FOSTER RAIL

Future of Surface Transport Research Rail

Coordination and Support Action

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Annual Summary/ Prioritisation & Recommendation report of the sector's R&D needs & priorities

WP	4	Rail Business Scenarios
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[1] Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants (including the JU), **RE** = Restricted to a group specified by the consortium (including the JU), **CO** = Confidential, only for members of the consortium (including the JU)

[2] Nature of the deliverable: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

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1. Executive Summary

The FOSTER RAIL project is addressing the challenge to strengthen and support research and innovation cooperation strategies in the European rail sector. The project's work plan foresees to enhance coordination among main stakeholders and actors in the European rail sector and rail industries and integrate the work done so far by ERRAC and its working groups. Starting with the already published ERRAC-ROADMAP, the FOSTER RAIL project will continue to coordinate the research and innovation agenda and priority setting process among the wide range of relevant stakeholders in the rail sector. The outcome of FOSTER RAIL will be a Rail Business Scenario as basis for new Strategic Rail Research and Innovation Agenda (SRRIA) and specific Rail Technology & Innovation Roadmaps aimed at 2050. The output will among others be used to advise the European Commission, Shift2Rail and other research programmes on their content.

Task 4.1 "Technology and Innovation Roadmaps" of the Work Package 4 will deliver updated and upgraded technology and innovation roadmaps in line with the SRRIA's strategic alignment and fill the gaps in the existing ERRAC Roadmaps. The new set of roadmaps (fully taking into account the work performed under the ERRAC Roadmap project) will be a plan that matches short-term and long-term goals with specific solutions to help meet those goals. The roadmaps will apply to a new product or process, or to emerging technologies. One of the aspects of this task is to summarise, cluster, prioritise and publish the sector's R&D needs. On the basis of this work, ERRAC advises the European Commission annually on the sector's R&D needs & priorities.

2. Description of the Deliverable

The aim of this deliverable is to provide the European Commission with the sector's R&D needs and priorities as input for - among others - the 2016/17 Work Program for the mobility related part of Horizon 2020 and its Calls for Proposals. It is based on the work of ERRAC and and the FOSTER-RAIL project and in particular the Roadmaps for Research and Innovation as developed by the EC funded CSA project ERRAC Roadmap, following extensive discussions between the members of ERRAC within the ERRAC Steering Committee. The conclusions of this preparatory work have been sent by the secretariat of ERRAC to the European Commission on 21 October 2014.

As the planning of this FOSTER-RAIL Deliverable was not in phase with the cyclus of the new Horizon 2020 Programme, its content could not yet be completely based on the work of WP4 in developing its new and updated Roadmaps.

3. Annual Summary/ Prioritisation & Recommendation report of the sector's R&D needs & priorities

Introduction

ERRAC has produced this document to provide guidance and input into the European Commission's process for formulating the 2016/7 Transport call of the Horizon 2020 research and innovation programme. It uses as a base the priorities emerging from ERRAC's FOSTERRAIL project (which is still in the process of completion) and further proposals made by the ERRAC Steering Committee, structuring them within a small number of generic themes that accord with EC policy objectives. As rail sector research will be mostly undertaken within the Shift2Rail JU from 2015/6, the focus of this document is rather on pan-modal transport issues: infrastructure, energy and environment, and on socio-economic and other non-technical and cross-cutting areas of research and innovation that will have a bearing on the future of railways and are envisaged in H2020.

Delivery of some of this proposed research and innovation would be expected to involve the strong participation of SMEs. The research would foster new opportunities for SMEs to contribute to the European economy.

The document covers a wide range of topics, reflecting ERRAC's view of the key underlying research and innovation gaps that are in urgent need of attention for the transport sector. Were more budget available than is currently contemplated, it could be usefully deployed. For each of the nine headline themes, supporting action areas are identified.

Deploying Innovative Technologies

Innovative technologies, materials and processes present the potential to make radical improvements in the quality and efficiency of transport systems, so should be a key focus for Horizon 2020. A major target should be to reduce the cost of transport system maintenance, but significant improvements can also be sought across the full scope of the businesses. Targets for research and innovation include the identification of the most promising transport opportunities for the application of breakthrough technologies and pilot deployment schemes, to overcome the 'valley of death' which often frustrates the transition towards commercial development.

Specific technologies might include (but not be limited to):

- Additive material and joining processes.
- 3D printing.
- Advanced composites – for mass reduction, LCC reduction, customer benefits.
- Virtual modelling, homologation and evaluation – harnessing the increasing power of the cyber world to solve complex, multidisciplinary, design problems for transport.

- Nano technology – e.g. new materials with properties such as self sensing and self healing.
- Advanced IT - including big data processing and analytics, machine learning, image and pattern recognition, passenger information systems and wearable technology.
- The industry internet - using the 'internet of things' including sensor networks.
- Drone technologies – e.g. to inspect and maintain transport systems.
- Mechatronic applications in the transport sector.

The call could also focus on providing a better understanding of the barriers to transport technology innovation and the development of new approaches to fostering its progress.

Intelligent Transport Systems

Transport's contribution to addressing societal challenges will be founded on an increased level of intelligence within transport systems, based on the development and implementation of breakthrough technology or of that transferred from other sectors. The intelligence may be vested in control systems, infrastructure, vehicles, or combinations of all of these.

In particular, research should look to progress the following areas:

- Shared information platforms and robust IT tools that facilitate real-time data exchange between transport modes, by using existing communication platforms and social networks.
- Innovative operational methods and tools for better public transport services, increased public transport capacity and faster recovery after incidents.
- The development of demonstrators of robotic equipment to replace simple repetitive tasks currently undertaken by maintenance teams.
- The automation of repetitive and arduous tasks will require improved management of the human/machine interface, a key safety issue. In some areas, artificially intelligent machines can already make better decisions than humans. With the advent of the 'second machine age' humans may find themselves controlling software machines that control other machines (thus MMI will become MMMI). The consequential risk and problems need to be analysed and mitigations planned.
- For freight it is urgent to specify and support the development of affordable control, command and communication systems for routes with lower density traffic with tighter margins and lower investment thresholds.

Energy and Sustainability

The key challenges for transport are to maximise the efficiency of its energy use, thereby reducing overall energy consumption and the maximum power level needed to sustain its business, both for economy (which facilitates affordability) and protection of the environment. In particular it must continue to reduce dependence on fossil fuels and reduce its carbon footprint.

Transport energy should not be viewed in isolation, and a key focus must be on the development of smart grids, where transport systems can benefit from and contribute to overall energy efficiency. Areas for development include the economic, legal and institutional framework for the smart grid and producing and piloting proposals for demonstrating smart grid applications.

Specific research needs are:

- Smart grids - economic, legal and institutional framework for the development of smart grids for energy capture (e.g. from kinetic processes) storage and adaptive feeding to rail, road and other applications.
- Inductive charging for electric vehicles, including EMUs / hybrid trains.
- Lightweight materials and bonding techniques to enable lighter vehicles.
- Energy storage, including future battery technologies, graphene supercapacitors, energy harvesting, including regenerative braking.
- Alternative propulsion energy sources, including hydrogen and natural gas; the operation of public transport and heavy vehicles using 60 - 80% energy from renewable sources.
- The reduction of negative environmental impacts from materials and processes; tools for measuring and improving overall sustainability.
- Next generation power semiconductor, with better efficiency, weight and volume and standards development for transport applications.

Climate change mitigation

Transport must plan to be resilient to the uncertainties of future climatic conditions and extreme weather. The focus of research and innovation should be to strengthen its planning and contingency arrangements, its physical and technical robustness and its ability to respond collaboratively across Europe in times of stress. In particular it has to be able to cope with low frequency, high impact events, whether of natural or other causation.

Research and innovation priorities are:

- Understand, measure and identify the means to reduce further the transport industry carbon footprint.
- Integrated transport sector responses to specific weather events - building cross-modal resilience into transport planning and operations.
- Measures to improve the technical resilience of transport infrastructure and vehicles to the effects of climate change and harsh environments.
- Disaster scenario planning and the transport responses. Measuring and managing the uncertainties and risk in the transport system.

Health, Safety and Security

Society expects continuing attention to reducing loss of life and adverse health effects associated with transport. This includes effects on transport users, employeees, neighbours and society as a whole. Further progress is needed to reduce the societal harm caused by transport through air and noise pollution. Transport safety and security face new challenges from cyber attack, which need to be countered.

Research and innovation should target:

- Air pollution reduction through further focus on controls of transport emissions.
- Noise pollution reduction, particularly in urban areas and at night, through technical innovation. This should include better understanding of the generation, propagation and mitigations of aerodynamic noise and ground-borne vibration.
- New tools to identify and limit human risk within the security process – relating to planning, design, operation and maintenance.
- Automation of infrastructure maintenance to reduce the danger to transport workers.
- Alternatives to road/rail crossings and improvements in safety systems for those that remain.
- Strategies and objectives for the use of active and passive systems to provide constant vigilance against day-to-day crime affecting transport systems, terrorism and cyber-attack; systems that are capable of being used by both experienced and inexperienced staff.

Socio-economic and behavioural research

Transport exists to serve society for mobility and logistics, but the needs of society change in response to many economic and demographic factors, calling for constant reappraisal and response by tranport system providers. Principal among these changes is the ageing and more demanding population, which imposes requirements for the transport system - technical and physical designs, approaches to provision of information etc. The new generation of transport users also have different requirements and aspirations. Research and innovation should focus on understanding and developing new solutions for these needs.

Delivery of the 2011 EC White Paper aspirations for modal shift remains contingent on the existence and operation of effective incentives within the transport system. In turn this needs a continuing reappraisal of the existing arrangements and assessment of the need for change. This is therefore a key focus for continuing research.

Tranport's future depends also on an ability to attract and retain a continuing corps of appropriately trained staff, to perform roles within an increasingly technically sophisticated sector, public acceptance of new infrastructure projects and a sustainable approach to

new infrastucture. Research and innovation should therefore seek to foster this aspect of sustainability.

Specific research needs are:

- Demographic trends and differences and their consequences for transport system design - understanding the needs and preparing effective responses.
- Multi-sense vehicles – innovative solutions for people with mobility impairment (the blind, the deaf etc).
- Cross-modal transfer incentive structures – delivering an updated appreciation of key drivers for use in transport policy development and designing practical measures to progress modal transfer policy delivery. This should include how to improve cost transparency in transport.
- A Europe-wide education platform for all levels (young professionals, experts, senior and top management) offering tailor-made programs that cover the needs of the modern and emerging sector to improve efficiency and reduce cost.
- Assessment of the skills requirements for the future transport sector. Analysis of gaps and recommendations for remedial action plans.
- Further analysis into customer needs and behaviours and the development of accessibility assessment tools.

Competitiveness of the European transport industry in global markets

European manufactures and transport service providers experience ever stronger competition from around the globe**.** Research and innovation efforts can help sustain and develop commercial advantage in home and export markets.

Research should focus on:

- A co-ordinated framework of good practice to reduce the cost of implementing new products and ensure their successful implementation, taking account of cultural impacts. Product/concept deployment strategies that anticipate and take account of system and human impacts, so include explanations of how best to implement the innovations working with the available people, existing knowledge and the developing culture.
- Interoperable basic components for freight vehicles - the same shape (e.g. to fit in the same place on locomotives), the same functionality (giving the same service) and the same interface (to be able to be connected directly). This is a common requirement in aviation and it should be studied to be applied in rail, enhancing competition and cost reduction.

Resource Utilisation across the transport sector

In both passenger transport and freight logistics continued economic success rests on ever-increasing efficiency based on better resource utilisation. Research can help maximise the use of resources by developing and applying new capabilities such as 'big data' analysis, 'lean' management, integrated communications tools, process automation and whole-system approaches.

Target areas are:

- Modular "plug-and-play" infrastructure design. Using the most advanced industrial knowledge and methods to obtain similar improvements for transport infrastructure. Standardised and modular architecture will also facilitate interoperable infrastructure and operation. It should promote lean design, Improved reliability, automated maintenance and reduced LCC.
- Innovation in standardisation forf infrastructure components. Designs that reduce problems with future-proofing. Use of recycled materials and innovative cross-modal techniques for infrastructure construction.
- Intermodal collaboration to provide seamless transport chains (one-stop-shop) including sustainable urban logistics solutions. This requires standardisation of information for transport planning and movement within the overall logistic chain.
- Methods to produce a competitive rolling motorway: cargo bundling, freight villages etc.
- Strengthening transhipment points as key nodes for combined transport, and increasing the efficiency of container handling within and between modes.
- Maximising infrastructure utilisation through new approaches to speed management (including operating speed compatibility for rail and other controlled systems).
- Land-use and spatial planning for sustainable and efficiency of public transport.
- Innovative concepts for decision support relating to infrastructure maintenance and renewal, taking advantage of condition data and other data across transport modes.

Urban Mobility

The key challenges in the area of urban mobility are congestion, protection of the environment, safety and accessibility. Solutions and overall optimisation, to enable the development and renewal of urban life, should integrate the consideration of the transport needs of residents, workers and visitors to urban centres and the related freight logistics requirements. Research should be focused on creating synergies across transport modes and with the planning process, integrating the opportunities afforded by emerging technology.

Key research areas are:

- The integration of transport modes for cities – including connection of all core airports to the rail network.

- Urban green logistics - planning sustainable urban areas by integrating rail freight: based on a catalogue of requirements for the optimal use of rail freight services in urban areas. Smart integration of rail transport nodes into urban conglomerations - hinterland dry ports.
- Transport hubs as urban ‘’consignment stock” (sector logistics) by using existing infrastructure (stations or stations facilities in central locations) as goods distribution centres. Linked with the integration of combined transport solutions and the use of light rail for freight.
- First and last mile challenges - how to penetrate cities by combining rail trunking with urban collection/distribution of goods by electric trucks.
- Urban and suburban public transport capacity optimisation and options for managing increases in demand (what to do when public transport systems are saturated).

4. Conclusions

This Deliverable has been produced to provide guidance and input into the European Commission's process for formulating the 2016/7 Transport call of the Horizon 2020 research and innovation programme.As rail sector research will be mostly undertaken within the Shift2Rail JU from 2015/6, the focus of this document is rather on pan-modal transport issues: infrastructure, energy and environment, and on socio-economic and other non-technical and cross-cutting areas of research and innovation that will have a bearing on the future of railways and are envisaged in H2020.

Nine headline themes have been identified based on the work of ERRAC, the EC funded ERRAC Roadmap CSA project as well as partly on the work carried out by the EC funded FOSTER-RAIL CSA project of which this report is a Deliverable. These themes are:

- Deploying Innovative Technologies
- Intelligent Transport Systems
- Energy and Sustainability
- Climate change mitigation
- Health, Safety and Security
- Socio-economic and behavioural research
- Competitiveness of the European transport industry in global markets
- Resource Utilisation across the transport sector
- Urban Mobility

For each of the nine headline themes, supporting action areas are identified.