ERRAC WORK PACKAGE 04

IMPROVING SAFETY & SECURITY ROADMAP

YEAR 3

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ERRAC SAFETY & SECURITY ROADMAP
FINAL ROADMAP

Scope of the Document

The scope of the present work package is to enhance awareness and perform actions to address the following key issues, which have been regarded as strategic in the railway sector:

- Railway systems are and must remain the safest transportation systems as safety is one of the pillars increasing the attractiveness of the railway system;
- Railway systems will be the most secure public transport mode without perceived intrusion to privacy

Considering that the EC WHITE PAPER ('*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system'*, 28 March 2011) [1] asks for:

- moving towards near zero fatalities in road transport by 2050,
- halving road casualties by 2020
- confirming EU as world leader in safety and security of transport in all modes of transport

Improving safety and security is imperative for all Railway stakeholders.

On this basis, the road-mapping work of this Working Package takes into account the protection of persons, such as train drivers, passengers, train-crew, track workers, shunting personnel, and pedestrians.

Advanced engineering systems and risk analysis methodologies for the design and operation of vehicles and infrastructure will also be considered of specific importance.

There will also be integrated approaches linking human elements, structural integrity, preventive, passive and active safety including monitoring systems, rescue and crisis management.

Safety has to be considered as an inherent component of the rail transport system related to infrastructure, freight (goods and containers), transport users and operators, rolling stock as well as measures at policy and legislative levels, including decision support and validation tools.

Security will be addressed wherever it is an inherent requirement to the transport system.

An additional point of attention will be the protection of critical infrastructure locations on the network, as well as signaling equipment, critical junctions, bridges tunnels etc.

The present document sums up the ERRAC Roadmap on Railway Safety & Security aspects; this living streamlined piece of work was born in 2010, and the following is the third and last edition.

Similarly to the first two editions, this the third is made of two main parts being, the update of the previous year's Railway Safety Roadmap and the Railway Security Roadmap (1st and 2nd issues).

As far as the Safety Roadmap is concerned, the most relevant facts to report in the 3rd edition are:

- The report concentrates on the European community railway system. Indeed for Urban Guided Transit (metro, tram and light rail) the rules applying to safety and security are depending only on national legislation. The European Research project MODSAFE - Modular Urban Transport Safety and Security Analysis - currently underway[1] provides a wide overview on the current situation regarding these issues throughout Europe. The purpose of the MODSafe project is to undertake research of major steps of the Safety Life Cycle of urban guided transport systems in Europe and to make proposals targeting security improvement

- The significant progress made during year 2011 by the mainline rail sector in filling the gap existing between the safety legal framework and the barriers introduced in the practical applications in the EU member states. The main European sector associations, for mainline rail, the industry association, UNIFE, and the railways association, CER, have jointly recommended an action toward to the European Commission which outlines the methodology to be adopted to cover this scope. The methodology, presently outlined in a public position paper [8], heavily relies on to the European Railway Agency (ERA) being empowered to more legitimately cover the role, as a unique, Europe wide, safety certification delivery body as far as the European community rail is concerned. As a matter of fact, the Railway Safety performance Report 2012, shows a wide spread of support towards the agency intention to continue finalising the development phase of the railway safety while starting to concentrate on what is expected to become its focused role of helping to establish improved implementation of SMS in EU, via correct implementation of safety regulations and certification.

[1] http://www.modsafe.eu/

MODSAFE is a FP7 R&D Collaborative project with a budget of €5.2 million Project, among which €3.5 EC grant. It started in September 2008 for 4 years and gathers 22 partners. It is coordinated by TÜV Rheinland InterTraffic GmbH (TRIT).

- The ERA Report on Safety Performance published on June 2012 **[5]** enriches and completes the previous editions with statistics from year 2006. It indicates that the safety performance in Europe is following a favorable decreasing trend. "The year 2010 was the safest year on the EU's railways for both passengers and rail staff since 2006… but there were a number of accidents resulting in extensive material damage that in less fortunate circumstances might have led to numerous casualties". However, this trend is very likely a result of the joint efforts made by the Agency from one side, and by the European Commission and the sector as a whole from the other side, intending to harmonise Safety Management practices in each EU member states. This practice needs to be supported and ERRAC representatives of Railway Safety and Security Research endorse it fully.

- While in the 2011, in the ERA report of 2012, on European Railway Safety Performance, the weather conditions are, for the first time, explicitly mentioned as having an impact on the causation of accidents.

    - Three brand new CSIs (CSI: Common Safety Indicators) have been introduced: Dangerous goods, LC type (LC: Level Crossing) and aggregated traffic performance data. These CSIs integration appears to be very much in line with the recommendations given in terms of Railway Safety by the EC in the White Paper in its edition 2011 – Art. 19 and 20
    - LC accidents rate is slightly higher at ***active LC***, representing slightly higher than 52% of LC in EU. This fact requires due attention as the report stresses again that 60% of 1256 fatalities are third-party victims (unauthorized trespasses and Level crossing users) while train collisions, derailment and fires cause less than 3% of fatalities. This would appear deserving of the highest vigilance on the external causes and the need to keep them under due control.

As far as the Security Roadmap is concerned, the future research needs are still based on the following three complementary priority areas: Human Factors, Technologies and Common procedure and regulations.

As for safety, the report concentrates on the European community rail system.

The most relevant issues to report on the third edition – which is complemented on local rail issues as part of the WP03 roadmaps reports - are:

- As regard Urban Guided Transit systems, a huge demonstration project on Security in Mass Transportation2, SECUR-ED, answering the Call SECURITY 2010 (SEC-2010.2.1-1 Security of mass transportation - phase II) started in April 2011 for 42 months with 40 partners and THALES as technical coordinator. SECUR-ED rationale is to create a global European improvement in mass transportation security through the development of

[2] http://www.secur-ed.eu/
The total budget is €40 million with a €26.5 million EC grant.

packaged modular solutions validated through the demonstrations, and made available to the full community of operators.

- In April 20113, CER, COLPOFER, EIM, ERFA, RAILPOL, UIC and UITP sent a joint letter on Land Transport Security in the Public Transport and Railway Sector to Mr Ruette Director at DG MOVE. Among other recommendations, the signatories call the European institutions to continue funding European Projects for which the needs have been defined by the sector;

[3] http://www.uitp.org/mos/positionspapers/130-en.pdf

DEFINITIONS IN FORCE

SAFETY ASPECTS

Are related to all types of accidents and incidents occurring on the working railway due to failures occurring in one or a combination of those: railway infrastructure, rolling stocks, equipments and operations

SECURITY ASPECTS

Are related to all types of accidents and incidents occurring on the working railway due to external factors emanating from human actions (vandalisms, terrorist acts, etc.)

ACCIDENT (according to Directive 2004/49/EC)

Means an unwanted or unintended sudden event or a specific chain of such events which have harmful consequences; accidents are divided into the following categories:

- Collisions of trains, including collisions with obstacles within the clearance gauge,
- Derailment of trains,
- Level crossing accidents, including accidents involving pedestrians at level-crossings,
- Accident to persons caused by rolling stock in motion, with the exception of suicides,
- Fires in Rolling Stock,
- Others

EXTENSIVE DISRUPTION OF TRAFFIC

Service on a main traffic line is suspended for six hours or more

PERSON KILLED (according to Commission Regulation 1192/2003)

Means any person killed immediately or dying within 30 days as result of an accident, excluding suicides

PERSON SERIOUSLY INJURED (according to Commission Regulation 1192/2003)

Means any person injured who was hospitalised for more than 24 hours as a result of an accident, excluding attempted suicides.

OTHER ABBEVIATIONS

"**ATP**"	Automatic Train Protection
"**CSI**"	Common Safety Indicator
"**CSM**"	Common Safety Methods
"**CA**"	Conformity Assessment
"**CST**"	Common Safety Targets
"**ECM**"	Entity in Charge of Maintenance
"**ERA**"	European Railway Agency
"**ERADIS**"	European Railway Agency Database of Interoperability and Safety
"**ERTMS**"	European Railway Traffic Management System
"**ETCS**"	European Train Control System
"**GDP**"	Gross Domestic Product
"**IM**"	Infrastructure Manager
"LC"	Level Crossing
"**NIB**"	National Investigation Body
"**NRV**"	National Reference Value
"**NSA**"	National Safety Authority
"RID"	Regulation concerning the International carriage of Dangerous goods by rail
"**RISC**"	Railway Interoperability and Safety Committee
"**RU**"	Railway Undertaking
"**SMS**"	Safety Management System

"**TSI**"	Technical Specification of Interoperability
"**VPC**"	Value of Preventing a Casualty
"**WTP**"	Willingness To Pay

ERRAC SAFETY ROADMAP

1 . PRESENT SITUATION

As regard the European community rail system, European Legislation requires Member states to report to ERA on significant accidents and serious accidents occurring in their territory.

The NSAs must report all significant accidents. The NIBs must investigate all serious accidents, notify the ERA of these investigations and, when closed, send the investigation report to the ERA.

The term significant accident covers a wider range of events than serious accidents according to directives 2004/49/EC, 2009/149/EC and regulation 2003/91/EC.

Significant Accident	Serious Accident
Any Accident involving at least on rail vehicle in motion, resulting in at least one killed or seriously injured person, or in significant damage (more than EUR 150.000) to stock, track, other installations or environment, or extensive disruptions to traffic	Any train collision or derailment of trains resulting in the death of at least one person or serious injuries to five or more persons, or extensive damage (more than 2 Million EUR) to rolling stock, infrastructure or environment, and any other similar accident with an obvious impact on railway safety regulations or the management of safety.

The Ratio between Significant and serious accidents is stable in the reported years and is about 75:1.

The ratio between precursors and significant accidents is not stable but strongly growing probably due methodological differences between countries in reporting precursors, as the RUs and IMs should normally investigate them in line with their SMSs.

The Ratio between Precursors and Significant Accidents is about 10:1.

Precursors are: (according to Directive 2009/149/EC – Annex I)

- Signal Passed at Danger
- Broken Rail
- Track Buckles
- Wrong side signaling Failure
- Broken Wheels on rolling stock in service
- Broken Axles on rolling stock in service

- **General indicators**

❖ The work on quality improvement of data collection, and specifically the one related to quality guidance for CSIs implementation issued from the ERA Safety Unit on March 2010, has clearly created tangible benefits. In the last edition of the report, **[5]** :

- ERA could check the consistency for all the indicators. Moreover, fluctuation, and a comparison with the Eurostat data could also be carried out.
- A statistical test was applied to the data to determine whether the variations in the figures for 2006–2009 exceeded natural variation or not.
- it has been possible to update some data reported in previous years; the CSI tables in the annex of this report replace the tables published in previous reports **[6] [7]** and **[6] [7]** .

❖ Based on data reported in **[5]**

- Around 3 000 significant accidents occur each year on the railways of the EU Member States. Accidents to persons caused by rolling stock in motion and level-crossing accidents constitute more than 75 %. of the total number of accidents, excluding suicides. The number of significant accidents per accident type in the period 2008–10 is shown in Figure 1. For all types of accident, the reported

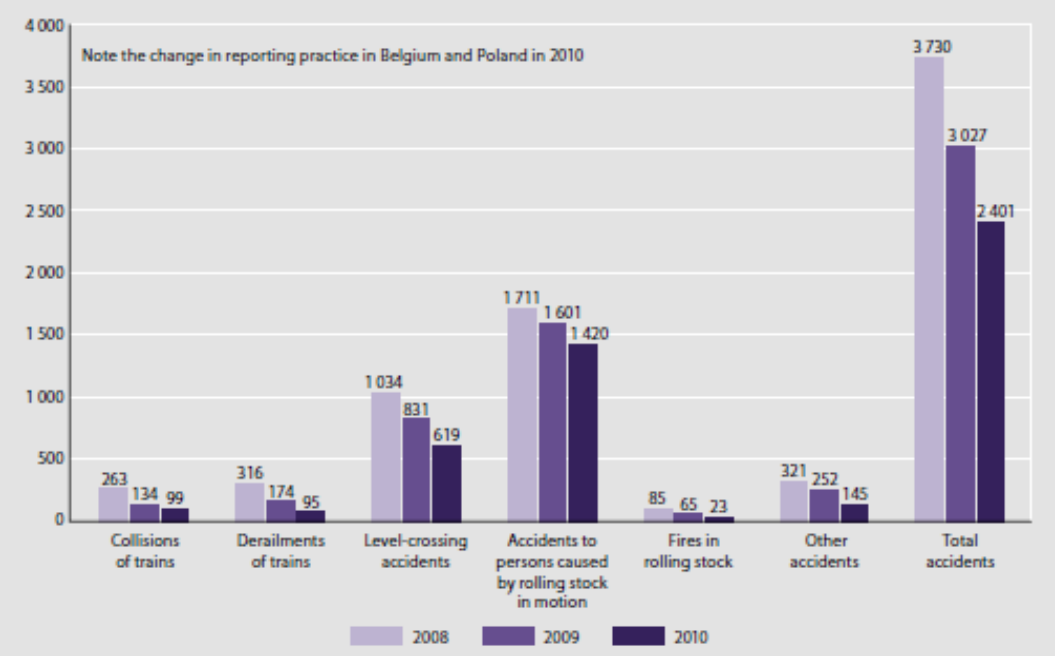


Figure 1 - Reported number of significant accidents per accident category

number of accidents in 2010 was lower than in the two preceding years and a distinct downward trend over the period 2008–10 can be observed.

- Figure 2 shows the number of fatalities in different categories of persons over the period 2008–10. With 750-recorded fatalities in 2010, unauthorised persons represent 60 % of all persons killed on railway premises, but their share of fatalities has been slightly decreasing since 2008. The number of level-crossing fatalities of 359 in 2010 is by far the lowest ever recorded on EU railways. This figure represents 29 % of railway fatalities, but only 1.2 % of road user fatalities. Level-crossing safety might therefore be perceived as a marginal problem by the road sector, while it is a key problem for the railway, because of its impact on railway operation.

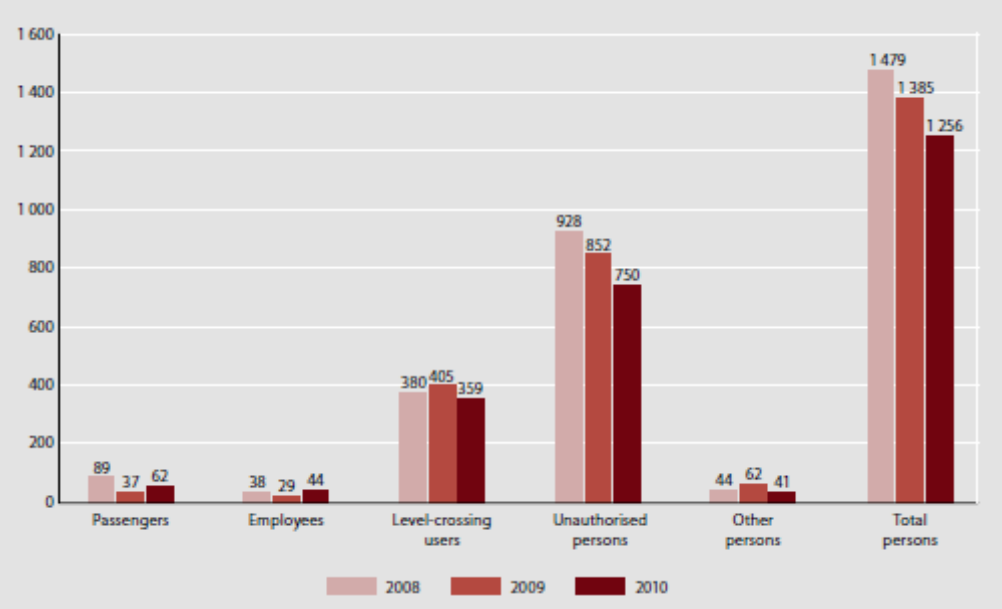


Figure 2 - Number of fatalities per victim category

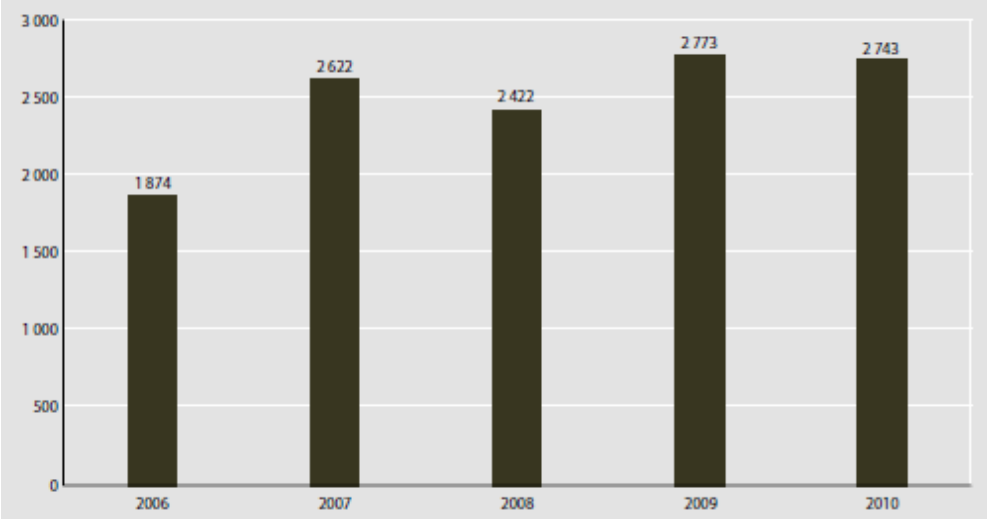


Figure 3 - Suicide fatalities

- Similarly as the previous years, suicides are reported separately from accident fatalities. They represent two thirds of them and, together with the unauthorized person fatalities, constitute 87 % of all fatalities occurring within the railway system. In 2010, more than 50 suicides were recorded on the EU railways on average each week, totalling 2 743, close to the record number in 2009. Although no trend can be derived from the available data, this is the second highest number of suicides reported to the Agency since 2006 (Figure 3).
- The data on the accidents costs show wide variation and it is evident to the Agency

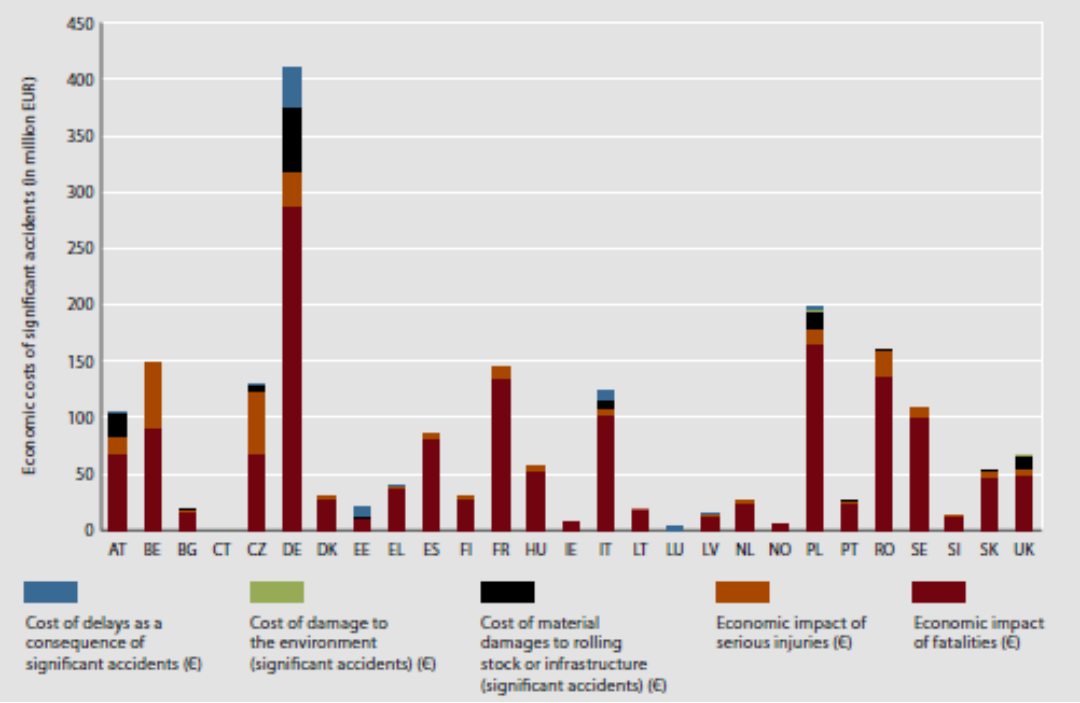


Figure 4 - Economic impact of significant accidents in 2010

that the Member States have problems in establishing reporting regimes for accident cost data. The economic impact of significant accidents in 2010 is shown in Figure 4. It has five components:

- Costs of fatalities,
- Cost of injuries,
- Costs of material damage,
- Costs of damage to the environment
- Cost of delays.

While the first two components are a priori available for all countries, the number of countries providing information on the costs of damage to infrastructure (17), to environment (4) and delays (12) is limited.

• Policy drives and constraints

Major present Policy driver still is the EC White Paper [1] .
In respect of Safety issues, the EC White Paper published on March 2011, presents many articles with special interest in improving safety and security in Railway Transportation.
Especially in chapter 3 "The strategy – What needs to be done" we find the Articles:

34. Enforcement of social, safety, security and environmental rules
36. Single European Railway Area
37. Quality jobs and working conditions
38. Transport security
39 Safe transport

• Financial perspectives

A financial perspective is sized in the EC WHITE PAPER **[1]** / Article 55

A well-performing transport network requires substantial resources. The cost of EU infrastructure development to match the demand for transport has been estimated at over € 1.5 trillion for 2010-2030. The completion of the TEN-T network requires about € 550 billion until 2020 out of which some € 215 billion can be referred to the removal of the main bottlenecks. This does not include investment in vehicles, equipment and charging infrastructure which may require an additional trillion to achieve the emission reduction goals for the transport system

Legislative framework

The European legislative framework bases on the following Directives and Regulations so far :

- **Directive 2009/149/EC (Safety Directive)** amending Directive 2004/49/EC of the European Parliament and of the Council as regards Common Safety Indicators and common methods to calculate accident costs
- **Directive 2008/57/EC (Interoperability Directive)** on the interoperability of the rail system within the Community
- **Directive 2008/110/EC (Safety Directive)** of the European Parliament and of the Council of 16 December 2008 on safety on the Community's railways amending Directive 2004/49/EC of 29 April 2004
- **Directive 2007/59/EC** on the certification of train drivers operating locomotives and trains on the railway system in the Community
- **Directive 2004/51/EC** amending Council Directive 91/440/EEC on the development of the Community's railways
- **Directive 2004/49/EC (Safety Directive)** on safety on the Community's railways and amending Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification
- **Directive 2004/17/EC** coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors
- **Directive 2001/16/**EC on the interoperability of the trans-European conventional rail system
- **Regulation (EC) No 201/2011** on the model of declaration of conformity to an authorised type of railway vehicle
- **Regulation (EC) No 352/2009** on the adoption of a common safety method on risk evaluation and assessment as referred to in Article 6(3)(a) of Directive 2004/49/EC of the European Parliament and of the Council
- **Regulation (EC) No 653/2007** on the use of a common European format for safety certificates and application documents in accordance with Article 10 of Directive 2004/49/EC of the European Parliament and of the Council and on the validity of safety certificates delivered under Directive 2001/14/EC
- **Regulation (EC) No 881/2004 (Agency Regulation**) establishing a European railway agency
- **Regulation (EC) No 91/2003** on rail Transport statistics

Targets

In EC 2011 White Paper [1] Ten Goals for a competitive and resource efficient transport system are clearly expressed: the ninth addresses an improving transportation system safety:

- By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by 2020. Make sure that the EU is a world leader in safety and security of transport in all modes of transport.

In annex 1 of the same paper the EU asks for an improvement in transport system safety suggesting some initiatives in order to save thousands of lives; in the European community rail system. The paper outlines:

1. *Progressively achieve a sector-wide approach to safety certification in the rail transport sector, building on existing approaches for infrastructure managers and railways undertakings and evaluating the possibility to rely on a European standard.*

2. *Enhance the role of ERA in the field of rail safety, in particular its supervision on national safety measures taken by National Safety Authorities and their progressive harmonisation.*

3. *Enhance the certification and maintenance process for safety critical components used to built rolling stocks and railway infrastructures. Enhance the role of ERA in these certification and maintenance processes*

Regarding the adoption of a Single Railway Safety Certificate replacing present Part A and Part B of Safety Directive 2004/49/EC as targeted in **[5]** , a step forward has been covered on 2011 by ERA, who has established and launched a consultation on the development of a migration strategy towards a single safety certificate (documents in table 1)

Publication Date	Title
18-03-2011	Consultation on the migration strategy to a single safety certificate
18-03-2011	Development of a migration strategy towards a single safety certificate

Table 1

Moreover in November 2011 CER/UNIFE published a joint Position Paper [8] to accelerate the developing of ERA's role to achieve a Single European Railway Area.

• Analysis of indicators

To achieve a consensus on initiatives aiming to improve safety in railway system, It is not enough to analyse data but the railway expertise has to deepen the causes of accident. To this end the Safety Database Activity Report of December 2011 published by UIC Safety Unit [9] is very useful. This document analyses the significant 2010 accidents over viewing the data by annexed sections that deepen the following discussion points:

- Trespassing, Level Crossing Accidents and Station Accident

- Analysis of Derailments
- Benchmarking Indicators

All CSIs currently in place are relevant for the assessment of the railway safety.
Moreover, external costs are often neglected when developing safety transport policies at a Member State level; the HEATCO project (FP6, delivered in 2006) represents a valid support for decision makers, since it estimates costs external to transport safety.
These estimations are necessary to develop safety policies sustainable for society; such an approach would facilitate an efficient allocation of economic resources to transport safety.
In particular, the HEATCO project provides values for two variables that are relevant in the estimation of external costs: the Value of Preventing a Casualty (VPC) and the Value of Travel Time Savings (VTTS). HEATCO provides 2002 values across Europe for these variables and suggests a linear update with the Gross Domestic Product (GDP) for the following years.
Nevertheless, such linearity is valid in the medium term only and a recalculation of all estimated values is now necessary. For that purpose, a research project could be funded within FP7.

2. STATE-OF-ART, RECENT PROJECTS, ONGOING RESEARCH

This section provides a structured review of projects and researches relating to safety railway system improving carried out in the last 10 years.
We selected more than 70 funded projects and researches whose topics cover all the railway sub-systems and fields.
In order to cluster these projects we grouped them focusing, at first, on the particular safety aspects where the single project studies in depth such as an accident or a precursor.
We have to distinguish projects and researches in two main safety classifications:

- Projects and researches aiming to study, mitigate or solve a peculiar accident or precursor;
- Projects and researches studying and deepening safety aspects in the railway system as a whole

This first grouping is shown in the table below:

Accident/ Precursor	Number of Projects	Completed	Ongoing	Total Cost (appox. In Euro)
Train collisions	6	6	0	15 Million
Derailment	3	2	1	11 Million

Level Crossing	2	2	0	4,1 Million
Rolling stock in motion	2	1	1	5,2 Million
Fires and Tunnels	10	8	2	35,9 Million
Signal Passed at Danger	4	4	0	12 Million
Track	10	5	5	67 Million
Rail	7	4	3	13 Million
Command/ Control	2	1	1	15,7 Million
Rolling Stock	14	10	4	75 Million

The second group of projects and researches deal with the railway system as a whole, focusing on specific safety related aspects. We considered about 11 projects in this group.

Railway System	**Number of Projects**	**Completed**	**Ongoing**	**Total Cost (appox. In Euro)**
	11	7	4	56,5 Million

In figure 5 and 6 we see a graph of the projects number and their cost.

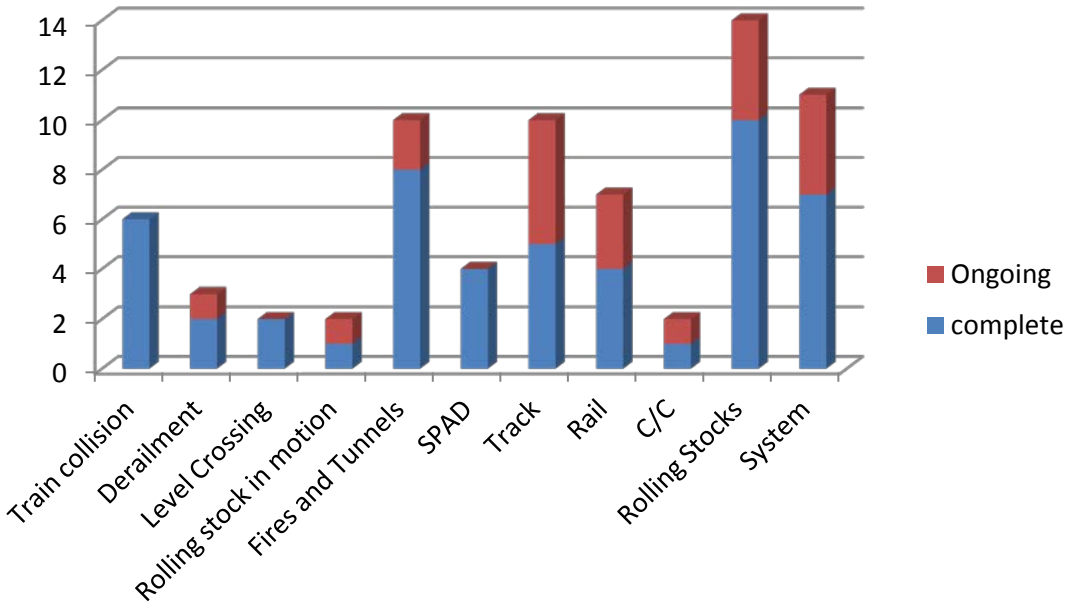


Figure 5 - Number of safety related projects

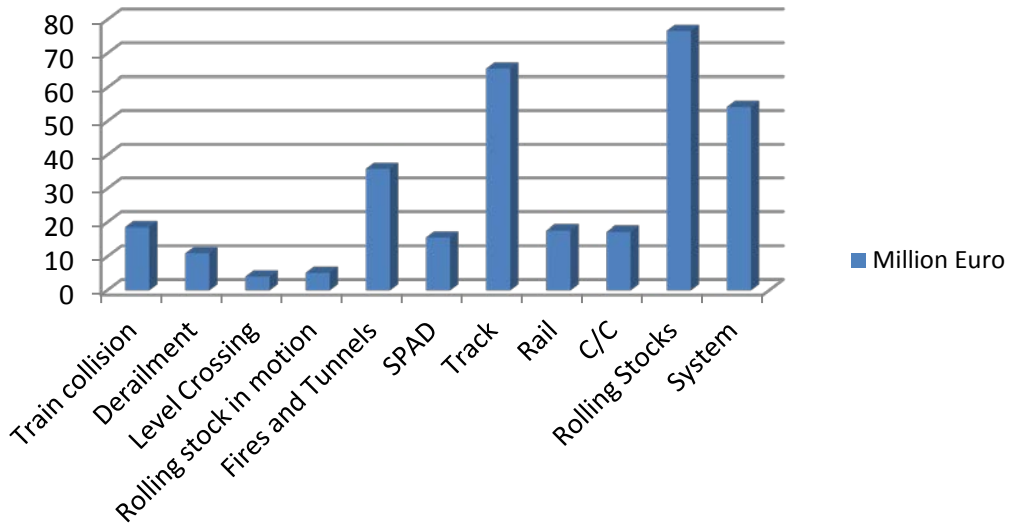


Figure 6 - Project costs

In the following sub-paragraphs we analyse the single safety aspect consistently with the scheme adopted focusing on each cluster:

- Main project table
- Objectives
- Results
- Implications

Train Collisions

On this topic we find 6 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
SAFEINTERIORS	Completed	UNIVERSTIY OF NEWCASTLE UPON TYNE - NEWRAIL-CENTRE FOR RAILWAY RESEARCH	2006-07-11	2010-07-10	FP6-SUSTDEV
SAFETRAIN	Completed	BOMBARDIER TRANSPORTATION PORTUGAL S.A.	1997-08-01	2001-07-31	FP4-BRITE/EURAM 3
SAFETRAM[4]	Completed	BOMBARDIER TRANSPORTATION PORTUGAL S.A.	2001-07-01	2004-10-31	FP5-GROWTH
APSN	Completed	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAP PELIJK ONDERZOEK - TNO - TNO AUTOMOTIVE	2004-04-01	2008-03-31	FP6-SUSTDEV
TRAINSAFE	Completed	UNIVERSITY OF SHEFFIELD - ADVANCED RAILWAY RESEARCH CENTRE	2002-01-01	2004-10-31	FP5-GROWTH
ALJOIN	Completed	D'APPOLONIA SPA	2002-08-01	2005-07-31	FP5-GROWTH

Objectives:
The target of all these projects is the introduction, as main aim, of new standards for vehicle construction based on measures to improve rail vehicle crashworthiness and passenger and crew survivability.
This is a typical passive safety approach (the vehicle crashworthiness improvement) in order to mitigate the effects of a significant accident against the active safety approach (signaling improvement) in order to avoid accident causes.

Results:

- These research projects brought together a good sized and balanced expertise network bringing together partners from all domains (industry, academia, stakeholders, etc.) and across all Europe. They have provided valuable input and allowed the building of a strong consensus, speeding up the standardization process.
- The partners had good collaboration and organised successful events.

[4]This project is not addressing mainline systems but tram and light rail.

- The project focussed mainly on dissemination activities, the implementation of the knowledge achieved being just a collateral activity.

Implications:

- Regarding Rolling stock design and implementation, these projects might provide input in regulations and/or standards. In order to improve the market uptake;
- A risk analysis on train collisions in the whole railway sector would be necessary to accomplish the results achieved within the studies on the specialities (e.g. fire resistance, crashworthiness, structural safety, etc.) involving other aspects of the system such as freight train collisions, Level Crossing accidents and railway system inspection;
- It would be useful to improve the coordination between projects studying precursors of train collisions such as the projects INFRACLEAR and REOST that address the issue relating to undesired obstacles on track.
- Project SAFEINTERIORS point out the need for further efforts in the assessment of severity of injuries and trauma and suitable experimental and numerical tools for the design and validation of interiors with respect to passive safety and occupant protection.

Derailments

On this topic we find 3 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
D-RAIL	Ongoing	UNIVERSITY OF NEWCASTLE UPON TYNE	2011-10-01	2014-09-30	FP7-TRANSPORT
SPURT[5]	Completed	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. - FRAUNHOFER-INSTITUTE FOR STRUCTURAL DURABILITY LBF	2003-12-01	2007-05-31	FP6-SUSTDEV
TURNOUTS[6]	Completed	DYNAMICS, STRUCTURES AND SYSTEMS INTERNATIONAL SA - D2S INTERNATIONAL	2003-11-01	2007-01-31	FP6-SUSTDEV

Objectives:

The Project D-RAIL is going to focusing on derailment causes occurring in freight traffic. D-RAIL studies how independent minor faults (such as a slight track twist and a failing bearing) could combine to cause derailment. SPURT and TURN-OUT projects studied how to improve the vehicle-track interaction in railway mass transit transportation systems (tram, light rail and metros) to enhance the safety level as effect of an efficiency improving of the system

Results:
D-RAIL is in execution. This research is quantifying the number of freight derailments and their economic impact issuing new recommendations for monitoring systems based on technical/economic grounds. SPURT and TURNOUT offered as main goal new operation

[5] This project is not addressing mainline systems but urban rail systems.

[6] This project is not addressing mainline systems but urban rail systems.

schemes to improve global efficiency of the system: a safety level improving would be a consequent result.

Implications:

D-RAIL has a very good safety improving approach suggesting many future solutions for this and other safety aspects. Carrying out :

- A Common international structure of derail databases offering a reliable implementation scenario's and guidelines for national/international use
- A vision of technological developments and innovation for industrial applications
- A better prediction of future traffic situation
- The knowledge about the combined causes contributing to a system accident

SPURT and TURNOUTS confirmed that safety is the natural consequence of an efficient, well designed, monitored and maintained railway system.

Level crossing

On this topic we find 2 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
SELCAT	Completed	TECHNISCHE UNIVERSITAT BRAUNSCHWEIG - INSTITUTE FOR TRAFFIC SAFETY AND AUTOMATION ENGINEERING	2006-09-01	2008-06-30	FP6-SUSTDEV
PANsafer	Completed	INRETS	2009-12-01	2011-12-30	ANR-TT

Objectives:

The SELCAT project main objective was to collect and disseminate knowledge related to:

- Level crossing risk appraisal, evaluating the main operational risks of different rail/road crossings in EU considering the different legislative framework in each member state in both rail and road sectors;
- Advanced technologies availability, for the reduction of existing risk;
- The application of special evaluation methodologies which take into account all relevant factors such as costs, performances and technological safety requirements.

PANsafer is a French national project whose objective was to actively contribute to reduce level crossing accidents by means of:

- the collection, the analysis and the dissemination of results, stimulating exchanges in level crossing safety area.
- the comparison of level crossing accidents databases

Results:

The SELCAT project fulfilled its aim to study deeply the background of level crossing accidents and the potential for the effective reduction of operational risks for road and rail transport and their users. But the project demonstrated that Level Crossing Safety improvement should be the result of increased levels of safety in both rail and road sectors.

One of the direct results of SELCAT project was the passing of a resolution in February 2008 for the development of a Road/Rail Interface Strategy for Europe. The motivation, idea, role, core elements of the strategy and benefits of the establishment have been outlined with the aim to carry on with the enhancement of level crossing safety after the conclusion of SELCAT.

Implications:

A Road/Rail Interface Safety group was established inside the European Level Crossing Forum with the strategic short-term objective of bringing together safety specialists from road and rail so as to better understand the issues at this intermodal interface.

A longer term target, through a multi-disciplined strategic plan, would foster a contribution to the reduction of the level of operating risks to rail from errors and omissions by third parties whilst supporting the overall objective of reducing the instances of fatality to road users and pedestrians.

Rolling stock in motion

On this topic we find 2 main projects as detailed in the following table:

Acronym	Status	Coordinator	Start	End	Program
RESTRAIL	Ongoing	UNION INTERNATIONALE DES CHEMINS DE FER - UIC	2011-10-01	2014-09-30	FP7-TRANSPORT
UNIACCESS [7]	Completed	GRUPO INTERES ACCESIBILIDAD TRANSPORTE A.I.E. - ENGINEERING	2005-01-01	2006-12-31	FP6-SUSTDEV

Objectives:
As already evaluated in previous paragraphs, the most common types of accident for which victims are registered are accidents caused by rolling stock in motion, but only a minority of rail accident victims in the EU-27 was actually passengers travelling on trains or railway employees. Two main projects could be selected in this cluster, RESTRAIL and UNIACCESS
The aim of the RESTRAIL project is to reduce the occurrence of suicides and trespasses on railway property and the costly service disruption these events cause, by providing the rail industry with an analysis and identification of cost-effective prevention and mitigation measures.
UNIACCESS project had the aim to collect useful state-of-the-art knowledge for designing universal accessibility systems to public transport (taxis, buses and trains) in order to produce a roadmap of future R&D in universal accessibility to public transport and to come up with new R&D project proposals that allow bridging the existing technology gaps, also to achieve a safer system.

Results:
RESTRAIL is carrying out a qualitative analysis of suicides and trespasses on railway properties and assessing of measures targeted to reduce railway suicides and prevent railway trespasses.
The project is also focusing on procedural aspects of handling an incident to mitigate its consequences. A field pilot test is foreseen and dissemination of information and knowledge takes place.
A better accessibility to vehicle will mitigate the risk of accident and UNIACCESS project demonstrated that the awareness of public transportation accessibility improving was poor so

[7] This project is not addressing mainline systems but urban public transport systems.

one of the project targets was to spread knowledge of universal design among various stakeholder groups to facilitate the adoption of new concepts in this matter.
The project examined the accessibility limits not only for reduced mobility users but also involving people that need lighter assistance service such elderly user, passenger with pram and so on.

Implications:
RESTRAIL would be over in 2014. The project is involving many rail stakeholders and after the field tests of selected measures, the project will provide with recommendations and tools for decision maker all over Europe.
The consortium UNIACCES proposed themes of new projects following research results:

- New standards for Interior design of vehicles, particularly concerning boarding/alighting requirements;
- Supporting tools to public authorities and operators in delivering universally accessible public transport.

Fires and Tunnels

On this topic we find 10 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
TRANSFEU[8]	Ongoing	LABORATOIRE NATIONAL DE METROLOGIE ET D'ESSAIS	2009-04-01	2012-11-30	FP7-TRANSPORT
SECUREMETRO[9]	Ongoing	UNIVERSITY OF NEWCASTLE UPON TYNE	2010-01-01	2012-12-31	FP7-TRANSPORT
CORPTUS	Completed	RISK ASSESSMENT INTERNATIONAL	2005-10-01	2008-04-30	FP6-SME
L-SURF	Completed	HAGERBACH TEST GALLERY LTD. - R&D	2005-03-01	2008-06-30	FP6-INFRASTRUCTURES
SAFE-T	Completed	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCH APPELIJK ONDERZOEK TNO* - TNO BUILDING AND CONSTRUCTION RESEARCH - CENTRE FOR FIRE RESEARCH	2003-04-01	2006-03-31	FP5-GROWTH
SIRTAKI	Completed	ETRA INVESTIGACION Y DESARROLLO, S.A - DEPARTMENT OF NEW TECHNOLOGIES	2001-09-01	2004-08-31	FP5-IST
VIRTUALFIRES	Completed	TECHNISCHE UNIVERSITAET GRAZ	2001-11-01	2004-04-30	FP5-IST
UPTUN	Completed	NEDERLANDSE ORGANISATIE VOOR	2002-09-01	2006-08-31	FP5-GROWTH

[8] This project is not only addressing mainline systems but all rail systems operated in tunnels.

[9] This project is not addressing mainline systems but metro systems.

		TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO* - TNO BUILDING AND CONSTRUCTION RESEARCH - CENTRE FOR FIRE RESEARCH			
DARTS	Completed	COWI CONSULTING ENGINEERS AND PLANNERS AS - TUNNEL DEPARTMENT - DIVISION RAIL, METRO AND TUNNEL	2001-03-01	2004-03-31	FP5-GROWTH
FIT	Completed	STUDIENGESELLSCHAFT FUER UNTERIRDISCHE VERKEHRSANLAGEN E.V.	2001-03-01	2005-02-28	FP5-GROWTH

Objectives:

Many projects were launched and completed in the period 2001-2008 within the 5th and 6th Framework related to fires and tunnel safety improving.

This general objective was promoted by European Commission after severe fire accidents in road and rail tunnels (1996 Channel Tunnel, 1999 Mont Blanc, e Tauern Tunnels, 2001 Gotthard Tunnel).

The project objectives were ambitious and Complete:

- FIT – Consultable database and guidelines
- DARTS - Cost Optimal and durable new design
- SIRTAKI – Advanced Tunnel Management
- VIRTUAL FIRES – Tunnel Fire simulator
- UPTUN – Upgrading of existing tunnels
- SAFE-T – Harmonized European Guidelines
- CORPTUS – Concrete Railtrack Panels for Tunnel Safety
- L-SURF - Large Scale Research Facility on Safety and Security

The last call funded two new projects that are in execution: TRANSFEU and SECUREMETRO.

The first project object is to support the European surface transportation systems standardization, developing a global approach of fire safety-performance requirements (toxicity, fire initiation, etc..) supported by measurements, simulation tools and applications.

SECUREMETRO aim is to increase safety and security in metro vehicle. Even if the project foresees a terrorist attack, It is interesting to get standards for vehicles to reduce firebombs effects.

Results:
The completed projects created an European large network of more than 100 companies, research institutes, governmental bodies working together on the fire and tunnels topic, sharing databases, tools, simulations and guidelines and Decision Support systems.
The results of FIT project were used as input for TSI Safety.

Implications:
The main follow-Up of fire & tunnels projects was the birth of COSUF a Committee on Operational Safety of Underground Facilities under the aegis of the International Tunneling an underground Space Association (ITA) whose aim would be to develop Centre of excellence for worldwide exchange of information and know how regarding safety and security in tunnels.

Signal passed at Danger

On this topic we find 4 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
EUDDPLUS	Completed	TSB INNOVATIONSAGENTUR BERLIN GMBH / FORSCHUNGS - UND ANWENDUNGSVERB UND VERKEHRSSYSTEMTEC - FORSCHUNGS- UND ANWENDUNGSVERB UND VERKEHRSSYSTEMTECHNIK BERLIN (FAV)	2006-07-01	2010-01-31	FP6-SUSTDEV
2TRAIN	Completed	BAYERISCHE JULIUS-MAXIMILIANS-UNIVERSITAET WUERZBURG - INSTITUTE OF PSYCHOLOGY III, CHAIR METHODOLOGY AND TRAFFIC PSYCHOLOGY	2006-10-01	2009-12-31	FP6-SUSTDEV
SAFEDMI	Completed	ANSALDO STS S.P.A. - PRODUCT DEVELOPMENT DEPT. (SVI) - PRODUCT DEVELOPMENT DEPT. (SVI)	2006-09-01	2008-08-31	FP6-SUSTDEV
ERGODESK	Completed	ALSTOM TRANSPORT SA	2005-09-01	2008-11-30	FP6-MOBILITY

Objectives:
The SPAD is the most feared precursor of accident in a railway system.
To mitigate o completely cancel this hazard the Infrastructure Managers and Railway Undertakings are progressively equipping Infrastructure and Cabs with ATP/ATC systems.

When the Automatic Protection system is not present or it is out of order, the human factor is determinant.
In the last years 4 major projects focused on the topic of railway driver factors.
EUDDPLUS and EURODESK aimed to specify and prototype an harmonized, interoperable and ergonomic train driver desk.
SAFEDMI focused on a safe Driver Machine Interface in order to increase the safety level of ATC on board system.
2Train outlined that to achieve a safe, competitive and interoperable railway system a special care to the qualification of train drivers is essential.

Results:
EDDPLUS designed, implemented and tested on a Locomotive an European Driver Desk; the ergonomic requirements of the system were tested by an eye tracking system and the operational data recorded on driver behavior were scientifically evaluated. Many public demonstrations took place.
SAFEDMI project designed and developed a SIL2 ERTMS integrated DMI fully according to ERTMS specifications.
2Train benchmarked training technologies, training and assessment curricula in Europe. Future training requirements were specified and developed. A permanent user group was constituted.

Implications:
The examined projects were successful.
Their evolution witnesses that an European research produces useful results for market uptake when it's aimed to a practical implementation.
EUDDPLUS and SAFEDMI technological platforms approach is useful for the whole safety improvement. The new systems development looks for simultaneously:

- More competitiveness (by means a longer Life Cycle Cost)
- More safety (by means ergonomics certification)
- More interoperability (by means an European Specification)

2Train proposed a higher competence level of railway staff in Europe together with an improvement and unification of training tools and methodologies in EU companies.

Track

On this topic we find 10 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
ACEM-RAIL	ongoing	CENTRO DE ESTUDIOS MATERIALES Y CONTROL DE OBRAS S.A.	2010-12-01	2013-11-30	FP7-TRANSPORT
SMART RAIL	ongoing	UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN	2011-09-01	2014-01-31	FP7-TRANSPORT
AUTOMAIN	ongoing	PRORAIL B.V.	2011-02-01	2014-01-31	FP7-TRANSPORT
DIAGNO-RAIL	ongoing	ENDITECH ANONYMOS ETERIA MELETES KE EFARMOGES	2011-01-01	2012-12-31	FP7-SME
MAINLINE	ongoing	UNION INTERNATIONALE DES CHEMINS DE FER - UIC	2011-10-01	2014-09-30	FP7-TRANSPORT
INNOTRACK	Completed	UNION INTERNATIONALE DES CHEMINS DE FER - UIC SYSTEM DEPARTMENT	2006-09-01	2009-12-31	FP6-SUSTDEV
PROMAIN	Completed	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. - FRAUNHOFER-INSTITUTE FOR STRUCTURAL DURABILITY LBF	2000-01-01	2004-01-01	FP5-Growth
INFRACLEAR	Completed	CYBERNETIX S.A. - INGENIERIE DES SYSTEMES AUTOMATIQUES ET ROBOTIQUES -	2004-02-01	2008-01-31	FP6-SUSTDEV

		DÉPARTEMENT MÉTROLOGIE-OPTIQUE-VISION			
SAFE-RAIL	Completed	D'APPOLONIA S.P.A. - - ROME BRANCH OFFICE'	2004-02-01	2008-01-31	FP6-SUSTDEV
URBAN TRACK	Completed	DYNAMICS, STRUCTURES AND SYSTEMS INTERNATIONAL	2006-09-01	2010-08-31	FP6-INFRASTRUCTURES

Objectives:
Track defects prevention is one of top contribution to railway system safety.
Such a prevention means a better track maintenance.
In the last ten years it's easy to find track maintenance optimizing projects and researches, so as new technology to support it, even if It's difficult to clearly understand if these projects aim to better maintenance or only to optimize costs.
In previous table we selected only most relevant projects considering track inspection and monitoring as the basis to an improved track management, because It's globally shared that the infrastructure diagnostic is one of the best prevention tool for infrastructure defects.
The selected ongoing projects funded by the Seventh Framework Programs (ACEM-RAIL, SMART-RAIL, AUTOMAIN, DIAGNO-RAIL, MAINLINE) focus on inspection and monitoring technologies, predictive algorithms, decision support tools to get :

- An infrastructure Life Cycle Cost reduction;
- An Infrastructure performance improving;
- An optimized planning of infrastructure maintenance activities;
- A safer infrastructure

The topics of ongoing researches are similar to the main achievements and approaches of some completed projects such as INNOTRACK and PROMAIN, but these new studies would use upgraded and improved technologies as a further supporting tool.

Results:
Completed projects of Fifth and Sixth framework programs increased the awareness that new solutions for better infrastructure performances would be found in Track maintenance methodologies
INNOTRACK provided, in a Concluding Technical Report, tools and guidelines to Infrastructure Managers, mainly in the optimization cost field but with studies oriented to a better management of track sub-systems.
PROMAIN promoted networking between operators and industries.
INFRACLEAR and SAFE-RAIL aimed to technology development (Loading Gauge inspection the first one, ballast and sub-ballast monitoring the second one).

URBANTRACK developed, tested and validated similarly tools, methods and product for urban rail track infrastructure.

Implications:

The listed project showed that Track monitoring and Inspection is one of the few methodologies that simultaneously :

- Increase Safety
- Increase Quality
- Reduce Cost

Moreover the expected technological development will produce in next ten years more benefits in this sector.
The only but relevant issue is the different reacting time, in this and other fields, between operators and industries.
These researches are quickly undertaken by the supply industry and this leads to significant innovation in products (components) and services offered by the industry itself.
However, the time to market lead by Operators acceptance needs to be significantly reduced to get the advantages of innovation.
This implies that a new European approach is required to support economy of scales and standardization of railway infrastructures products and tools.

Rail

On this topic we find 7 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
PNMIDEA	Completed	UNIFE - TATA	2009-06-01	2012-05-31	FP7-TRANSPORT
INTERAIL	Ongoing	INSTITUTO DE SOLDADURA E QUALIDADE	2009-10-01	2012-09-30	FP7-TRANSPORT
I-RAIL	ongoing	DYNAMICS, STRUCTURES AND SYSTEMS INTERNATIONAL	2010-11-01	2012-10-31	FP7-SME
MONITORAIL	Ongoing	TWI LIMITED	2011-02-01	2013-01-31	FP7-SME
RAILECT	Completed	TWI LIMITED	2008-09-01	2010-12-31	FP7-SME
URAIL	Completed	TECNOGAMMA S.A.S. - TBC	2004-11-01	2007-01-31	FP6-SME
INFRA-STAR	Completed	AEA TECHNOLOGY RAIL BV	2000-05-01	2003-10-31	FP5-GROWTH

Objectives:

Rail Failure prevention is a very specialist field. Completed and ongoing projects and researches shared the object to improve inspection technologies and methodologies to reduce the rolling contact fatigue (INFRASTAR).

New technologies are today siding the historical Ultrasonic sensors (U-RAIL, RAILECT, MONITORAIL) using intelligent image acquisition devices in urban rail systems(PMNIDEA).

New performance high speed and wireless inspection are under evaluation with new ongoing studies (MONITORAIL, INTERAIL)

Results:

The projects with so specialist targets reach easily some result such as :

- Information collection about rail defects (in rail or welding)
- Development and validation of common models to describing the detection defect in their various locations
- Design of the appropriate inspection system
- Development of a prototype device
- Validation of the final prototype by both laboratory and field trials

All the listed projects followed and reached, more or less, the above mentioned stages.

Implications:

This kind of research fields generally produce products with a fast market uptake.
The partners in the project consortia are very often, middle-little companies with the support of Universities or research centers with some exception (MONITORAIL and INFRASTAR) if the research is ambitious.
It would be useful such approach when a specialist sector need a technological upgrade or a larger market

Command/Control

On this topic we find 2 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
INESS	Completed	UNION INTERNATIONALE DES CHEMINS DE FER - UIC	2008-10-01	2012-03-31	FP7-TRANSPORT
GADEROS	Completed	INGENIERIA Y ECONOMIA DEL TRANSPORTE, S.A.	2003-03-05	2008-03-04	FP5-GROWTH

Objectives:
Since 1990 the EU is promoting the reformation of parts of the signaling subsystem under the ERTMS/ETCS program.
The two above listed promoted the integration of Position System Galileo inside ERTMS/ETCS (GADEROS) and Interlocking Systems (INESS)

Results:
Functional and system requirements specification were produced and some simulation platforms were carried out.

Implications:

ERTMS/ETCS implementation is ongoing in Europe. Operators already implemented this interoperable systems are called to exercise these new applications on field.

Rolling stock

On this topic we find 14 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
DYNOTRAIN (cluster TRIO-TRAIN)	Completed	UNION DES INDUSTRIES FERROVIAIRES EUROPEENNES - UNIFE	2009-06-01	2013-05-31	FP7-TRANSPORT
PANTOTRAIN (cluster TRIO-TRAIN)	Completed	UNION DES INDUSTRIES FERROVIAIRES EUROPEENNES - UNIFE	2009-06-01	2012-05-31	FP7-TRANSPORT
AEROTRAIN (cluster TRIO-TRAIN)	Completed	UNION DES INDUSTRIES FERROVIAIRES EUROPEENNES - UNIFE	2009-06-01	2012-05-31	FP7-TRANSPORT
SAFERAIL	Completed	TWI LIMITED	2008-10-01	2011-09-30	FP7-TRANSPORT
CORFAT	Ongoing	TUV AUSTRIA SERVICES GMBH	2008-11-01	2012-10-31	FP7-TRANSPORT
EURAXELS	Ongoing	UNIFE / GHH-VALDUNE	2010-11-01	2013-&0-31	FP7-TRANSPORT
EUREMCO	Ongoing	UNION DES INDUSTRIES FERROVIAIRES EUROPEENNES - UNIFE	2011-10-01	2014-09-30	FP7-TRANSPORT
TREND	Ongoing	CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	2011-11-01	2014-04-30	FP7-TRANSPORT
VERA	Completed	MER MEC S.P.A. - USE (ELECTRONIC SYSTEM UNIT)	2004-09-01	2008-08-31	FP6-MOBILITY

INTERGAUGE	Completed	POLITECHNIKA WARSZAWSKA - FACULTY OF TRANSPORT	2006-01-01	2008-06-30	FP6-SUSTDEV
WIDEM	Completed	LUCCHINI SIDERMECCANICA SPA - RESEARCH & DEVELOPMENT	2005-01-01	2008-06-30	FP6-SUSTDEV
DELIGHT TRANSPORTS	Completed	CENTER OF MARITIME TECHNOLOGIES E. V. - CENTER OF MARITIME TECHNOLOGIES E.V.	2006-11-01	2010-01-31	FP6-SUSTDEV
MODTRAIN	Completed	UNION OF EUROPEAN RAILWAY INDUSTRIES	2004-02-01	2008-04-30	FP6-SUSTDEV
RAILCOM	Completed	MOVARES NEDERLAND B.V. - HOLLAND RAILCONSULT	2005-12-01	2009-05-31	FP6-SUSTDEV

Objectives:
The selected projects and researches deal with Rolling Stocks System and Sub-systems with four main topics :

- Rolling Stock Interoperability in Design, Implementation and Homologation (MODTRAIN, Cluster TRIOTRAIN, INTERGAUGE)
- Wheel sets and Axels failure prevention (SAFERAIL, VERA, WIDEM)
- Electromagnetic Compatibility (EUREMCO, TREND, RAILCOM)
- Preventive Maintenance (CORFAT, EURAXELS)

Only 4 projects are still ongoing on EMC and Maintenance, and It is relevant to stress this new main concern to prevent maintenance acts in rolling stock operation

Results:

Sub-systems technological platforms and homogeneous approach in rolling stock homologations were the main strategical issues of big projects such as MODTRAIN and TRIOTRAIN.
Their approach focused on standards in requirements of Rolling Stock components and their homologation.

The large consensus these projects found among the stakeholders will encourage the mutual acknowledgement of rolling stocks in EU member states.
The Wheels and axles control improvement takes advantage from the novel inspection technologies and the listed projects are ready for a market uptake.
Ongoing projects are expected to define standards in the debated field of Electromagnetic Compatibility and to update the Rolling Stock maintenance models by means new methodologies.

Implications:

Rolling Stocks projects are facing the new boundary of European technical harmonization.
What ERTMS/ETCS partially solved in signaling systems, In Rolling Stocks field It could be solved by an Unique Book in which It would be possible to find all the rules to admit Rolling Stocks in the whole European Railway Infrastructure

Railway system

On this topic we find 11 main projects as detailed in the following table :

Acronym	Status	Coordinator	Start	End	Program
RAILSAFE	Completed	NORGES TEKNISK - NATURVITENSKAPELIGE UNIVERSITET - DEPARTMENT OF PRODUCTION AND QUALITY ENGINEERING	2004-07-01	2005-06-30	FP6-MOBILITY
ALARP	Ongoing	ANSALDO STS S.P.A.	2010-01-01	2012-12-31	FP7-TRANSPORT
REOST	Completed	UNIVERSITA DEGLI STUDI DI GENOVA - DIPARTIMENTO DI INGEGNERIA ELETTRICA	2002-04-01	2004-09-30	FP5-IST
INTEGRAIL	Completed	UNION OF EUROPEAN RAILWAY INDUSTRIES	2005-01-01	2009-03-31	FP6-SUSTDEV
GLOBAL VIEW	Completed	UNION INTERNATIONALE DES CHEMIN DEFER - TECHNOLOGY AND RESEARCH DEPARTMENT	2006-12-01	2008-11-30	FP6-SUSTDEV
MOGENTES	Completed	AUSTRIAN RESEARCH CENTERS GMBH - ARC	2008-01-01	2010-12-31	FP7-ICT
SAMNET	Completed	INSTITUT NATIONAL DE RECHERCHE SUR LES TRANSPORTS ET LEUR SECURITE	2002-12-20	2011-12-19	FP5-GROWTH
OPENCOSS	Ongoing	FUNDACION TECNALIA RESEARCH & INNOVATION	2011-10-01	2015-03-31	FP7-ICT
EXCROSS	Ongoing	DEEP BLUE SRL	2011-10-01	2013-12-31	FP7-TRANSPORT
SAMRAIL	Completed	WS ATKINS RAIL LIMITED	2003-01-31	2008-01-30	FP5-GROWTH
SYNER-G	Ongoing	ARISTOTELIO PANEPISTIMIO THESSALONIKIS	2009-11-01	2012-10-31	FP7-ENVIRONMENT

Objectives:

The 11 selected Railway system projects deal with the whole Railway transportation system.

Concerning safety system aspects the majors are SAMNET and SAMRAIL.

SAMNET aimed to support the EU-harmonization railway systems sharing the pragmatical usability of trans-European safety requirements.

The project thematic network were based on EU directives on interoperability and supported the development of 49/04 Safety directive.

The following SAMRAIL project carried out the development of a common safety management approach in EU'S railways in order to implement the 49/04 Safety Directive

Another broad-spectrum project was INTEGRAIL whose very ambitious target was to offer, solutions and technologies to integrate the railway subsystems.

Other researches and studies aimed to deepen other system cross-themes such as the dissemination of safety railway culture (RAILSAFE, GLOBAL VIEW and EXCROSS), the availability of open safety platform (OPENCOSS) and diffusion of a mature railway concept such as the safety critical-system dependability (MOGENTES).

More recent projects (7th Call) are studying more specialist cross-aspect like worker-safety (ALARP) and Earthquake resilience (SYNER-G)

Results:

The SAMNET/SAMRAIL projects achieved a number of essential milestones towards establishing a competitive but safe European rail system by developing key elements regarding the implementation of the safety directive. Wide consultation and dissemination were organised to develop and refine the main results of these projects.

INTEGRAIL proposed a strong but too much ambitious railway integration; If it focused on only some sub-systems integration it would be more successful.

The other project had a minor impact on the system but proposed concepts and ideas that would deserve an implementation follow up.

Implications:

The Railway safety system projects identified three/four topics for further researches and studies on :

• ORGANISATION - The way in which an organisation and its staff behave towards rules is one of the determining factors in the safety culture of the organisation. An open and learning culture should be fostered in Europe which encourages group support for safe behavior.

• COMMON STANDARDS Development of common standards for cross-acceptance of sub-systems

• COMMON SAFETY DATABASE for the railways for the existing incident and accident databases of member state railways and that of Eurostat are found to be incompatible to each other in many respects.

• CONTINUOUS LEARNING is an integral part of a constantly expanding and changing railway industry. Each member state railways have part formal and part informal processes which have helped them to learn from incidents and accidents and from operational
failures of planned processes.

The Analysis of the main last ten years safety related projects is detailed in Table 1 in the following page

Expected results, impacts, market uptake perspectives can be accessed through ERRAC ROADMAP evaluation group that is setting up a database comprehensive of all these aspects.

Safety Aspect	Completed 2003-2012 (4rd ,5th,6th call and oth.)	Completed 7th call)	Ongoing 7th call)
Train collisions	**6** (SAFEINTERIORS,SAFETRAIN,SAFETRAM, APSN,TRAINSAFE, ALJOIN)		
Derailments	**2** (SPURT,TURNOUTS)		**1**(D-RAIL)
Level Crossings	**2** (SELCAT,PANsafer)		
Rolling stock in motion	**1** (UNIACCESS)		**1**(REST-RAIL)
Fires and Tunnels	**8** (SAFE-T,SIRTAKI,VIRTUALFIRES,UPTUN, DARTS,FIT,L-SURF ,CORPTUS)		**2**(TRANSFEU, SECUREMETRO)
Signal Passed at Danger	**4**(EUDDPLUS, 2TRAIN, SAFEDMI, ERGODESK)		
Track	**5** (INNOTRACK , PROMAIN, INFRACLEAR,SAFE-RAIL, URBAN TRACK)		**5**(ACEM-RAIL,SMART-RAIL,AUTOMAIN, DIAGNORAIL,MAINLINE, I-RAIL)
Rail	**2** (INFRASTAR, URAIL)	**2**(PMNIDEA,RAILECT)	**3**(INTERAIL, MONITORAIL-I-RAIL)
Command/ Control	**1** (GADEROS)	**1**(INESS)	
Rolling stocks	**6** (MODTRAIN, INTERGAUGE, VERA, WIDEM, DELIGHT TRANSPORTS, RAILCOM)	**4**(SAFERAIL, PANTOTRAIN, AEROTRAIN, DYNOTRAIN)	**4**(CORFAT, EURAXELS, EUREMCO, TREND)
Railway system	**6** (RAILSAFE, REOST, INTEGRAIL, GLOBAL VIEW, SAMNET,SAMRAIL)	**1**(MOGENTES)	**4**(ALARP, OPENCOSS, EXCROSS, SYNER-G)

Table 1 Project summary

4. VISION

The 2050 vision

A common vision to an acceptable safety level is difficult to share.
The reasons are essentially the following:

- The level of risk that is socially acceptable in a real life situation is different in each member state and it must take into account factors such as people liberty and comfort and also the competitiveness of the different modes of the transportation system;
- The existing national rules and procedures to prevent, detect and mitigate any form of the transportation system failures are too much concerned to the historical, technological and industrial awareness of the single member states;
- The existing national systems and procedures to protect people (transport users, staff and Thirds) from harm are strictly link to each member state sensitiveness on that;

A common European Vision to orient research activities should harmonize these approaches and set a common target.

Concerning Road transport, European Commission set in 28 March 2011 WHITE PAPER [1] an unequivocal goal: "…***moving close to zero fatalities in road transport by 2050 and halving road casualties by 2020***.."

Comparing Data e Vision on road Transport we get the siding figure 7.

If we get the already mentioned strategical issue that "**Railway system is and must remain the safest transportation system"** It is evident that railway system already should align to the same 2050 target.

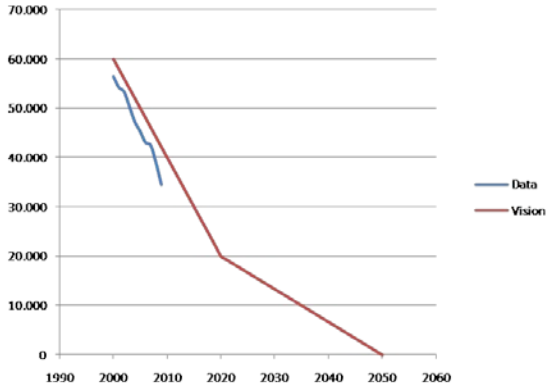


Figure 7 - Data and Vision comparison on road transportation fatalities

However, whilst the enormous amount of fatalities in road transport allows its ambition of having the "50%" target within 2020, the same target is less achievable in Rail also considering the relative indexes (i.e. fatalities per passengers*km) that show Railway system is much more safe than any other transportation system.

Anyway In figure 8 we parallel the same vision (-50% fatalities within 2020 and as-low-as reasonably possible fatalities within 2050).

Railway system shows a decreasing trend in fatalities (about -6% per year in the last three years) and this reduction concerns all the type of accidents and precursors even if more than 80% of the fatalities are not within the control of the railways.

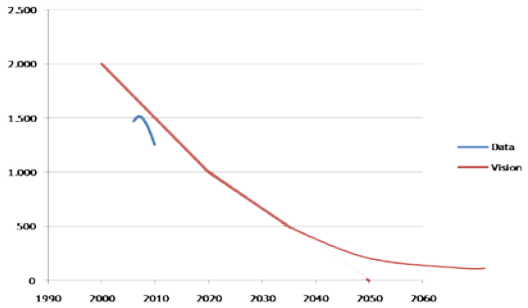


Figure 8 - Data and Vision comparison on rail transportation fatalities

Internal and External Causes the short-medium term approach

The main issue to be solved in such a long term vision is that in railway system "**the vast majority of significant accidents had external causes**".
Railway safety expertise remains pessimist in a significant reduction of external causes in railway accident.
The first main difference is that an accident internal cause is almost always related to an internal precursor that could be mitigated o prevented while an accident caused by external factors has external related precursors whose origins are, very often, difficult to be investigated and assessed.
Precursors mitigation projects and researches could strongly reduce 20% accidents and fatalities caused by internal system failures.
A short-medium term roadmap should be oriented on precursors and internal causes mitigation.

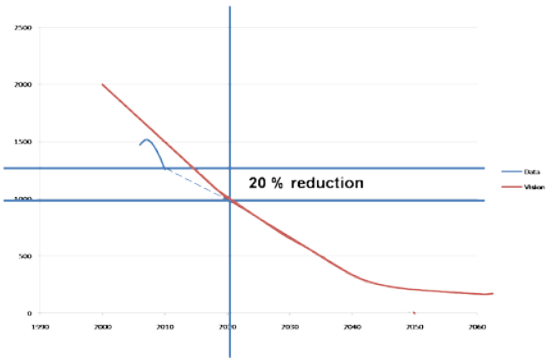


Figure 9 - Fatalities reduction in 2020

Referring to 2050 vision the deadline of this first stage would be 2020 (see figure 9).
Research agenda in the next six-seven years will focus on railway sub-systems (infrastructure, Rolling Stocks, Signaling, Operation and Maintenance) and Human Factors, in order to achieve the 20% reduction of accidents related to internal failures and faults but in full respect of the railway system interoperability and competitiveness improvement.

A new System approach- Long term Target

A 2050-Long term target need a new system approach in which the first and most important challenge would be to keep the number of fatalities as low as we have it now with growing traffic intensities.

Today, 75-80% of fatalities are level crossing user and unauthorized persons.

To avoid these typologies of accident railway system shall follow the three basic requirements as far as reasonably practicable:

- A collision between a rolling stock and an obstacle wherever on railway infrastructure shall be avoided ;
- The interaction between unauthorized People and a Rolling Stock in Motion wherever on railway infrastructure shall be avoided;
- Authorized people shall be protected from harm by Fire, Toxicity, Overpressure ,Electrical and Electromagnetical effects;

Level Crossing, Climate and Environmental Phenomena are considered external causes to accident because they could facilitate the above mentioned requirements failure.

In order to respect the 2050 target **to keep the number of fatalities at least as low as we have it now with growing traffic volumes** in system approach three stages are expected:

Target 2020 – Completion of Technical specifications and standards; products solutions and rule assessment, market uptake;
Target 2030 – Fully integration in railway system operation;
Target 2050 – Fully coverage on European System;

Safety projects and researches are already migrating from a single sub-system failure avoidance to a whole railways system approach.
In previous EU Framework Programs (from 4th to 6th) the System oriented projects were about 15%, with the last call they consist of more than 20%.
This trend confirms the increased awareness of perceiving safety in the rail sector in a more system-oriented perspective that takes into account that:

- the railways are an particularly safe mode of transport with an extremely low percentage of fatalities and accidents compared to the other modes of transport, especially compared to road transport;
- Appropriate investments and the involvement of other actors of the transport system would be needed to increase global safety in a long term vision;
- The railway system is and will remain the safest transportation mode: so to sustain a future safe mobility in Europe, the first and most important challenge for the railway system would be to keep the number of fatalities as low as we have it now with growing traffic volumes, improving present safety levels and keeping the associated costs as low as possible in order to increase rail transport profitability.

This ambitious vision will be considered in the roadmap, also considering that It asks for future research projects that simultaneously:

- Increase Railway System Safety;
- Increase Railway System Quality;
- Reduce Railway system Cost;

4. ROADMAP DEVELOPMENT

Road map Development will respect the following scheme

Area	Sector	Sub System/ Function	TOPIC	Critical Requirements	Technologies	Target 2015	Target 2020	Target 2030	Target 2050

Areas & Sectors

Two main areas are selected coherently with safety projects and researches clustering and implication analysis:

- Railway Internal Causes :
    - Derailments
    - Fires and Tunnels
    - Train Collisions
    - Human Factors
    - Infrastructure
    - Rolling Stocks
    - Command/Control
    - Railway System
- Railway External Causes:
    - Level Crossing
    - Rolling Stock in motion
    - Environment and Climate phenomena

Sub-systems & Sub-function

Each sector could be branched in two or more sub systems or functions to be deepened.

For Instance in Derailment sector we consider Infrastructure and Rolling Stocks as subsystems

Topics

This section must be filled by the delivery target (products, services or technology) of the project or research such as a Warning System or an Inspection system and so on.

Critical Requirements

They are the challenging requirements of the product or service selected.

Researches, standardizations and developments will focus on them

Technologies

They are the existing or developing technologies to be adopted or explored in the selected products or service.

TARGETS

Four horizons are foreseen, in order to focus research priorities:

- **Target 2015** short term horizon
- **Target 2020** short-medium term horizon
- **Target 2030** medium-long term horizon
- **Target 2050** long term horizon

For each Topic 5 typologies of targets are expected in the related horizon:

- RESEARCH (**RES**) means that research and innovation are expected to be completed, within horizon data delivering new concepts, technologies, services;
- STANDARD (**STD**) means that a new concept, technology, or service is completely ruled and standardized within horizon data;
- DEVELOPMENT (**DEV**) means that a new concept, technology, or service is prototyped and tested on field;
- MARKET (**MKT**) means that the new concept, technology, or service is assessed or/and homologated and then available on market
- OPERATION (**OPE**) means that the new concept, technology, or service is in operation (used and maintained)
- INTEGRATION (**INT**) means that the new concept, technology, or service is an integrated asset of Railway system, its Life Cycle cost is well know and it contributes to the competitiveness and interoperability of the whole system

In the following paragraphs it is shown the roadmap for each sector with related topics. Some Sector and Topic Cells were selected to be part of the safety integrated roadmap.

5. DERAILMENT ROADMAP

<table>
<tr><th>Area</th><th>Sector</th><th>Sub-system / Sub function</th><th>TOPICS</th><th>Critical Requirements</th><th>Technologies</th><th>2015</th><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td rowspan="6">Internal Causes</td><td rowspan="6">Derailment</td><td rowspan="3">Infrastructure</td><td rowspan="2">Track Inspection</td><td rowspan="2">Measurement Accuracy</td><td rowspan="4">Video
Laser
Acoustic
Inertial Systems
Others</td><td>STD</td><td rowspan="3">MKT</td><td>RES</td><td rowspan="3">MKT</td></tr>
<tr><td>DEV</td><td>STD</td></tr>
<tr><td>MKT</td><td>DEV</td></tr>
<tr><td>Wayside Train monitoring systems</td><td>System Integration</td><td>OPE</td><td>INT</td><td>INT</td><td>INT</td></tr>
<tr><td rowspan="3">Rolling stocks</td><td rowspan="3">Dynamics Monitoring</td><td rowspan="3">Cost</td><td rowspan="3">Inertial Systems
Others</td><td>STD</td><td rowspan="3">MKT</td><td>RES</td><td rowspan="3">MKT</td></tr>
<tr><td>DEV</td><td>STD</td></tr>
<tr><td>MKT</td><td>DEV</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>OPE</td><td>INT</td><td>INT</td><td>INT</td></tr>
</table>

6. FIRES AND TUNNELS ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Fire safety in Railway Tunnel	Infrastructure	Tunnel Safety Embedded system	Energy availability	Video Infrared Acoustic Micro-Eolic Others	RES	MKT	RES	MKT
						STD		STD	
						DEV		DEV	
				Cost	Asset Management Support System	STD	OPE	INT	
						DEV	MKT	MKT	
			Wayside Train monitoring systems	System Integration	Video Laser Acoustic, Others	OPE	INT	INT	INT

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Fire safety in Railway Tunnel	Rolling stocks	Fire effects full protection	Cost	New materials	RES	MKT	RES	MKT
						STD		DEV	
						DEV	OPE	INT	
			Ever moving rolling stocks	Energy availability	Microturbine Others	RES	RES	STD	
						STD	STD	DEV	
						DEV	DEV	OPE	INT

7. TRAIN COLLISIONS ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Train Collisions prevention and mitigation (active and passive safety)	Safety active system	Permanent Way clearance inspection	Inspection Accuracy	Video Infrared Acoustic Laser Fiber Optics Others	STD DEV MKT	MKT	RES STD DEV	MKT
			Collision preventing system integration	System Integration	HS/HD communications	OPE	INT	INT	INT

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Train Collisions prevention and mitigation (active and passive safety)	Safety passive system	Vehicle crashworthiness improving	Cost	New Materials Others	STD	MKT	RES	MKT
						DEV		STD	
						MKT		DEV	
			Occupant protection			OPE	INT	INT	INT

8. HUMAN FACTORS ROADMAP

<table>
<tr><th>Area</th><th>Sector</th><th>Sub-system / Sub function</th><th>TOPICS</th><th>Critical Requirements</th><th>Technologies</th><th>2015</th><th>2020</th><th>2030</th><th>2050</th></tr>
<tr><td rowspan="7">Internal Causes</td><td rowspan="7">Human Factors</td><td rowspan="3">Innovation & Interoperability</td><td rowspan="2">Safety related human factor mitigation</td><td rowspan="2">Operation rules and procedures review</td><td rowspan="3">Requirements engineering Tools</td><td>RES</td><td rowspan="2">MKT</td><td rowspan="2">MKT</td><td rowspan="2">MKT</td></tr>
<tr><td>STD</td></tr>
<tr><td>DEV</td><td>OPE</td><td>INT</td><td>INT</td></tr>
<tr><td rowspan="2">No- impact due to human errors on railway system safety</td><td rowspan="2">Safety embedded system development</td><td rowspan="2">HW/SW safety platforms
Others</td><td>RES</td><td>RES</td><td>RES</td><td rowspan="2">MKT</td></tr>
<tr><td rowspan="2">STD</td><td rowspan="2">DEV</td><td>MKT</td></tr>
<tr><td rowspan="2">Training</td><td rowspan="3">Human reliability certification process</td><td rowspan="3">Methodologies and technological standardization for an European patent</td><td rowspan="3">Simulators
E-training tools
Others</td><td>OPE</td><td>INT</td><td>INT</td><td>INT</td></tr>
<tr><td>RES</td><td>RES</td><td>DEV</td><td rowspan="3">MKT</td></tr>
<tr><td>Health and behaviour</td><td>STD</td><td>DEV</td><td rowspan="2">MKT</td></tr>
<tr><td></td><td>DEV</td><td>MKT</td></tr>
</table>

9. INFRASTRUCTURE ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Infrastructure safety Improvement	Inspection	Track Inspection	Measurement accuracy	Video Laser Acoustic Inertial systems Ultrasounds Load Cells Decision Support systems tools Others	STD	MKT	RES	MKT
						DEV		DEV	
						MKT		MKT	
			Rail Inspection	Measurement speed		OPE	INT	INT	INT
			Civil Works Inspection	Cost					
		Innovation & interoperability	Command/control Systems Compatibility	Cost	Electromagnetism GPS Others	RES	MKT	RES	MKT
						STD		DEV	
						DEV		MKT	

10. ROLLING STOCKS ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Rolling Stocks	Innovation & Interoperability	European Rolling Stocks Platform	System Integration	HW/SW safety systems HW/SW real time platforms Others	STD	MKT	MKT	MKT
						DEV			
						MKT			
				Cost		OPE	OPE	INT	INT
				Common standards					
		Inspection	Wheel sets and axels failure prevention	System Integration	Video Laser Decision Support Tools Others	STD	MKT	RES	MKT
			Vehicle preventive maintenance			DEV		DEV	
						MKT		MKT	
						OPE	INT	INT	INT

11. COMMAND/CONTROL ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Command Control	Innovation & Interoperability	European Rolling Stocks Platform	National Systems Integration	Innovative transponders On Board systems integration Radio Infill Others	STD DEV MKT	MKT	MKT	MKT
			ETCS New Generation	Cost		OPE	INT	INT	INT
		Inspection	C/C system failure prevention	Zero-false warning	Diagnostics embedded systems Diagnostics vehicles Others	STD DEV MKT	MKT	MKT	MKT
						OPE	INT	INT	INT

12. RAILWAY SYSTEM ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Internal Causes	Railway System	Safety Management System	Railway System Organization standards	System Approach	Decision maker Tools	STD	INT	INT	INT
			Common safety database						
		European Safety Certificate	Industry/operators continuous learning						
			European systems cross-acceptance						

13. LEVEL CROSSINGS ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
External Causes	Level Crossings	System Approach	Rail-Road Accident prevention platform	Intermodal specialists coordination and cooperation	Video communication Radio Warnings Light Warnings Others	RES	DEV	MKT	MKT
						STD	MKT		
						DEV	OPE	INT	INT
		Rules and Standards definition	European level crossing risk ranking	National Standards and requirements	Decision support system tool	RES	MKT	MKT	MKT
						STD			
						DEV			
						MKT	INT	INT	INT

14. ROLLING STOCKS IN MOTION ROADMAP

Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
External Causes	Protecting people from moving Rolling Stocks	System approach	Train Clearance Detector	Fast processing systems	HW/SW safety Platforms Real time systems Inspection and monitoring sensors Others	RES	DEV	MKT	MKT
				Real time safety platforms		STD			
			Railway Trespasses Prevention	Cost		DEV	STD		
			Railway Suicides Risk Reduction	Decision Maker recommendations and Tools availability			MKT		
							OPE	OPE	INT
		Rules and standards definition	Universal Railway Station	Cost	Others	RES	DEV	MKT	MKT
						STD	STD		
			Railway vehicle universal access	Interoperable Requirements and Standards		DEV	MKT	OPE	INT

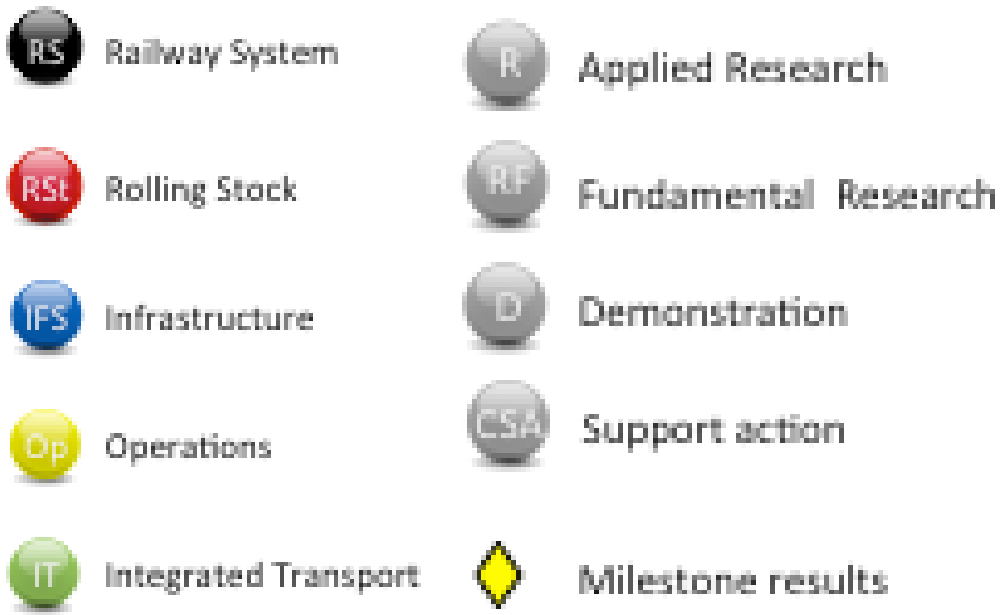
15. ENVIRONMENT AND CLIMATE ROADMAP

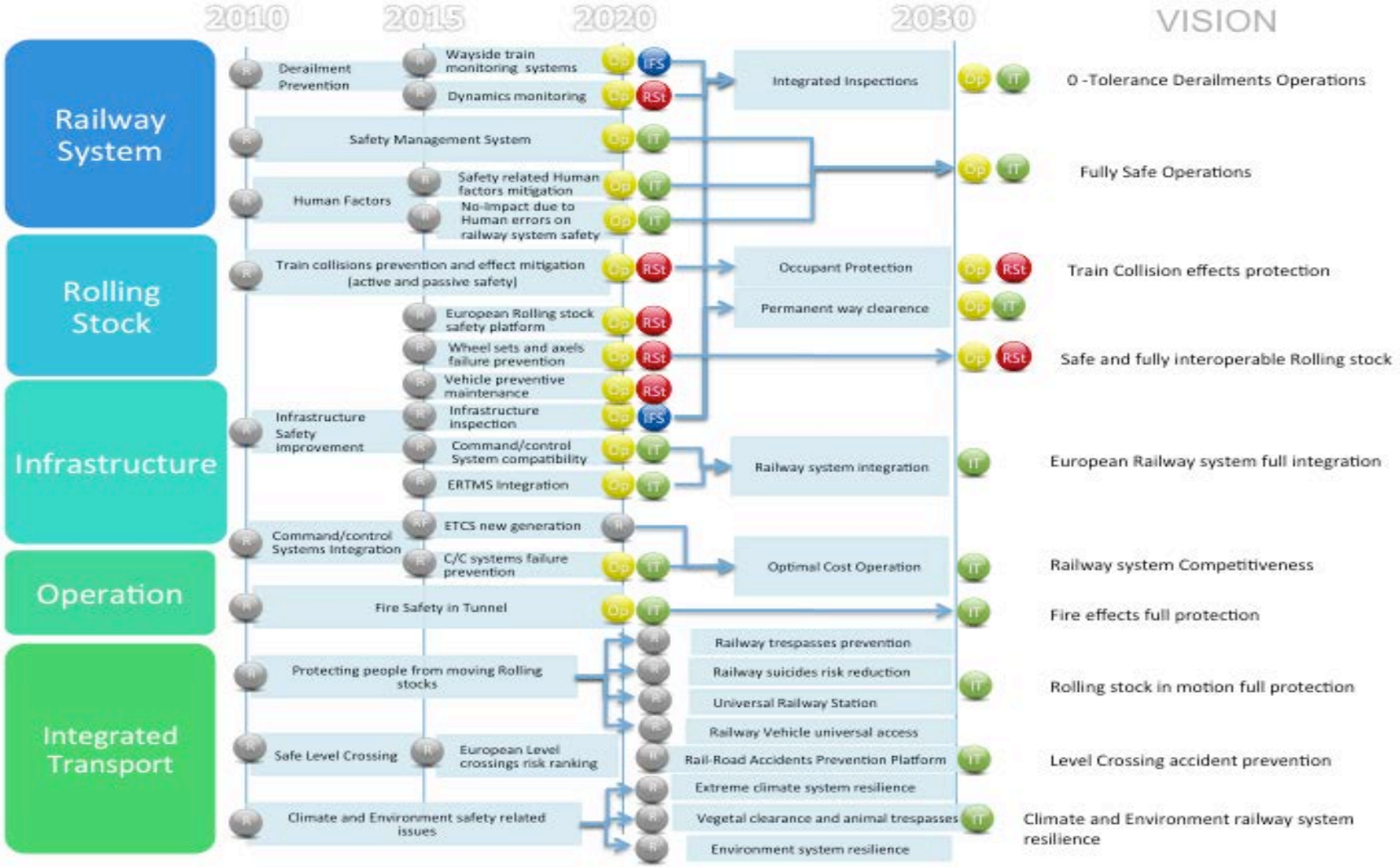
Area	Sector	Sub-system / Sub function	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
External Causes	Climate &environmental safety related issues	Extreme Climate events	Extreme climate System Resilience	Understanding and engineering of existing and future risks to mitigate effects	Video Laser Acoustic Fiber Optics Infrared Others	RES	DEV	MKT	MKT
				System Integration		STD	MKT	OPE	INT
				Cost					
		Environment Events	Vegetation clearance and animal trespasses	Cost	Video Laser Acoustic Fiber Optics Infrared Others	RES STD	DEV STD	MKT	MKT
			Environment events resilience			DEV	MKT	OPE	INT

16. SAFETY INTEGRATED ROADMAP PICTORIAL VIEW

The selected sectors and topics are integrated in the following scheme that addresses 2030 target.

The symbol in the pictorial view are described:




2010
2015
2020
2030
VISION
Railway System
Rolling Stock
Infrastructure
Operation
Integrated Transport
Derailment Prevention
Wayside train monitoring systems
Dynamics monitoring
Safety Management System
Human Factors
Safety related Human factors mitigation
No-impact due to Human errors on railway system safety
Train collisions prevention and effect mitigation (active and passive safety)
European Rolling stock safety platform
Wheel sets and axels failure prevention
Vehicle preventive maintenance
Infrastructure Safety improvement
Infrastructure inspection
Command/control System compatibility
ERTMS integration
Command/control Systems Integration
ETCS new generation
C/C systems failure prevention
Fire Safety in Tunnel
Protecting people from moving Rolling stocks
Safe Level Crossing
European Level crossings risk ranking
Climate and Environment safety related issues
Integrated Inspections
Occupant Protection
Permanent way clearence
Railway system integration
Optimal Cost Operation
Railway trespasses prevention
Railway suicides risk reduction
Universal Railway Station
Railway Vehicle universal access
Rail-Road Accidents Prevention Platform
Extreme climate system resilience
Vegetal clearance and animal trespasses
Environment system resilience
0 -Tolerance Derailments Operations
Fully Safe Operations
Train Collision effects protection
Safe and fully interoperable Rolling stock
European Railway system full integration
Railway system Competitiveness
Fire effects full protection
Rolling stock in motion full protection
Level Crossing accident prevention
Climate and Environment railway system resilience

ERRAC SECURITY ROADMAP

1. PRESENT SITUATION

• General indicators

Rail security involves the protection of infrastructure, goods and persons (staff and customers) against deliberate attacks or intent to cause damage. These events are not predictable because they are due to external factors. There are no common definitions of indicators for rail security at European level and the sharing of responsibilities in security policies differs in each country[10]

Over roughly the last twenty years, security issues of all kinds have grown in importance to the point that railway companies have had to take account of this new factor. Terrorism in particular has evolved from national terrorism to international terrorism, which is quite different and itself in permanent evolution.

The features of the rail sector – the geographical extent of its infrastructure, the traffic volumes using said infrastructure and the political and media repercussions of any attack on rail transport – mean that the railway companies are a prized target for terrorists, and could be exposed to significant threats.

To face these threats, rail companies had to organise themselves. They have built a business oriented security policy and implemented real security strategies in partnership with national authorities.

• Legislative framework (EU, National, Regional,…)

To address the demand for security of the rail transport system, legal and organisational devices are implemented at **the national level** with systems that are specific to each state.

Directives, Rail Directives, TSI, standards

There is no dedicated EU regulation for railways or common security rules in the European Union (EU) to protect rail transport against acts of unlawful interference (and no new regulation is called for by the sector[11]) . However some security measures are included in existing regulations. In addition some white and green papers as well as some communications

[10]However the project MODSAFE proposed a glossary accepted by UITP and UNIFE members, and the project SECUR-ED is complementing it.

[11] See CER, COLPOFER, EIM, ERFA, RAILPOL, UIC and UITP joint letter to DG MOVE on Land Transport Security in the Public Transport and Railway Sector.

in the past years deal with transportation systems in Europe and the European Commission is working on possible new texts

On one hand European directives were created for safety, on the other hand the only legal instruments for security that exist at the European level for transport services are those defined in the RID for the transport of dangerous goods, and in the Regulation (EC) No 1371/2007 on rail passengers' rights and obligations (article 26 which sets in place a "right to security" for passengers on board trains and in station).

The rail sector together with the public transport sector have sent a common position to the European commission on 7 April 2011 and decided to continue to meet together on these topics[12]

[12] http://www.uitp.org/mos/positionspapers/130-en.pdf

2. State-of-art, recent projects, ongoing research

TRIPS - Transport Infrastructures Protection System (EC PASR 2005 project)
Under PARS 2005, the European Commission decided to fund the research project TRIPS (TRansport Infrastructures Protection System) to design and demonstrate an anti-terrorist security system architecture to better detect terrorist threats and hence better protect railway passengers and infrastructures.

The challenge of enhancing security in railway network systems involves and combines in one mission, many aspects, of key security objectives. An effective rail security system will address several of the other security missions defined by the EU.

The TRIPS project will investigate possibilities offered by technology and improved processes to consider innovative solutions that increase the effectiveness and reactivity for protection of passengers and infrastructure. The recent terrorist attacks show how vulnerable public transport systems are to these kind of threats.

The global objectives of the TRIPS project are:

- To qualify and quantify the security threats, vulnerabilities and risks to railway systems for a range of operating conditions;
- For the range of current and perceived future threats, to assess a range of passive and active sensor technologies operating within railway environments and railway operational timescales;
- To address issues of communications and systems infrastructure and architecture, particularly legacy systems, and their impact on delivering current and perceived future protection of railway systems;
- To consider innovative solutions for railway protection and to show proof of concept demonstrations (consideration of economics, political, social and human factors will be made);
- To define current limitations and provide a roadmap for future developments and research requirements.

The TRIPS project embraces the problem in a wide approach, even though a limited period of 18 months and it will include tangible verification of technologies, focused on some critical aspects of railway. The project include railway tracks, railway infrastructure surveillance, detection of explosive inside carriage and coach or other non conventional threats, as well as a communication and protection system architecture design. The TRIPS project is a positive step towards ensuring efficient transfer of security technology, knowledge and innovation from enterprises RTD activities, some of which have not been traditionally associated with the railways, to the rail transportation systems.

RAILPROTECT - **Innovative Technologies for Safer and more Secure Land Mass-Transport Infrastructure under Terrorist Attacks**.

The project aims at reducing the vulnerability of rail station infrastructures and rolling stock to explosion loads. The assessment of this vulnerability is achieved via numerical simulations of the blast effects. Thus, engineering design simulation tools are being developed based on structural and fluid mechanics and appropriate geometry mapping techniques for large structures. Case studies of typical stations and coaches are also elaborated for assessing the efficiency of these tools in predicting the performance of structures and the injury risk levels of the occupants.

The project has been motivated by the need to mitigate shortcomings identified subsequent to the terrorist attacks that have targeted the urban transport systems of two major European capitals. The need to take initiatives in this area is reinforced by the current climate, which indicates that such attacks will not abate in the foreseeable future.

The nature of land mass passenger transport, with its open security architecture and widely dispersed assets, would suggest that measures comparable to those applicable to civil aviation cannot, and will not, be put into place in the near future. Nevertheless, a number of security measures have been introduced following conventional lines and centring on increased surveillance and patrols.

If it is not possible to completely eliminate the hazard, and it is not possible to secure all the assets that make up the land mass passenger transport system, then the best option available is to reduce the overall risk by securing specific vulnerable system elements. One such area is the resilience of moveable and unmovable parts of the land mass passenger transport infrastructure.

COUNTERACT - **Cluster of user networks in transport and energy relating to antiterrorist activities (EC FP6 project).**

The research project focuses on critical infrastructures. They are those which, if disrupted as a result of a terrorist attack, would have an impact of regional, national or international scale on communities and economies. Such an attack could be co-ordinated, disrupting several infrastructures directly or through cascade effects. This proposal is aimed at assessing and recommending feasible and cost-effective solutions for the improvement of security in four key sectors of critical infrastructure, urban public transport, rail transport, air transport, maritime transport, freight transport and energy.

These sectors, for the COUNTEARCT proposes, have been grouped in the following clusters, attending to similarity and economy of resources criteria: - Surface Passenger Transport - Freight Transport - Air Transport - Energy Each of these sectors is represented by a thematic cluster comprising a network of Users and a number of Partners, one of which is a security company.

DEMASST: **demonstration project within EU's Seventh Framework Programme for Research and Technological Development (FP7).**

The major goal of the project is to produce a roadmap definition for the Phase 2 demonstration programme Security of Mass Transportation, which will promote large scale integration, validation and demonstration of new security systems of systems going significantly beyond the state of art;

The malicious threats, particularly those posed by terrorists, require a comprehensive approach: if security improvements are patchy, perpetrators are likely to find the loopholes left. With their open access points and interconnections, surface mass transportation systems

are highly vulnerable, while it is technically and economically, impossible for the multiple operators to employ security measures similar to those used at airports.
DEMASST aims to take on the dual challenges of analysis and networking necessary to define and achieve commitment for the strategic roadmap for the Phase 2 Demonstration project. The project develops a highly structured approach to the demonstration programme built on identifying the main security gaps and the most promising integrated solutions, utilising sufficiently mature technologies, for filling them.

SECURE-ED (FP7) : **ongoing project - Phase 2 of DEMASST : demonstration project with an objective to provide a set of tools to improve urban transport security;**

The SECUR-ED project will provide dedicated and easy to use tools designed to share the best knowledge between operators while preserving cultural and geographical specificities. This will allow all cities to benefits from advances in security related procedures, thus globally enhancing the attractiveness of collective transport in Europe. Simultaneously, SECUR-ED will provide new technical capacities addressing the most efficient topics for security enhancement. These capacities will be designed in an interoperable way, so as to facilitate their adoption and use by various operators. This will in turn promote and facilitate the adoption of European security solutions for transportation operators and further opening up the European market. Security in urban mass transportation should not be seen only as specific to each operator, or city, or country. Recommendations shall be built up in order to create at the European level, a shared perception of the security and privacy issues by many of the EU countries, taking into account similar expectations expressed by passengers, citizens and associations in the 27 countries of the Union. The SECUR-ED project will promote the creation of a reusable Security Framework for Urban Mass Transportation throughout Europe. In the project there is the active participation of many different cities, of the two main representative associations (UITP & UNIFE) The project goals are:

- **Interoperability** is the capacity of a subsystem to cooperate and exchange information, reliably and without errors. This capability allows resources optimization, facility of interaction among different systems, reuse of data from heterogeneous sources, with the aim to offer new and efficient services.
- **Interchangeability** is the hallmark of subsystems to be removable and replaceable with other systems with the same functionality without the need to make any changes to the logic and to software integration.
- **Modularity** is the characteristic of a system to be decomposed into subsystem autonomous and independent, correlated and replaceable. The interfaces of the individual subsystem must show the elements that allow each module to communicate with other components of the system.

PROTECTRAIL (FP7): ongoing project -The Railway-Industry Partnership for Integrated Security of Rail Transport.
The project aims to develop an integrated system to improve the security of rail transportation through better protection of railways and trains, and to reduce disparity in security between European railway systems.
Facing the problem of enhancing the railway security with a systematic top-down approach (i.e. to search for an all-inclusive solution valid for all the conceivable threat scenarios) is judged by PROTECTRAIL members too ambitious even if it could generate potential economies of scale and effort rationalisation. The proposed PROTECTRAIL approach is therefore to split the problem of making the railway more secure into smaller asset-specific security problems

(missions) for which it is easier to reach satisfactory solutions applicable and usable in different threat scenarios. Each sub-mission could be therefore better oriented to particularly significant areas of interest, resulting from risk analysis or from rail operator priorities. In a clear view of scope and performance goals, for each sub mission it will be easier to define, research and develop solutions in terms of architectures, technology deployment, as well as the necessary procedures, organizations to manage the specific issue. The PROTECTRAIL challenge is therefore to make interoperable the single asset-specific solutions and to conceive and design a modular architectural framework where each asset-specific solution can be plugged, that is the basis to assure a streamlined process of federation, integration and interoperability of respective solutions. The PROTECTRAIL project will address the following security sub-missions: protection of signal and power distribution systems against any terrorism act, track clearance, clearance of trains before and after daily use, staff clearance, luggage clearance control, passenger clearance control, freight clearance control, tracking and monitoring of rolling stock carrying dangerous goods, protection of communication and information systems, stations, buildings and infrastructure protection

SECURESTATION : ongoing project :Research to improve passenger station and terminal resilience to terrorist attacks and safety incidents through technologies and methodologies enabling design to reduce the impact of blast, fire and the dispersion of toxic agents on passengers, staff and infrastructure; SecureStation will consider threats from terrorist attacks and safety incidents caused by blast, fire and accidental or deliberate particle dispersion. The four project objectives are:

- To increase resilience of passenger stations and terminals through structural design, interior design, and building services design, realising everyday benefits while designing for security;
- To ensure cost-effectiveness of countermeasures through application of risk analysis methodologies to prioritise actions taken in design and operation of passenger stations and terminals;
- To deliver a Constructive Design Handbook addressing new build and retro-fit cases to serve as a powerful decision support tool for owners and operators to increase station security and safety from terrorist bomb blast, CBRN attacks involving particle dispersion, and fire events.
- To create harmonization and the standardization of risk assessment methodologies, technologies and design solutions thereby supporting wide application by the numerous EC public transport organisations and associated key stakeholders.

Therefore, the main focus of the SecureStation proposal will be to produce the necessary tools to build safer and more secure infrastructure whilst providing maximum operating resilience. The proposal covers the development of Risk Assessment Methodology (including simulation results), specifically focusing on passenger stations/ terminals (a scenario specific methodology) and the development of a Constructive Design Handbook. These two main outputs will be accompanied by dissemination activity at a transport security conference, and through an extensive End User group

RESTRAIL (FP 7) : ongoing project : research project on reduction of Suicides and Trespasses on RAILway property

The project, already described in safety roadmap, aims to reduce the occurrence of suicides and trespass on railway property and the service disruption and other consequences these

events cause by providing the rail industry with an analysis and identification of cost effective prevention and mitigation measures;

SECRET (FP 7) - SECurity of Railways against Electromagnetic aTtacks

SECRET is a research project selected by the European Commission as part of the 4th transport call for proposals under the 7th Framework Programme for Research and Development.
SECRET addresses the protection of railway infrastructure against Electromagnetic (EM) attacks. Railway infrastructure is an attractive target for EM attacks because of its familiarity and ease of access, with extended economic and security consequences. Today, the European rail network is evolving to harmonise the management system. This is reflected by new integrated technologies, adequate procedures and centralisation of command centres. The new technologies facilitate the implementation of a harmonised system and improve the network competitiveness.
However, they are also highly vulnerable to EM attacks. Railway actors fear this growing EM vulnerability and have no knowledge on the extent and severity of consequences. SECRET will develop innovative solutions to reinforce the infrastructure and to prevent the European railway from the EM vulnerability resulting from the harmonisation process. This requires development of technologies in compliance with ERTMS and production of technical recommendations improving the European standardisation and the railway infrastructure resiliency. The work plan of the project extends over 36 months and is structured in five work packages in charge of the technical work.
The main objectives are to:

- identify the vulnerability points at different levels (from the electronic to the systemic vision)
- identify EM attack scenarios and risk assessment (service degradation, potential accidents, economic impacts…)
- identify public equipment which can be used to generate EM attacks
- develop protection rules to strengthen the infrastructure (at electronic, architecture and systemic levels)
- develop EM attack detection devices and processes
- develop resilient architecture able to adequately react in case of EM attack detection
- extract recommendations to ensure resiliency and contribute to standards

CIPRNET (FP7 in negotiation) : critical infrastructures protection expert network;

CIPRNet links together a network of European expert centres on CIP R&D, geographically dispersed, into an integrated virtual community with the capability to support national, cross-border and regional crisis management in their preparation for and effective response to large national and cross-border disaster emergencies.
The capability of effectively responding to a large disaster regarding any critical infrastructure consists of two capabilities:

- The capability of the onsite disaster response managers and first responders to act prompt and in the appropriate way, and
- The capability of the expert support community to assess the interactions among multiple critical infrastructure systems (electricity, water supply, transportation, etc.) that support the preparation, response and recovery actions and the population in and around the disaster area.

3. VISION

A future sustainable mobility will be strongly conditioned by Security issues in Urban Collective Transport Services, Long Distance national and International Transport Systems, High Speed systems and high volume freight transportations.

The European Union policies should be more influenced by these Security issues and they could benefit from better coordinated actions between increasing number of stakeholders of Security.

However, regarding **Key asset** protection, it is the first and more complex economic issue because infrastructures (permanent way and civil works) lifecycle is usually over 100 years while stations ask for a continuing refurbishment in order to meet customer satisfaction.

Therefore, any evolution in terms of adding security systems must take into account this constraint and opportunity; designing key assets with the appropriate security requirements and avoiding to add the security constraints on an existing design.

Moreover some evolutions aiming at more security might as well be concerning new **procedures, regulations and standards** and processes, and not only **Technological equipment and systems**.

The second issue concerns **Human Factors** covering both staff recruitment and training on potential threats, and possibly the involvement of passengers in improving their own security.

Therefore, security policies have to address **Protection of Key Assets** by means three complementary sectors, on which future research needs to be based:

- **Human factors**, covering both staff recruitment and training, and possibly the involvement of passengers in their own security. Lasting value might be achieved with their involvement, whether concerning prevention, alarms, interventions, crisis management, tackling a disorder, crisis management and communication etc.;
- **Technologies,** their development must support staff efficiency; this could be new video-surveillance or image recognition technology, or automatic detection of abnormal situations and suspicious or dangerous objects (explosives or others), help for decision taking.
- **Procedures, Regulations, Recomandations and Standards** ensuring a coherent whole. Railway system need a clear definition of a standard approach in the development of a security protection system. Likewise Safety Integrity Level (SIL) a Security Resilience Level (SRL) should be a standard approach to define the technological countermeasures guaranteeing an adeguate protection.

As **key assets** we refer to**:** trains, production sites (as signalling posts, energy sub-stations and shunting yards) and Stations, with special care to Main and High Speed ones.

The protection should include: technical protection; organizational protection; design and equipment issues.

Some Issues should be taken into account as critical, they are:

- Rail Security is a **shared responsibility between authorities and railway operators and Infrastructure managers**: all stakeholders need to be involved: operators, security agencies, police, rescue and emergency services;
- Need to ensure a successful "**balance between security and personal freedom**"
- Need to involve efficiently more and more stakeholders due to the **opening of the European market** ;
- **Cost** of the security policies and conditions of competition within the rail sector and between the various transport modes
- Terrorist attacks are an issue, but **daily crimes** are the most important ones to cope with.
- **Threats Knowledge** for railways (not sorted in respect to their importance which can vary a great deal from a country to another:

o Metal theft	- Robbery
o Cybercrime	- CBRN/CBRNE
o Illegal access	- Unattended luggage
o Aggression to staff / to customer	- Suicide with bomb
o Vandalism	- Fire attack
o Obstacle on the tracks	- Stone throwing
o Sabotage	- Bomb
o Major malicious technical failure	-Blackmail of previous items

On the other hand the **Feeling of Security** of Railway systems is an area as important as the Objective Security level itself for the whole competitiveness of the Railway transportation system.
In a Security system, people is directly involved so we have to address both security level and feeling of security.
For example, the security measures in station shall be "convivial" while the protection of an electricity or nuclear electricity plant must be "aggressive".
For these reasons, all the already mentioned, relevant sectors for Security shall also be analysed in terms of feeling of security, felt by staff, passengers and other users.
This approach addresses a parallel roadmap for the feeling of security focusing the same sectors with the aim of looking for a balance between objective level of Security (in terms of volume of people, technological devices and organization) and its perception by users.

The gap between objective level of security and feeling of security could be reduced by the role and correct use of Media.
Media should inform people and users about investment and development made in the whole framework of security beyond the news arising from casual security accidents.

4. ROADMAP DEVELOPMENT

Area

The roadmap development foresees the clustering of Security topics formulated in two main areas:

- Security
- Feeling of security

Sectors

The roadmap development foresees the clustering of Security topics in the four main areas outlined in the Security Vision :

- Key assets protection
- Human factor
- Security Technology
- Security procedures, regulations, recommendation and Standards

Topics

Some priorities and implications were identified in the described projects together with security R&D needs expressed by EIM (the European Rail Infrastructure Managers association).

Production sites protection:- At this moment in time, EIM members see trains, production sites (as signalling posts and shunting yards) and stations as key assets. Are there more key assets to protect? The protection should include: technical protection; organizational protection; design and equipment issues.

End product: An overview of protection measures to protect key assets based on scenario's and cost-benefit analyses. Obtain specifications for shunting yards to fulfil the RID-S regulation regarding the protections of the goods.

Need to develop legal issues (for defining fines, prosecutions...) beyond technological answers

No-hindering sensors : Ideally the detection systems should detect explosives, radioactive substances, biological and toxic agents without hindering the operational processes.

End product: a detection system that does not hinder the operational processes, that is based on cost-benefit analyses, and that keeps into account the likelihood of terrorist methods.

The time factor, length or duration of control and detection is critically important.

CCTV - CCTV is now only used in a reactive manner. How can CCTV be used in a proactive manner? Where cameras should be placed? What type of cameras should be used? What are the criteria? How can the monitoring be managed in an economic and sensitive way? How the relations with the police have to be organized? Is it possible to have transponders on the carriers who send the surveillance cameras a signal when it arrives to a shunting yard? Carry information on the goods.

Need of developing new software answering the role assigned to CCTV systems

End product: Information and experiences using CCTV in a proactive manner on an economic and sensitive way.

Station Design Guide - The design of stations is a key factor toward a perspective of prevention and damage control. All the measures have to be based on business cases and there has to be a difference between existing stations and new stations.

End product: On business cases related basis for regulation for designing new stations.

Threats and Scenario's - A scenario describes a possible event in what, how and where it occurs. After making scenario's the likelihood and the consequences have to be examined. Based on this, you can take possible measures.

End product: an elaboration of scenario's included the likelihood and the consequences.

Threat levels - Can we harmonize the different systems of threat levels and relate it to measures? How to define the threat level for an international train running through various countries, whose intelligence services defined on a national basis various levels of threat ?

End product: A common view of all possible measures related to a further elaboration of threat levels.

End product: A menu of options.

PPP (Public Private Partnership) - Railway security is just a subsystem within national security and national railway security is only a subsystem within international railway security. What roles can be defined for governments, police forces, intelligence services, train operating companies, etcetera? What possibilities exist for international regulation of the responsibilities? What logical option for cooperation within the current responsibilities between stakeholders (incumbents and new comings, national and foreigners) and private suppliers is preferred?

End product:

Common understanding of responsibilities and workflow charts for PPP.

How to avoid distortions of competition within the rail sector and between the transport modes.

Security organization at international level - Given the large number of new entrants and the fragmentation of railway companies, the number of railway operators is growing fast. How to divide the burden of responsibility between states, railway companies (Incumbent/ new comings, foreign companies / international companies) and infrastructure managers? Should there be a move to create a 'security certificate' as a guarantee of a minimum level of security (in the same way as safety certificates)? Or invent a common charter on a voluntary basis ?

End product: Definition of the security organization needed for international traffic considering that, in this case, the efficiency of each country security measures depends upon its neighbours.

Assessment of rail security and cost Benefit analysis -

- From economic point of view
- From customer point of view (feeling of security)

End product: Methodology to evaluate the cost/benefits of rail security

High speed: risks and opportunities - The needs related to high speed systems are special in several ways (level of threat, customer expectations (time, cost...), competition with other modes of transport, some infrastructures require special protection (e.g. the Channel Tunnel) …). How to integrate security constraints in a system undergoing rapid development which allows forward planning?
End product: toolbox of best practices to integrate security in the high speed system during the design and development phases.

Call for tenders DG MOVE in progress: published on 18 June 2012, deadline for bids on 20 August 2012, opening of the tenders on 6 September 2012

Security of main stations The size of the flows, the number of users (travelers, shops consumers…), time of opening and rush hours, create specific security problems and improve terrorist threats by itself.

Improving security in existing stations or integrating security constraints in the conception of future stations are two different questions.

In addition, the question of intermodality (urban transport…) has to be addressed, and perhaps also the specific aspects of stations linked to airports or integrated in airports terminals *following priorities are the outcome of R&D needs of the EIM.*

Critical Requirements

They are the challenging requirements of the product or service selected.

Researches, standardizations and developments will focus on them

Technologies

They are the existing or developing technologies to be adopted or explored in the selected products or service.

Targets

Four horizons are foreseen, in order to focus research priorities:

- **Target 2015** : short term horizon
- **Target 2020** : short-medium term horizon
- **Target 2030** : medium-long term horizon
- **Target 2050** : long term horizon

For each Topic 6 typologies of milestones are expected in the related horizon:

- RESEARCH (**RES**) means that research and innovation are expected to be completed, within target data delivering new concepts, technologies, services;
- STANDARD (**STD**) means that a new concept, technology, or service is completely ruled and standardized within target data;
- DEVELOPMENT (**DEV**) means that a new concept, technology, or service is prototyped and tested on field;
- MARKET (**MKT**) means that the new concept, technology, or service is assessed or/and homologated and then available on market;
- OPERATION (**OPE**) means that the new concept, technology, or service is in operation (used and maintained) ;
- INTEGRATION (**INT**) means that the new concept, technology, or service is an integrated asset of Railway system, its Life Cycle cost is well known and it contributes to the competitiveness and interoperability of the whole system;

In the following paragraphs it is shown the roadmap for each sector with related topics. Some Sector and Topic Cells were selected to be part of the safety integrated roadmap.

5. Key Asset Protection Roadmap

Area	Sector	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Security	Key Assets protection	Production Sites	Cost	Video Infrared Laser Acoustic Sniffers Others	RES	MKT	MKT	MKT
		Main Stations Security	Balance between security and personal freedom		STD			
		High Speed	Threats Knowledge		DEV	OPE	INT	INT
		Station Design Guide	Cost	Design tool	RES	DEV	MKT	MKT
					STD	MKT	OPE	INT

6. Security Human Factor Roadmap

Area	Sector	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Security	Human factors	Asset vulnerability levels	Daily Crimes	Simulators E-training Tools Others	RES	DEV	DEV	DEV
					STD	MKT	MKT	MKT
					DEV	OPE	INT	INT
		Security accident Scenarios	Threats Knowledge and Management (under national intelligence services control)	Decision Support System Tool Others	RES	RES	RES	RES
					STD	DEV	DEV	DEV
					DEV	MKT	MKT	MKT
					MKT	OPE	INT	INT

7. Security Detection Systems Roadmap

Area	Sector	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Security	Detection Systems	No-hindering Sensors	Intrusion with operational activities Cost	Infrared Laser Acoustic Sniffers Others	RES	RES	RES	RES
					STD	STD	STD	STD
					DEV	DEV	DEV	DEV
					MKT	MKT	MKT	MKT
					OPE	OPE	INT	INT
		CCTV	Balance between security and personal freedom	Linear Camera Termo camera Video Comm. Laser Others	RES	RES	MKT	MKT
					STD	STD		
					DEV	DEV	INT	INT
					MKT	MKT		
					OPE	INT		

8. Security Procedures, Regulation and Standards Roadmap

Area	Sector	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Security	Procedures, Regulations, Recommendations and Standards	PPP	Shared responsibility between authorities and railway operators	Decision support system tools Others	STD	STD	STD	STD
		Security organization at international level			OPE	INT	INT	INT
		Assessment of rail security and cost Benefit analysis	Shared responsibility between authorities and railway operators	Requirements engineering tools	STD	STD	STD	STD
					OPE	INT	INT	INT

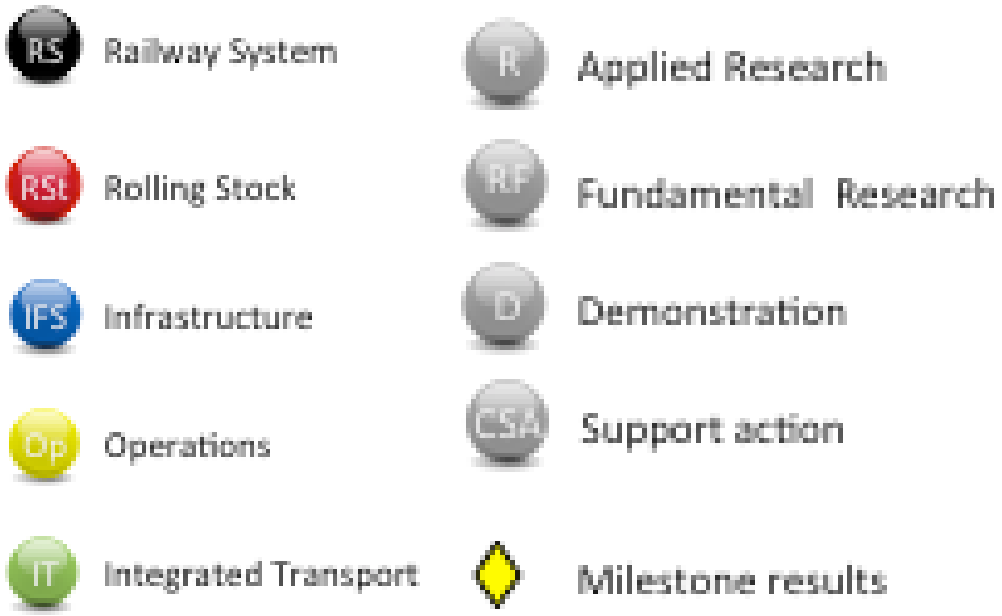
9. Feeling of Security Roadmap

Area	Sector	TOPICS	Critical Requirements	Technologies	2015	2020	2030	2050
Feeling of Security	Key asset protection	Trains security perception	Balance between human/technological survey	New technologies	RES	MKT	MKT	MKT
		Station Security Perception	Knowledge of perception of security at national level	E-training tools European survey on Security rights	STD			
	Human Factors	Passengers and users security perception			DEV	OPE	INT	INT
	Detection Systems	No-intrusive sensors	Soft Technology availability	Innovative soft-technologies	RES	MKT	MKT	MKT
		Time-spent in security check	Optimal use of journey time for security checks	Innovative technology Design station tools	STD			
					DEV	OPE	INT	INT
	Procedures, Regulations, Recomandations and standards	Privacy and personal freedom protection	Balance between National,Political and institutional framework and Railway system	Survey on privacy juridical framework vs. European harmonization	STD	OPE	INT	INT

10. SECURITY INTEGRATED ROADMAP PICTORIAL VIEW

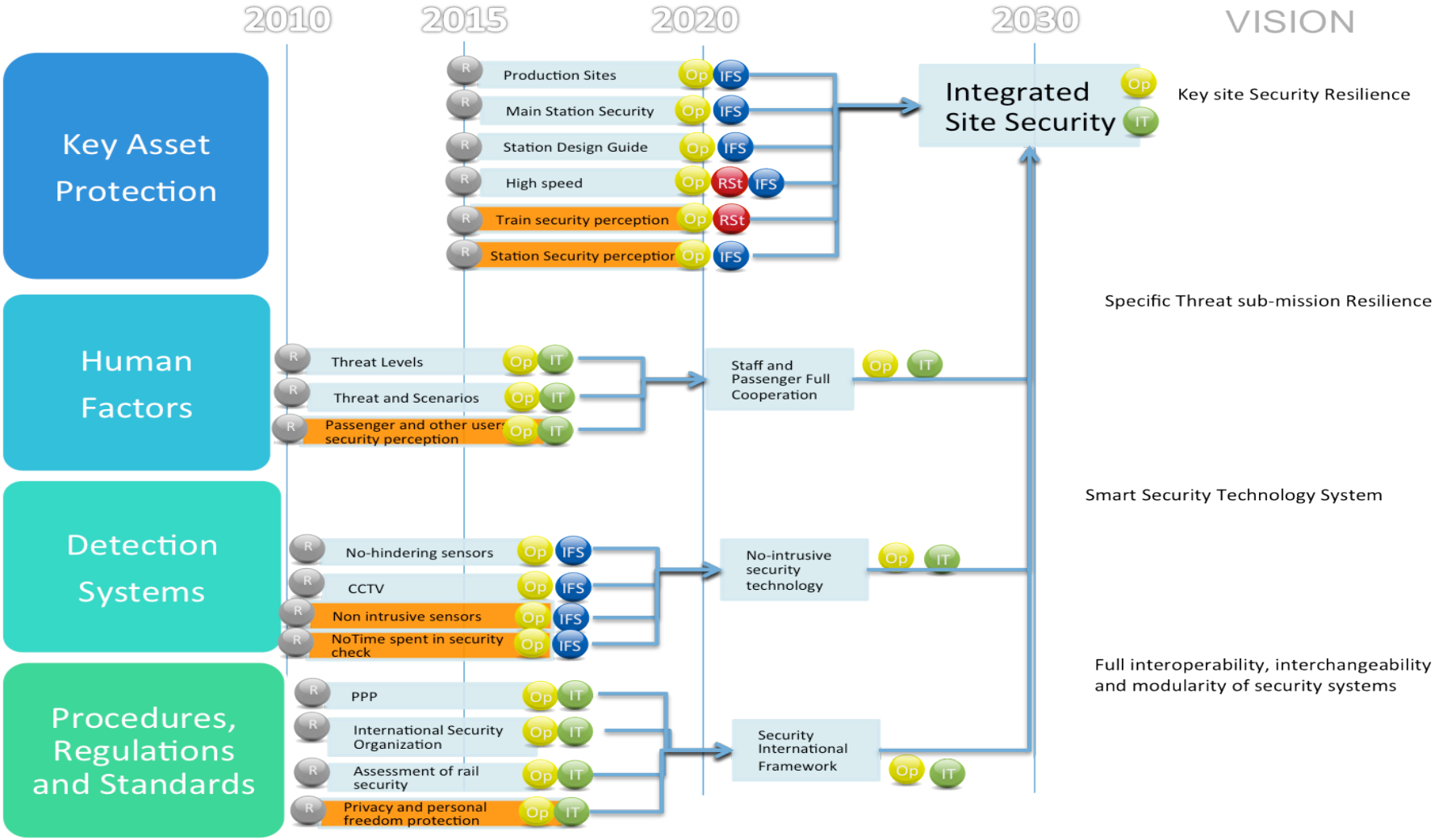
The selected sectors and topics are integrated in the following scheme that addresses 2030 target.

The symbol in the pictorial view are described:



ERRAC SECURITY ROADMAP

Feeling of Security



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