB, SNCF, Siemens Rail Automation, Railenium and University of Ljubljana.

TRA2016 and other dissemination activities

The NeTIRail-INFRA project has been disseminated widely in the first 12 months of the project including at TRA2016 in Warsaw 18th-21st April 2016, where NeTIRail-INFRA was disseminated through stand up presentations at the UIC stand. NeTIRail-INFRA has also been presented at a number of other workshops and conferences these include Brussels CPDP (Computer, Privacy and Data Protection) Conference January 2016 and at the Romanian Club Feroviar International Conference Railway Pro in March 2016. Summaries of the NeTIRail-INFRA project may also be found on the research portals TRIP – Transport Research & Innovation Portal www.transport-research.info and RSSB/UICs SPARK portal of railway research www.sparkrail.org.

Facts and figures

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Consortium

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