First Interim Report  
Title: Periodic Activity Report 2

<table>
<thead>
<tr>
<th>Contract number :</th>
<th>285259</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project acronym :</td>
<td>TREND</td>
</tr>
<tr>
<td>Project title :</td>
<td>TEST OF ROLLING STOCK ELECTROMAGNETIC COMPATIBILITY FOR CROSS-DOMAIN INTEROPERABILITY</td>
</tr>
<tr>
<td>Funding Scheme:</td>
<td>7th Framework Programme (FP7) –Transport</td>
</tr>
<tr>
<td>Date of latest version of Annex I</td>
<td>26/02/2013</td>
</tr>
<tr>
<td>Periodic Report</td>
<td>2\textsuperscript{nd}</td>
</tr>
<tr>
<td>Period Covered</td>
<td>1/05/2013 - 30/04/2014</td>
</tr>
<tr>
<td>Project Coordinator</td>
<td>CEIT</td>
</tr>
</tbody>
</table>
| Organisation | CEIT  
Paseo de Manuel Lardizabal, 15  
20.018, San Sebastián- SPAIN  
Tel:+34 943212800 Fax: (+34) 943 213076 |
| Project Website address: | http://www.trend-eu.org |

The TREND project was funded by the European Commission under the 7\textsuperscript{th} Framework Programme (FP7) –Transport  
Coordinator: CEIT
Index

1. PUBLISHABLE SUMMARY 5
2. CORE OF THE REPORT FOR THE PERIOD 12
   2.1 Overview of general project objectives 12
   2.2 Objectives for the reporting period 12
   2.3 Budget follow up table 13
3. WORK PROGRESS AND ACHIEVEMENTS DURING THE PERIOD 19
   3.1 WP2: Identification of Railway System Electromagnetic Interferences 19
   3.2 WP3: Assessment of Current Harmonized EMC Approval Test 20
   3.3 WP4: Design of the Railway System Model 21
   3.4 WP5: Identification on Reasonable EMC worst case Conditions 22
   3.5 WP6: Test Setup Design and Verification 23
   3.6 WP7: Design and Verification of Cross-Acceptance Test Sites 27
   3.7 WP8: Design and Verification of Testing Procedure 30
   3.8 WP9: Dissemination and Exploitation 33
4. PROJECT MANAGEMENT 36
   4.1 Introduction 36
   4.2 Consortium management tasks and achievements 37
      4.2.1. Problems which have occurred and how they were solved or envisaged solutions. 39
      4.2.2. Changes in the consortium 39
      4.2.3. Changes to the legal status of any of the beneficiaries 39
   4.3 Project planning and status 40
      4.3.1. Impact of possible deviations from the planned milestones and deliverables 40
   4.4 List of project meetings 42
      4.4.1. Consortium Meetings 42
   4.5 Use of foreground and dissemination activities during this period 43
      4.5.1. Development of the project website and rss 43
      4.5.2. Media 43
      4.5.3. Meetings 43
      4.5.4. Publications 43
      4.5.5. Analysis of the web site impact 44
      4.5.6. General Dissemination Roadmap 46
   4.6 Deliverables and milestones tables 48
      4.6.1. Deliverables (excluding the periodic and final reports) 48
      4.6.2. Milestones 49
LIST OF ANNEXES

Annex A.1: 2nd Meeting with Advisory Board
Annex A.2: 5th Steering Committee Meeting
Annex A.3: 5th Scientific Committee Meeting
Annex A.4: Summary of the Dissemination Activities

LIST OF CHANGES

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Contributors</th>
<th>Section Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2 Unificada v2</td>
<td>26/05/2014</td>
<td>All</td>
<td>All (each contributions)</td>
</tr>
<tr>
<td>D2 CEIT</td>
<td>25/06/2014</td>
<td>All</td>
<td>All (completed)</td>
</tr>
</tbody>
</table>
Declaration by the scientific representative of the project coordinator

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate) ¹:
  - [ ] has fully achieved its objectives and technical goals for the period;
  - [X] has achieved most of its objectives and technical goals for the period with relatively minor deviations.
  - [ ] has failed to achieve critical objectives and/or is not at all on schedule.
- The public website, if applicable
  - [X] is up to date
  - [ ] is not up to date
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 3.4) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 3.2.3 (Project Management) in accordance with Article II.3f of the Grant Agreement.

Name of scientific representative of the Coordinator: Íñigo Adin Marcos

Date: 25/06/2014

For most of the projects, the signature of this declaration could be done directly via the IT reporting tool through an adapted IT mechanism.

¹ If either of these boxes below is ticked, the report should reflect these and any remedial actions taken.
1. PUBLISHABLE SUMMARY

List of Beneficiaries

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Short name</th>
<th>Country</th>
<th>Project entry month</th>
<th>Project exit month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS</td>
<td>CEIT</td>
<td>Spain</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES INVESTIGACIÓN Y DESARROLLO, S.L.</td>
<td>CAF I+D</td>
<td>Spain</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>CENTRO DE ESTUDIOS Y EXPERIMENTACION DE OBRAS PUBLICAS</td>
<td>CEDEX</td>
<td>Spain</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>INSTITUT FRANCAIS DES SCIENCES ET TECHNOLOGIES DES TRANSPORTS, DE L'AMENAGEMENT ET DES RESEAUX</td>
<td>IFSTTAR</td>
<td>France</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>YORK EMC SERVICES (2007) LIMITED</td>
<td>Y-EMC</td>
<td>United Kingdom</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>TRAFIKVERKET - TRV</td>
<td>TV</td>
<td>Sweden</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>LULEA TEKNISKA UNIVERSITET</td>
<td>LTU</td>
<td>Sweden</td>
<td>1</td>
<td>30</td>
</tr>
</tbody>
</table>

Contact details

Dr. Iñigo Adin
CEIT
Paseo Manuel de Lardizabal, 15
20018 San Sebastian (Spain)
Tel. (+34)943212800
Fax: (+34)943213076
Email: iadin@ceit.es

Summary description of project objectives

The TREND project proposal identified the objectives of this project and aimed to progress the understanding of the EMC of rolling stock with the railway environment beyond the current 'state-of-the-art' for the targeted signalling and communication systems.

Three points are highlighted for the technical point of view, and the first one summarizes the first phase of the project:

1 - Identification of the representative worst case conditions for the targeted signalling and communication systems that includes not only steady state but also transient behaviour. These conditions refer not only to rolling stock but also to infrastructure conditions. To achieve this, the first objective of the project proposed is: modelling of the electromagnetic interferences affecting
the signalling and communication systems addressed by TREND in a complete railway environment to obtain the representative worst-case conditions for EMC approval tests.

The second part of the project and its objectives was summarized by the 2 next points. These have been the objectives pursued during the second period here reported:

2 - Definition of a controlled test environment that comprises a test setup and a test site. This test environment will provide repeatability, reliability and accuracy. Moreover, the test environment will be able to reproduce infrastructure representative worst-case conditions

3 - Design of a testing procedure that introduces stimulus to generate the representative worst case conditions and, captures and processes data in a way that the compatibility margin is evaluated to demonstrate availability and safety.

Finally, the dissemination is also a key objective of the project and 6 levels have been pointed out: Worldwide level with web page, contribution to technical journals and international congresses, contribution to the standards and active working groups on signalling and communications, dissemination to the industry, dissemination to the main stakeholders in railway and EMC topics and improvement of courses for professional advancement and also for students.

### Work performed and main results achieved

Technically, the first period of the project was dedicated to WP2, WP3, WP4 and WP5 and the activities performed during Period 2 are here related to WP6, WP7 and WP8. WP1 and WP9 which are for Management and Dissemination activities are global activities.

**WP1: MANAGEMENT**

In this first work package, the Person-Months are dedicated to the management activities. CEIT, as project coordinator, has had the main responsibilities in such matters: administrative, financial, legal and IPR activities. The technical management with tasks review and generic progress review meetings are also CEIT’s responsibilities in both periods. For the Advisory Board’s meetings, CEIT and CEDEX have shared the efforts for organization, but the expenses and invitation have been managed by CEIT.

**WP2: IDENTIFICATION OF RAILWAY SYSTEM ELECTROMAGNETIC INTERFERENCES**

No efforts have been dedicated to this WP in the second period of the project.

**WP3: ASSESSMENT OF CURRENT HARMONIZED EMC APPROVAL TESTS**

No efforts have been dedicated to this WP in the second period of the project.

**WP4: DESIGN OF THE RAILWAY SYSTEM MODEL**

No efforts have been dedicated to this WP in the second period of the project. The results and conclusions have been directly used in the WP6, WP7 and WP8.

**WP5: IDENTIFICATION OF REASONABLE EMC WORST CASE CONDITIONS**

No efforts have been dedicated to this WP in the second period of the project. The results and conclusions have also been directly used in the WP6, WP7 and WP8.

**WP6: TEST SETUP DESIGN AND VERIFICATION**

**WP7: DESIGN AND VERIFICATION OF CROSS-ACCEPTANCE TEST SITES**

**WP8: DESIGN AND VERIFICATION OF TESTING PROCEDURE**
In the second part of the project, the work flow of the project has been redesigned and 4 working groups have been created, for the 4 signalling and communications under study:

- CEIT, CEDEX and CAF for spot signalling systems BTM
- IFSTTAR for GSM-R
- LTU and TV for DC Swedish Track Circuits
- Y-EMC for Broadcasting services

Each working group has dedicated its effort on the analysis, design and verification of the whole task “Test setup, test site and test procedure” of each one system (shared as presented in the list just above).

**a) BTM Working group**

In the second part of the project, the spot signalling system BTM has been studied from two points of view necessarily linked: balise immunity and rolling stock emissions. These points are the two sections of the Subset 116 which is a document thought to foresee the real environments where the BTM would have to be installed. To contribute to both matters in that documents, which has some sections currently to be completed or even to be defined, the BTM working group has design the test setup, test site and test procedure for the BTM immunity tests and the Rolling stock emissions. The activities for the first one have been realized in the laboratory, at CEDEX, where the actual setup, site and procedure have been analyzed and some improvements have been proposed. Considering the realistic interferences captured on-board the high speed trains used in that project, we consider than other structural parameters should be considered for the interference shape. The activities of the second one have been undertaken on-field (OARIS train form CAF) with the proposed loop and a dedicated data acquisition system. The analysis and the time-frequency post-processing of the signals were coordinated with the laboratory for a proper calibration of the loop. The results of both fields have been sent to the UNISIG-UNIFE subset116 working group for their consideration.

**b) GSM-R working group**

For the measurement of the interferences able to affect the GSM-R communication a test setup was designed to permit to compare the EM disturbances with the GSM-R useful signal. This design and implementation permits to analyse the interferences over by time windows similar to the duration of a GSMR burst and with a time resolution which correspond to the binary rate of the GSM-R protocol. The GSM-R test set-up was improved and assessed in laboratory applying noise scenarios including transient disturbances initially collected during different railway campaign measurements. The results showed that the test set-up is available whatever the EM noise conditions and on the site on which these conditions were observed. Only one limitation was identified concerning the automatic estimation of the GSMR useful signal: it was noticed that the estimation is imperfect when the GSMR covering is very low and the impact of the interferences collected can be underestimated. Finally, a complete GSM-R test set-up and procedure was defined. This test procedure included the creation of a reference base which permits to directly link the characteristics of the measured interferences with the impact on the GSM-R communication quality. The test procedure requires to fix the parameters of configuration of the measurement equipment such as they were defined during the base reference creation. The studies here performed in TREND showed also that it is primordial that the measurements are carried out with a GSM-R antenna and in its operational position.

**c) DC Track Circuits working group**

The objective of the DC track circuit working group was to analyze and propose a test setup, test site and test procedure for the worst case conditions pointed out in the first period of the project for DC track circuits. This work has been coordinated between LTU and TV. TV has supported the former with the appropriate data drawings, information from interviews and, obviously, the track
control of all the equipment around the track circuits, on field, so that can be defined in the test setup. With the data and the analysis performed by the maintenance unit of LTU, the design of the test setup, test site and test procedure has been performed and validated.

The three case studies have resulted in a proposal that may be considered in future revision of the safety documents for this kind of detection system. TV is actually currently planning to include the tests in their documentation.

d) Broadcasting Services working group
The broadcasting services working group has focus the efforts on the test setup, test site and test procedure to measure the total radiated power from the arcing interferences. For that, the test configuration, parameters and procedure have been tested and validated in a proper location: a reverberation chamber.

First, preliminary measurements of the representative tests have been set up in the chamber. With those results, the test procedure requirements could have been defined, with proposal on how to operate with the arcing wheel in order to produce representative measurements according to the one found in the real railway environment. The final design of the test site included the application of the environment external to the laboratory. The worst case conditions recreation has been managed by changing the parameters of the test setup to vary gap length, wheel speed etc. The results have been verified when compared to results taken outside the chamber. This also includes some work into the new draft versions of EN50121 to determine the relation between the measurements and the new standards.

WP9: DISSEMINATION AND EXPLOITATION

The 6 activities proposed for dissemination have been considered during the whole process of the project. In the first part of the project, all the items have been started, excepting the contribution to standards as this requires the final information. But this has been the main effort during the second part of the project, as a result of the “test setup, test site and test procedure” design developed by each working group. The more significant results are here listed:

- Publication of the main results of the projects in the deliverables
- Results directly disseminated to main stakeholders in railway and EMC standardization
- 1 technical journal
- 10 conference papers
- 2 railway EMC courses
- 7 participations in railway magazines and industry forums
- 1 workshop for EMC railway
- 1 workshop for Train Signalling System Interference Estimation

Expected final results

The call answered by this project (SST.2011-25.1) expounded the need to complete and harmonize the rolling stock approval tests for EMC, as this has been for years a major problem for railway system integrators in terms of time and costs:

- Time to market of the new systems integrated in the rolling stock
- And overall, time of operation for railway lines crossing borders inside the European Union.

As widely known, currently most of the countries have their own signalling and control systems which are non-interoperable. This increases the time for border crossing and hence of the whole travel duration. This also requires the integration several control systems which increases enormously the cost of the train borne equipment.

The first step to address this matter was the definition of the European Railway Traffic Management System (ERTMS), partially funded by the European Commission. The next step results from the requirements of the train operators and the rolling stock integrators (through European Railway Agency) who are reporting cost concerns due to 4 issues:
1. On-board CCS for the modification of existing vehicles and/or the additional PIS (Placing In Service). Up to 7M€ for ETCS software changes.

2. Electromagnetic Compatibility

3. Running dynamics

4. Pantographs.

The TREND project addresses issue 2. and the EMC issues associated with 3. and 4., in-line with the guidance presented in the call and to the report issues. The scientific and technical objectives presented to further the state-of-the-art in the proposal and the progress shown by work packages WP2 and WP3 of the project, demonstrate the need for this project and are starting to address the EMC issues:

Objective 1: the first objective, “the modelling of the railway system and the integration of the electromagnetic interferences affecting the communication systems in a complete railway environment to obtain the representative worst case conditions for EMC approval test” is directly addressed to issues 2, 3 and 4 of the previous list. The costs issues reported in the ERA open points’ reports could be notably diminished for the railway industry (train manufacturers, rolling stock and signalling systems integrators, infrastructure responsible and by hence the passengers and freight transport industry) with a better understanding of the signalling and communication systems and their problems associated, by means of modelling the real environment. In the case of TREND project, some step forwards could be done for the modelling of the specific signalling and communication systems: BTM, GSM-R, DC track Circuits and generic Broadcasting Services. For them, the most the close environment should be modelled in order to focus the attention on the detailed action of the real interferences.

Objective 2, 3 and 4: These objectives propose the “design and verification of a test site, test setup and test procedure that reproduces the representative worst case conditions”. The test site, test setup and test procedure for the mentioned signalling and communication systems will enable the improvement of the EMC approval testing. This test setup and procedure will have to include the rolling stock electromagnetic emissions that could affect interoperability including transient phenomena, so electromagnetic compatibility can be demonstrated and safety and availability can be assessed.

Objective 5: The dissemination objective is also a key part of the project, in which the 6 levels defined in the proposal of action are important for the TREND consortium: Worldwide level, scientific level, industrial level, stakeholder level, professional level and normative level.

## Potential impact and use

The impact of TREND project embraces the safety, the availability and the economical concepts, which are here linked in the fields of railway communications and signalling. From a European point of view, it helps in some step forwards.

The interoperability and the cross-acceptance issues presented by the answered call and laying the foundation of TREND project are of major importance into the European Union. The steps forward that could be done for some of the standardized EMC approval tests, here studied, would improve the safety guaranty of the railway systems. This also influences enormously the availability of the trains and their integrated systems which has a significant impact on the competitiveness of the companies and on the users’ vision of the railway transport system. Both, passenger and freight market could progressively increase the rail transport volume as this kind of project keep on working on advances for signalling and communication systems. But also, the companies will save time and money on the costly measurement campaigns and punctual problems in specific places of the deployed railways.

As initially proposed in the Part B of the DOW document, the impact of the project offers opportunities on various levels:

**Users – Passenger and Freight market.**
The users of the railway transport are [EUROSTAT 2008]:

- In 2008, 405 billion passenger-kilometres were registered in the European Union (excluding Bulgaria), a 4.2% growth compared to 2007.
- The total performance of rail freight transport in the EU-27 was 447 billion tonnekilometres in 2008.
- These enormous figures have taken place in the 216,018 of kilometres-length of the lines in the European Union.

The previous data exhibit the impact of the TREND project in terms of the improvements foreseen on the railway availability for users and railway companies. Up to 2008 (last year reported by the Eurostat report at the moment of the writing of the project proposal and which trends have been confirmed by the data in the 2010 Eurostat analysis), both the passenger and the freight market have had a positive growth, and so, this tendency would be accentuated with the higher availability achieved by the fully interoperable on-board systems and trains; Highlighting the words “Punctuality” and “simple logistic”.

Furthermore, in 2008, some 2848 people were victims (seriously injured or killed) of railway accidents in the EU-27. Of the total number, 17.4 % were either train passengers or railway employees. Approximately two thirds (68.6 %) of the lives lost in rail accidents were from incidents involving rolling stock in motion, with almost all the others (26.6 %) from incidents at level-crossings. That figure could be decreased with the improvement brought by the TREND project in terms of safety for certain critical zones where the signalling is the only protection.

Transport service enterprises and their employees

The last recount done by Eurostat [EUROSTAT 2008], FIF (La Fédération des Industries Ferroviaires) [FIF] and UK Railway Companies [UK RAIL], establishes that there are 453 enterprises in the railway transport service in the EU-27. So, the trains’ higher availability and the foreseeable increase in the railway transports, for all kind of users, would have a clear impact on the service enterprises of the European Union. This is directly scalable to the employment of these principle railway industries: 891,852 people at the end of 2008. This figure would be increased if the railway transport and the investment on that solution for the mass and freight transport have an increase in its use.

Railway enterprises and other stakeholders

The number of enterprises involved in the railway industry is much higher than the figure reported in the last point. Companies such as train manufacturers, railway systems’ integrators, equipment developers, R&D centres and other technology providers are also affected by the impact of the TREND project. For them, this project will have a secondary economical benefit from 2 point of view. First, the foreseen preservation of the growth of the railway transport for passengers and freight goods will maintain the growth of the railway industry and its associated companies and will benefit the creation of employment. And second, the rolling stock system modelling, the test site, the test setup and the test procedure foreseen by TREND, will minimize the expensive measurement campaigns during the design of any communication equipment for railway applications. Obviously, the equipment assigned for on-board communications has to be validated for its use, as the other parts of the complete train. Up to now, this validation needs on board measurements, and even with them, the availability and the safety is not assured, since the worst case conditions may not have been tested. With the test laboratory to be proposed by TREND, some measurement campaigns could be diminished. That would mean a big save in time and money for the designs for the railway industry. That would have an impact not only for these railway enterprises but also for the users, as the technology would have a quicker adoption in the trains.

Standardization bodies

The successful completions of the objectives of TREND will help the European Union in the way to have a fully operable and unified network, as the EMC standards would have more accurate limits and procedures for their approval tests. The operational and technical integration of the different national railway systems in the European Union and accession countries will be simplified by the renewed EMC standards. In that case, BTM, GSM;-R, DC Track Circuits are core
part of ERTMS and the Broadcasting Services are an unequivocal element in nowadays lives, also on-board the means of transport. The harmonization for the whole European Union will be improved, or at least some help will be provided in the way to do. The standardization bodies like UNISIG are the first receivers of the results from TREND in all the dissemination levels. And also will be benefited the scientific one, more dedicated to specific investigations advances.

**Public administrations**

Railway transport is a key area of development from the economical, from the sustainable and from the environmental point of view. Undoubtedly, the steps forwards for the improvement of the availability and the safety thanks to the TREND project would help in this deployment. But, primarily, the interoperability and the cross-operation between different rail networks that is improved and helped by the goals of this project proposal is crucial in avoiding some of the obstacles found in the use of large European lines and systems and equipments from different suppliers.

---

**Project logo and website**

[http://www.trend-eu.org](http://www.trend-eu.org)