

Final Report for Publication

The "OPTIRAILS" Project
Contract N°: RA 98 RS 3015

Project
Coordinator: SYSTRA

Partners:

P02: AEATR
P03: ITALFERR
P04: TRADEMCO
P05: TIFSA
P06: HB
P07: SNCF
P08: FS
P09: RENFE
P10: EPFL
P11: CSEE TRANSPORT
P12: INRETS
P13: SOFREAVIA

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FINAL REPORT FOR PUBLICATION

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1. THE PARTNERSHIP

1.1 Consortium description

In OPTIRAILS consortium, several EU-countries are represented through consultants, research centres and railway companies.

Through the participation of the railway organizations from some countries, it has been possible to overview the status of traffic management systems under operation in Europe and to integrate the knowledge of operation in the drafting of Functional Requirement Specifications devoted to European railway corridors. The main partners led about one workpackage or important activity each one.

The remainder of the partners (other than rail organisations) has mainly contributed to the WP1 – analysis of existing situation in their country.

In the past, the main partners have successfully worked together in the past with success on similar subjects. They also have a working knowledge of the associated partner Railway organisations and of the other partners which are consultants.

Advantages of the partnership:

- Trans national cooperation
- Partners well known in the field with strong experience, reputable quality record, technically and financially credible
- Project Manager strongly experienced
- Railway organisations as partners
- Many EU member state are represented
- Efficient project management structure with main and associate partners
- Partners know each other and have successfully collaborated in the past on related projects
- Good integration of SMEs

Organisations Involved

Main partners

- P01 SYSTRA (Project Coordinator and Workpackage Coordinator)
- P02 AEATR (Workpackage Coordinator)
- P03 ITALFERR (Workpackage Coordinator)
- P04 TRADEMCO (Workpackage Coordinator)

Partners

- P05 TIFSA
- P06 HB
- P07 SNCF
- P08 FS
- P09 RENFE

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P10	EPFL
P11	CSEE Transport
P12	INRETS
P13	SOFREAVIA

1.2 Partners Profiles

Partner 01: SYSTRA, France

Company profile

SYSTRA is involved in intercity and freight railway transportation planning, in preliminary engineering and management studies and in environmental and economic impact assessments. SYSTRA participated in many R&D programs set up by E.E.C. and was in particular, project coordinator of the LIBERAIL project. As a subsidiary of the French National Railways, it has access to their know-how, their personnel and data on the topics of railway interoperability, railway management and planning as well as to the experience gathered in multimodal transportation modes.

SYSTRA is also involved in all engineering phases of projects including public urban, suburban and interurban transportation activities. Its long term involvement in this sole field has made it one of the most prominent world-wide leaders in the industry. As such it has particularly developed skills in coordinating large multipartner involvements in multinational jobs.

SYSTRA has a Quality Assurance System certified by the internationally accredited AFAQ (Agence Française pour l'Assurance Qualité) as meeting the requirements of ISO 9001 recommendations.

Partner 02: AEATR, United Kingdom

Company profile

AEA Technology plc is an organisation which is dedicated to solving the technological demands of railway companies in a confidential and cost-effective manner. Our approach to problem solving is both professional and pragmatic ; we are committed to providing expert, unbiased guidance to railway operators and industry.

We are acknowledged and respected as world leaders in many engineering and scientific disciplines which, together, form the core of railway technology. The major business of our organisation is consultancy, research, engineering development, testing and project management for railway authorities and suppliers across the globe. We have consequently worked for railway clients in 24 countries during the last five years. Our personnel have been engaged in

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projects ranging from routine scientific testing, short term problem definition and solution, to longer term strategic research. For example, we have carried out vehicle testing in Europe, provided engineering skills to Hong Kong and provided consultancy services for the specification of a new high speed railway in Taiwan.

We are firmly committed to serving the rail industry in its new form by continuing to give professional and independent advice based on our unparalleled experience and expertise. At our Derby HQ, our staff of over 250 engineers, scientists and support staff are unique in their knowledge, skills and expertise in relation to all aspects of a railway system: traction and rolling stock, track and signalling control and operational needs. We can assemble very quickly project teams which embody the appropriate engineering or scientific skills, knowledge and expertise.

Partner 03: ITALFERR, Italy

Company profile

ITALFERR S.p.A. is the consulting engineering subsidiary of the Italian State Railways (FS) founded in Rome in 1984. Shareholders are the Italian State Railways (93%), CREDIOP S.p.A. (5.5%) and Financiere Systra (1.5). Share capital is 14,186 million Italian lire (US\$ 8.87 million), fully paid up.

ITALFERR operates in the fields of high-speed and conventional railway systems, metros and in complementary sectors. ITALFERR services cover all aspects of a modern transport system and include: development plans, feasibility studies, conceptual design and system definition, studies of innovative systems and new technologies, preliminary and final designs, environmental impact appraisal, cost estimates, technical specifications, tender documents, supervision of works, testing, inspection, start-up assistance, project management, technical specifications, experimentation, testing and maintenance of technological systems and rolling stock, research and development aimed at transfer of technology, personnel training, organization and management studies, engineering software production, type-approval procedures, quality control.

ITALFERR has a Quality Management System certified by the internationally accredited SGS International Certification Services as meeting the requirements of ISO 9001/UNI EN ISO 9001 – Ed. 1994. The Quality System provides for Quality Assurance in design, development, production and, where relevant, installation and servicing.

ITALFERR staff includes railway engineers, economists, and technicians with many years of experience in positions of responsibility with the Italian State Railways. It also includes professionals experienced in the management of urban and regional transport authorities.

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Partner 04: TRADEMCO, Greece

Company profile

TRADEMCO was established in 1985 by V. Evmolpidis and G. Emmanoulopoulos who are also the managers of the company. The company provides consulting services to the public and the private sector and is active in research and development in the fields of transportation planning, regional development, physical design of transport infrastructure projects, feasibility studies and investment appraisal, environmental impact assessment, project management, application of new technologies to transportation, tourism, industry and trade, development of specialised software applications, personnel training in technical and organisational matters.

Since its establishment, TRADEMCO has performed many studies and applied research projects which are recognised for their comprehensiveness and quality. In many cases, TRADEMCO also conducts the administrative and technical management of the projects. The company employs specialized scientists with postgraduate degrees from Europe and USA. The overall personnel including administrative personnel is above 30. TRADEMCO is registered in EU records of Consultants for the following Directorates: DGIII, DGVII, DGVIII, DGXIII, DGXVI.

TRADEMCO actively participates in EEC R&D programs (ESPRIT, DRIVE, ENS, ORA, TELEMATIQUE, MIPPS, 4th Framework program for R&D) and has already developed innovative telematic applications which are now used in the market.

Partner 05: TIFSA, Spain

Company profile

TIFSA is a railway engineering and transport consulting company established by RENFE (Spanish National Railways Network Organisation) in 1983.

The share capital of TIFSA is distributed as follows:

- 51% RENFE (Spanish Railways)
- 24.5% SYSTRA (SNCF – French Railways – Consultancy and Engineering)
- 24.5% DE-CONSULT (DB – German Railways – Consultancy and Engineering)

TIFSA is registered to work with the highest qualifications for the Ministry of Public Works, Transport and Environment of Spain.

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For projects abroad, TIFSA is registered with:

- World Bank
- Inter American Development Bank
- Asian Development Bank
- Commission of European Communities (DGI, DGIII, DGVII and DGVIII)
- European Bank for Reconstruction and Development

Partner 06: HEUSCH BOESEFELDT (HB), Germany

Company profile

Foundation and continuous growth

Dr. Heinz Heusch and Jochen Boesefeldt started business in 1966 with urban and inter urban traffic planning. Still active as managing directors, they look after a company now with an emerged range of activities. Today's motto is to provide and secure a transport system which guarantees individual mobility, both for passengers and freight, keeping in mind a stronger need for environmental protection. Besides this variety of knowledge, it is both, continuity and experience which makes Heusch / Boesefeldt an important partner in many fields of transport.

Heusch / Boesefeldt GmbH by numbers

Since 1981, Heusch / Boesefeldt has the legal basis of a GmbH (limited liability company). In the head office in Aachen three divisions are located:

- Basic studies
- Transport and Environmental Planning
- Traffic Control Engineering

In addition to the head office, there are branch offices in Hamburg, Berlin and München.

More than 150 employees work in interdisciplinary teams. Most staff members represent academic disciplines with university or college administration degrees, whereas the supporting staff includes technicians and employees.

Heusch / Boesefeldt's common stock capital amounts to 2 million DM. In 1995, the company's turnover reached about 20 million DM.

Partner 07: SNCF, France

Company profile

SNCF (Société Nationale des Chemins de fer Français) has been a public industrial and commercial establishment (public agency with industrial and commercial activities) since its reform in 1983. It is a wholly state-owned

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company which is largely autonomous in its operations, relations with the government being set by four-year contracts.

SNCF is an integrated railway company acting both as a railway operator and an infrastructure manager as defined in directive 91/440/EEC. It has a large number of subsidiaries engaged in various activities (combined transport, road haulage, tour operating, hotels, etc.) related to transportation.

SNCF has a management system based on business sectors: Long distance Passenger services, Regional Services, Paris Region Commuter Services, Freight, Sernam (parcels), Infrastructure. Each sector is in charge of developing and implementing the corporate strategy, directing marketing and drawing up a customer oriented service-offer in order to match the needs of its specific market. Services are provided to the business sectors by the technical departments (traction power, rolling stock, track maintenance, etc.) and carried out by 23 "Regions" on a contractual basis.

SNCF operates 31,770 km of lines ¹, including over 1,281 km of high speed passenger lines.

It owns a fleet of 5,700 locomotives and other motor units (diesel rail cars, turbotrains, EMUs, and 348 TGV train sets), 15,500 passenger cars and 47,600 freight wagons.

It carries 55.5 billion passenger-kilometers per year on its main line routes and 9 billion passenger-kilometers on its Paris commuter network. Freight traffic is 135 million tons, 55 billion ton.kilometers per year.

Staff numbers 173,422 employees.

Annual operating revenue is in excess of 52 billion FRF (not including compensations for provision of public services and infrastructure charges, which amount to approximately 22 billion FRF).

Partner 08: FS, Italy

Company profile

Ferrovie dello Stato

Ferrovie dello Stato (FS) is the national rail transportation company of Italy. Operations reach a level of about 8000 trains per day and 350 million train-kilometers per year. It participates in this project proposal through its Infrastructure Business Unit ; the latter is currently involved in major

¹ All figures quoted are 1998 figures

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development projects at national and European level, especially in the areas of train communications, command and control systems. Test sites for ERTMS, the Company is also currently involved in several projects within the 4th European Union RDT Framework in Transport, Telematics and Information Technology (e.g. EUROPE, EUROPEAN RAILWAYS OPTIMISATION PLANNING ENVIRONMENT).

Partner 09: RENFE, Spain

Company profile

Renfe is a service company fighting on one of the most competitive markets – that of transport. Here, the train, the plane, the bus, the lorry and even the private vehicle compete to increase their market share. And yet, all these means of transport – which are very often apparently no more than competitors – are potential allies. What is necessary, then, is to facilitate travelling options in order to meet all the needs of the end customer, the traveller and the entrepreneur.

In this respect, the legal framework within which the company is managed is set out in three documents : European guidelines 91/440 ; Renfe's Statute ; and the Contract-Programme signed between the State and the company for the 1994-98 period.

European guidelines 91/440 clearly distinguish between infrastructure management (maintenance and traffic) and transport services. It points out the need to start up a process of autonomy in the management of European railway companies and urges the various Member States to undertake the financial reorganisation of these companies, as heavy indebtedness – mainly the result of the debts which these same States have incurred with the railway companies – is a characteristic of them all.

Renfe's Statute describes the company as a transport service company and elaborates on the need for specialization per business. It clearly distinguishes between the direct management of railway transport services and the maintenance, management and development of the system, which, when all is said and done, is a public system belonging to the State.

The Contract-Programme between Renfe and the State for the 1994-98 period sets forth and quantifies the relationship that exists between them, with the result that within the Contract-Programme both sides have signed five agreements. These specify the obligations of each partner regarding Commuter Trains, Regional Trains, Infrastructure Management, Clearing of the interest produced by the State's debt to Renfe, and finally, the Feasibility Plan for those business units which must reach the threshold of profitability.

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Partner 10: EPFL – Ecole Polytechnique Fédérale de Lausanne (Swiss Federal Institute of Technology – Lausanne) - **Switzerland**

ITEP – Institute of Transport and Planning
Transport Systems Planning and Operation.

Company profile

Mission

Ensure education in and basic research on public transport.

Aim at sustainable mobility through better efficient intermodality for passengers and freight.

Goals

Education: Undergraduate and postgraduate courses in transport ; acquire a basic multidisciplinary understanding of the approach to transport systems, transportation system planning and operation, cost analysis and the selection of alternatives.

Research: Oriented towards problem anticipation and solving in transportation engineering ; the on-going development of tools based on the most recent research, to improve the engineer's efficiency.

Consulting: Heavily related to research work.

Activities

More than 30 years of research in transportation planning, system and operation design, and the management of public transport systems.

Development of methodology for problem identification and analysis (audits) ; methodology for planning complex transport systems.

Creation of software tools to help engineers and planners to come up with better, faster design alternatives, and evaluate them in a multi-criteria, conflicting environment.

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Partner 11: CSEE Transport, France

Company profile

CSEE Transport, a specialist of railway signalling, is well-known throughout the world for its important experience in the area of traffic safety since its creation in 1902. Its international dimensions are demonstrated through many projects, each of which constitutes a reference in Europe, America, Asia-Pacific and so on.

CSEE Transport, a 100 % subsidiary of Ansaldo Signal N.V., since December 1996, collaborates closely with two other companies of the Group : Ansaldo Signalamento Ferroviario S.p.A. and Union Switch & Signal Inc.

From this day, Ansaldo Signal Group with its three companies and their respective subsidiaries, make up the second largest signalling company in the world in terms of turnover, and the first one in terms of product diversification, geographical presence and market penetration.

The Joint-venture in Beijing created by CSEE Transport with Beijing Railway Signalling Factory, a subsidiary of China Railway Signalling and Telecommunication Corporation, is due to permit a local production to bid for international tenders.

CSEE Transport is active in many areas of railway technology, ranging from standard railway and metro signalling systems to computer-based interlocking, automatic train protection and cab-signalling systems. CSEE Transport is also specialized in mass-transit CTC systems such as those in installation for the existing Hong Kong underground railway network and the new railway line for Lantau Airport.

CSEE Transport's ATC systems, TVM 300 and TVM 430, operated in France since 1981, were originally designed for high speed lines and have been adapted for large scale projects such as the Channel Tunnel railway for mixed traffic with 150 sec. headway and the Korea High speed line as a turn-key contract.

Within the scope of ERTMS project (European Railway Traffic Management System), the SNCF notified CSEE Transport, by the end of December 1997, a study and supply market of on-board prototypes. This order includes :

- EUROCAE equipments, with interoperability in all the future European lines,
- STM TVM equipments connected to EUROCAE equipments, which will enable the train circulation, on High Speed lines (T.G.V.) equipped with signalling system TVM 430 or TVM 300.

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- **Partner 12: INRETS, France**

Company profile

General description of the Institute

INRETS-DART (IND)_[number of employees : 415] [turnover : 36.5 million ECU]

The Department Analysis and Traffic Control (D.A.R.T) is a Research Center of INRETS specialized in analysis and traffic control. Its action covers main activities such as image processing, traffic control, simulation and prediction :

- Motorway access control : the aim is to develop regulation methods, making it possible to prevent in real time recurring or non-recurring congestion of motorways or urban expressways by access control and collective guidance of drivers, using variable message signs.
- Tools and interfaces to manage the stitched network in Ile-de-France: this project has been included in the framework of a progressive implementation of the SIRIUS system on the expressway network of the Ile-de-France region.
- Simulation: the objectives of this project are, first to define tools to help the Vessel Traffic Services (VTS) operators to evaluate traffic data on zones and, secondly to define new regulation actions which could be implemented.
- Traffic prediction: development of traffic simulation and prediction programs which sum up the know how in this domain (META, SIMAUT, DAVIS, PHEDRE, ATHENA, MITHRA, ...). These programs are the results of fundamental and experimental studies. The outputs are tools to design modern systems of route information, guidance and control.
- Traffic measurement using computer vision (image processing): this project is related to the study of supervision systems and traffic flow measurements. It was marked by real world experimentation. Development of the TRISTAR System which deals with automatic Incident Detection, flow and queue measurement on a toll motorway. Image processing has been used in urban junctions sending data to the "Intelligent junction system" which supervises and controls the urban junctions by means of artificial intelligence technologies. This project has also enabled the study of devices able to measure the number of pedestrians either using a guided transport system or walking on passages.

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Partner 13: SOFREAVIA, France

Company profile

SOFREAVIA and its subsidiary SOFREAVIA Service were respectively founded in 1969 and 1975 on the initiative of the French Government which is the major shareholder (40% of the capital). The SOFREAVIA Group, as a company, has established a well-known competence in the fields of Civil Aviation, Meteorology and more recently, environmental surveillance systems. The Group carries out its studies and services in Europe and world-wide.

The Group SOFREAVIA benefits from a privileged relationship with the French Directorate General of Civil Aviation (DGAC) and the National Meteorological Service. This leads to a collaboration between the Group and the Air Navigation Research Centre (CENA) and the Air Navigation Technical Service (STNA), enabling DGAC experts to be seconded to SOFREAVIA on specific projects. In consequence, highly skilled teams in a wide range of fields can be set up to carry out studies, projects or services as required.

In 1991, the Group widened its scope of activities with the creation of the Air Traffic Management Division, to support Air Traffic Management developments world-wide. This division is dedicated to support Civil Aviation Authorities and organisations for the improvement of existing systems and the development of new ones, based on the latest international concepts and standards in air navigation as defined by ICAO. It is involved in major European Research and Development programmes and studies for the CEC and EUROCONTROL. It is recognised as a leading member of several consortia in Europe.

The main fields of expertise of the Group are the following :

- Economic and organisational studies
- Air Navigation and Air Traffic Control (ATC)
- Air Traffic Management (ATM) :
 - Air Space Management (ASM),
 - Air Traffic Flow Management (AFTM) and ATC
- Infrastructure and Advanced Systems of Communication, Navigation and Surveillance
- Airport equipment
- Meteorology and environment
- Training and assistance
- Airport management

The Group and more specifically the ATM division has been involved in several programmes, projects, and studies.

2. EXECUTIVE SUMMARY

2.1 Background

2.2 Objectives

2.3 Technical description

2.4 Results and conclusion

2. EXECUTIVE SUMMARY

2.1 Background

The existing ERTMS project is mainly safety and technology-oriented. A «traffic management» layer is presently missing for making the ERTMS/ETML project a complete European rail traffic management system. Within this perspective, the main objective of task 11.4 is to identify functional and technical facilities for the pan-European rail traffic management within the ERTMS framework.

The OPTIRAILS Consortium's main objective is to specify a rail traffic management system architecture (ERTMS/ETML) within the ERTMS framework and applicable to the international railway corridors. The purpose of this rail traffic management system will mainly consist in improving :

- real-time train dispatching and route planning,
- rail nodes fluidity,
- customer and operating staff information.

To achieve this objective, it was planned to first elaborate a requirement definition through:

- ◇ Analysis of the existing status of ERTMS (on-board architecture, ground mounted architecture already designed by some railways, available train management technologies),
- ◇ Functional and technical analysis of the traffic management area, and identification of the traffic management subsystems to be optimised,
- ◇ Analysis of potential implementation cases of the studied traffic management system,

With a comparative multi-criteria analysis of existing/research tools and technologies convenient for requirement definition, the most promising combination of tools and techniques has been identified for the new traffic management system. This analysis will bear on :

- ◇ Existing tools and techniques used for traffic management,
- ◇ Research studies/experiments in train dispatching, route planning and rail nodes fluidity.
- ◇ Intelligent techniques which seem appropriate to traffic management, such as autonomous entities, expert systems, resource allocation algorithms, heuristics...
- ◇ Air traffic regulation systems and road regulation systems.

2. EXECUTIVE SUMMARY

The Functional Requirement Specifications (FRS) related to the ERTMS traffic management layer (ETML) for international corridors, have been worked out. FRS' drafts have been reviewed and approved by the Reviewing Board of UIC where several European railways were represented.

A preliminary cost/benefit analysis of the traffic management system has been performed (on application field) through a quantitative evaluation/costing and an assessment of impacts.

This OPTIRAILS (OPTImisation of traffic through the European RAIL traffic management Systems) research project aims at providing the EU documentation and recommendations that will help go further towards a project implementation within the framework of 5th RTD Programme and TEN feasibility project.

Four reports has been elaborated in this perspective:

1. A review of the existing status of ERTMS, ETCS, GSM-R projects in Europe mainly as regards the particular experience already gained in France, Germany, Italy, Spain and on some other countries. Data and projects carried out by UIC have been reported. The potential impact of the New Directive on path allocation has also been taken into consideration.
2. An in-depth analysis of methods and tools available in the field of the rail traffic dispatching and also a survey of potential implementation cases in Europe. Functional requirements of traffic management have been assessed and the prefeasibility study of the project has been carried out.
3. An in-depth project design of traffic management related to system, interfaces and tools leading to their Functional Requirement Specifications (FRS) accompanied by a preliminary cost-benefit analysis of the project.
4. A dissemination of the previous issues, recommendations through circulation of documents and organisation of seminars.

This project has particularly focused on the definition of traffic management tools based on the existing and foreseeable ERTMS design. Co-operation with other European projects sponsored by UE such as LIBERAIL, EUFRANET, MORANE, EUROPE-TRIS, EUROPE-TRIP has been undertaken in order to establish a collaborative European framework. Co-operation with projects sponsored by UIC such as the EIRENE project has also been provided.

2. EXECUTIVE SUMMARY

2.2 Objectives of the project

The main objective of the project is to extend the current activity of ERTMS to the rail traffic management of the main European corridors with a view to:

1. Considering ERTMS as a rational market able to increase the quality of services and their flexibility for the benefit of passengers and freight customers, to improve travelling times and to reduce costs.
2. Developing a collaborative framework facilitating the technical harmonisation of traffic management systems, mainly those devoted to the Trans-European Network (TEN).
3. Promoting the potentialities of new technologies able to bring relevant solutions in the traffic management field such as radio system and GSM.

In order to achieve this goal, the project team has:

- Analysed the existing status of the ERTMS/ETCS project by investigation of data, description and results gained from the different test bases in France, Germany, Italy, Spain but also coming from data base and studies developed by UIC in the ETCS/ETML considerations.
- Assessed methods and tools available in the field of train dispatching, route planning and free flow traffic.
- Prepared functional requirements of the traffic management project.
- Worked out the basic design of methods and tools suggested with system scenarios, system requirements and action plan.
- Carried out a preliminary cost-benefit analysis of the project supposed implemented on the main European railway corridors.
- Disseminated the relevant information related to results and issues of the project.

2. EXECUTIVE SUMMARY

2.3 Technical description

2.3.1 Analysis of the existing status

The objective of this workpackage has been to perform an accurate analysis of the existing status of ERTMS implementation in Europe, with the objective of:

- analysing the state of the art of ERTMS system architecture and its future development, with the rail traffic management in view ;
- collecting existing data related to different ERTMS designs already studied in Italy, Germany and France ;
- analysing the existing train management technologies.

The outputs of the workpackage are basically :

- a description of the state of the art of train management technologies,
- a description of the state of the art of the experimental ERTMS systems on the existing trial site,
- an assessment on the main European projects related to the OPTIRAILS objectives ;
- an analysis of functionality already existing / foreseen in the ERTMS projects and foreseen in the European projects, with the aim of identifying the functionalities which have to be integrated in the future layer ;
- the foreseeable development and/or evolution of the ERTMS system architecture ;

From the analysis of existing train regulation systems in Europe, some common needs arise :

- Need of an integrated informative system as a national centre where decisions about resolution of delays and other problems out of normal schedules are taken.
- Reduction in the number of Traffic Control and regulation Centres distributed on the network increasing the jurisdiction of a few centres thanks to the adoption of technologies for automated data transmission and problems solution.
- A management more oriented to the line instead of a regional one, that is more interesting at least for the main lines.
- Division between Regulation managers and Movements Inspectors.
- Definition of a real time centralized database.

2. EXECUTIVE SUMMARY

- Need of real time communication link between distributed regulation centres and national centres.
- Need of integration new functionality in the centralization of information and controls.

About the ERTMS / ETCS implementation status, it was observed that :

- The availability of Euroradio functions of level 2 and 3 of ERTMS / ETCS will not be foreseen so that ERTMS / ETML will start without such real time possibilities.
- On the other hand, the main need for an European traffic will be satisfied thanks to the use of the STM (Standardized Traffic Management). In fact, without the STMs, only special trains with all the complete on-board existing ATC devices will be used for international journeys while the use of cheaper STMs will enable a larger set of trains to be used for international tracks.
- A wider use of STM, will make it possible to extend the today's idea of corridor from the main line to all the secondary lines that can be run thanks to the right STM.

About the impact of European research on ETML development, it was noted that many European projects have produced or are producing interesting works about the traffic management :

- Interoperability will be reached in short times thanks to the adoption of the STMs.
- Many studies on economical problems will provide solutions to the impact that the railway world will undergo with the liberalisation.
- Many projects are working already on traffic management, but with objectives relevant to subsystems : the results of those projects are mainly technologies dedicated to the solution or the simplification of one or more technical problem involved in railway management, while a global vision of the management at an European level was never approached.

As far as the main ETML functions required by European railways are concerned, these can be summarized as follows :

- need for an Optirails dialogue extension (by MMI)
- use of an Optirails Public or Elect Reachable Announcement (by EIRENE)
- Optirails Smoothing Instructions Route Indication System
- Automatic Route setting using ERTMS data.
- Conflict detection

2. EXECUTIVE SUMMARY

- Conflict solving
- Connection problems (co-operation with Infrastructure Managers and Train Operating Companies)
- Path re-allocation

2.3.2 Assessment of methods and tools

2.3.2.1 General

The second step devoted to this workpackage was to ensure the continuation of the progress made by the former workpackage « analysis of the existing status », by focusing on the methods and tools used to satisfy the following needs :

- analyse the requirements of existing business models in the railway field.
- analyse the theoretical approach to real-time management methods and tools, that are already in use or being investigated in research projects, in railway and other transport modes.
- analyse the applied systems for optimising traffic flow, in rail, road and air real-time management.
- analyse the real-time needs of transport users and transport producers.
- collect data about potential implementation cases concerning the European corridors.
- compile the collected data and conduct a pre-feasibility study.

Outputs of this workpackage shall be used to define the foundations of the next Workpackage : « Project Design and Feasibility Assessment », which represents the third scientific step of the project. At this point, the preliminary functional requirement specifications and cost benefit analysis of the OPTIRAILS project have been presented.

2.3.2.2 Presentation of workpackage 2 (WP2) « Assessment of methods and tools »

The real-time traffic management methods and tools, examined as part of WP2 for certain European countries, present three main characteristics :

- 1) They are aimed at controlling train product delivery despite the (actual or potential) occurrence of many events, only of which can be controlled.
- 2) They are used to solve complex operating problems, which depends on associating the Infrastructure Manager and the Train Operating Companies,

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- 3) They are close to the train command/control systems, for safety reasons and also because of technology, the use of which is gathered among multilateral partners for economical purposes.

WP2 stressed that in all transport modes, there are several operating levels that work together to allow best use of capacities and damage reduction. Task-sharing is based on the legal territory where each Infrastructure Manager is responsible for public safety.

Traffic management must deal with the legal constraints integrated in the transport conditions, bearing on travel time and pricing, in so far as operators are informed about existing conditions. This is similarly done for road use by public transport companies (i.e. speed limitations and fees to be paid), and for air or rail capacity negotiation. But if all elements can be discussed and included in path allocation (in timetable negotiating), a real-time decision-making cannot use the same procedures.

WP2 concludes that not all conflicts can be solved by automated machines in the near future, even if some devices can help to detect them on lines equipped with a train describer. Most conflicts are to be controlled at a regional or national level, with a so-called Local Area Device (LAD), that provides operating staff with information on the traffic and so can be seen as a management tool. These devices are going to be co-ordinated by national centres in most of Europe, so that ETML would work with few partners at the European level – regional centres will be reduced to a limited number like 3 to 8, depending on the country.

The WP2 assessment of methods and tools contains also proposals for developing actions in the area of service quality control. The main ideas correspond to long-range paths, where joining paths could be replaced by assembling paths, thanks to an overview of origin/destination and tools similar to the TRIS/ TRIO tools used in the EUROPE project. Other concepts are involved as well:

A Delay Evolving to End Dossier (DEED) is a kind of product not yet existing for international trains, because each Infrastructure Manager rates its territorial performance and there is no overall accountability except to the end users. Such analysis is assumed to highlight problems at the European level and to provide arguments in favour of capital expenditure policies.

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An Arranged Immediate Deal (AID) is a formal way of recording what was agreed at the moment of making a real-time decision, an asset in terms of transport activity records.

WP2 also contains, for instance, a description of a corridor through France, intended to help identify the problems involved in this specific case. It appears that a 1200 km-long corridor features about 5 or 6 « problem nodes » and that interoperability is due to reduce them, probably substantially thanks to the cancellation of locomotive exchanges. This exercise also demonstrates a concept of corridor description that could inspire delay cause analysis with a view to future actions.

2.3.3 Project design and feasibility assessment (WP3)

In order to achieve a high quality service, high levels of reliability are needed. Reliability includes punctuality, correct and timely information, low levels of equipment failure, all elements working together. Unreliability can be assessed in two ways, in the form of equipment failures and in terms of service downgrading when things go wrong. Engineering developments will contribute to more reliable equipment, but traffic management systems are needed to manage the effects of disruption from the many external events that can affect railway operations.

Never has it been more important to effectively manage rail operations than in today's customer-focussed and highly competitive transportation environment. The product needs to become more attractive to potential customers and when this is achieved, new capacity will be required to enable rail to recapture its market share.

Several member states have begun to invest in the style of Traffic Management Systems capable of predicting potential conflicts and, in some cases calculating solutions. Examples are the SURF system in Switzerland and the Control Centre of the Future installed in the UK.

These will deliver better service delivery within each country, but the European dimension for trans-European transportation will remain. As in the airline industry with EUROCONTROL, the issue of effective rail flows across Europe is an important one. A champion of international trains is required to provide the commitment necessary to achieve service quality.

The EU is committed to sustaining the effectiveness of Rail to passengers and shippers of goods, in order that it can become an attractive option in

2. EXECUTIVE SUMMARY

the transportation sector. Being successful will help mitigate some of the negative aspects of alternative transport modes and will contribute to the access needed for many areas of Europe to grow and develop.

Passenger traffic is increasing successfully. However, growing railways are beginning to suffer problems of congestion. Congested national railways will not be friendly to international trains. Much remains to be done for freight. Rail needs to do more to boost freight. It is not acceptable for regional and intercity trains to be scheduled first and for freight to have what is left over. This is beginning to change with a greater defence of freight paths emerging.

The existing European Rail Traffic Management System (ERTMS) developed so far in Europe is mainly safety, train control and communications but, as already seen, a layer to manage train operations (ETML) is missing.

The overall aim of ERTMS/ ETML is the harmonisation between national systems to the overall benefit of trans-European corridors. The European layer may well consider the national systems as « black boxes » dealing with the problems of their own rail networks, but the European layer must steer the local choices where appropriate to ensure the overall common good for the corridor.

The main objectives of the envisaged system are :

- ? to deliver the contracted plan
- ? to promote interoperability (in operations term)
- ? to establish efficient and cost-effective rail traffic corridors
- ? to provide an uniform access to the rail market

The general requirements of a system to achieve these objectives are as follows :

- ? The collection and maintenance of data to produce a real time model of current operations.
- ? The means of making the information in the model available to the players involved either dynamically or by request
- ? Methods of analysis of the current conditions to identify potential conflicts requiring action.
- ? Decision support tools able to generate solutions or to assist players in formulating solutions.

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The success of the daily plan is a matter of properly managing all the resources to ensure that they are in the right place at the right time. The key to this is information management and the communications infrastructure. Systems that meet the general requirements given above are the foundation on which to build.

The work of the EU and UIC is vested in a project called OPTIRAILS. The current work is concerned with specifying the functional requirements of a Pan-European Traffic Management System. A further project, OPTIRAILS II has been commissioned to produce a Systems Requirement Specification. This project was due to start in May 2000.

The underlying principles guiding much of the work on OPTIRAILS include :

- ? The system proposed must provide added-value at the European level
- ? It must be acceptable to the member states operational organisations
- ? It must be capable of evolving along with the development programmes of the member states.
- ? It must be affordable.
- ? It must be capable of an implementation within 5 years.
- ? It should concentrate on real time control (not planning)

OPTIRAILS has completed a survey of the current and planned supporting systems and infrastructure in several member states. It has also identified possible methods and tools needed to meet the general requirements.

Currently, work is in progress to identify the functional requirements.

The project team, in connection with defining the functional requirements, is addressing a number of issues. These include, user requirements, the relationship with the national operations centres and the scope in functionality and approach of potential systems.

The others include, the implementation of systems on the basis of specific corridors, the degree to which a common infrastructure exists across Europe to support the system being developed the activity restriction (at least in the early stages) to Infrastructure Manager activities alone, the involvement of others players (cf TOCs, end Users, FOCs, Maintenance, Planners), what particular type of problems should be tackled, and the likely success in forecasting in order to provide a proactive approach to problems and some optimisation in decisions.

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OPTIRAILS is seeking after bringing to Europe-wide operations what ETCS has brought to Europe-wide signalling and to play its part in the delivery of a quality rail service.

2.4 Results and conclusion

2.4.1 Strategic Goals

The strategic goals of the proposed system are:

- The fulfilment of the interoperability requirements for the Transport European Network,
- The creation of a single market for procurement,
- The optimisation of European rail operations at a European-wide level, and in particular, focusing on the freeway corridors.

Interoperability, in a traffic management context, is defined in terms of considering as a whole the journey of an international train from origin to destination, consistent service delivery along the international route, corridor-wide solutions to problems and no discontinuities in interchange processes due to a border. This means that when a change is required, for example, of route or locomotives, the efficiency of the process when it occurs at the border is no different from when it happens within a single country.

The European layer is expected to steer local choices in order to optimize traffic from an international point of view and manage the spread of information on a scale which promotes the common good for the corridor.

The proposed system addresses the real-time control of operations and seeks to harmonise the equivalent activities of the national railways systems across Europe. It will facilitate the national systems working together for the good of the international corridor, to avoid local interests conflicting with more global ones. Similar to the way organisations within one country work together without necessarily one of them being the leader.

Although each organisation has its own business objectives and priorities, their relationships must be based on openness, fairness, sharing the damage to service delivery etc. We believe that this should be achievable provided that the rail industry takes some view at least of its competitors being road and air transport rather than other railway operators.

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2.4.2 Operations Management Philosophy

In railway operations management no single person or function is responsible for the success or failure of the objectives. Many functions play equally important roles in the operation. The success of the daily plan is a matter of properly managing all the resources involved to ensure that they are in the right place at the right time.

The key to managing this complexity lies with establishing an approach offering the right level of information management, collaboration and co-operation and the communications infrastructure. Further developments can then take a system towards the prediction of potential problems and identifying the most appropriate action needed to either avoid or to manage them.

This philosophy is reflected in six technical options being considered for OPTIRAILS project design, which are :

- ? Option I for collecting data and performance monitoring
- ? Option II for centralizing the information on a corridor
- ? Option III where path assembling without scientific optimisation for the corridor as a whole is made
- ? Option IV for negotiated solutions with involved actors
- ? Option V for a start to corridor-wide problem solving
- ? Option VI for comprehensive detection and resolution of traffic management problems.

The short term options favour information management and co-operative processing. Only in the longer term, does Optirails attempt to meet the considerable challenge of providing a fully comprehensive managerial system in its own right. The approach taken is correct to meet the short-term objectives of keeping the system simple and of achieving an implementation within 5 years.

2.4.3 European added-value

European added value opportunities are identified.

Individual layers of the national traffic management organisations each add some value to the management of railway operations, either working independently or in conjunction with other activities. In broader terms, on

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a European level, then similar scope for additional value is possible from individual national regional centres linking with their counterparts in other countries.

However, genuine benefits from Optirails beyond what are achievable from national centres working collaboratively, have been identified. Most notable are the concepts for a “champion” of international trains, facilitating co-operation and collaboration, acting as a central source of information reducing communications cost between centres. Additional savings in delay are identified too from taking a wider view of problem solving. The concept system introduces further scope for benefits from widening the scope of the traffic management activity to intermodal and combine traffic, and from being involved in the logistics of goods transportation.

2.4.4 Concept system

The definition of a concept system for traffic management has been used to keep a focus on what might be ultimately desired in order to drive forwards the ambitions of the earlier systems and to set a high level of ambition for a system in the longer term.

2.4.5 Key elements

The basic elements of the traffic management system have been identified as :

- The collection and maintenance of data to produce a real-time computer model of the current operations on the corridor.
- Processing the data of the model and disseminating the information either dynamically or on request, in the most appropriate form and level of detail depending on the user task being dealt with
- An analysis of the current conditions to identify potential operations problems requiring action and bringing the users attention to them together with the relevant information
- Tools to either generate solutions or to assist the user in formulating solutions
- Maintaining the external links required to achieve intermodality
- Customer oriented in serving a wider transport market

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A feasible set of functions is defined in the workpackage, working within a pragmatic scope, that takes into account the existing and planned national infrastructures, acceptable relationships with involved organisations, technology, and cost.

2.4.6 Business Models

Business models are identified that recognize that a business activity contains a number of various technical elements and relationships working together. Each combination of elements and relationships represents a different business model. The six technical options proposed for Optirails have been studied and their relationships with National systems considered. Together these offer an evolutionary path to a comprehensive traffic management system, where each later system in the development path is designed to contain the functions of the earlier systems, and the relationships have opportunities to mature with mutual confidence in the implemented systems.

There is a clear distinction made between an Optirails system acting to facilitate collaboration and information sharing between the parties involved in the traffic management on a specific corridor, and Optirails taking an active role in producing solutions to the problems encountered. This separation occurs in moving from Option IV to Option V where Optirails becomes a participating player in the activities of managing the traffic.

The concept of the higher level « Strategic Control function » is introduced with the purpose of linking together many regional path segments into one or more European paths and to recommend which one to follow. The steps required in this process are defined.

2.4.7 Links to ERTMS

Few direct relationships between ERTMS/ ETCS and GSM-R have been identified. The functional gap between the high level traffic management system and the low level signalling and control system in most cases is too wide for there to be an « organisational » direct link. In most cases the type of signalling system installed is transparent to the high-level traffic management system. In areas where there is no ERTMS/ ETCS then this is an advantage since Optirails can offer equivalent facilities. The direct links to the train available under ERTMS/ ETCS and GSM-R could be used for speed advice and passenger information on board the train.

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However, these links are likely to be established between national centres and the trains. Further links from a pan-European system would result in unnecessary complication. Links of the nature should be consolidated either through the national systems or through the pan-European system but not both.

2.4.8 Technical feasibility

The potential technical feasibility for a pan-European Traffic Management system is considered by the team as high with much of the technology required being common place.

Two specific areas that present unknown challenges to the feasibility of a pan-European system are identified. The degree to which knowledge of local conditions (lying outside the scope of the European model of operations) has to be used to generate viable corridor-wide solutions to traffic problems. The accuracy to which forecasts can be made on future events (e.g. estimated arrival times) for use in reliably predicting potential conflicts for which advanced corrective actions need to be identified.

Using the tools within the national centres as agents to problem solving at the corridor level seems more effective, at least in the shorter term. Problem solving on the railways is different from the challenges facing air traffic thanks to Eurocontrol for example. Many of the problems have significant local elements that must be taken into account. Using local data and local tools appears to be a more feasible approach in our view and is considered likely to aid the acceptance of Optirails by National organisations.

2.4.9 Tools criteria

A high-level process model of the railway has been produced as part of the tools criteria definition. Train Operator, Path Management and Track management are described. The user needs are identified in a number of scenarios that show how the need is expressed and is met. The process of Short Notice Path Management is considered in more detail. This task is concerned with making adjustments to the scheduled plan to include market requests and to deal with real-time events and contingency disruptions.

The requirements for tools needed by the six technical options considered are identified.

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2.4.10 Flexible pathing

The requirements for tools needed by the six technical options considered are identified.

There is much discussion of flexibility in railway operations. In the context of Optirails it is defined as the ability to make a new plan where one part comes from the longer-term plan, and the other part every time it is necessary. To achieve flexibility, then the processes involved must be flexible too, including those of the Train Operating Companies.

It is seen as the most important means that railways must follow to cope with the new market context. Railways must show their “readiness to do business” and be able to change quickly to fit with customer needs. Particularly in freight, long term planning is no longer the right way to offer access to the infrastructure.

In order to improve the understanding of train paths some fundamental properties and “states” that the train path can take are described.

2.4.11 Optimisation of what ?

There are several bases for optimisation possible on the railway, for example, minimise delay, maximise capacity, maximise revenue from performance regimes. Optimisation should be targeted at maximising service effectiveness, thereby increasing the attractiveness and development of international rail transport.

2.4.12 Functional requirements

Functional requirements and tools requirements have been identified and specified for each of the six technical options covered by the report.

2.4.13 Interfaces

Interface requirements between Optirails and National / Regional systems have been identified. They have been considered also in terms of the type of systems that Optirails requires to connect with. The interface definition is at a high level and seeks to identify the National systems involved, what they do and what developments might be needed to support Optirails better.

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It is not appropriate to define specific messages and message formats at this stage of the functional specification work. The work done by UIC contained in document “*Specification for standard data exchange*” is recognised but is considered to be more relevant to the System Requirements Specification in Optirails II.

2.4.14 Cost / Benefit

A preliminary Cost/benefit analysis is included, based on a fairly general view of potential benefits from the system. Improved service delivery of international traffic is forecast to halt the decline in this market sector offering both commercial and socio-economic benefit. Set against the cost estimates the rates of return have been calculated as follows,

for FIRR a value of 10% with NPV = 774 000 euros
for EIRR a value of 15 % with NPV = 3 572 000 euros
(the baseline for profitability in Europe is set at 8 %)

These results, which are to be considered as orders of magnitude, nevertheless, show a potential profitability for such a project. They will be consolidated during the coming Optirails II project.

3. OBJECTIVES OF THE PROJECT

3.1 *The objectives of OPTIRAILS*

The aim of the task is to provide the administrative and technical support to regular Assessment and Review of RTD projects in the Transport Programme. The assessments and reviews themselves have integrated the main issues of the OPTIRAILS project.

Task 11.4 of the Rail Transport Research Programme is mainly to identify functional and technical facilities for the pan-European rail traffic management within the ERTMS framework.

Consequently, the OPTIRAILS Consortium main objective for Task 11.4 is to specify a prospective rail traffic management system within the ERTMS framework, whose purpose is mainly to improve:

- real-time train dispatching and route planning,
- rail nodes fluidity,
- customer and operating staff information.

3.2 *Supplementary objectives*

In task 12.9 “Study of the impact of the Transport RTD Programme including the development of a methodology to analyse the impacts and results”.

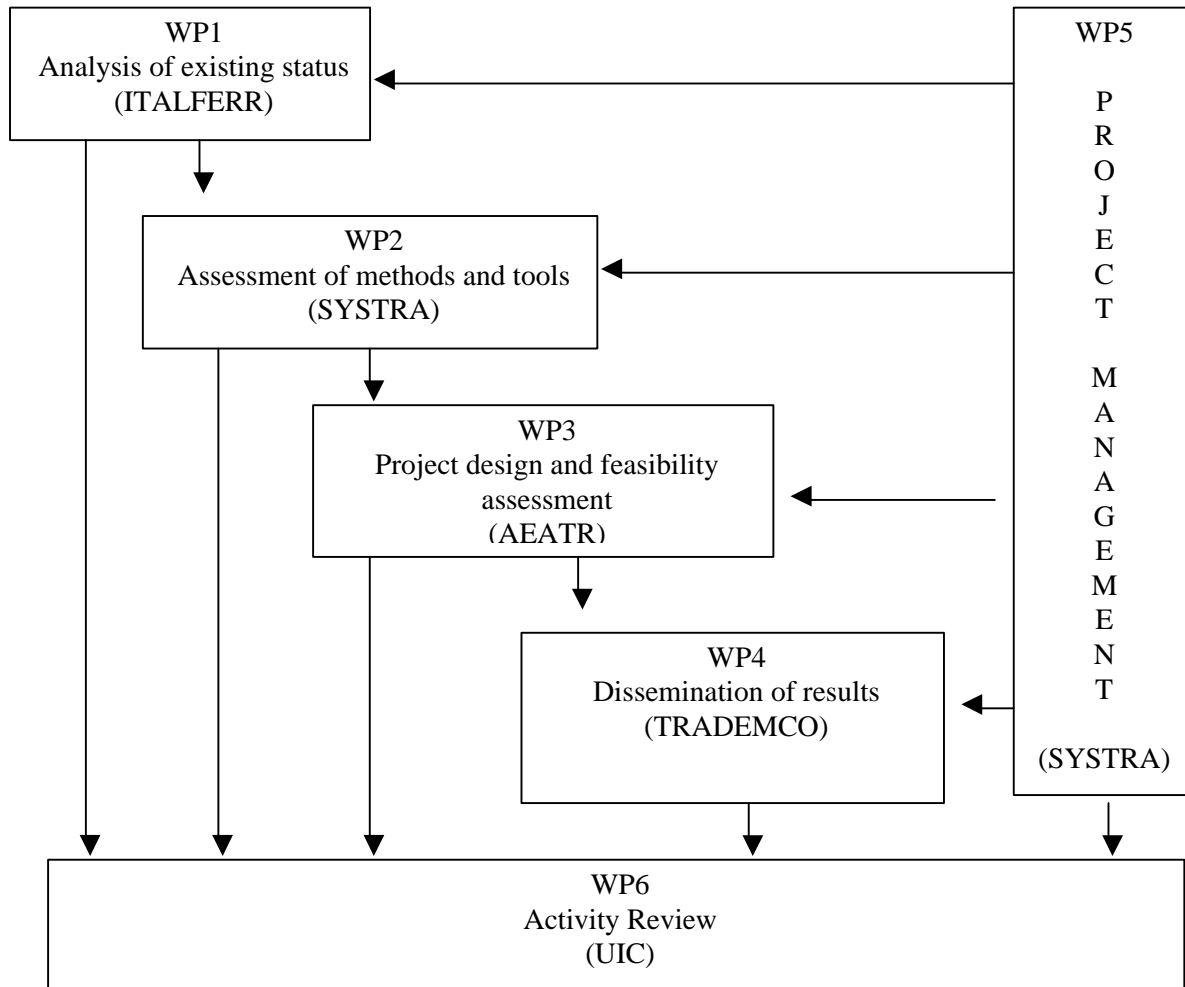
The objective of the task is to analyse the impact of the Transport RTD Programme on the transport sector and at a more general socio-economic level. The collected information will be used to assess the costs and benefits of the Transport RTD Programme, to prioritise future efforts in transport RTD and to disseminate the results of the Transport RTD Programme. The OPTIRAILS issues have also to be integrated in this project.

In addition to the above tasks to which it contributes, OPTIRAILS is interested in and has received input or exchange findings and results from the following projects sponsored by DGIII (D4) – DGVII (A, B, E Projects EUFRANET, LIBERAIL, ERTMS) and DGXIII (EURO-TRIP, EURO-TRIS, MARCO).

4. MEANS USED TO ACHIEVE THE OBJECTIVES

4.1 General

In order to achieve the objectives, OPTIRAILS encompassed 6 workpackages which were interrelated as shown in the following diagram.



In this organisation, several EU countries were represented through consultants, research centres and railway organisations. Through the participation of railway organisations from some countries, ERTMS information and traffic management methods presently in use were taken into account. The other partners have mainly contributed to data collection, assessment of methods and tools and to the working out of Functional Requirement Specifications.

4. MEANS USED TO ACHIEVE THE OBJECTIVES

In the past, the main partners have successfully worked on similar subjects. They also have a working knowledge of partner Railway organisations and of the other partners which are consultants.

4.2 Organisations involved

Main Partners

P01 SYSTRA
P02 AEATR
P03 ITALFERR
P04 TRADEMCO

Partners

P05 TIFSA
P06 HB
P07 SNCF
P08 FS
P09 RENFE
P10 EPFL
P11 CSEE TRANSPORT
P12 INRETS
P13 SOFREAVIA

The representatives of the four main partners form the Management Committee steered by the project leader, SYSTRA, who controlled all the work, and was responsible for the budget and the timely submission of deliverables.

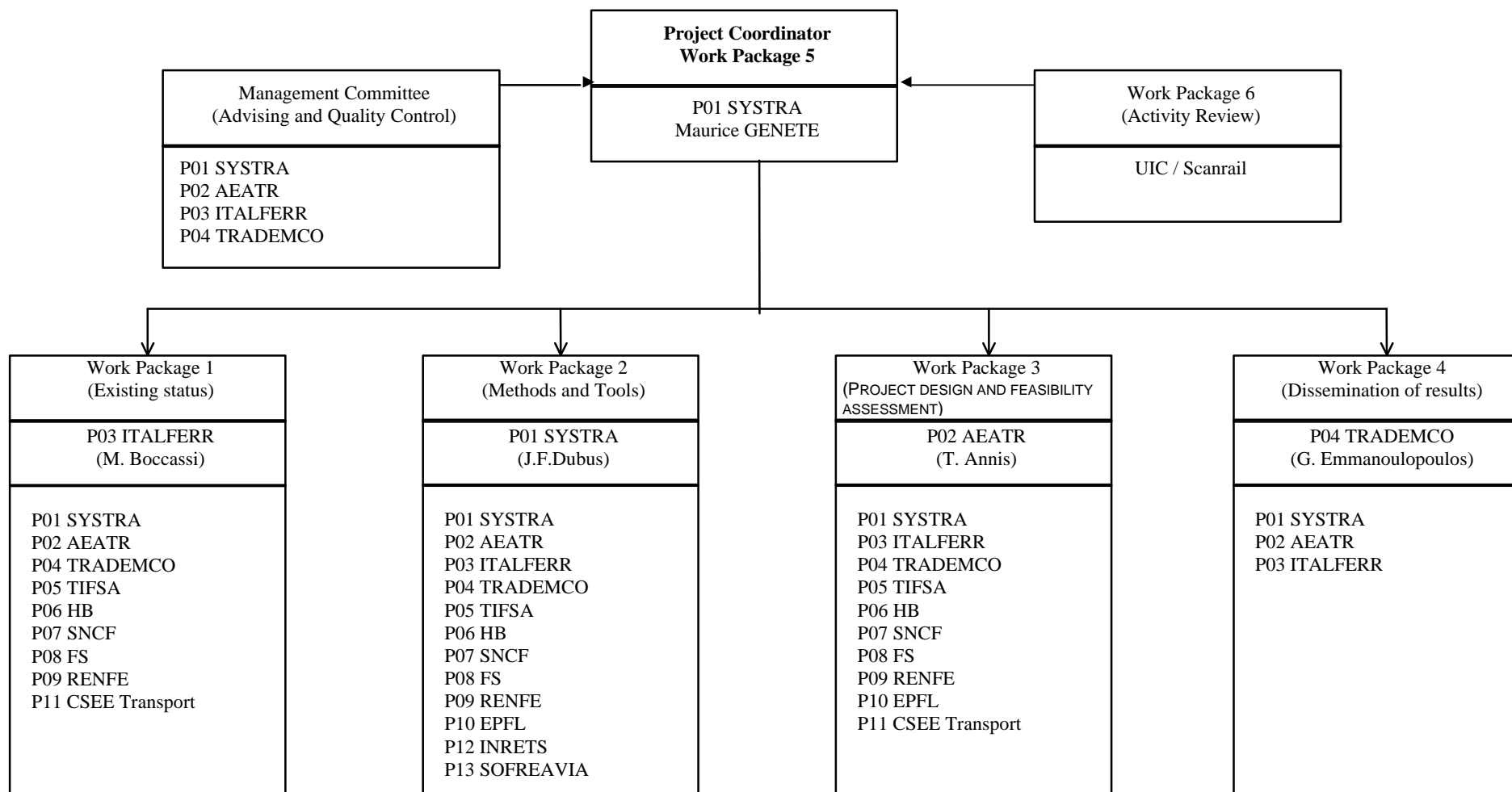
The Management Committee was responsible for the daily management of the consortium and for assessing the quality of the work done and its conformity to standards (ISO 9000).

Each partner was assigned particular pieces of work to fulfil as described in the workpackages.

For each workpackage, the leader in charge has organized the work according to schedule constraints and to the results from previous tasks.

4. MEANS USED TO ACHIEVE THE OBJECTIVES

4.3 Optirails consortium organisational chart



5. SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE PROJECT

5.1 Analysis of existing conditions (WP1)

5.1.1 Introduction

5.1.2 Existing train regulations systems in the European Railways

5.1.3 ERTMS / ETC Implementation

5.1.4 Impact of European research on ETML development

5.1.5 ETML : optimising the European Traffic Management Layer

5.1.5.1 General

5.1.5.2 The role of ETML

5.1.5.3 Hypothesis of scenarios

5. *SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE PROJECT*

5.1 Analysis of existing conditions(WP1)

5.1.1 Introduction

The present document is the Summary of the OPTIRAILS Workpackage 1 final report.

As exposed in the OPTIRAILS technical annex, the existing ERTMS project is mainly safety and technology oriented. What is missing at present is a “Traffic Management Layer”.

The main objective of the OPTIRAILS Consortium is to specify a rail traffic management system architecture (ERTMS/ERTML) within the ERTMS framework and applicable to the international railway corridors.

To achieve this, it was important to define the future requirements, and this was possible through:

- the analysis of the state of the art (ERTMS projects and existing systems);
- the functional and technical analysis of the traffic management area;
- the analysis of potential implementation cases of the studied traffic management system.

In this scenario, the first step of the OPTIRAILS Consortium, the Workpackage 1 of the project, was to perform an accurate analysis of the existing status, with the objective of:

- analysing the state of the art of ERTMS system architecture and its future development, with the rail traffic management in view;
- collecting existing data related to different ERTMS designs already studied in Italy, Germany and France;
- analysing the existing train management technologies.

The outputs of the Workpackage were collected in the final deliverable of the workpackage. They are basically:

5. *SCIENTIFIC AND TECHNICAL ORGANISATION OF THE PROJECT*

- a description of the state of the art of train management technologies;
- a description of the state of the art of the experimental ERTMS systems on the existing trial site;
- an assessment on the main European projects related to the OPTIRAILS objectives;
- an analysis of functionality already existing/foreseen in the ERTMS projects and in the European projects, with the aim of identifying the functionality which have to be integrated in the future layer;
- the foreseeable development and/or evolution of the ERTMS system architecture;

5.1.2 Existing train regulation systems in the European Railways

A short overview on the systems that are implemented or, better, are going to be implemented by the European railways has been useful to understand the trend of the needs that, notwithstanding with the great differences among the European railways, are arising in the field of management of railway traffic.

From the analysis, some common needs arise:

- Need of an integrated informative system as a national centre where decisions about resolution of delays and other problems out of normal schedules are taken.
- Reduction in the number of Traffic Control and regulation Centres distributed on the network widening the jurisdiction of a few centres thanks to the adoption of technologies for automated data transmission and problems solution.
- A management more oriented to the line instead of a regional one, therefore more interesting, at least for the main lines.
- Division between Regulation managers and Movement Inspectors.
- Definition of a real time centralised database.
- Need of a real time communication link between distributed regulation centres and national centre.

5. *SCIENTIFIC AND TECHNICAL ORGANISATION OF THE PROJECT*

- Need of integrating new functionalities in the centralisation of information and controls.

It was also recognised that the UK economical model could be useful when a more concrete approach will be needed to allow the interfacing of different entities:

- An office is enabled to allow buying a train-path independently from the TOC.
- Penalties, but also incomes, are foreseen for the compliance to the timetable.
- Information about train running must be centralised not only for management purposes, but also for pricing definition and for sharing of responsibilities.

5.1.3 ERTMS / ETCS Implementation

The implementation of ERTMS / ETCS is today only in an experimental phase.

Also some new high speed lines are foreseen to adopt the ERTMS / ETCS for the train run protection.

As the result of the survey it was found that :

- The availability of Euroradio functions of level 2 and 3 of ERTMS / ETCS will not be foreseen so that ERTMS / ERTMS will start without such real time possibilities.
- From the other side the main need for an European traffic will be satisfied thanks to the use of the STM: in fact, without the STMs only special trains with all the complete on board existing ATC devices will be used for international journeys while the use of cheaper STMs will enable a larger set of trains to be used for international tracks.
- A wider use of STM, will allow to extend the today's idea of corridor from the main line to all the secondary lines that can be run thanks to the right STM.

5. *SCIENTIFIC AND TECHNICAL ORGANISATION OF THE PROJECT*

As every project can run also without the ERTMS / ETCS train location report to the Radio Centres and from these to ETML, in any case an improvement in traffic management can be reached also by train location from existing systems if the interoperability is guaranteed by the adoption of the national STM to allow the ERTMS / ETCS equipped trains to run all over the European network.

The results of the investigation of the actual status and of the foreseen applications in railway management, show an increasing interest of the main European Railways in complementary applications. Also other features are considered today as a part of the future management system namely:

- the use of expert systems for conflict solving in real time;
- tracing and tracking of freight by ERTMS / ETCS real time train location;
- automatic announcement for the passenger in the stations, and on board based on real time data;
- maintenance programming based on real data;
- centralised security and closed circuit monitoring of unattended posts and stations.

The functions of ERTMS / ETML will have to foresee all the aspects involved on the today's and future feature of the overall European management system.

5.1.4 Impact of European research on ETML development

Many European projects have yielded or are yielding really interesting works about the traffic management:

- Interoperability will be reached in short times thanks to the adoption of the STMs.
- Many studies on economical problems will provide solutions to the impact that the railway world will have with the liberalisation.
- Many projects are already working on traffic management, but with objectives relevant to subsystems: the results of those projects are mainly technologies dedicated to the solution or the simplification of one or more technical problem related to railway management, while a global vision of the management at an European level was never approached. It is really the job of OPTIRAILS.

5. *SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE PROJECT*

5.1.5 **ETML: optimising the European Train Traffic Management**

5.1.5.1 *General*

The first part of the study has highlighted that the actual implementation of the operational level of the supervision in the future European network, due to the presence of different IMs, shows a relevant lack of harmonisation: for example, different systems are used for the command/control activities and only the future implementation of ERTMS/ETCS will at least, allow the uniformity of some involved functions (e.g. reporting of train position, etc.) and only the use of STMs will enable a first step of interoperability.

This may be, anyhow, justifiable if we consider the substantial differences existing between different IMs, due to historical reasons: different distributions of the railway network on the territory, different services, etc.

Nevertheless, the new European directives concerning separation and privatisation of the IMs and TOCs activities have been accelerated or started, where still not activated, the process of information collection and traffic data reporting about the national railway traffic towards the supervision centre as we can see in the UK implementation. It will be important not only for the traffic management and supervision, but also as tools for data recording and, maybe, “certification” of traffic quality, to allow invoicing the slots on the railway network by the IMs to the TOCs.

Really, it’s possible to find many studies already undertaken about this matter at European level: great part of the result of such studies confirms the tendency towards the free competition on the future railway market; for such a reason, powerful and reliable tools are needed to be assigned at the disposal of the management of the basic infrastructures of the railway transport (IMs).

The presence of various approaches for the centralisation of the information at national level, the different ways of defining the different jurisdictions on the track according to the relevance of the line, the different operational levels at which analogous decisions are taken in the different countries, the different technologies implemented today to support the network supervision, make

5. *SCIENTIFIC AND TECHNICAL ORGANISATION OF THE PROJECT*

difficult to reach a completely unified approach to ETML in short times.

Also the safeguard of technological investments made in recent times may become a problem if a drastic innovative ETML implementation is proposed.

For these reasons, the development of ETML has to foresee more implementation steps, with objectives of short, medium and long period. It is also certain that the system will have to foresee different rules and tools for the management/supervision of the passenger and freights traffic.

5.1.5.2 *The role of ETML*

It is important to underline that, on the basis of the result of this first part of the analysis, several scenarios for the realisation of ETML were envisaged.

In particular, it is possible to foresee that ETML is a system (or better, a group of tools and rules) used as support of an European organisation. The aim of OPTIRAILS study will be focused on the definition of such means but also the analysis of the organisation, at least from a general point of view, will be needed to allow a system approach.

This first analysis emphasises that such organisation has to be able to operate at an international level to co-ordinate the operational work of the national institutions but as an independent body whose decisions have to be accepted by both IMs and TOCs of every involved country.

The main feature of the European supervision management level of the railway traffic will be analogous to the job of the main national centres that centralise information on traffic behaviour on the basis of the data coming from the regional and from main line management centres and intervene to solve problems that cannot be approached within only one of the submitted jurisdictions: similarly, at an upper level, ERTML will update the data base of the real timetable of the international trains to compare it with the theoretical one and co-ordinate the interventions needed to restore it in case of delays or accidents.

Obviously, such features are implemented according to different organisational approaches in the various involved countries, so that it

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is necessary to identify the limits of the organisation activity devoted to the utilisation of ETML (or integrated in ETML).

Furthermore it is evident that ETML and/or a body strictly linked with it (an hypothetical European agency, which would have analogies with the transportation by air) have to be enabled to carry out, in perfect autonomy and impartiality, all the stages specified into the type of business. In particular :

- The definition of the timetable ; owing to the requirements of the TOCs and IMs (it is foreseen a mediation role).
- The management of daily activities ; on the basis of the foreseen timetable it carries out the function of supervisor and identify/authorise the possible additional “slots”, requested by TOCs, after IMs;
- Management of the anomalies, on the base of conventions and rules defined and agreed with TOCs and IMs, that constitute also a part of the agreement;
- Reporting and statistics, at the disposal of IMs and TOCs in order to settle the relative authorities, on the basis of the information supplied by a third independant part.

In the limits of intervention of such an independent body, either if it is integrated within ETML or if it is directly the Customer of ETML, it is almost necessary to define its activities. The functions, ETML must be endowed of which depend on the requirements of such an organisation. Those functions may be: interfaces between subsystems or interfaces towards the outside, but anyhow, they must be present.

5.1.5.3 *Hypothesis of scenarios*

i) Short term (ETML level 1)

As far as the contacts between existing systems and ETML are concerned, we might think that, at a first stage (short period), the supervision national systems (SODG in Italy, Netzzentrale in Germany, etc.) will be connected to an European system. This will permit to supply it with updated information regarding the state of circulation interested in and the same system connected to national organisations (part of national systems or devoted organisations dedicated to realise corrections to the abnormal situations) proposed / requested by the European centre. The train location is centralised at the European level on the basis of existing technologies. The passing of a train by areas belonging to different IM's jurisdiction shall

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continue to be managed according to the today's procedure already defined according to international agreements. Real time intervention will be possible on the basis of existing telecommunication systems and technologies. Interoperability will be based on existing special trains already realised to operate under different traction power supply and ATC systems.

ii) Medium term (ETML level 2)

In the medium run, it is possible to foresee a greater flexibility on the plans that allow the European structure to engage/sell further paths for freight and passenger transportation. The initial idea of European corridor will be restored starting from the (only possible today) main line based (that will be equipped with ERTMS / ETC, but not only), to a larger set of railway lines able to connect different countries thanks to a wider use of STMs on board trains (the costs of such intermediate pseudo-interoperability must be agreed between the relevant IMs and TOCs, but even in this case, the presence of an independent body able to operate as a broker will be useful. The real time position report will be possible only for the Euroradio equipped tracks, so, a mixed approach for the centralised information will be considered for the main line passenger trains, if the international line is not completely ERTMS / ETCS level 2 or 3 equipped; for the other lines, a mixed approach based on existing technologies, but also on EIRENE unsafe messages where a radio link is realised outside of ERTMS/ ETCS, will have to be considered. Also for the communication link between border control centres for the passage of the train from different jurisdictions a mixed approach should be possible. In fact, if on the main lines a unified ETML procedure should have been defined and adopted, for the secondary lines, where the use of different technologies makes more difficult the adoption of an European standard based on automated procedures more difficult, a bi-lateral regulation approach could still be used.

iii) Long term (ETML level 3)

In the long run, at last, it is possible to foresee, through the information supplied by ERTMS / ETCS level 2 or 3, that the system ETML may have receive both TOCs and IMs information to be used for the real time intervention and for the statistical analysis ; the validation of the collected information concerning circulation will be really simplified, in order to supply updated reports about circulation t the involved subjects. At last, it will be possible to realise the appropriate interfaces between command/control systems of different IMs, on the borders, where realising continuity allows the creation of international monitored corridors, with exchange of information from

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an IM's system to another of a different organisation for every type of lines.

The standardisation of both common functionality of national control centres finalised to the exchange of information with the European centre and of the interfaces between adjacent command/control systems could be studied and defined in the short term too. The second one is strictly linked to the use that the single IMs will like to do of the information coming out from the ERTMS systems (level 2 and 3 in particular). It's important, in the study, to define this aspect, at least in the main features.

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5.2 Assessment of methods and tools (WP2)

5.2.1 Background

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- 5.2.1.2 Activity scheme*
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5.2.2 Brief on Requirements Analysis

- 5.2.2.1 Introduction*
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- 5.2.3.1 High level Functional Requirements*
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- 5.2.3.6 What happens if ERTMS is applied ?*
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- 5.2.3.10 Proposed methods and tools for implementation*
- 5.2.3.11 Proposals for traffic control enhancement at the high level*
- 5.2.3.12 Inventory of requested services*
- 5.2.3.13 Traffic management breakdown*
- 5.2.3.14 Potential gains*
- 5.2.3.15 Specific services for freight operators*
- 5.2.3.16 Draft terms of reference*
- 5.2.3.17 Preliminary implementation study*
- 5.2.3.18 Analysis of problems in a corridor*
- 5.2.3.19 Possible tools for path assembling*

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5.2.4 **Optirails implementation phasing**

- 5.2.4.1 *Environment*
- 5.2.4.2 *UIC « Traffic Management System »*
- 5.2.4.3 *The will to implement ERTMS*
- 5.2.4.4 *Pressure of transport users and producers*
- 5.2.4.5 *Implementation steps*

5.2.5 **Shaping OPTIRAILS**

- 5.2.5.1 *Long term view*
- 5.2.5.2 *Comments on ETCS / ETML in ERTMS*

5.2.6 **Conclusions**

- 5.2.6.1 *Main issues of workpackage 2*
- 5.2.6.2 *Proposed inputs to workpackage 3*

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5.2 *Assessment of methods and tools (WP2)*

5.2.1 **Background**

5.2.1.1 *Optirails Research Project*

The OPTIRAILS consortium has to carry out a search for a real-time traffic management system, to work at the European level, along international railways corridors, and within the ERTMS framework at any level of implementation.

The OPTIRAILS consortium has to meet two main requirements:

- The system should be acceptable by the Railways.
- The system should be simple.

To achieve these objectives, it is necessary to define the functional requirements and to assess the feasibility of the hypothetical system. This is done in three steps. The first step is the Workpackage 1: "Analysis of Existing Conditions".

The second step has to ensure the continuation of the progress made by Workpackage 1, by focusing on the methods and tools used to satisfy the following needs:

- analyse the requirements of existing business models in the railway field.
- analyse the theoretical approach to real-time management methods and tools, that are already in use or being investigated in research projects, in railway and other transport modes.
- analyse the applied systems for optimising traffic flow, in rail, road and air real-time management.
- analyse the real-time needs of transport users and transport producers.
- collect data about potential implementation cases concerning the European corridors.
- compile the collected data and conduct a pre-feasibility study.

Workpackage 2 outputs shall be used to define the foundations of Workpackage 3: "Project Design and Feasibility Assessment", which

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represents the third step of the project. At this point, the preliminary functional requirement of the OPTIRAILS project will be presented.

This section presents a summary of Workpackage 2, which is an intermediate stage based on Workpackage 1, and is intended to supply the material needed for Workpackage 3.

5.2.1.2 Activity scheme

The content of Workpackage 2 activity and the breakdown of tasks between partners were proposed and agreed during the plenary meeting held in Brussels on January 20th. The timetable given in the Technical Annex has been approximately complied with and managed as reported hereafter.

During February– March– April, until April 20th, the staff involved in the Workpackage 2 had to work simultaneously on the Work package 1 and on the tasks in Workpackage 2 that did not depend on the results of Workpackage 1.

On April 28th, a plenary meeting was held during which DG VII and UIC provided comments and guidelines for the continuation of this research. It was specified that OPTIRAILS should redesign a given path impacted by disturbances in real-time. In addition, the project had to explore several traffic management scenarios and to evaluate each of them through a cost / benefit analysis, then to propose a feasible solution. During this plenary meeting, the choice of corridors was discussed. Among four main corridors the business case of Rotterdam – Italy through the Gotthard Pass corridor was retained.

A specific steering meeting was held on June 18th, with DG VII and UIC representatives in attendance in order to validate project design guidelines as following:

- 1) Monitor full Origin / Destination of international trains
- 2) Consolidate the concept of international train
- 3) Clarify the OPTIRAILS process
- 4) Evaluate the value added by OPTIRAILS through especially considering the following parameters: time, cost, quality and flexibility

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- 5) The overall broad OPTIRAILS design, leading to a logical set of 5 evolutionary business models was set up as follows :
- Step 1 : Monitoring model (the simplest)
 - Step 2 : Information model
 - Step 3: Advisory model
 - Step 4 : Supervision model
 - Step 5: Managerial model (the most sophisticated).

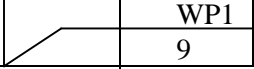
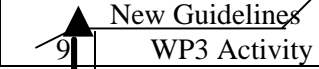
Business models must be fully compatible to permit the transition from one to another (according to time scale) without any loss of functionality.

- 6) As far as the methodology provided to elaborate the Functional Requirement Specifications is concerned, it was agreed to study the following chain:
- a) Who are the final users of OPTIRAILS ?
 - b) Who are the technical users ?
 - c) What are the needs of the different user ?
 - d) What are the requested functionalities for each need ?
 - e) Which parts of the system (core system or interfaces) are concerned by the functionality ?
 - f) What is the class of the functionality (mandatory, useful, nice to have)?
 - g) What is the term for implementation of the functionality (short term, medium term, long term)
 - h) The methodology has to be pursued by the allocation of the functionality to business models. It is important to know what functionality is behind each business model and for which time phase.
 - i) An additional table has also to indicate the main railway networks in Europe where the functionality is already implemented (if the case arises)
 - j) The cost / benefit analysis is due to yield orders of magnitude of the business models supposed implemented in the selected railway corridor (the Netherlands, Germany, Switzerland (Gotthard pass), Italy).
 - k) Each business model represents an additional investment which could be compensated by economic surplus (mainly time saving for passengers and goods on the corridor).
 - l) The definition of functionality will be based on the pilot corridor Rotterdam – South of Italy.

Since WP3 started on June, and in accordance with the updated requests of DG7 and UIC, WP2 had simultaneously to achieve the

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assessment of methods/tools and to feed the Workpackage 3 activity with the aforementioned methods / tools to the extent covered by WP2. As a result of these events, the deliverables were not exactly as anticipated in the Technical Annex. The diagram hereunder summarises the WP2 activity scheme connected to WP1 and WP3.

Time>	January	February	March	April	May	June	July	August	
Meetings	20			28		18			
		WP1 9					New Guidelines WP3 Activity		
Activity	of WP2	Start of WP2-----Assessment of methods/tools						--> end of WP2	

The drawing up of Functional Requirements Specifications will use six working options as the foundations of the aforementioned business models. At this time, these options are:

- Option 1: Collecting data and monitoring for performance
- Option 2: Centralised information per corridor
- Option 3: Path assembling without scientific optimisation
- Option 4: Solutions from negotiations with the partners involved
- Option 5: Procedural/ organisation (based on recognised approved procedures between actors)
- Option 6: Problem detection/ problem resolution

In parallel, the methods/tools assessment made in the course of WP2 gave rise to a top down ranking of three scenarios matching these options.

Scenarios (from top to bottom) seen by WP2	Options to be detailed by WP3
Intervention: OPTIRAILS as a full centralised system is trusted by all the partners involved	Option 6
	Option 5
Intercession: OPTIRAILS involves a job- sharing between a centralised server and rail partners	Option 4
	Option 3
Information: The ETML work is an extension of existing Railways practises	Option 2
	Option 1

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5.2.1.3 *Comments about the scope of workpackage 2 deliverables*

As we have seen, the scope of WP2 is not a precise match for the objectives listed in the Technical Annex, for several reasons:

- i) The scope of the Workpackage 2 Report was handled like that of a research project. It is always difficult to anticipate, long beforehand, what the issues of a forecast task will be. Unpredictable difficulties can appear, methods, tools and techniques evolve and unsuccessful ways have to be abandoned.
- ii) The subject itself is complex, calling for a mix of knowledge, methods, tools, technologies and experiences from various countries and cultures. Of course, the major issues recorded in the deliverables are the result of brainstorming sessions and discussions leading to a negotiated consensus between partners. This fact explains also why there are deviations between the work implemented and the work planned in the Technical Annex.
- iii) The intermediate position of WP2, which had to integrate WP1 issues while preparing inputs for WP3, represented additional constraints. These were due to the simultaneous progress of tasks in each workpackage, involving the necessary interaction, but also to a shortage of outputs/inputs at one specific moment of the timetable, near by the WP2 tasks ending.
- iv) While WP2 was underway, the OPTIRAILS Consortium received guidelines from the clients at a Plenary meeting or a Steering meeting – for the most part in June 1999. These guidelines were very important for general project design but they involved modifications to WP2 work, that was close to its completion.

A case in point is the client's desire to have OPTIRAILS be a "monitoring system", able to use its traffic statistics to create added value.

- v) As a result, the scope of WP2 does not cover the working out of Functional Requirements Specifications for WP3, which contains one specific volume on these FRS.

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- vi) Moreover, assessments are not carried out systematically due to the absence of experience on site or shortage of performance criteria. This is specially true for the case of the fuzzy logic tool, whose relevance is postulated by the scientific literature but not yet borne out by practical implementation.

5.2.2 Brief on Requirements Analysis

5.2.2.1 Introduction

One major issue of the WP2 study, resulting from railways experience and practices is as follows: OPTIRAILS is assigned the function of monitoring international traffic, to periodically produce information on traffic.

In fact, the basic need is to know if trains are running on time, even if no delay is involved. Each Infrastructure Manager and Train Operating Company wants to check transport production regularly to prevent or minimise any lapse.

Due to the international traffic development and to the use of ERTMS, long- range paths will require an overview from origin to destination, that is different from the present view.

This leads to requirements for a European system, summarised below.

5.2.2.2 Summary of requirements analysis issues

The present summary aims to provide indications for the Functional Requirement Specifications of the European Traffic Management Layer, in anticipation of the evolution in terms of equipment and of relationships as defined between partners.

The first scenario should be “Information”, corresponding to the basic needs of Rail partners to work together in a better way.

The second scenario could be “Intercession”, when OPTIRAILS, thanks to its being geared to the European level, enables a partner to achieve time saving.

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The third scenario would be “Intervention”, if OPTIRAILS is allowed to interact between Main Operation Centres and Train Operators representatives, as per its contracts, thereby optimising traffic and minimising damage for all.

5.2.2.2.1 Common methods of request acceptance

- i) In any case, the system should be able to accept questions with or without a train number reference, or only with references such as a time slot and station name.
However a train number is not always sufficient to ensure that the caller and the provider have a good understanding. People will not always know the number of a train path, which is a complex technical reference.
- ii) The system should accept any caller mother tongue and should answer in the same language.
- iii) In any case, the system should work only using a “public” information ; i. e. separate from private life and from the interest of train operators.
- iv) In specific cases, the system could accept to give particular types of information to authorised bodies.

5.2.2.2.2 Common approach to a quality contract

- i) The system will be able to indicate if a train is on time within a margin of five minutes.
- ii) The system will be able to report that a train will be more than five minutes late, with an accuracy of 5 minutes.
- iii) The system will be able to predict an estimated arrival time for any station where a train has to stop, with an accuracy of 5 minutes.
- iv) The system will be able to report on the load of a freight train, with respect to legal obligations, including for a "cargo unit" different from the concept of wagon load or train load, and whose specifications would be given by the Train Operators.
- v) The system will be able to give the current position of any train by identifying the section where it is located, this section being no more than twenty kilometres long (based on train describers supposed in service in the line divisions monitored by OPTIRAILS).
- vi) The system will be able to provide an answer within one minute after accepting the request.

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5.2.2.2.3 Common methods of information delivery

- i) In any case, the system should not deliver information diverging from that given by the concerned IM, if the request refers to IM's domain, i.e. decision concerning train path organisation , incident management, etc.).
- ii) In any case, the system should not deliver information diverging from that given by the concerned TOC, if the request touches the TOC's domain, i.e. trainload, resources management, etc.).
- iii) In any case, if requested, the system should report information provided on behalf of an IM or TOC to a per contract appointed entity.

5.2.2.2.4 Information about the past.

- i) Information is classified as "past" if it concerns a train position (or event) which has been recorded more than 10 minutes ago, with an accuracy of five minutes from the current time.
- ii) "Past" information is stored in the "Past" memory as soon as it is ten minutes old.
- iii) "Past" information is stored in the memory for one year, according to the corresponding timetable dates.
- iv) Information concerning a past event can be used according to IM and TOC specifications.

5.2.2.2.5 Information about the present situation

- i) Information is classified as "present" as long as the latest statement about a train (or an event) is not older than ten minutes.
- ii) Information about the present status of an event is a short summary of any cause of delay, described in terms as agreed in the UIC leaflet 450-2.

5.2.2.2.6 Information about the future

- i) Information is classified as being about the future if it concerns a train position at a time which has not been reached yet.
- ii) Information about the future is a confirmation if no deviation from the timetable is foreseen or stated.
- iii) Information about the future is a prediction if any deviation from the timetable is foreseen or stated .

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- iv) Information about the future will be labelled "Estimated Time of Arrival", if the calculation used fulfils certain conditions agreed by rail partners.
- v) Information about the future is a forecast if it concerns a train position at more than two hours from the present time.

5.2.2.2.7 Information tools

- i) All media available to the public should be used by the system (phone, fax, mail, the Internet, etc.).
- ii) The system will allow data and vocal communication among all European rail partners (IM or TOC) at the national level of operation, by the fastest and most suitable means.
- iii) The system will use all the UIC communication standards with all rail partners, mostly the standardised Data Exchange-Catalogue of Messages.
- iv) The system will use all traffic management functions implemented at local, regional or national levels , working together with the signalling and other train control devices, which will all supply information consistent with all requirements.
- v) The system will use the following requirements:
 - "actual time", i.e. use a common time reference
 - "up dating", i.e. take into account the last agreement about timetable changes
 - "monitoring", i.e. make regular checks of operating events
 - "Delay Evolving to End Dossier", i.e. report on causes and consequences from origin to destination and analyse all delays so as to reduce them.

The above requirements will help with the definition of FRS or SRS corresponding to the so-called Options 1 and 2, which are also foundations for the subsequent Options 3 to 6.

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5.2.3 Major Findings

5.2.3.1 *High Level Functional Requirements*

Seeing that ERTMS will replace many existing facilities including equipment used for real- time traffic management, a bottom up approach naturally starts by looking at which high- level European concepts should be developed.

- Today, the highest level of real- time traffic management is national. Some supranational organisations exist for timetable design or the supply of information, such as the “ One Stop Shops” for freight corridors, but there is no general European overview.
- In each European country, real- time traffic management is restricted to the territory covered by national Infrastructure Managers (one or more). In short, they perform traffic control because they have to ensure the rail safety.
- The functional requirements of the activity under consideration, which includes dispatching in real-time and reactive management, can be based upon the contracts linking Operators with IMs, i.e. the timetables taking effect on the specified day, and the ratio of timetable recovery if any event hinders traffic flow.

In conclusion, OPTIRAILS should cover a high level of international European management not ensured by national or regional bodies, relying today on current methods and tools and, tomorrow, on European standardised methods/ tools. In addition, OPTIRAILS can co-exist with the already TMS Systems and the work process at the different Infrastructure Managers.

5.2.3.2 *User Needs*

When drawing up any functional requirements, it is necessary to evaluate some users requirements. If possible, the latter should be confirmed by user representatives. User needs have been outlined, based on several interviews with Train Operators, speaking for end users and for themselves, and with Infrastructure Managers expressing technical requests.

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- The main needs identified are: tracing and tracking of passenger and freight, locomotives and wagons, status of resources (IMs and TOCs).
- Other needs concern information about rescheduling and revised path allocation, real-time support for IMs and TOCs in solving problems.

Passengers want to re-organise their transport schedule rather independently and conveniently for them. Freight operators would like to be aware to the extent of events having an impact on their own management, or on the downstream activity, and to participate in transport production decision making.

Today, the situation is different in each country. Generally, a national freight representative works together with IM real-time traffic management staff to defend the interests of the freight sector. In the future, having European paths purchased by TOCs would give rise to difficulties when a decision is to be taken about priority. It is possible that a European system may evolve without a consensus on criteria, even if it is characterised by neutral behaviour and a lack of discrimination. European priority criteria could be agreed for long-range paths, they could evolve depending on the real-time traffic management, and would be a new element in collaborative decision making.

In this field, OPTIRAILS appears as a recommendable alternative for the ETML System.

5.2.3.3 *Process Charts*

European general trends could be set up, according to comparisons between Railways:

- Each national business model uses similar processes, technically speaking (path allocation system, train product delivery and quality control of methods & tools).
- Most IMs concentrate path management in regional and national centres. Path management is generally close to the train control by signalling.
- Most TOCs develop tools for improving traffic control (integrating crew and stock) and user information. Sometimes they use their own equipment not the IM's one.

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- Relationships between partners vary considerably. Most IMs use a national traffic control centre to co-ordinate regional or local actions that do not always enable the organisation of long-distance re-routing because they are responsible for their area and short travel times.
- International processes present significant gaps. International path allocation is effected by joining national paths for which each IM uses its particular path allocation system. It takes time to answer a demand. Path assembly methods & tools used for scheduling the precise timetable are not useful in real-time traffic control which requires a fast estimation.
- Real-time traffic management is mainly oriented to timetable recovery. It is difficult to take into account commercial considerations, e.g. actual time constraints corresponding to a slot of expected arrival time which is different from the distinct allocated path. Such a concept exists within local area management, and can be extended to the optimisation of departure/arrival time.

The processes in use in every European country produce national timetables and the national portion of international trains. These processes generally end the day preceding the real-time traffic management slot.

A different process is then used by different staff to control traffic and operate train product delivery. Somewhere they use tools helping with conflict detection on the line. These different tools can work in compliance with European priority criteria, or the required arrival-time window, which would be provided by OPTIRAILS through the European Traffic Management Layer.

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5.2.3.4 *Theoretical Approaches*

Theoretical approaches dealing with dispatching and with the tactical level of air, rail and road traffic management have been explored. The results are:

- No theoretical approach to real-time problem solving is now available.
- Projects aim to optimise algorithms (change train sequencing to reduce delays) or to define concepts for computer-aided systems.
- Visualisation of a global situation with highlighted gaps will allow better decision making than a partial vision from a local viewpoint.
- Prediction is an important decision making element that should be evolving towards more accuracy.
- Conflict detection/resolution systems can be implemented to enhance path management by the IM. They can be different in each country, being applied to local conflicts.
- The modulation of train speed to smooth traffic is reserved for a future step, when useful information will be displayed on train-borne MMI. It should be limited to operation centres that must manage heavy traffic.

These approaches indicate that European dispatching will long remain a patchwork of various systems that the European Traffic Management Layer will have to cope with. However, OPTIRAILS will have to co-exist with the already existing TMS System at regional or national levels.

5.2.3.5 *Methods and tools used in all modes*

There are conspicuous differences between railways and other transport modes. But in so far as real-time traffic management has to satisfy similar transport customer needs, all modes were explored. The methods & tools identified present a common denominator, summarised in 7 points:

- **TARGET MEMORY** is to focus on the desired transport objective (the last contract agreed in the updated timetable, which is the base of real time negotiations between operating crew and staff when an event causes some change).

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- **AVAILABILITY MEMORY** is to integrate all resources available at a given moment in every domain, to permit route or timetable changes.
- **TRICK OF THE TRADE** is the experience acquired by operators, used to make decisions faster than a present- day computer could make.
- **ACTION STAGE** is a time slot, the duration of which does not exceed two hours. During this slot, its role is more to guide the partners involved in action than to play their part.
- **ACTION EFFICIENCY** is the use of economical criteria, as input for real- time decision making processes.
- **ACTION RAPIDITY** consists of working- time criteria for decision making, according to the degree of urgency and the number of data to take into account.
- **ACTION EQUITY** is the agreement between partners about all real- time decision making criteria, input and processes.

Clearly, there is a large human component in this kind of management, that is the reason why a computer may not suffice to handle all traffic management tasks nowadays.

The air European Central Flow Management Unit deals with thousands of flights every day but only arranges delays to avoid an overload for Area Control Centres. The present approach to future air traffic control is foreseen as involving a human- centred automation (the system should advise users what-not-to-do), and providing pilots with tools like “cockpit display” or “traffic information and traffic situation display”.

A moral of the story could be that operating staff and crew continue to be key to operation but their strong points will be enhanced by technology.

5.2.3.6 *What happens if ERTMS is applied?*

The proposed breakdown between ETCS and ETML in ERTMS takes into account when each has to work and the location of each element.

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The only role of ETCS is to ensure safety. ETML will use the time tables and other available information to give the route- setting orders.

When ETCS level 1 is implemented, there is no Radio Block Centre (RBC). The route- setting function is performed by signalmen, according to timetable and available information provided by the traffic controller. The latter will use ETML information to check whether the possible choice of route- setting is in accordance with high level objectives. As necessary, a driver can be provided with information about conditions on the line by safety radio, if any.

When ETCS level 2 or 3 is implemented, there is a Radio Block Centre (RBC). According to the function 4.9.1 of ETCS FRS, the RBC must be able to request an external system to provide a route to be set. The route setting request must take account of train location and actual speed.

Generally, the signalmen have information on train approaching early and the route- setting function can be performed as above. But the RBC allows more an accurate view of train run and a calculation by a traffic management system, if any. The RBC permits other functions related to the train speed or stop, e.g. advisory speed, advisory station stop, and additional functions that are designed to enhance the rail performance.

These functions will be achieved using the national/ regional part of the Traffic Management Systems which will be linked with ETML to provide the layer with data concerning train progress and to return relevant orders to all partners involved in action, i.e. controllers, signalmen, crew or drivers on train and staff in stations.

The RBC will establish a strong communication link between train and ground. Several functions of ETCS will contribute to enhance the knowledge of what is wrong on train, where it is, and so on. Thanks to a better view of train status and infrastructure conditions, ETCS and ETML will work together: ETCS as a communication link between train and local operators, ETML as a communication mean between national/ regional and international partners. Each role will be detailed further in FRS.

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The Local Area Devices communicate with ETCS and Main Operation Centres.
A direct link between Main Operation Centres and ETCS is feasible through RBC.

5.2.3.7 *Typical Case Reporting*

The purpose here is to study in depth the real-time traffic management in several modes and to extract some typical cases of methods and tools from the reports.

- Road traffic management in the greater Paris area (Ile-de-France) is performed by several partners using a common server and a database that is constantly being updated.
- Road traffic management uses many traffic measurement detectors, video monitoring, signs and communication systems for reporting. The work is divided between several control centres.
- Air traffic management, called “Tactical Phase” on operation day, is shared between many Area Control Centres (several in each country) and the Central Flow Management Unit (CFMU of EUROCONTROL agency, in charge of non stop monitoring of all European flights.
- EUROCONTROL operates a Central Office for Delay Analysis (CODA) in order to provide policy-makers and managers with timely, consistent and comprehensive information concerning the European situation.
- Rail traffic management in Europe is a patchwork of national management’s, each having different regulations and tools for sharing train command/control and traffic control in control centres.

The following general trends are observed in Europe:

- More flexibility and short- notice response for path allocation
- Fewer operation centres in each country
- A national database monitoring the traffic will generally be available.
- Some train operating companies develop their own information system, in parallel with the infrastructure system.

As a result of this study, organisation at European level appears feasible, being like that of EUROCONTROL which manages more than 20 000 flights per day, involving many parties with different roles and a strong common interest: safe transport development and user satisfaction. As a result, OPTIRAILS can learn from Air Traffic Control methodology but tools cannot be transposed directly due to the specificity of the two transportation modes.

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5.2.3.8 *Potential Implementation Corridors*

Among the 41 European corridors listed, the corridors selected can be seen at a glance: those used by passengers only were not retained. Among those used by freight trains, the Belifret, East-West and North-South corridors were considered.

Belifret offers few international paths through Belgium, Luxembourg, France or Italy.

The East-West corridor also offers very few paths through the UK, Euro Tunnel, France, Belgium, Germany or Austria to Hungary. These concerned countries are modestly involved in the OPTIRAILS project and the assessment of such a corridor was not carried out.

The North- South corridor which offers about 40 international paths per day is used by mixed traffic and it is managed by IMs which appear intended to implement ERTMS.

- The corridor running from ROTTERDAM to KÖLN, BASEL, CHIASSO, MILAN, GENOVA/GIOIA TAURO has the largest number of paths.
- The Federal Swiss Railways agree with the idea of testing a business case based on data available for operating situation met in the past.

Therefore, this corridor is proposed for implementation start-up, and first as a business case to carry out a cost/benefits analysis of the OPTIRAILS project. The Swiss “One Stop Shop” and the future federal traffic control centre will help to implement OPTIRAILS, thanks to their experience of some multiparty rail cooperation. A common goal should motivate all partners along this corridor, namely the development of rail freight traffic in Europe.

5.2.3.9 *Optimisation of European traffic management.*

This research was focused on the future use of ERTMS, based on the Technical Annex of the OPTIRAILS Contract, and the progress that ETCS is expected to make.

Considering the OPTIRAILS obligation to produce FRS of ETML in few months, the WP2 assessment of methods/ tools concentrates on means that will be useful for traffic optimisation. It is assessed that

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the cost and feasibility of the European system will depend on four key elements:

- The UIC so-called “Traffic Management System”, which will require all rail partners to use the UIC catalogue of messages for data exchange. This provides a foundation for the European Traffic Management Layer, within which some functions may be used for traffic optimising by a European Unit, called “OPTIRAILS”.
- Real-time traffic management involves Infrastructure Managers and Train Operating Companies, which must negotiate win/win solutions to all problems for which the calculation, simulation and study of the European point of view can be covered by OPTIRAILS in the proposed “Arranged Immediate Deal”.
- Traffic is not yet monitored at the European level. This should enhance rail service, thanks to better information, and in particular a Delay Evolving to End Dossier.
- The implementation of GSM-R and ETCS will facilitate traffic control by local area devices within Operation Centre Control. GSM-R will accelerate the collaboration of all parties concerned to optimise the real-time management of any event with the European overview providing added value.

The system listed first is supposed to work in approximately two/three years and to be mandatory for all rail partners, under the auspices of UIC.

The type OPTIRAILS services mentioned above (items 2 and 3) would be acceptable to all partners as long as said services enhance their own management.

The last item corresponds to a long term vision, using full ERTMS possibilities.

5.2.3.10 *Proposed methods and tools for implementation*

The development of transport organisation contracts between different partners will raise difficulties for the existing management system involving close relationship between one Infrastructure Manager in each country and its customary partners. Including more parties calls for a new behaviour, more flexible and faster for path management. This is why the following items are proposed:

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- International freight traffic management can be improved thanks to the international view of problems, resources and stakes that OPTIRAILS could provide.
- Tools like TRIS and TRIO (EUROPE project) could help with real- time traffic management because they work fast, with an acceptable time accuracy.
- A European Monitoring Unit like the Central Flow Management Unit of the EUROCONTROL Agency can provide operation centres (national or other) with a European point of view concerning the rank of priority to be given to an international train, if and when necessary. This could be OPTIRAILS' role.

The proposition lies in making OPTIRAILS an agent of real- time traffic management, dealing with IMs and TOCs, bringing them a European overview to use in problem solving.

5.2.3.11 *Proposals for traffic control enhancement at the high level*

The traffic management activity has been studied and broken down in detailed functions according to the methods & tools assessed and the sharing of tasks.

Some functions are identified in view of further system specifications.

- Updating is an important function for checking the limit between timetabling (long or short term allocations until the last contracted timetable) and real-time on the day of operation; this function is intended to provide any system with the right time- table for operation on a given day.
- Monitoring is a second key management function as regards proper train running, infrastructure status, etc , and the collection of all necessary data.
- “Estimated time of arrival” is a function required by Infrastructure Managers for themselves and to inform their clients (TOC or other). This will be a new calculation of

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international paths, not only within each country, but with each partner agreement.

- Global problem solving can be optimised by several IMs and TOCs in a so-called “Arranged Immediate Deal” depending on the contractual basis for OPTIRAILS work concerning ETML.

These main functions are expected to enhance the traffic management.

5.2.3.12 *Inventory of the requested services*

In preparation to the functional requirements specifications, the requested services expressed are synthesised and classified according to ERTMS aims.

- In certain circumstances, traffic managers need to communicate quickly with transport operators and third bodies and to interact with them when a problem occurs to make a collaborative decision about the best solution.
- The list of customary requests under consideration shows better response accuracy and faster decision making. These improvements will be achieved if at least ETCS level 2 is implemented, using radio-communication and facilities provided by RBC. Multiparty conversation in mother tongue will be useful for interoperable trains.
- Considering time saved thanks to ETCS level 2 or 3, plus the last times noted in the WP2 delay analysis, it might be expected that most delays could be shortened

All parties request information that will enable them to keep the situation under control. IMs and TOCs are trying to improve existing means in that direction, but mostly within each country or language-speaking area. Interoperability calls for machine translation to be used in case of event, otherwise the real-time traffic management may be difficult.

The use of ETML and OPTIRAILS, with all proposed methods/tools, is expected to save operating time, and thus to reduce delays and subsequent damage.

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5.2.3.13 *Traffic management breakdown*

During the assessment of methods and tools, it was noted that the full ERTMS functions include not only the train command/control component and the layer component but also various devices developed in each country.

A place for each party is proposed as follows:

- A Traffic Management System can be understood as the part of ERTMS not included in ETCS, i.e. any Local Area Device (LAD) in existing signalling system or in Operation Centres that supply input to train command/control system.
- A Traffic Management Layer can be a common resource for operating tasks and information tasks shared between IMs, TOCs, and OSS + OPTIRAILS, irrespective of ERTMS implementation.
- A Traffic Monitoring Unit, called OPTIRAILS, could be a traffic management partner that, like the others, generates added value.

5.2.3.14 *Potential gains*

The causes of delays in France have been analysed during four years. They show where lost minutes could be reduced thanks to full deployment of ERTMS:

- Most delays, almost two thirds, are caused by mistakes by train operators. Part of this time can be saved thanks to a better, faster and more accurate real-time management.
- The information stored in ETML, continuously updated by applying the UIC leaflet 407, can be used by every partner, with the help of OPTIRAILS, to make Arranged Immediate Deal with the other parties concerned.
- The role of OPTIRAILS would be to note and measure the progresses at European level of:
 - ⇒ Train services quality
 - ⇒ User's information quality
 - ⇒ Interoperability

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The assessment made in OPTIRAILS Workpackage 2 sets out principles. At first glimpse it appears that the economical stakes are sufficient to justify investing in the proposed system.

An example is Rail Tracker, a system able to locate freight consignments anywhere in the world where the relevant software is installed, therefore not in the European rail network. Workpackage 3 will provide additional figures that will make it possible to estimate the desired values.

5.2.3.15 *Specific services for freight operators*

Depending on the contracts binding freight operators and OPTIRAILS in the area of operating resources optimisation, specific international management services could be provided, in real time.

This can lead to following consideration:

1. International traffic flows and operation time windows in marshalling yards (user requirements specified by Operators).
2. Studied train paths are arranged and proposed to an IM for agreement.

Such arrangements lead to the integration of alternatives solutions and negotiations between TOCs and IMs, to find and establish a win/win solution.

This provides an indication of contracted timetables and rosters used for real- time traffic management. A real-time collaborative decision making will call for both types of diagrams and TOCs + IMs negotiation about an “Arranged Immediate Deal”.

The transport organisation is shared between many IMs and partners with a part to play in the train product delivery. Each party’s role is like a piece of a puzzle.

This is why real time decision making is difficult, and seems very complex from viewpoint of operating staff. This is an additional cause of delay when any fault affects the system, either via the TOC or the IM.

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Making future access to Infrastructure available to several different Train Operators would have an impact in this area of management, which should deal with priority ranking. This gives rise to questions:

- Will customary national freight operator be representative for any other?
- The function of One Stop Shop will it include real time traffic management?

Given the state of uncertainty about future railways organisation, it appears wise to satisfy constant needs irrespective of the final organisation. So path assembly and an origin/ destination overview for international traffic development will no doubt be required to implement long distance cross border paths.

OPTIRAILS could assist all partners, if it is entrusted with providing added value in the area of problem- solving for international trains.

5.2.3.16 *Draft terms of reference*

Among the proposed terms of reference for ETML and OPTIRAILS functions, the most important could be:

- The European traffic management layer should obtain results in reducing lost time and wasted resources of the international traffic, provided that no damage results from its management for other national or regional traffics.
- The European traffic management layer should have measurable effects on the timetable recovery after incident ratio. The measuring apparatus could be different from one country to another, but should process common data on same criteria. Then a European assessment will be attempted.
- For data interchange, the European traffic management layer will work under the control of each IM by applying the TMS UIC leaflet 407, and partly under OPTIRAILS as per its job specifications.

OPTIRAILS is proposed as a tool for measuring service quality and interoperability advances at the European level.

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5.2.3.17 *Preliminary implementation study*

To insert any new party in a real-time situation is not easy. A study of OPTIRAILS interfacing and product delivery has been done.

A study about possible implementation has carried out in preparation for the OPTIRAILS design.

- A priori, the inputs to OPTIRAILS do not need additional tasks for IMs or TOCs, because generally these will be only a copy of messages exchanged by applying the TMS UIC leaflet. Thus the system will process captured data.
- The outputs of OPTIRAILS are a set of information available in the layer for any authorised body, mainly international data and data for IM use.
- An Internet site could be fed by OPTIRAILS depending on its contractual scope and based on the “FITNESS” concept (Freight International Traffic Now Easily Showing System). This example involving freight can be followed by others.
- A database could be consulted by corridor users to obtain details concerning the traffic situation in real time, according to confidence rules.
- Information could automatically be sent to the subscribers of the OPTIRAILS provider, depending on their rights as operators or customers and their requirements.

In short, the present organisation involves existing rail partners and is based on their uses in each country. They can continue in this way and work separately, and simply join paths together when they agree on path allocation. Today, this is done during the time- tabling, this is not done in real-time management. Tomorrow this will be done more easily with TRIS sub-systems, so called TCM (Traffic Capacity Management), TTC (Timetable TeleConferencing) and FTM (Freight Timetable Marketing), included in the EUROPE project. But, in this case, the optimisation will remain regional in the absence of a global origin/ destination overview.

OPTIRAILS is intended to provide corridor managers with cross border overview from origin to destination and real-time information to help them with traffic management.

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International rail traffic is not increasing as fast as the road sector. OPTIRAILS implementation gives an opportunity to spur a type of traffic expected to expand.

The first phase providing information is close to present possibilities and compatible with the rules of communication to be implemented. It is a light additional service because there are presently few international trains, but this should change in the near future. Then the existing way of life could evolve accordingly. If OPTIRAILS is implemented, it could evolve sooner with better conditions.

5.2.3.18 *Analysis of problems in a corridor*

A study of the BELIFRET corridor shows that the problems in a corridor are located in few places, i.e. about five nodes for 1000 km.

- A representation of a corridor can be obtained by making a rough description of the lines and nodes for locating problems to be solved.
- A corridor history can be provided and summarised to extract feedback useful for rail traffic development.

The consecutive OPTIRAILS proposal is to implement and display a broad view of the monitored corridor, and make problem related to information available in a clear, simple and free way to any authorised body, compulsorily an Infrastructure Manager.

5.2.3.19 *Possible tools for path assembly*

The study has investigated tools for handling problems in real time, seeking to identify the most suitable ones.

The trick of trade now has two aspects: line conflict and nodal problem.

As the European level is not yet ready to handle local nodes or connecting problems that are still managed by Main Operation Centres (e.g. in Germany), the specifications for tools should include a path-simulation and long-distance resource problems study.

TRIS/TRIO appears to be possible tools for path simulation on the lines. These tools will be adapted to long-distance cases.

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The FLOU algorithm (Flow Line Optimum Utilisation) offers, for path optimisation, an avenue to be thoroughly explored.

- Any path simulation effected in real-time must only take a few minutes, at a “feasibility level”, i.e. without the under-one-minute accuracy of timetabling.
- TRIO could be used to carry out a resource optimisation study that would be useful for OPTIRAILS and partners.

The TRIS timetable teleconferencing provides an example of a tool that can correspond to an approximate real-time management need, subject to an acceptable working time and detailed operating performances. TRIO offers a similar possibility for resource simulation, at a “feasibility level”. These assessments would be checked by testing.

5.2.4 **Optirails Implementation Phasing**

5.2.4.1 *Environment*

The requirements given by DG VII and UIC to design OPTIRAILS were, to state them briefly, to be simple, and to be acceptable.

According to the pre-feasibility study carried out under WP2, these conditions seem to be satisfied. This position is based on three observations:

- The UIC traffic management system will come into effect as a working system used by IMs and TOCs in every European country and between European countries.
- There is a will to implement ERTMS, both ETCS and ETML, mostly shown by the Swiss federal railways, but also by other railways.
- Driven by customer needs and population demands, international rail transport services (passengers and freight alike) are increasing in volume. The qualities required are punctuality, regularity and economical benefits.

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5.2.4.2 *UIC "Traffic Management System"*

The concept of a service provider is foreseen in the draft of UIC leaflet 407 "Traffic Management System". Every partner can be a service provider or receiver. The UIC project specifies the type and size of standardised messages for bilateral exchange, to fulfil the needs of IMs and TOCs within the existing national organisation.

This scheme is comparable to the air traffic control organisation before the Central Flow Management Unit by EUROCONTROL was implemented. Since a European organisation has been capable of improving overall traffic with respect to the requirements of each Area Traffic Control, the feasibility of a similar set-up is being assessed in some rail corridors where the number of train running is comparable to the number of flights involved. The difference lies in conflict type, but a common rule is to solve conflicts with local area system. This might be compared to a brick used to build the management structure.

In the aforementioned UIC document, the diagram representing the partners working together looks like a building in which the rail partners are like apartments and ETML would be like a roof covering the building.

The origin/ destination overview and information management is handled at the central level. This is the proposed position of OPTIRAILS. ETML is a database common market used by all partners. ETML will display necessary information at workstations that could be in operation centres, either national, regional or local, or in signal boxes.

But OPTIRAILS should do much more than providing one type of information . However it would not be realistic to implement at time all the possible functions. In the example of the roof above all Rail partners, there would be a lot of pipes and wires linking everybody that should be phased.

5.2.4.3 *The will to implement ERTMS*

WP2 noted that most European countries are willing to implement ERTMS, but Switzerland has taken the lead towards start-up. The choice of the North- South corridor through the St Gotthard Pass is

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linked to the advantages offered by Switzerland in the area of international traffic and modern tools development.

The SURF system covering the network via traffic control centres is to be centralised in a federal control centre. There would be an opportunity to link this centre with Italy (Milan, for example at the beginning) and Germany (Frankfurt/ Main).

According to the interviews carried out as part of WP2, the Swiss federal railways could provide the best foundation for initial implementation of ETML and OPTIRAILS.

5.2.4.4 *Pressure of transport users and producers*

Even if each country is able to develop its own means to satisfy transport requirements, transport users are becoming European – or even operate worldwide. In a free open market area, the attractiveness of a transport depends on the service offering, and customers are particularly appreciative of good information services.

This implies a general requirement for some minimum level of service quality, whatever the country or operator. The latter can propose different levels of services at different rates. This means that the Infrastructure Managers will have to take path in demand and price into account, depending on services.

Operators can obtain transport information, thanks to latest technology support systems. The information that operators do not know is the decision made by the Infrastructure Managers in order to solve train conflict.

It can be assumed that future operators will want to seek decision making involvement to the extent that they have their own information – contact with their driver or crew.

The present situation in Operation Centres, with the usual national entities involved, can evolve towards a multilateral decision-making. So with a view to future complex operating situations, OPTIRAILS can help with decision-making, mainly by representing several operators, in so far as permitted by contract.

In conclusion, the three items discussed above point towards a favourable opportunity for European railways to introduce a new common approach. Common regulations will be provided by UIC and a will to implement ERTMS exists in Switzerland.

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5.2.4.5 *Implementation steps*

So, it is proposed to consider the following modules as necessary in a first step:

- Wide Highway of European Exchanges Layer, (WHEEL) which is the highway of information shown overlying IMs and TOCs in the diagram presenting the UIC standardised Data Exchange – Catalogue of Messages; this layer must be used for International Services.
- Delay Evolving to the End Dossier (DEED), analysis of the causes of delays and proposals concerning actions to correct delays, is a type of OPTIRAILS product which is intended to enhance service quality and also the infrastructure use.
- European OPTIRAILS partnership: as a result of the European directives concerning a fair access to infrastructure, an agreement on how to allow competition to operate appears necessary. A common support to the market can be provided by OPTIRAILS, either as "observer" or "partner", depending on the contract binding all partners to provide them with the requested services.
- Conversation in mother tongue is a module necessary to extend communication to many people using their own language. However, if first implemented in Switzerland (multilingual), it could be introduced only on trial basis during the first step.

The benefits expected from this first step are limited to freight traffic savings. So, the system implemented at this step should be designed to evolve with the envisaged production of Estimated Time of Arrival and the Arranged Immediate Deal, growing up with adequate means at each stage.

The results expected in terms of reducing of delays would be more important with each step. The most important reduction could be effected by combining all potential facilities provided by ERTMS/ETCS Level 2 (viz MORANE). Thanks to radio communication between trains and operations centres, all available information could be used to fast collaborative decision-making brought by OPTIRAILS, and then to disseminate consecutive instructions to all concerned bodies.

With the proposed arrangement working, it is assessed that the most possible efficiency could reduce the delays to almost a half of their present level. This assessment covers the predicted development of

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European freight rail traffic, the increase of which is due to raise problems or conflicts on infrastructure during the next decade.

The implementation phasing is proposed as follows.

Phase / Year	2000	2001	2002	2003	2004
Project design	studies				
FRS/SRS/Costs	validation				
Project tender		Approval	Contract		
Implementation			Works		
Commissioning				Tests	
Start of use					First step *

5.2.5 **Shaping Optirails**

5.2.5.1 *Long term view*

The full efficiency of a high-level traffic management system should not be restricted to monitoring functionality. Additional functionalities could make OPTIRAILS a reliable advisory system and, ultimately, a managerial entity trusted by all parties involved.

Here, the added value of the system will be a good prediction of the estimated time of arrival of international trains. Basically, that means the production of a two-hour maximum prediction, based on a calculation taking into account any change in the path allocated by IMs and resources managed by TOCs.

To implement such global optimisation, IMs and TOCs will negotiate an AID (Arranged Immediate Deal)., within the framework of OPTIRAILS.

This would be done by using the international data acquired by the OPTIRAILS operator to make a collaborative decision between the partners. The result could be a change of path, or a change in resources, or assistance to save time if an incident occurs.

Such decisions could be made referring to predetermined strategies (already agreed and recorded in OPTIRAILS large memory), or using more sophisticated tools (algorithms, simulators, etc) that are able to provide a solution under real-time conditions.

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These broad requirements will be useful in elaborating the FRS related to Options 3 to 6.

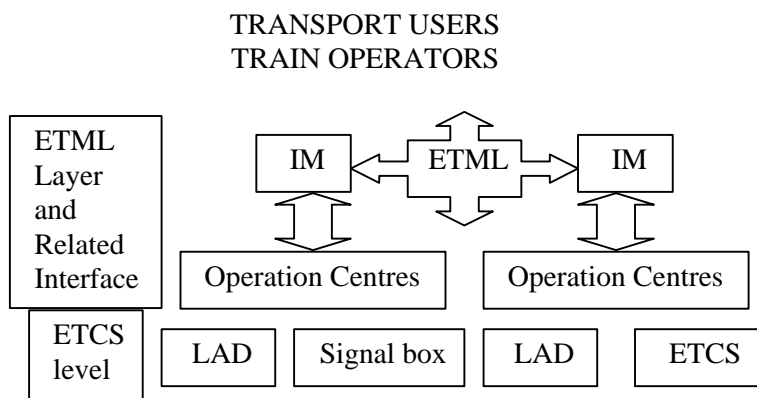
5.2.5.1 *Comments on ETCS and ETML in ERTMS*

The main findings of this report include differences between ETCS and ETML. As a result, ETML should take an increasing role in the future.

5.2.5.2.1 Difference of action time

For safety reasons ETCS will be confined in train control execution, e.g. signalling interfacing with trains. This means an action time depending on the case, from about one minute to few minutes before the exact “real-time” train run.

Considering that, now, ETCS only includes the Class 1 requirements, the others could be classified in ETML if a principle of continuity is admitted in ERTMS. If so, systems like ARS (Automatic Route Setting or Intelligent Route Setting) could be classified as Local Area Devices (LAD) related to ETML. The latter will have to work before the route setting by signalmen or LAD, to prepare for it, and after route- setting, to carry out quality control.



In the same way, modifying the timetable requires a traffic management process that could take place in ETML if done during the day of operation.

In so far as possible, the Arranged Immediate Deal (AID) made after the last timetable updating could include an agreement about the «arranged path» that would provide a new basis for delay

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calculation. ETML must also check the execution of transport by IM and to compare it with the expected result in order to update the Estimated Time of Arrival.

In conclusion, ETML would be acknowledged as including all out-of-safety elements working together in real-time traffic management, starting from the last timetable updating of the day and ending with the statement of arrival (train describer or any communication means).

5.2.5.2.2 Difference of processing

ETCS will be implemented on new lines, or on existing lines for replacing old fashioned equipment with a view to interoperability. An example of co-ordination between IM and TOC uses of ERTMS is given by the new German high-speed line that would be used by ICE to link Amsterdam and Frankfurt/Main. This is a bilateral agreement. There is no co-ordinated European masterplan for all TOCs and IMs, and corresponding to the interoperability progress along corridors.

ETML could be implemented everywhere in Europe according to the definition proposed above and to the natural implementation of national operation centres in every European country. However, using present signalling, train describer and operation centre equipment would not provide all expected benefits.

Some TOCs are going to implement for their own use many facilities using communication means and devices designed each time to attain one goal. Apparently, TOCs are going to satisfy their needs without ERTMS or GSM-R. The question of one masterplan should be raised concerning MORANE and the uses of GSM-R in the part of ERTMS out of ETCS.

In conclusion, ETML would be more useful for improving cross-border international traffic if there were a common will for implementing consistently ground and trains .

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5.2.6 **Conclusions**

5.2.6.1 *Main issues of Workpackage 2*

The real-time traffic management methods and tools, examined as part of WP2 for certain European countries, present three main characteristics:

- 1°) They are aimed at controlling product delivery despite the (actual or potential) occurrence of many events, only some of which can be controlled.
- 2°) They are used to solve complex operating problems, which depends on associating the Infrastructure Manager and the Train Operating Companies,
- 3°) They are close to the train command/ control systems, for safety reasons and also because of technology, the use of which is gathered among multilateral partners for economical purposes.

WP2 stressed that in all transport modes, there are several operating levels that work together to allow best use of capacities and damage reduction. Task-sharing is based on the legal territory where each Infrastructure Manager is responsible for public safety.

Traffic management must deal with the legal constraints integrated in the transport conditions, bearing on travel time and pricing, in so far as operators are informed about existing conditions. This is similarly done for road use by public transport companies (i.e. speed limitations and fees to be paid), and for air or rail capacity negotiation. But if all elements can be discussed and included in path allocation (in timetable negotiating), a real-time decision-making cannot use the same procedures.

WP2 concludes that not all conflicts can be solved by automated machines in the near future, even if some devices can help detection of them on lines equipped with a train describer. Most conflicts are to be controlled at a regional or national level, with a so-called Local Area Device (LAD), that provides operating staff with information on the traffic and so can be seen as a management tool. These devices are going to be co-ordinated by national centres in most of Europe, so that ETML would work with few partners at the European

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level - regional centres will be reduced to a number like 3 to 8, depending on the country.

The WP2 assessment of methods and tools contains proposals for developing actions in the area of service quality control. The main ideas correspond to long-range paths, where joining paths could be replaced by assembling paths, thanks to an overview of origin/destination and tools similar to the TRIS/ TRIO tools used in the EUROPE project. Other concepts are involved as well:

A Delay Evolving to End Dossier (DEED) is a kind of product not yet existing for international trains, because each Infrastructure Manager rates its territorial performance and there is no overall accountability except to the end users. Such analysis is assumed to highlight problems at the European level and to provide arguments in favour of capital expenditure policies.

An Arranged Immediate Deal (AID) is a formal way of recording what was agreed at the moment of making a real-time decision, an asset in terms of transport activity records.

WP2 also contains a description of a corridor through France, intended to help identify the problems involved in this specific case. It appears that a 1200km-long corridor features about 5 or 6 “problem nodes” and that interoperability should reduce them, probably substantially thanks to the cancellation of locomotive exchanges. This exercise also demonstrates a concept of corridor description that could inspire delay cause analysis with a view to future actions.

5.2.6.2 *Proposed inputs to Workpackage 3*

The following findings of WP2 are noted as input for WP3.

First, the figures concerning flights managed daily by the Central Flow Management Unit of EUROCONTROL (more than 20 000 per day) and the methods related, achieve a global optimisation over many areas giving their requirements to the central calculation unit. The comparison with the road sector also revealed the possibility of co- ordination between partners like the city of Paris, the ring road manager and the suburban highway network which each have their own problems. The general trend of national operation centres (Frankfurt/ Main) and SNCF in Paris to co-ordinate regional actions and to take into account the TOCs advice at the relevant level.

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Secondly the description of real-time traffic management based on the use of ETML and OPTIRAILS has placed a role for this activity in the chain of transport production:

- after timetable design (reference timetable for a long period),
- after timetable agreement (contractual timetable for the day of operation),
- after the pre-operational period in back-office (operational timetable updated with last-minute changes),
- now, when the AID (Arranged Immediate Deal) is involved, recording a decision “about” the contractual path,
- until the end of train running, each in turn.

It is noted that the multi-layer structure of some projects (MARCO and EUROPE TRIP/TRIS/TRIO) with a central system helping others, could be relevant. The recommended approach is to allocate responsibility to some areas like region or country and OPTIRAILS would coordinate path management and deal with train priority.

It is also observed that in every country, the IM or TOC is improving performance with the help of larger area management, but they lack information from neighbouring countries about actual paths, as well as simulation tools covering international corridors, controlled separately. These shared deficiencies open up a field for OPTIRAILS development in information, intercession or intervention.

For typical situations described the OPTIRAILS role is always to help partners to optimise the results for all, either via the Arranged Immediate Deal or by advice based on an “origin/ destination” view of paths. Here, the OPTIRAILS benefits represented delay analysis, a foundation for WP3, is outlined.

In conclusion, as far as inputs are concerned, it can be stated that OPTIRAILS can work with data captured in all areas of rail partners activity, thanks to their applying UIC “Traffic Management System”. The WP2 classification of relationship (Information, Intercession, Intervention) determines the drafting of the FRS to be followed in WP3 and according to six working options (monitoring, centralised information, path assembling, negotiation, procedural decision and managerial supervision).

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5.3 *Project design and feasibility assessment (WP3)*

5.3.1 **Introduction**

Two areas of work are covered by this part of the project programme as follows,

- The production of the Functional Requirements of a proposed Pan-European Traffic Management system .
- A preliminary Cost/Benefit Analysis of the proposed system

In setting down the functionality of the system, we are not necessarily looking for the ideal system, but for the best way to proceed.

5.3.2 **The critical success factors**

The critical success factors for this work have been identified as follows:

5.3.2.1 *Define the system targets, scope, performance, organisation and content needed to match the system objectives,*

The approach taken was affected to a large extent by the lack of a full set of User Requirements Specification. This situation is not uncommon at this stage in the thinking of new concepts, since some level of development is needed before the interests of potential users are understood.

The absence of a formal user requirements specification was compensated for in two ways as follows:

- By a breakdown of the system objectives (e.g. to introduce interoperability) into required system features
- By taking an unconstrained conceptual view of the requirements for rail transportation.

The earlier work of the project was then used to apply constraints in order to identify a feasible set of functions working within a pragmatic scope which takes into account existing and planned national infrastructures, acceptable relationships with involved organisations, technology, and cost. The design of proposed models

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was tested in this way, to show whether the system to be is feasible, or otherwise. (see figure 5.3.1)

5.3.2.2 *Understand the technical and organisational environments in which the system will operate and be supported,*

This area of work draws on the earlier work of the project, “*analysis of status*” and “*assessment of method and tools*”. The results of this work were used to understand the extent of a common infrastructure and problem set in order to judge the nature of an Optirails system as either one with standard interfaces to a common infrastructure dealing with a standard set of problems, or one of having to link with several different systems and having to tackle different types of problems depending on the country concerned at the time.

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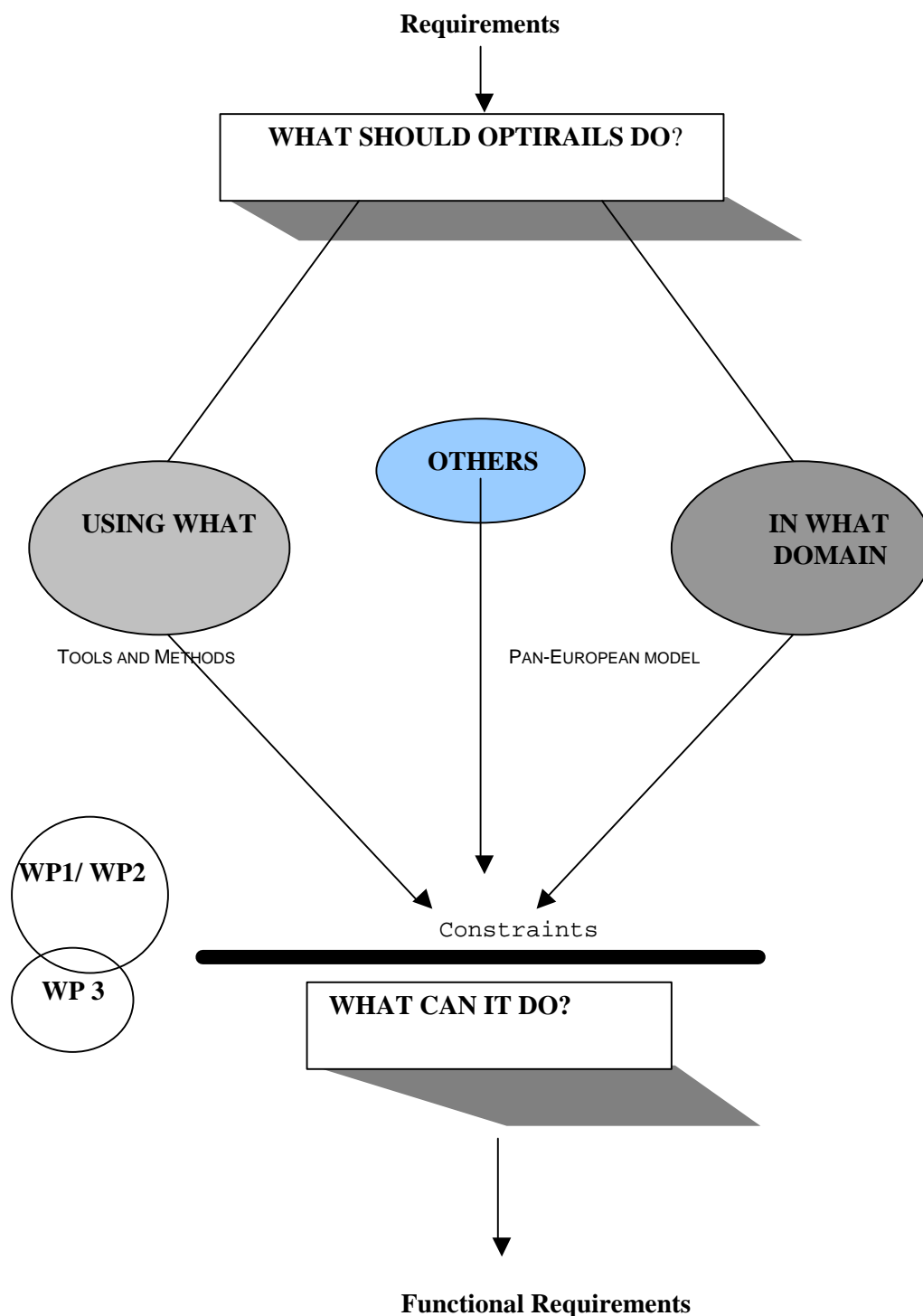


Figure 5.3.1 Schematic relationship between workpackages

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The common denominator of existing infrastructure and organisations is important. Optirails will operate with what is in place in the member states either currently or with future developments. It is unlikely that Optirails could drive forward the type and number of implementations at this time. Therefore, the level of commonality in supporting Optirails is a key issue in defining a single system for the corridors of Europe. A high level of common support offers the opportunity for common interfaces and functions. A low level of commonality would undermine the concept of a pan-European traffic management system since the consistency in functions and data exchange would be predominantly lost.

5.3.2.3 Identify the categories of problems to be handled by the system

Clearly the functions of the system will depend in part on the problems the system is handling. These problems have been defined at different levels of detail according to the position in the overall evolution to a full Optirails system managing a broad scope of problems. Earlier system functionality is well defined for an Infrastructure organisation as prime user of Optirails.

5.3.2.4 Understand what techniques are available for problem solving and their suitability to railways,

This understanding has been taken from earlier work on the project and use in defining the system functionality

5.3.2.5 Recognition of the separate challenges, technical, political, and value, facing the development and implementation of the proposed system.

Other factors, in addition to the technical requirements have been considered in defining the system functionality. Substantial consideration has been given to the possible relationships between Optirails and the organisations active in each country involved. The technical and organisational progress of Optirails may progress at different rates and this factor is considered of great importance in the development of the system.

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5.3.3 **Decomposition of objectives**

Analysis and decomposition of the stated objectives for Optirails has been done to assist in identifying the functional requirements.

5.3.3.1 *Interpretation of Objectives*

The objectives for Optirails were stated as follows;

Objective 1. To achieve interoperability in traffic management

Objective 2 To develop a single market

Objective 3 To deliver efficient and effective rail corridors

5.3.3.2 *Decomposition of Objectives*

Decomposition of Objective 1; to achieve interoperability in traffic management

To achieve this objective, a system including the following features is required.

- Identify Origin and Destination
- Monitoring and forecasting of a train`s progress by all on the corridor at any time
- Consistent monitoring and information dissemination
- Seamless borders (interchanges at borders match internal interchange efficiencies)
- Continuous (e.g. no discontinuities) process change along corridor
- Information sharing along the corridor
- Communications structure to support information exchange
- Harmonised procedures
- Multilingual exchange
- Predict problems and identify solutions independent of borders.
- Corridor-wide maintenance, cleaning, fuelling scheduling
- Corridor-wide crew scheduling
- Equity in decision criteria between freight and passenger trains and between national and international trains
- Contracts with several operators

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- Border priority systems
- Overview of cross border needs
- Corridor - wide thinking and decision making (including concepts of sharing “service damage”)

Decomposition of Objective 2

Does not contribute to particular functionality requirements

Decomposition of Objective 3 to achieve efficient and effective Rail corridors

To achieve this objective, a system including the following features is required.

- Corridor -wide service delivery (with particular new focus on Freight)
- Minimise delay and deviations from plans, (most cost-effective)
- Promote corridor-wide planning (particularly for all interchanges including inter-modal transfers)
- Exploit corridor-wide technology to achieve consistent performance

- Provide information along the corridor on which actions can be taken
- Corridor -wide connections awareness
- Strong links with National centres and simple cross-border links.

5.3.4 The conceptual approach to system requirements

The high-level, conceptual view taken of the requirements for Railways in general as a business, has identified the following critical success factors:

- Stay in Business! Meet the aspirations of its existing and new customers.
- Offer an attractive product. For example, frequent access, journey times, price, content, quality, and value for money.
- Informed and easy access to the product
- Cost-effective delivery of the product sold
- Customer satisfaction
- Sustain a competitive advantage

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- Having the right organization in place to develop, make and deliver the product
- Capability to have the business grown (including provision of international transport services) and to increase traffic flows
- Inspire Confidence (demonstrate proper management to shareholders and customers alike)
- A viable supporting infrastructure, with the features needed for the Optirails single approach, common across the systems of a specific corridor.
- Reliability in service delivery
- All elements working together
- Ability to manage exceptional conditions to protect service delivery
- Offer the right levels of information management, dissemination, collaboration and co-operation
- The communications structure to draw on the developments in individual systems to produce solutions that support the common good.
- Facilitate the negotiations needed between players in the fragmented railway to generate accepted solutions.

The European layer is expected to steer local choices in order to optimise traffic from an international point of view and manage the spread of information on a scale which promotes the common good for the corridor, to avoid local interests contrasting with more global ones.

These factors were used to identify a number of key objectives requiring a number of functions. A selection of key functions was made for inclusion in the proposed system from applying some unifying concepts.

5.3.4.1 *Proposed concepts to be used in defining the functions*

The next stage in the analysis of requirements was to identify the functions of the system needed to meet the objectives set down. Some concepts to start from were set down in order to guide the definition of functions . These concepts included,

- In order to provide a service, reliability is needed. To achieve reliability a realistic and workable plan is needed to which the operations adhere. The most cost-effective manner of service delivery is working to the plan.

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- It is recognized that no single person or function is responsible for the success or failure of objectives. Many functions play equally important roles in the operation. Each of these groups may only see a part of the overall operations. The success of the daily plan is a matter of properly managing all the resources to ensure that they are in the right place at the right time. The key to this is information management and the communications structure.
- In addition to sharing information, traffic management systems must support collaborative activity such as discussion, agreement, decision-making, delegation, exception handling, handing over tasks, and negotiation.
- Although no judgement is being made about levels of the traffic management organization, we need to recognize the added value opportunities from a European level
- The system must in its first role remain customer oriented.
- The key to performance improvement in railway traffic management beyond greater collaboration and information exchange, lies with the introduction of a proactive method of working.
- Although automation is possible in some areas of activity, technology will play a more significant role in supporting human operators, particularly in the decision-making activity.

These concepts are applied to the candidate functions impacting the critical success factors for the rail industry, to identify the most important to be reflected in the Specifications of Functional Requirements for Optirails.

5.3.5 Key Features of the traffic management system

The work on identifying system features has indicated that the key features of a Traffic Management system are, as follows,

- The collection and maintenance of data to produce a real-time computer model of the current operations on the corridor
- Processing the data of the model and disseminating the information either dynamically or on request, in the most appropriate form and level of detail depending on the user task being dealt with
- An analysis of the current conditions to identify potential operations problems requiring action and bringing the users attention to them together with the relevant information
- Tools to either generate solutions or to assist the user in formulating solutions

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- Maintaining the external links required to achieve intermodality
- Customer oriented in serving a wider transport market

These major features indicate an evolution of proposed traffic systems which will take the development from working with a greater knowledge of the current operating conditions, through to the prediction of several types of operating problems and technical assistance to identifying the best corrective measures to be taken.

The stages for which function definition has been given by the project are as follows,

- Option I - Operations Monitoring
- Option II - A Centralised information system
- Option III - International Path Assembling
- Option IV - Negotiation between Players
- Option V - Preliminary Solutions
- Option VI - Comprehensive solutions

The options are so structured that earlier options are included in the later ones and therefore, the functionality of an early option is contained in the later one. Functions are also designated *as mandatory, preferred, or nice to have*. These may change in some cases following a more detailed definition of user requirements.

There is a clear distinction made between an Optirails system acting to facilitate collaboration and information sharing between the parties involved in the traffic management on a specific corridor, and Optirails taking an active role in producing solutions to the problems encountered. This separation occurs in moving from Option IV to Option V where Optirails becomes a participating player in developing solutions of its own in the activities of managing the traffic.

5.3.6 Option 1 Data Monitoring System

5.3.6.1 Description

The data monitoring option provides a system of Optirails which is capable of capturing data automatically, storing it, and capable of processing requests for performance indicators derived from the captured data as an offline activity. This approach anticipates the emergence of a pan-European *performance regime* against which the

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performance of individual countries in delivering the service would be monitored.

The performance indicators required are of timings, costs, quality, flexibility and reliability of the service delivery from pan-European passenger and freight traffic.

In order to measure the current status of service delivery, the following key parameters need to be produced

- Timetable comparisons viz,
 - a) Reference timetable versus contracted timetable
 - b) Contracted timetable versus actual timetable
 - c) Scheduled timetable versus actual timetableComparison b) is a commercial measure
Comparison c) is a train control efficiency measure
- Number of cancellations
- The average time taken to recover timetable after a disturbance, (recovery is defined as back to a target timetable or within a specified margin)
- Average delay on the corridor
- Likelihood of large disruption arising from a minor disturbance
- Time lost at borders and reasons (and/or interchanges of resources at other places in general including within a national boundary e.g. yards)
- The accuracy of train time forecasts
- The status of the network
- Delay causes
- Affect on schedules of changing the tonnage or type of train
- Affect of changes to the train composition on the schedules

5.3.6.2 *Objectives*

The purpose of Optirails as a monitoring system is to collect and record data on the running of pan-European passenger and freight trains in order to identify the strengths and weaknesses of the current service delivery offered by this mode of transport.

5.3.6.3 *Method of functioning*

Optirails (Option 1) will be online to the national infrastructure systems of the member states. In some cases data will be received unsolicited at the time it is relevant for the national systems to send it. In other cases the data exchange will occur upon request. The data is stored to be available for the production of offline reports

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when requested by the Users. The data sent to Optirails is that which is normally automatically available from the current developments. There is no intention to require the national organisations to manually collect large amounts of data for Optirails purposes.

5.3.7 **Option II Centralised Information System**

5.3.7.1 *Description*

Option 2 is the centralised information system. Data similar to option 1 will be captured and used to provide online information to users. The user from a set menu will define a chosen set of the available information and the timing of its display. The requests for information which are allowed are given in the list below. Items included in < > represent the variable part of the request message.

- a) *Where is a <specified train>*
- b) *What is the estimated time at a <location>*
- c) *What route is the <train> on*
- d) *What is the next train at my <border>*
- e) *What is the status of the network in <country> (in terms of availability, congestion, faults, spare capacity for example)*
- f) *What are the likely delays from <location > to <location>*
- g) *What path access is available between <location> to <location> at <time>*
- h) *Why is a <train> delayed*
- i) *What delays are forecasted between <location> and <location> at <time>*
- j) *What reduction in infrastructure is planned at <location> on <day> at <time>*
- k) *What are the requirements for access to your <country> infrastructure*
- l) *What happened with actual train running on <day> (for example average delay and number of cancellations)*
- m) *What are the route availability parameters from <location> to <location> e.g. gauging, axle loads, train lengths etc.*
- n) *Print the actual and contracted timetables for <train> comparison*
- o) *Print the reference timetable and contracted timetable for <train> for comparison showing differences in times and high level routing.*
- p) *Print the reference timetable and actual timetable for all trains on the corridor for comparison showing differences in times and routing.*

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- q) What is the comparison of forecasted time and actual time for <train> at <location>
- r) What is the technical composition of <train>
- s) What is the expected load for <train>
- t) What is the expected occupancy of <train>at <locations>

The messages given above in italics can trigger on-going automatic transmission of data to the requesting IM

An important aspect of Optirails (option II) is the introduction for the first time, of the system attempting to give commitment to the service delivery of pan-European trains, by ensuring that Infrastructure managers get the information they need to provide traffic quality management.

5.3.7.2 *Objectives*

The objective of Optirails (Option II) is to promote enhanced quality service delivery from better informed infrastructure managers by establishing and maintaining a model of current operations and making available to users the information contained in the model either dynamically or by request .

5.3.7.3 *Method of functioning*

Optirails (Option II) will establish and maintain a model of current operations on the corridor through its links to the national systems of the Infrastructure organisations. This model will be used to provide operations information to the Infrastructure managers involved either dynamically or by request (see list of requests above). In the short term, the requests for information will only arise from the infrastructure organisations. However, they may act as agents for other interested users.

5.3.8 **Option III Path Assembly**

5.3.8.1 *Description*

The definition of the option is to combine individual path offerings (coming in response to a request to each particular country) in order to assemble an effective and feasible corridor-wide path that will best expedite progress of an international train

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The option begins to introduce a more proactive form of working in dealing with international trains. The provision of an expected path through one country of the corridor will enable other countries ahead on the route to make provision for its future path across their infrastructure.

Option III continues to build on the concept of an Optirails system taking responsibility and having a commitment to international trains. Its commitment under this option would be to work to attempt to safeguard the continuity and efficiency of the train's path along the length of the corridor.

This option seeks to judge the value of the path, in the context of the corridor, and to contribute to generate higher value paths by taking an overall view. On some occasions this may involve a further request for alternative path offerings from the national pathing systems which, it is anticipated, will feature in the infrastructure organisations.

Optirails (Option III) will bring proactive management to pathing, with the information and communications infrastructure required.

5.3.8.2 Objectives

The objective of Optirails(option III) is to improve the progress of a pan -European train by seeking to remove the unwanted discontinuities in the real-time pathing along the corridor.

5.3.8.3 Method of functioning

Optirails (Option III) would seek to ensure the smooth pathing of an international train along the corridor. For each country involved in the journey from origin to destination, Optirails would request details on the intended path for the train. The information would be processed by Optirails to determine the continuity and value of the path depending on some comparison of the estimated time at the destination with the target arrival time. Pathing improvements may be sought by requesting alternative pathing offers from one or more of the countries on the corridor. If the forecasted path is changed due to a change in circumstances, then Optirails would be informed and repeat the assembling task as required.

Information on the assembled path would be sent to the Infrastructure managers involved in order that they may plan ahead and make provision for the train.

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5.3.9 **Option IV Negotiation with actors**

5.3.9.1 *Description*

This option facilitates an online exchange of views between actors in order to develop a consensus between them on a train path country by country, for trains whose planned path has become unavailable or is no longer suitable or possible due to other reasons. For example, the required resources are not available. In performing the role of facilitator, in this option, Optirails does not bring its own solutions to the negotiations. It will act as `honest broker` to encourage solutions. For example, Optirails may suggest an alternative timing for a possession by one infrastructure organisation, in order to keep a specific international train on a specific path that will prove beneficial on another section of the corridor, contributing to the overall progress of the train.

Optirails involvement in negotiations will depend on its knowledge/information on what is happening. The degree to which it is in touch. Options I, II,III contribute data on train timings and pathing. However, in option IV, new data, additional to earlier options, is envisaged in Optirails, that will introduce it to other issues, such as stock and crew resourcing.

Negotiations deal with real time problems. Negotiated solutions to the following will be attempted by Option 4:

- Path assembling problems arising from delays, changes in infrastructure status and resources problems
- Agreement on Freight arrival windows
- Operations management problems involving crews, wagons, locomotives, advisory speeds

This approach relies on the openness of offers from the players and willingness of players to achieve the common good. OPTIRAILS seeks to achieve co-operation, not combative operation. The concept of sharing disbenefits among players along the corridor is introduced. Other players which may not be directly involved in the first place, but which are known to be able to contribute to a solution, for example, they may have resources available, could be brought into the negotiations by Optirails.

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5.3.9.2 *Objectives*

The objective of Optirails (Option IV) is to seek to improve the management of international traffic by acting as a facilitator of negotiations between the parties involved in order to achieve solutions to problems which offer the common good to operations on the corridor

5.3.9.3 *Method of functioning*

Optirails (optionIV) will use its model of current operations captured as a function of Optirails (Option I) to identify, or be informed of circumstances or conditions which are counter to the overall success of the traffic management of the corridor. These issues will be raised with the players involved in order to promote negotiations between them to solve or avoid the problems affecting the flow of traffic along the corridor.

5.3.10 **Option V Optirails as a Player**

5.3.10.1 *Description*

At this stage of development, Optirails (Option V) will begin to be able of predicting potential problems along the corridor and calculating solutions itself. The process of selecting solutions will be through negotiation similar to option IV. However, in this option V, solutions from Optirails will be available for consideration. For this option, the model of current operations will need to contain data on national trains in addition to the international trains and a model of the network infrastructure at an appropriate level of detail in order to identify potential conflicts and be capable of generating solutions. The value of Optirails predicting potential problems and calculating solutions itself, arises from Optirails having a different perspective on the operations than the national organisations, Optirails will be taking a view from the international train perspective in proposing solutions for the common good of the corridor. The national organisations are more likely to have delivery of the national services as their highest priority (especially when making decisions involving international freight trains). Under this option, Optirails begins to actively champion international trains.

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Optirails (option V) will restrict its problem prediction and resolution activities to those of train pathing from a timing element. The availability of resources such as crews, in judging the overall viability of the path will not be considered at this stage. Optirails in its solutions will be seeking to reduce avoidable delay to international trains in a way that respects the requirements of national trains. Optirails may mature during this stage of development to a system whose solutions are accepted without negotiation and which can be implemented as a recommendation, or automatically in some cases.

5.3.10.2 *Objectives*

The objective of Optirails (option V) is to begin to represent explicitly international trains in managing the operations along the specified corridor and to bring international train-led solutions into the negotiating process of determining the common good for the corridor.

5.3.10.3 *Method of functioning*

Optirails (option V) will use its model of current operations, enhanced to include national train services and network infrastructure to identify potential problems and its problem solving tools to calculate solutions. The solutions are designed to deliver the effective progress of the international trains along the corridor, and give reasonable consideration to the needs of the national train services. Solutions from Optirails are included in the negotiated solution for the corridor as a whole. For example, a particular pathing solution identified by Optirails may enable agreement from another player to have the necessary resources, (say) available at the forecasted time.

5.3.11 *Option VI Full tools*

5.3.11.1 *Description*

Optirails (option VI) is a more capable player than Option V in terms of the methods it contains, and with a bigger scope to recognise and tackle a broader range of problems.

The option is likely to evolve with technology and with the growing acceptance of Optirails as a valuable system, from advising to directive in its relationship with national systems. The problems to be tackled by this option will include;

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- Delay
- Cross-border discontinuities in time and resources availability
- Disruption to national service delivery by international trains
- Lack of capacity for international trains
- Lack of information on international trains
- Sharing service damage between countries

For each of these types of problem, Optirails will be capable of making its own positive contribution towards a solution that seeks the common good for all traffic on the corridor.

5.3.11.2 Objectives

The purpose of Optirails (option VI) is to provide a system capable of recognising most of the operating problems that reduce the quality of service offered from international trains and resolving them in a way that minimises the damages to service delivery (e.g. delay)

5.3.11.3 Method of functioning

The system will work from a comprehensive model of the operations on the corridor and its network implementing its own tools for problem prediction and resolution. The benefit of using its own tools, is that they will tackle the problems based on criteria focussing on international traffic. This will ensure an international perspective to the problem solving. The protocol employed between Optirails and the national centres will protect against inconsistent decision making and conflicting objectives. Optirails decisions will continue to be implemented through the national centres and a fully collaborative exchange of information will be established to ensure a common understanding of the corrective measures being recommended or taken. There will be a range of information dissemination channels (e.g. internet, teleconferencing) and which may include the system being open to end users who may require information on current operations.

Several options have been identified for Optirails systems. For each option, the functional requirements have been defined, and included in one library of functional requirements. The specific functions are then extracted from the library for each Optirails option and referred to in the relevant section describing the option.

Interfacing and support system requirements applying to each option are also included in the section relevant to a specific option.

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Interface requirements between Optirails and National systems have been identified. The interface definition is at a high level and seeks to identify the national systems involved, what they do and what developments might be needed to support Optirails better.

It was decided that it was not appropriate to define specific messages and message formats at this stage of the specification work. The work done by UIC contained in document “*Specification for standard data exchange*” is recognised but was considered to be more relevant to the SRS stage in Optirails II. These message formats will represent a constraint on the SRS since where specific data is recognised as needed to be exchanged, the appropriate message, if it exists should be used to prevent Optirails from generating non standard messages.

Also the recognition of the need for tools within Optirails has changed between WP 2 and WP 3.

Earlier thoughts assumed Optirails would capture data and use its own installed tools to identify and solve problems. However, within the study it was recognised that this approach was too ambitious, inefficient and would not encourage acceptance of Optirails by the National organisations. Using the tools installed within the National centres as agents to problem solving at the corridor level seems more plausible, effective and possible, at least in the shorter term. Problem solving on the railways is different from the challenges facing Eurocontrol for example. Many of the problems have significant local elements that must be taken into account. Using local data and local tools appears to be a more feasible approach in our view.

5.3.12 Tools performance criteria

5.3.12.1 Introduction

The potential performance of prospective tools to be used in Optirails has been considered in detail with the following conclusions:

- New train management system concepts should focus on flexibility and co-operative procedures.
- A two-system, two-level general system framework should be clearly identified and management rulings set up for European

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railway corridors: i.e. passenger and freight transport, tactical and strategic control areas.

- Besides specific conditions, where passengers traffics can be considered the prime user of the infrastructure, freight exploitation should be managed in more flexible ways.
- New path management should be explored. In particular the traditional “fixed path” concept could be substituted with the “scheduling area management” model, between the “best guaranteed” and “maximum allowed commercial” speed.
- Owing to traffic contingencies, transport operators should be given “explicit” ability to re-schedule (e.g. postpone) their train departure time, and infrastructure managers would provide new agreed and quality-referenced scheduling plans.
- Performance about train delivery and delays should be rationally revealed and reported; in particular TOC related delays or re-scheduling requirements should be kept separate and each IM performance should be clearly identified.
- The optimisation criteria for running and control trains over European corridors should take into account economic factors of both infrastructure management and transport operators.

In principle for some questions the proposed solution can have “pros” and “cons”; specifically in this subject we can easily find that for any “pro” there is at least one objecting “con”. Therefore we should be clever in identifying which one is the better compromise for making improvements and taking the system to a more favourable, dynamic equilibrium working point.

The first step was a consideration of the rail process model. The next step covered a consideration of the path management process and followed with a number of scenarios for path management requirements from users. An understanding of the dynamics of path management has been attempted through a series of state transition diagrams showing the dynamics of the process.

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5.3.12.2 Railway Process

The first step is a general definition of the railway process.

In this phase processes and sub-processes are identified both for Train Operators and for Infrastructure Operators; inside Infrastructure Operators Track Management and Path Management are distinctly detailed.

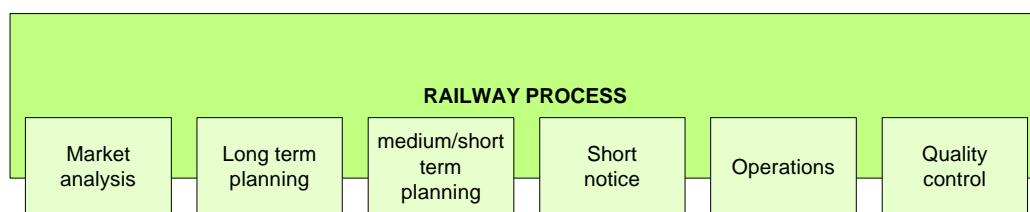


Figure 5.3.2 Railway process

The following figure summarises the relationships involved

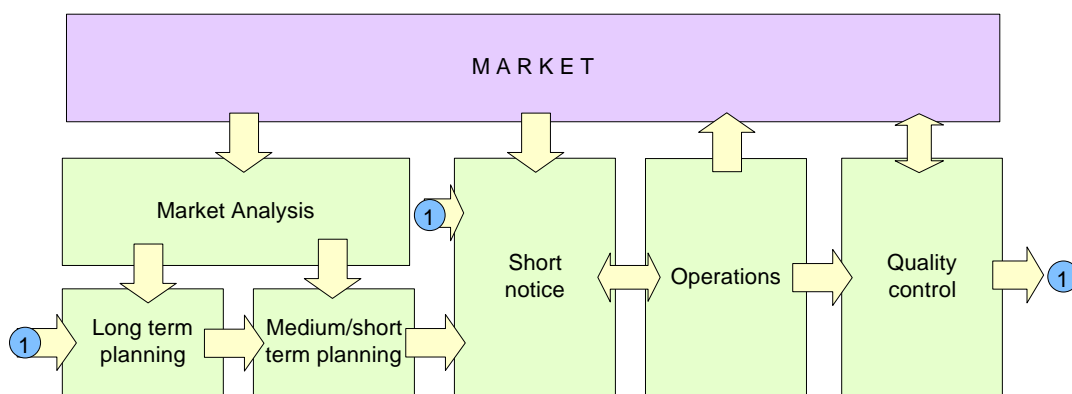


Figure 5.3.3: process model

The links between Operations/Quality control, and the Markets represent Service delivery, the target of Optirails.

In the second step, Path Management sub-process is specified defining its components and its interfaces with Train Operators and Track Management.

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5.3.13 **Path management**

Starting from previous process model, now we focus on path management process.

5.3.13.1 Process model

This chapter specifies path management process model.

The following figure shows the railway process where “path management” is detailed while TOC’s activities and track management functions (summarised with grey boxes) are considered as external entities.

Two other external entities are showed (in a shadowed box):

- the box “External events” is related to everything which could lead to a disruption in planned actions (both for track maintenance and train running);
- the box “Strategy” represents the strategic driver of the process showing the business targets to be achieved.

The following activities are defined:

- Path request/offer
- Timetable planning
- Contingency planning
- Possession management
- Real time traffic management
- Real time monitoring
- Post sale management

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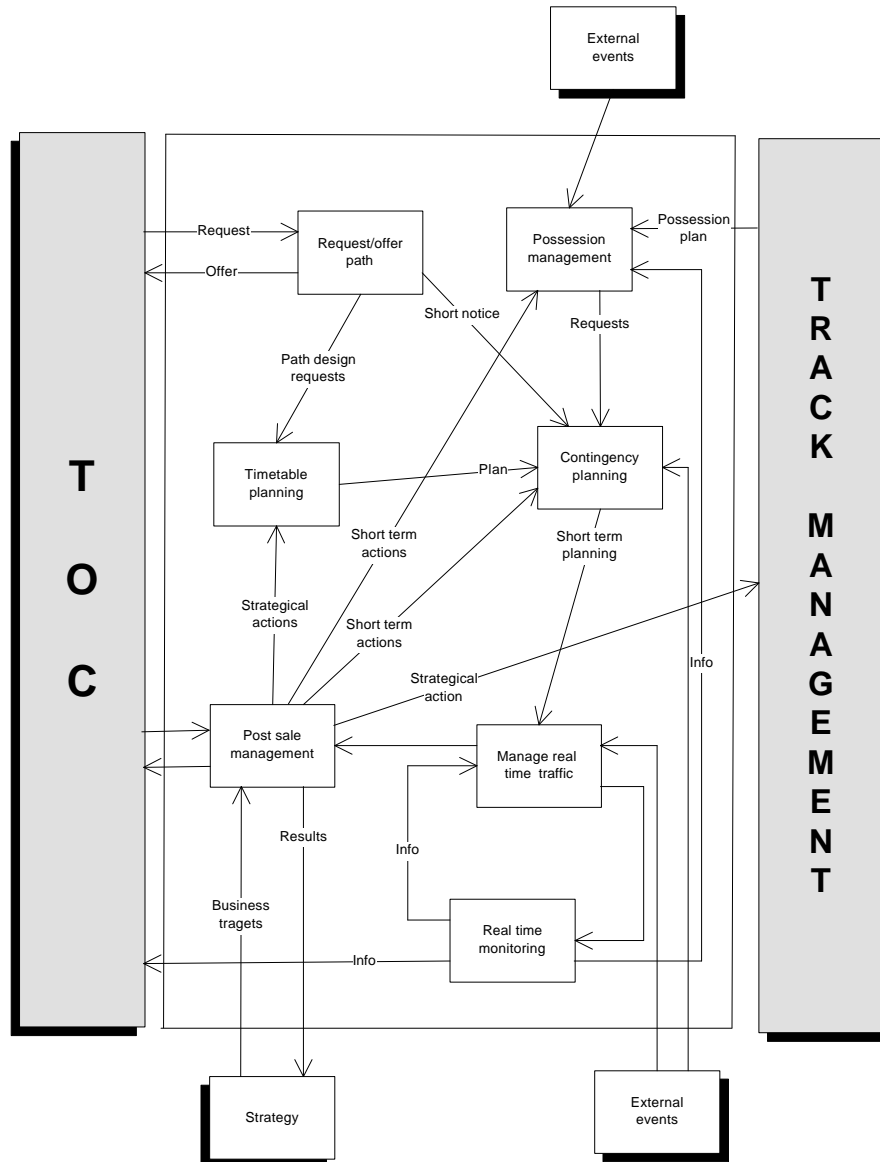


Figure 5.3.4 : Path management process

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In the third step some scenarios are provided specifying users' needs. Interaction diagrams are used to define scenarios.

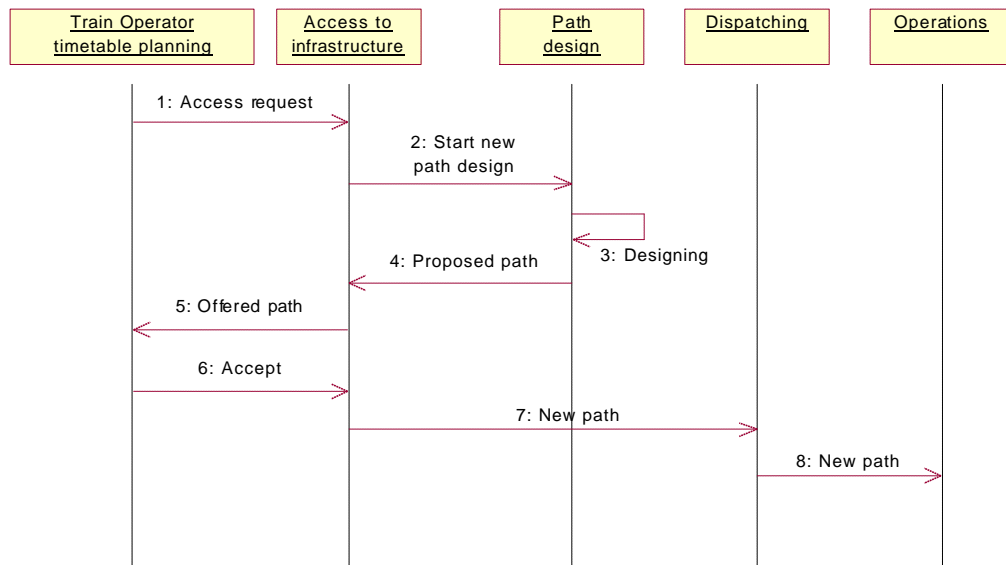


Figure 5.3.5 : Interaction diagrams

Finally a process model for “Short notice path management” is defined, using path life cycle as guideline. Both static and dynamic behaviour are provided using a State Transition Diagram where nodes represent states and arcs actions.

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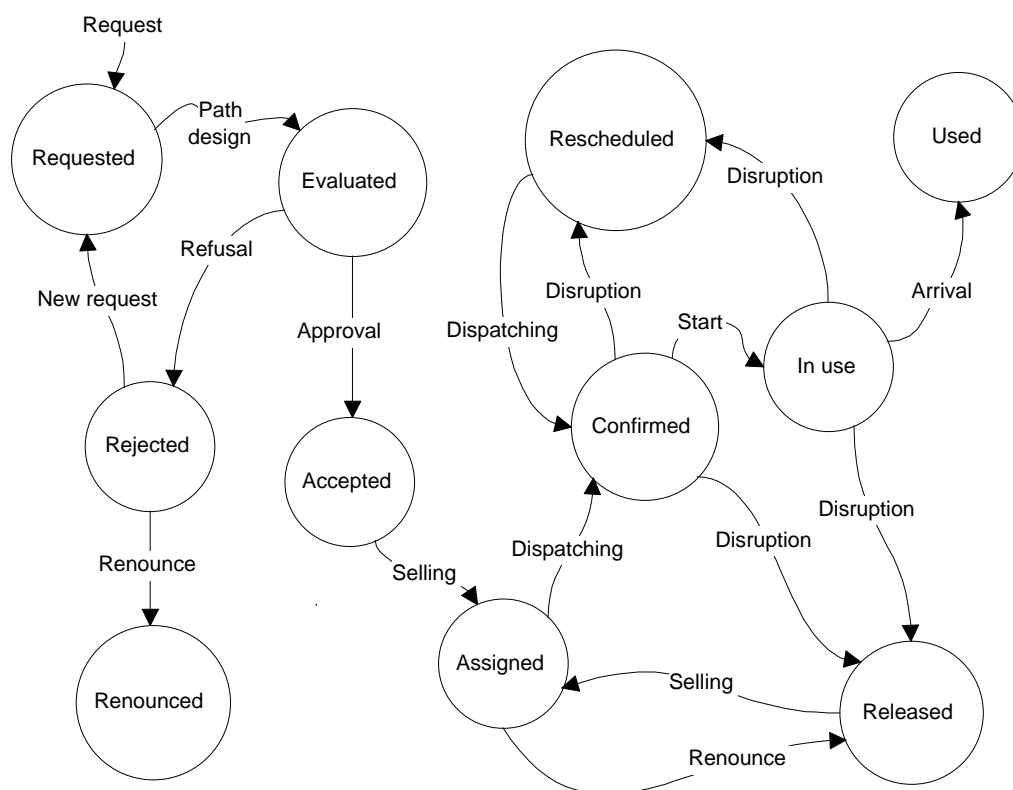


Figure 5.3.6 : State transition diagram

5.3.14 **Criteria for Path Optimisation**

The aim of this work is to provide a framework for addressing the problem of rail transport “optimisation” in view of European, long-distance corridors, where new control and co-ordination systems can be implemented.

The main focus of this note is to address conceptual analysis and give some operational hints that can be verified and exploited in further stages of the project (i.e. system requirements, specifications and prototyping validation).

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5.3.14.1 *System Context*

5.3.14.1.1 Introduction

We first introduce a general survey of problems facing the meaning of rail traffic optimisation and current situation of long-distance corridor (i.e. Freightways) corridor exploitation; then focus our main interest on freight transport development and ways to improve it by offering a flexible and affordable model for needs specific on European scale; finally we propose a conceptual framework based on flexible scheduling and co-operation among infrastructure managers. This is aimed to be a supporting basis to fit in medium and higher option exploitation of OPTIRAILS.

5.3.14.1.2 Rail traffic optimisation: a difficult concept

The word “optimisation” is generally esoteric and represents a concept which may be “limited” in scope or misunderstood. Firstly it implies the “correct” problem boundaries and definition, which cannot be either an easy task. Optimising the wrong problem would be useless, labour wasteful and perhaps even dangerous. Therefore it implies the correct understanding of the system and of final user real needs and requirements.

This should introduce a more customer oriented approach before formalising system requirements and technical solutions.

Optimisation is moreover a global concept in complex system management, like railway transportation. Confining ourselves to very limited views and aspects of the system to be “optimised” might also result in poor and useless exercise; e.g. spending a large amount of intellectual and financial resources for optimising one criterion having very small influence on the overall system process and performance.

The definition of this project task would have been better, e.g., criteria for improving service effectiveness of European rail corridors; more generally, increasing the attractiveness and development of international rail transport, which is in fact the target of OPTIRAILS as well as of other related projects.

Nevertheless we should in any case confine ourselves to more limited and operational issues, that however require more strategic and policy objectives be clearly set in the background. Being interoperability, European network development and freightways exploitation the general major concerns, we should at

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least determine how the optimisation criteria fit in the overall scenario, where our project is aimed at putting foundation for a European Train Management Layer (ETML) within the ERTMS framework.

In addition we should constrain our thinking to “fixed” or given infrastructure (as well as existing rolling stock), being not the present scope to analyse whether new line investments or high speed freight lines are to be built; which may also involve much greater optimisation criteria and decisions.

So optimise what?

We could first focus our reasoning on two terms of reference: *logistic supply chain* and *flexibility*.

Furthermore we should highlight that we are addressing here the “European” level question and not simply classical or local optimisation problems, which is not the scope of OPTIRAILS.

We were tempted to write this note starting from the usual definition of an optimisation problem, e.g. which optimisation function is to be minimised, e.g. traditional train delays, which are the constraints to be satisfied and so on; then providing a lengthy literature survey, and finally proposing some mathematical model which could have been, in the best case, a modest make up of current ones.

We have refrained from doing so. Firstly because it would have been a very classical approach; secondly because some scholarly material is already available and present in other EU-RTD funded project documentation or similar, as we see in the aftermath; thirdly, we believe it would be better giving a contribution to help thinking and brainstorming on the “real” problem before accepting standard and more traditional (may be easier) solutions.

In summary we should try to investigate “lateral” solutions that may be a bit innovative and may suggest some re-engineering exercise in order to improve the European railways rating as more attractive, friendly and reliable system.

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5.3.14.1.3 Two business systems

One should first recall that European railways are a two-business system, i.e. passenger and freight transportation. In fact these can be very different and be dependent upon specific requirements and market drivers. When addressing “system” planning and customer management, one should take into account diverse characteristics and client needs.

Are the passengers and freight requirements the same or can the “same” business model apply to both of them?

Open access principles for infrastructure management may have introduced some ambiguous notions about the same rights to accommodate customers (passenger and freight trains) which are in fact different and require specific services.

Needless to say, passenger transportation needs to be very tight and accurately, say rigidly scheduled; moreover in many cases it maintains natural priorities which can be hardly questioned e.g. by simple market mechanisms (based on access fee competition or willingness to pay).

Therefore one should be careful and accept the idea that, besides particular conditions, passenger traffic is the first client (prime user) and would benefit of path allocation priorities.

In this context the question is more co-ordination than competition; this can appear a more antiquate and questionable view, but in fact it represents reality, at least in the short run (i.e. fixed infrastructure capacity).

In many situations where rail infrastructure is people saturated, there is no freight possibility but using the residual capacity and perform average passenger commercial speeds. This can require either higher speed freight trains or impose some pathing constraints and generalised “flexing”, as it may happen to high speed passenger trains in very saturated metropolitan areas.

On the other hand, (at least) some types of freight transport do not need the binding delivery timings required by passengers, and a more flexible infrastructure usage could be tolerated. This may not be the accepted case, when freight transport operators try to trade off increased speed performance with system reliability (!).

Following European directives and railways deregulation, it appears that access-to-infrastructure is just “one” problem and some dogmatic solution has to be found.

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Instead, due to network diversity and operating conditions, the problem needs to be differently managed, say setting priorities according to type of rail line (zone of line section) and period of service (time windows).

Therefore there may be no absolute optimisation function, with the same model and parameters working in “all the seasons”.

There are particular or exceptional conditions where any conventional objective function can disappear and other factors or priorities come into play.

Many attempts in the past to provide train control centres with the more sophisticated algorithms to help real-time train management activities have been in fact unsuccessful due to their inability to manage different scenarios.

At the same time not too much has been developed about contingency and incident management support systems.

Another issue that is becoming important in defining the optimisation function is the economic impact of those decisions implying real time train management and regulation. The so-called “performance regime”, which would govern contracts between the infrastructure management and train operators, could become one of the leading parameters for taking decisions.

However we would not like to have contracts between IM and TO too rigidly and unilaterally based on delay accountancy, as will be discussed in the aftermath.

In general, once the priority passenger traffic is accommodated, the rest of capacity - which can also be very high with respect to market needs - should then be “optimised” for other passenger and mostly freight operations.

Finally there may be other situations where passenger and freight transport can be fair competitors in accessing the same infrastructure, and that could be resolved by some market mechanism.

Where the residual or freight allocable capacity really becomes a market obstacle, and no other network (e.g. alternate routes) solutions are available, infrastructure development is unavoidable.

In general, we assume in this note that passenger traffic is already fairly well optimised and is given in current operation the best effort to tightly respect the published timetable.

On the other hand freight can represent the more short term growth opportunity for European corridors.

For these reasons we are addressing here train management criteria that can most fit in freight transportation.

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But the main question is: what are the freight business needs?

5.3.14.1.4 Logistic chain performance: the real problem

Long distance rail transport is to be considered as one segment of the more general logistic chain, and in many cases it is the most important, owing to time and resources involved. In this context it should not represent the “weakest ring” of the chain, for the traffic would shift to other transport modes (e.g. road).

What does the competing mode offer and which are its key factors?

Common answer is:

Speed, flexibility, block (door-to-door) service, price, regularity, quality of service, including information and customer relations.

Then what railway optimisation need to be competitive?

Being this note limited to infrastructure management, the main pertinent issues addressed by OPTIRAILS should regard commercial speed, regularity, quality of service and most flexibility; finally *information* is the means through which all the others can be optimised, given other physical constraints.

Besides passenger trains regularity, due to their fixed schedules, we assume that optimising the “*commercial*” *speed* and *flexibility* of freight transport can represent the very target of this OPTIRAILS project task. Given other parameters be acceptable for the final market (specifically total transport price), *and* better integration in the overall logistic chain, these factors can doubtless increase the railway attractiveness and its market share.

Rail commercial or block speed already compares very favourably with road transport, where some speed limits also apply. Instead rail regularity and service reliability are generally criticised.

As a result, railway freight departments tend to impose higher speed to their trains, and put pressure on infrastructure management to draw even faster and “tight” paths on the timetable diagram. Unfortunately, traffic regularity records do not always follow the expected targets, due to many reasons. For instance trains are often delivered (loaded by the customer) and set up late of schedule, and cannot comply the nominal timetable; in fact once the nominal tight path is lost, one can no longer guarantee the scheduled timetable.

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The infrastructure management could impose contractual penalties for train delivery delays, but this would be unfriendly and questionable policy in very competitive markets. Train material preparation and composition times are very often dependent on factors which are outside the railway system (e.g. ship, truck arrival); which, through a relatively rigid timetable, may nevertheless be very sensitive to variations of external conditions. In optimisation related algorithms, this means great sensitivity to initial conditions, while the railway system robustness is generally low.

In order to increase service speed, rail transport managers require more powerful engines and faster rolling stock, which however provide only limited benefits at system level and increase operating costs. The major cost benefit from increasing speed of freight trains can be in crew management, which is nevertheless very much sensitive to service regularity (e.g. overwork costs).

Do we only need very much faster freight trains, rigid timetables and very compelling contracts between IM and Transport Operators, who are already pressured by other market strains?

At the same time, major efforts in the rail industry, aimed at increasing rolling stock maximum speed, should be devoted the same to improving material reliability and other cost effects on infrastructure usage. Another productivity trend, followed by some railways, is increasing the maximum axle load.

This view may be a bit unconventional, but aims at stressing focus on effectiveness and cost-benefit considerations at system level. In other words, the commercial speed of freight transport on trans-European corridors, being the main system performance in the logistic chain, is only partly dependent upon maximum rolling stock design speed.

In addition, being the design or operating speed of trains much higher than the commercial one, the system should be able to make more profit of sufficient “slack” time and still satisfy the final customer requirements.

“Slack time” in the logistic chain can be the difference at arrival station between what is guaranteed by the minimal appealing commercial speed and the nominal arrival time, at the permitted operating speeds (which can also vary on different line sections).

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Besides other factors (like operating costs), the commercial speed is the one imposed for one being competitive in the market, including:

- train stops and other station operations (engine change, technical checks, crew relief etc...)
- margins for recovering train run irregularities
- path flexing due to timetable construction
- delayed departure time (that can be a maximum allowance for the transport operator)
- transport terminal operations.

The arrival time to be guaranteed by the commercial speed is obviously the latest one tolerated by the service to be market appealing.

In other cases an additional criterion can be imposed, that is the arrival time at destination must be kept within some given limit (e.g. goods delivery or consignment time).

One can suggest that the most optimising criterion for the railway segment, within other constraints, is to maintain the commercial speed of a given transport within the limits that can be imposed or accepted by the logistic chain.

These requirements can be trivial, but are more market (user) oriented and different than requiring “high speed freight trains with no delays”.

Our general view, which will be commented in the aftermath, is depicted in the following figure.

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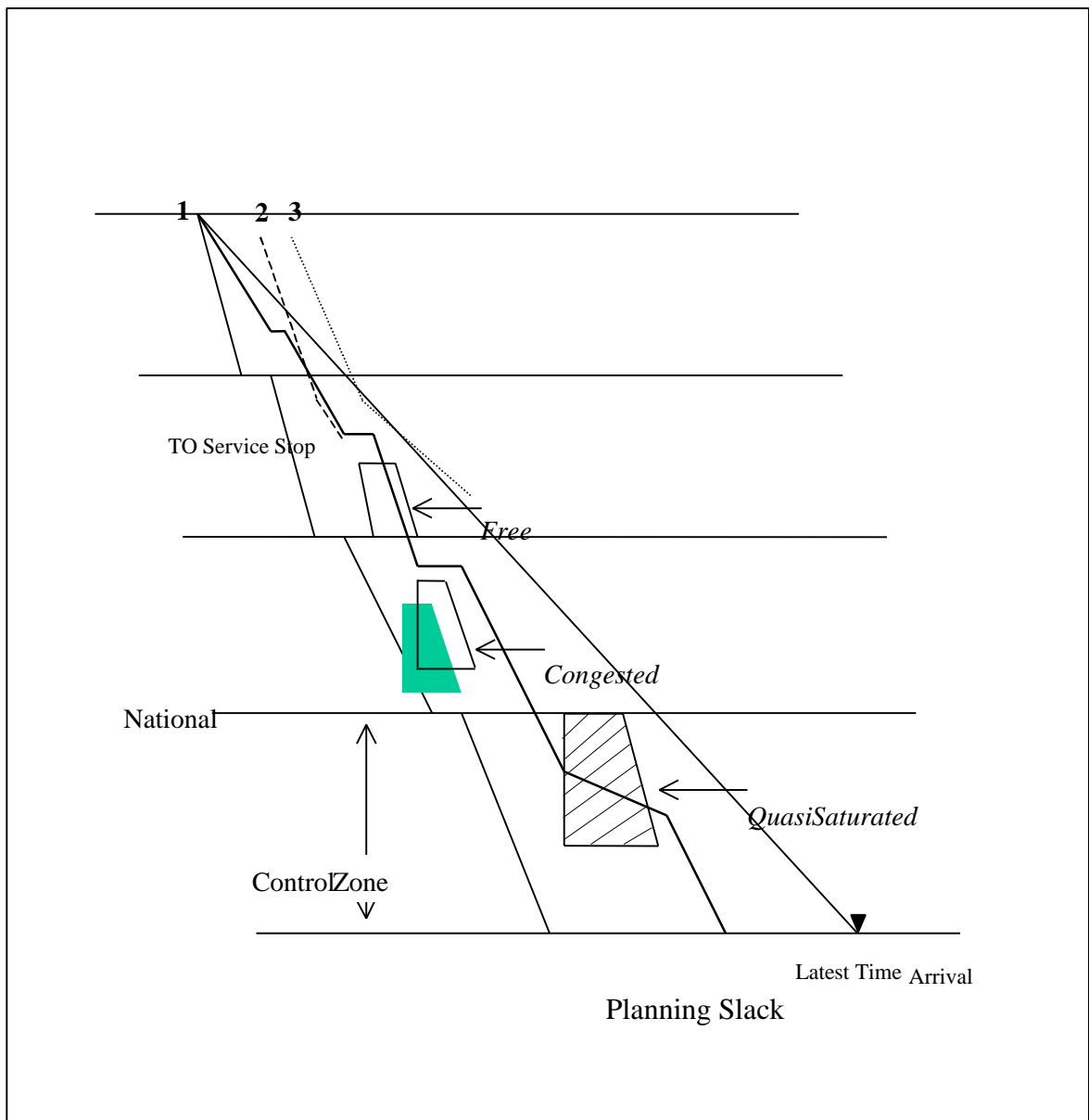


Figure 5.3.7: Flexible scheduling on long-distance corridor

Briefly we are proposing a freight train scheduling and management model with a slack time in the order of 10-15% current operating delivery time. This can be +2 hours for some European corridor management.

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5.3.14.2 Flexibility Requirements for the Business model

Flexibility is the most important means that railways must follow to cope with new market context: the railway bid in transportation market must be able to change quickly to fit with customers' needs.

Particularly for freight transportation a long term planning is no more the right way to offer the access to infrastructure.

So railway companies must re-engineer their business processes to become able to reply to short noticed market requests. Both in timetable planning and operations some process modifications must be carried out to make the infrastructure management able to become flexible.

With "flexibility" we do not mean only the ability in modifying the plan in order to satisfy customers' needs but also, and mainly, the ability in making a "new" plan where a part of it comes from long term planning and another part is designed every time it's necessary. To obtain this all the processes must be flexible: so not only the planning stage must be re-engineered but the dissemination phase has to change as well.

Moreover the "flexibility challenge" does not only concern Infrastructure Managers but also Train Operators. Train Operators are involved both as resource planning actors and as target in dissemination phase. Train Operators resource planning phase must be as flexible as the Infrastructure Managers timetabling one: in fact, in the time required to reply to a short notice request the time taken by the resource planning phase must obviously be considered too.

In order to realise all these activities two issues must be remembered:

- Information can reach everyone needing it in very short time only by means of an appropriate Information Technology Support.
- The required flexibility can be achieved, only by means of appropriate changes to regulation processes.

Another key word to look at as a guideline is "co-operative model". International railway transportation must be considered as a whole by every national Infrastructure Operator involved in the process. So a co-operative model must be used to avoid that local interest contrast with global ones.

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Some initiatives should be carried out to promote co-operative model. Incentives should be designed to guide local organisation choices forward a global management of international trains.

Finally, before the new business model for short notice and reactive path management on long-distance European corridors can be implemented, a basic understanding of our main object – the train “path” – must be reached among all the concerned parties (i.e. railways and their information systems developers). Central to this is to agree on some fundamental properties or “states” a path can assume during its overall life-cycle.

On the basis of such a diagram, path behaviour or path management scenarios can also be easily drawn in order to complete process analysis. In addition e.g. once path is assigned to one service, it cannot be allocated to another, and this would recommend its state uniqueness.

The situation and current path state should be also allowed to change due to various events, which would require in parallel dynamic path manageability. This can be driven both by contingency (short-notice) occurring or real-time events (as defined in other OPTIRAILS project sections), though the interest of the present section is focusing on the former. In fact we assume that the long distance European corridor management is here the main theme, while the real-time or short-distance path management is another scope.

What does it happen if the train loses its assigned path ?

The question is only partly different from the requirement to provide a path whenever some client is asking for it.

In summary this requires flexibility, an issue that is often debated when questioning about current railways pitfalls. At the same time, lack of flexibility is usually considered a railway drawback vs. road competition.

*How much is the slack time of road transport?
What does it mean a path is “fixed”?*

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Truly fixed paths do not likely exist, as in fact they only nominally follow the scheduled timetable, with random (even minor) variations. The fixed path schedule is therefore only a reference control variable that continuously needs to be updated. Moreover a path is generally lost when a train delays its departure, for any reason, say, only by a few minutes and it needs to be rescheduled (!).

A similar problem arises when the path requires being more heavily re-scheduled, because, as one says, it has lost its slot. For freight traffic this can frequently happen for exogenous reasons, that in many cases should not be recorded as true “delays”. On the other hand railways cannot change either the environment constraints or some rules of the market.

Flexibility also means the ability to make real time schedule re-design according to market needs and logistic chain variations.

A general assumption is that by offering a fixed quality train schedule, the market development in the long run can be improved but this is still to be demonstrated, if the logistic chain has contingency cycles shorter than those required to stabilise the demand.

This does not obviously apply to all kinds of transport (there are traffics that are more regular than others are), but the question remains whether flexibility should remain an intrinsic design factor and become a key driver of railway performance.

Traditional freight plans aim obviously at solving the timetable “stability” problems, being meshed with the passenger network, and subject to other organisational or technological constraints. But we believe railways can be more flexible than they are, or they are supposed to be.

Put it another way, it could be questionable to counteract a naturally “stochastic” system by trying to make it even more “deterministic”. That would require so much energy and organisational control power that railways, like other systems, have not yet been able to demonstrate in the past decades.

A different strategy would be to increase its robustness through flexibility and more adaptive behaviour.

One can question when a path is “optimal”. From the classical dispatcher point of view, it can be if it is easy to manage, or can be flexed (within the assigned bounds) without having impact on other schedules, and it can easily recover delays.

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Flexing means the necessity to stretch (slow) the train due to some reason, like permitting an overtake or make it parallel to a slower train.

Flexibility is therefore obtained by allowing the departure time shift on the time axis (at least within certain limits), flexing its nominal (i.e. maximum speed) running times and stopping trains for other causes (e.g. before a possession for maintenance ceases). If all that is or can be reasonably pro-actively “scheduled” - that is not passively or randomly suffered - it can be part of the system plan, given that the final results remain within the commercial logistic chain requirements.

The main question is more likely on the transport resources side. In fact some path (infrastructure) management solutions can have costly alternatives (i.e. crew and engines productivity) that would be hardly accepted by the operators.

This issue must also be investigated in detail, also pointing out that the optimisation problem should be a systemic one, taking into account both the infrastructure and transport operators’ requirements, i.e. in the total cost function.

We understand this may not be very easily accepted - owing to separation between IM and TOC - but we should not refrain from considering the “total” railway production function vs. the competing mode.

Following an exemplary case in basic economic literature, the question would be if there exist a “bathtub” cost function, made of IM and TOC cost curves, which minimises the final rail transport cost in between. And how this minimum is linked to the final commercial speed.

Furthermore this composite analysis would mean addressing the problem with a modern “total quality” view, where the general target is to minimise the production transport costs, which can also affect more general and social benefits (e.g. overall optimal resource allocation and internalising externalities), that are out of scope of this note.

In the case under study, the analysis is made even more difficult by the congestion levels of the railway lines, that can vary according to different zones (line sections) and time windows (periods of the day).

In addition flexibility can be further improved by relaxing some constraints, mostly depending on organisational limits (trade union rulings) and lack of practical tools (information technology).

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We conjecture that, by smoothing and co-ordinating the European railway scheduling exercise, the freight commercial speed could be higher than the actual target (i.e. 50 km/h) and still provide for some slack.

It can be OPTIRAILS task to set a better feasible target.

In this context high speed freight trains would give even more benefit, by recovering flexing and decreasing total operating costs (i.e. time variable dependent).

By doing this, railway transport can likely become more flexible than road; and European infrastructure managers and operators should be fairly aware to co-operate in this direction.

There are other barriers, due to other interoperability standards, which are out of scope of this discussion, that must be concurrently overcome to improve flexibility and overall logistic chain (e.g. operations, crew and border hand over engine management).

A model framework for path optimisation has been discussed and studied in detail. The factors affecting line capacity and schedule making have been identified and the commercial design speed for a train stated as a function of these factors.

Taking into account the meaning of “real-time” within the ETML context, (see 5.4.) above, a concept of “flexibility within constrained schedules” (FICS) is introduced, where limits representing the best speed performance and the commercial speed accepted by the customer define a scheduling time frame (so-called Scheduling Area). The aim is then to schedule the train within these limits, while offering incentives to IMs to do better than the traditional minimum performance target. Improvements on the minimum performance targets provide “slacks” which can be used later in the journey to maintain schedules. The priority of the train may be changed in the control strategy by the amount of “slacks” available to it. The responsibility for improved performance is shared by the IMs involved on the corridor. Pathing methods based on, for example, a game theory approach can be used to promote the better performance, where strategies for pathing have to be selected and where some pay-off is at stake.

The solution procedure depends on the information level available.

This can be different, according to:

- corridor distance ahead of the train current position (it may be useless to give very accurate forecasts where there are several

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- Regional Areas between current and very far forecasted entrance point);
- the information detail made available by each IM about its assignable capacity, that is paths which can be precisely identified, are best guessed, having some (+/- minutes) uncertainty margins, or simply belong to a particular time frame.

As it happens with current real time control system, forecasting can be increasingly improved as train approaches to the decision point.

In the proposed model, moreover we refrain from recommending a global optimisation algorithm, that would be too rigid and likely poorly accepted by various Regional management; rather we prefer to sketch the general procedure, leaving regional optimisation and specific tooling to the single players, and soliciting further research and discussion about the more strategic issue

The decision support system should recommend one or more strategies but direct interactions between the human controllers would still remain high and productive. E.g. with new co-operative IT tools and videoconferencing, following demonstrators built within the EU-RTD Framework (EUROPE-TRIS Project).

The flexibility concept introduced by Scheduling Area Management should facilitate the process of integrating long-term planning and short-notice scheduling among IMs, giving more freedom for reaching agreements.

Today one IM should refrain to guarantee too much “tight” performance due to current constraints and other factors (e.g. maintenance programmes), while the Scheduling Area concept could be more acceptable in terms of re-pathing plus allowances for internal and commercial delays thresholds.

These considerations would stress the principle that train control over a European corridor should have full supervision ability for real-time reporting and forecasting about traffic and infrastructure status, fulfil requirements of the strategic level, and be mostly based on infrastructure capacity availability, that is dynamically updated in time and space.

As aforementioned, the “capacity availability” is what the European Strategic Controller is authorised to know by information flows from all the ERCs. Specifically, this capacity can be at best represented as the equivalent and distinct number of paths which can be available, if required, at the given time or within the assumed time window.

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Path capacity information and dynamic updating follow the general principles of air traffic control and co-ordination over continental areas (e.g. EUROCONTROL).

5.3.14.2.1 National vs. international transport

In the proposed model we do not make any explicit distinction between national and European freight transport operations, both having in principle the same opportunity to access the infrastructure and being managed by the European Regional Controllers. In particular we keep this model abstract and do not put any constraint for a freight transport to be labelled “international” if it crosses at least one border.

According to flexibility criteria, the rail infrastructure capacity management should be free to allocate, de-allocate and re-allocate capacity, as it is required by the market and real time traffic state, according to the regulations and contractual conditions.

For instance we can give allocation priority to an international transport, on a time limit reservation basis in the Scheduling Area, but still keep any other transport free to access the infrastructure, if that has no impact on others’ contractual rights nor any predictable reduction in quality of service.

Let us suppose, for instance, that one manages transports from Rotterdam to Milan via Chiasso (border station between Switzerland and Italy) and requires for TOC request be no later than one day before the train departure. If we have no international path reservation on day D (e.g. in The Netherlands), we can still manage a request for a transport within Italian boundaries (e.g. Chiasso-Milano) reserved on day $D+1$ and delivered on $D+3$.

In cases like this there should be no problem in allocating the potential capacity to any transport that would be requiring.

If capacity is scarce and we need to optimise it, it may be no benefit to discuss about “freezing” and reserving some capacity for certain operations, that either may be not use it or can do it in slightly different ways than originally planned (e.g. delayed or somehow shifted path).

Managing “area” more than “line” paths would make the allocation exercise easier. By the way, more infrastructure-

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flexibility can also be more appealing for transport operators, who are not obliged to make long run fixed plans.

These remarks should concentrate our efforts about managing flexible capacity, as it is required in real-time (above defined) operations, and not simply focusing on contractual obligations between IM and TOC, which can make the overall problem of infrastructure management a business more constrained than necessary.

Very rigid and strongly timetable-like scheduling rules between IM and TOC could be in the end a negative constraint for both and have a negative impact on the overall target to develop the railway system.

In general we observe that one way to develop mature service industries is to apply yield management policies, which aim at using capacity by flexible and real-time methods.

Once freight is allowed this opportunity, and capacity is at a premium, we may concentrate with more clear and simple rules on improving the service required by the prime users (passengers), and managing the slots in appropriate ways. Nevertheless, when generalised flexing would be the rule, freight trains also must be required to comply with it. In a sense the method proposed here partly follows the yield management concepts.

5.3.14.2.2 Path management

The application of the proposed method requires implementing new procedures in the infrastructure managers' organisations in order to support "path management" at the European level. Real time communications and decision processes are necessary to support the new operating model that is based on co-operation and quasi-perfect knowledge of the resources available.

In the foregoing we have also pointed out the principle of information symmetry between the national and international market in the path assignment process for improving capacity usage.

In the first part of this volume we have made more in depth analysis about the "path" entity, which is the focal object of our study, and identified the various states that characterise this entity all through its information modelling life cycle. Real time updating about this state can provide the information needed to carry out path management, that means changing the path state through

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agreed transactions between the various European Regional Centres and/or Transport Operators, and providing the best available forecasts for infrastructure capacity utilisation in the ERTMS planning window.

5.3.15 **Feasibility of Pan-European Traffic Management System**

5.3.15.1 *Organisational*

From an organisational point of view, the possibility of some higher level traffic management system can readily be envisaged to perform a role that includes co-ordinating national activities, providing a central source of information and in some cases, as appropriate contributing to the problem solving for the overall good. Other institutions exist to carry out a similar role in other fields of activity. Examples are Interpol, and Eurocontrol. Key to the success is establishing the right relationships with the parties involved to capture the value added by the higher level activity. In the disaggregated railway, infrastructure organisations control train paths, Train Operating Companies control locomotives, rolling stock and crew resources allocations and Infrastructure maintenance Companies deal with maintenance and repairs. Each organisation has its own business objectives and priorities. Many incidents will require two or more organisations to cooperate across borders in order to derive an optimal solution. At the same time, the demands for excellent delivery are ever present and are being added to. These include demands for revenue from train paths, more effective use of leased resources, greater accountabilities, the need for the common good and others that can call for negotiation, agreement and which require discussion between parties.

These relationships should be based on openness, fairness, sharing the damage to service delivery etc. These relationships should be achievable providing the rail industry takes some view at least of its competition being roads and air transport modes rather than between individual railway operators.

Organisational structures are described in Workpackage 1 and Workpackage 2. The Optirails options that appear to contribute most to meeting the requirements for a pan-European Traffic Management system are those featuring functionality which offer high levels of information exchange and collaborative working. A synthesis of organisations so far implemented is necessary. A comparison of such organisations can help to design the Functional Requirements Specification and it is relevant to show

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clearly who is responsible for what in traffic management. This process needs to be continued in Optirails II.

5.3.15.2 *Technical feasibility*

The potential technical feasibility for a pan-European Traffic Management system is high. The capability to capture increasingly more data concerning the rail network is growing, providing ever-greater opportunities for establishing a comprehensive real time model of current operations. This is the starting point for controllers taking swift and appropriate action to manage potential problems. "What can be measured, can be managed". The more that is known about the current state of the network, then the better the opportunities to manage it.

Computer networks facilitating sharing information are now commonplace and systems to promote collaborative working between actors are emerging (e.g. groupware, teleconferencing, decision support tools). Within some areas of computing there is a growing appreciation that organisations are about processes and people working and collaborating together. This is case within railways. The success of railway operations does not depend on the success or failure of one individual or activity. It depends on all elements of the activity working successfully together. If computer systems are to support industry in a positive way, then they must promote this style of activity.

The use of new methods for solving numerically hard problems and the unstructured problems often faced by railways makes the transition from academic theory to industrial applications. The evidence of these techniques in industry is emerging rapidly. These techniques are introduced in Workpackage 2. To date, railways have been slow to adopt them, although they are suited to problems of resource scheduling and sequencing.

Two specific areas which present unknown challenges for the feasibility of a pan-European system are, the degree to which knowledge of local conditions (lying outside the scope of the European model of operations) has to be used to generate viable corridor-wide solutions to traffic problems, and the accuracy to which forecasts can be made on future events (e.g. estimated arrival times) for use in reliably predicting potential conflicts for which advanced corrective actions need to be identified. A key issue affecting service delivery across Europe is the ability to forecast ahead to predict the impact of disturbances. Broad estimates of forecasted arrival times at borders might only be possible from the level of detail within OPTIRAILS. If this is the

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case, then the opportunities for positive action based on reliable estimates, and for optimised solutions will be greatly diminished. The impact of these two elements will need to be evaluated at some stage as part of the considerations of technical feasibility.

5.3.16 **Relationship to ERTMS**

Few direct relationships between ERTMS/ETCS and GSM-R have been identified. The functional gap between the high level traffic management system and the low level signalling and control system in most cases is too wide for there to be an "organisational" direct link. In most cases the type of signalling system installed is transparent to the high- level traffic management system. In areas where there is no ERTMS/ETCS then this is an advantage since Optirails can offer equivalent facilities. The direct links to the train, available under ERTMS/ETCS and GSM-R, could be used for speed advice and passenger information on board the train. However, these links are likely to be established between national centres and the trains. Further links from a pan-European system would result in unnecessary complication. Links of this nature should be consolidated either through the national systems or through the pan-European system but not through both.

5.3.16.1 *Real-time concept in ERTMS*

We should also define what "real-time" means in the ERTMS environment - specifically OPTIRAILS project; that is a concept often used and associated with "train management".

In the present context "real-time" is to be adopted more extensively and widely time framed than it usually is in the railway control systems jargon, where it means directly control train by some signalling system, or any decision making process requiring very fast and reactive actions, within limited space and time windows ahead of train approach.

This subject is not the primary context of this project, that aims in fact at a higher level of train management. Being each ERC entitled to perform the "low level" or tactical function of real-time control, we are concerned here in carrying out a more strategic function, where the real-time requirements are determined by the "characteristic times" of European corridor management.

In case of freightways services for instance require a 1 200 km trip be covered within 24 hours; therefore a 1 day period could at least be defined as the higher-level system characteristic time. That

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would suffice if everything were smooth after departure and no more control action should be needed, when a transport is running across Europe.

To be safer, let us assume our control system should have a characteristic or reaction time one order of magnitude less than the above, e.g. 2 hours, which can also correspond to the transit time through one ERC.

This can represent a general ruling for setting requirements for the higher real-time ERTMS level; that is time frames for which a control action is needed, between 20 and 2 hours, depending on the event. Below this, i.e. typically within each ERC authority, more real-time or reactive short-term control should be taken at regional or more local (station) level.

As soon as a freight train is set up and departs, say at initial station A of the Corridor, a “real-time” control window is opened, which is updated for the following day or so and through which the transport history will develop.

5.3.17 Relationships to national systems

The relationships between Optirails and parties involved in traffic management at the national level are key to the successful introduction of a Pan-European system. The figure 5.3.8 shows the possible relationships offered by each option being considered. However, the 5 year position is not yet known. In other words, the degree to which Optirails can be integrated with national systems, or must stand apart from them is not known. Thus a careful staging of its introduction is recommended. Early relationships should be as unobtrusive as necessary at the first stage in order to let Optirails demonstrate its value. One might envisage an evolution in systems as follows:

- a) The reported data yielded by the data monitoring option demonstrates the value of the data available
- b) The value of the reported data encourages infrastructure organisations to seek the information on-line
- c) A recognition that the on-line information could be used to present the corridor-wide view of current operations for consideration in national decisions
- d) Sufficient confidence established in the role played by Optirails that the possibility of global solutions becomes recognised and accepted.

The main goal of OPTIRAILS is to add a new higher layer to the European Traffic Management system to achieve greater harmonisation between Ims on a corridor.

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In some cases links exist between two adjacent countries (C1 <-> C2 or C2<-> C3) that offer some early warning of approaching trains but the global vision (beginning with a link between C1<->C3 for example) is usually missing.

The Optirails study (of WP2) has showed that in each particular country, there is an organisation capable of managing the traffic. These organisations are more or less aided by tools but even manually they are able to give information (train describer) and to solve in real time re-routing or re-scheduling problems.

In a near future (5 years ?), in parallel or without OPTIRAILS, they will continue to develop powerful tools capable of fully taking into account their national traffic.

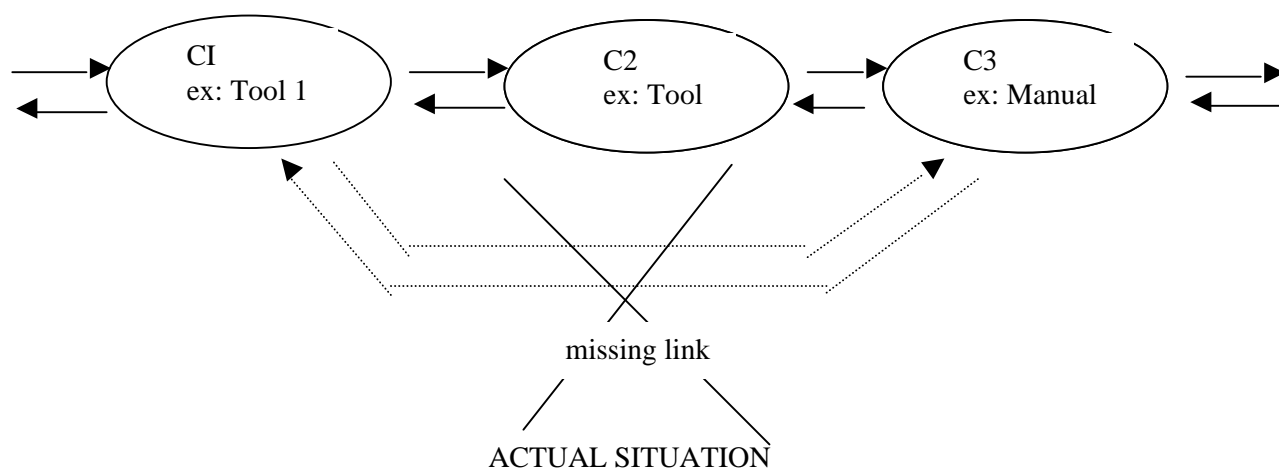


Figure 5.3.8 : Relationships to national systems

Both a centralised and decentralised approach can be considered for establishing the higher level of control.

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5.3.17.1 Centralised

Under a centralised approach OPTIRAILS would capture all detailed information about the traffic of national and international trains inside the countries and redefine the path and the schedule of international trains in case of perturbation.

However, in parallel, due to the available information given to IMs, they would continue to calculate solutions to the problems themselves that in many cases would be different due to different knowledge and objectives. This conflict must be resolved. The centralised approach would see the Optirails solution being taken at the expense of the local solution to achieve the common good for the corridor.

This is the case of course for EUROCONTROL which in the future will manage even the local traffic in the airports (gate to gate approach).

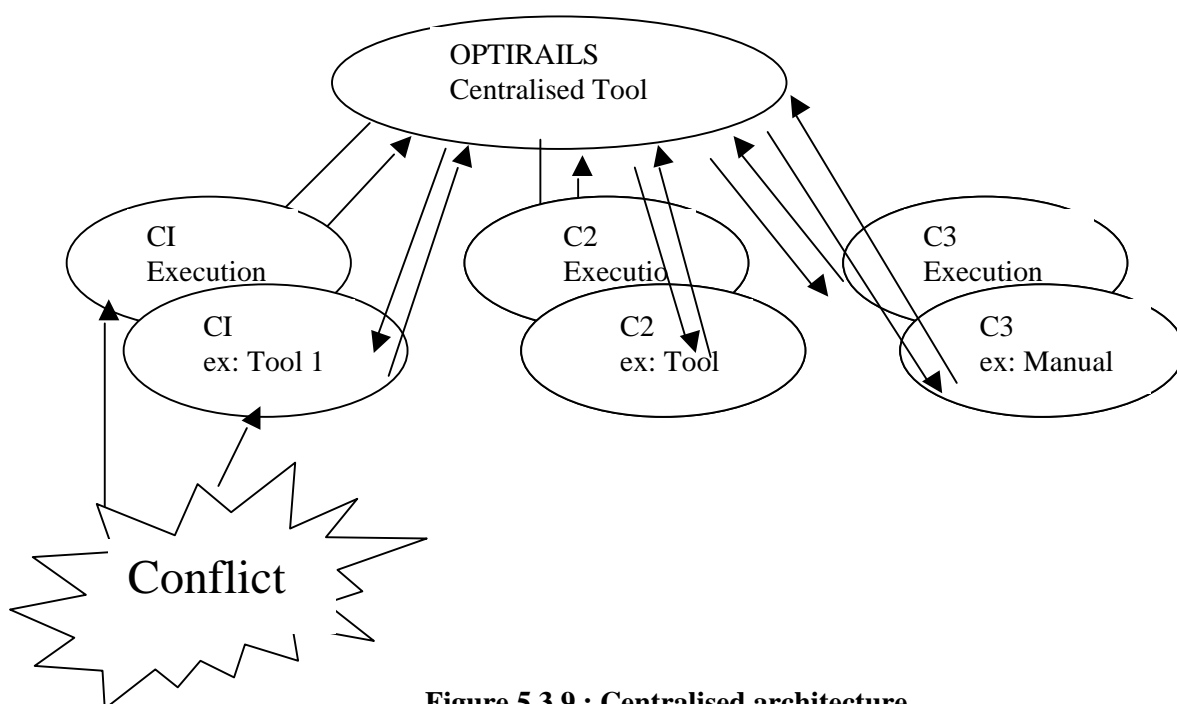


Figure 5.3.9 : Centralised architecture

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5.3.17.2 Decentralised

The other possibility is to fully use the power of national tools, giving them all information they need to manage international trains.

When all parameters needed for traffic management are previously known at the border, or earlier from previous countries, there is no major difference for an IM between national and international trains and all particularities can be taken into account by the national traffic management.

In this case OPTIRAILS has nothing to do with the position of international (and national) trains within a country. The main information is the expected position and time of the train at the border, and the targets for the train, taking into account the various possibilities for the global international path.

Ex: initial path $A \rightarrow C \rightarrow E$ must be re routed or re-scheduled with various possibilities:

- $A \rightarrow C \rightarrow E$ with estimated delay or may be $A \rightarrow C \rightarrow F$ (effect of delay in C1 on C2)
 - $A \rightarrow B \rightarrow E$ or $A \rightarrow B \rightarrow F$
 - $A \rightarrow D \rightarrow F$
- all cases having in impact on the following C3 (not represented)...

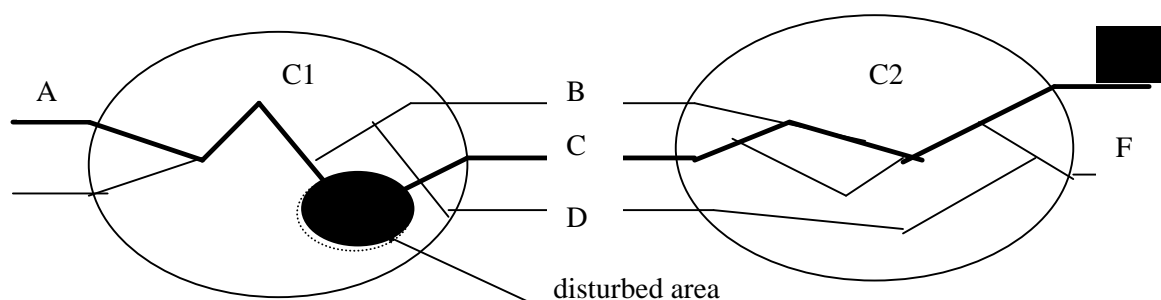


Figure 5.3.10 : Decentralised architecture

The purpose of OPTIRAILS tool in this case is to organise in real time the exchange of information relative to each possible scenario in order to elaborate a global solution at European level.

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The goal would be to unify the operation of existing tools via the definition of a higher layer in charge of the global managing.

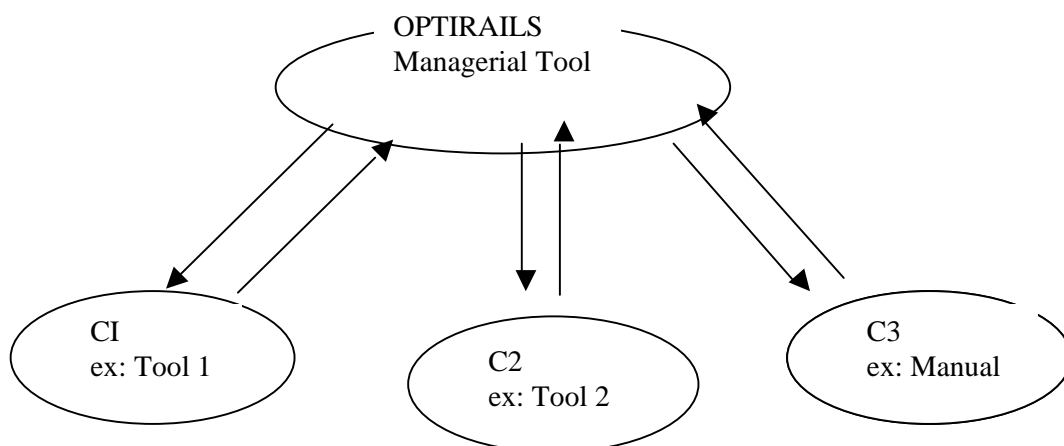


Figure 5.3.11 : Distributed architecture

In order to define general optimisation criteria for European corridors, we divide these into “control zones” which represent regional train control areas within traditional national boundaries. Each control area can therefore work within assigned tasks and rulings in view of the European train management system.

Control areas can be defined according to the current national IM organisations (e.g. dispatching sections) but also to some other criteria; for instance European control zones can be of different extension or have some homogeneity factor characterising the area (e.g. signalling system).

In principle the ERTMS working view should consider only the control area performance, regarding the international traffic, and not the operating behaviour inside the “black box” zone, which would specifically remain “locally” controlled.

In order to have a European operating model, we conceive a “two-level” train management system, composed of :

- European Regional Areas (ERA)
 - European Corridor Area (ECA)
- each of them having its own control or optimisation system.

European Regional Control (ERC) and European Corridor Control (ECC) functions can respectively manage this, e.g..

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Within this two-level hierarchical system, a supervising controller entity would be recognised to co-ordinate the overall corridor, while each control area would be actually managed under a regional or national authority.

The “European controller” does need to be a physical entity or a specific organisation ; in fact we wish to introduce it only as an “abstract” function, completely based on *information technology* and *process* rules. In general we should keep to a minimum additional organisational and bureaucratic burden on European railways.

It can be assumed that the European Control of ERTMS should be implemented in principle with “virtual” employees, performing some new functions embedded in existing, upgraded or future train control systems.

This model proposes a “distributed intelligence” system where information is made available where it is needed and a virtual advisory system (i.e. technologically implemented), with some human interface, recommends the operator behaviour and control strategies.

In this framework, each European regional centre (ERC) would be working within assigned or pre-defined tasks in managing the European traffic flows.

Therefore each ERC would have to manage two overlapping activities or constraints, from national and international movements.

In so doing, the ERC should have assigned clear but flexible operating rules in its authority area.

Specifically it would be working within agreed and pre-defined control ranges (e.g. slack intervals) for path management more than being subject to very tight and deterministic deadlines, like fixed paths.

In other words, the ERC would be free of managing paths within some time slacks or scheduling windows, and optimising path services by its own methods. The European Corridor Controller would work at a more strategic level and get the output from the regional controllers as “black box” performance, say within the contracted or prescribed (agreed) limits.

The definition of this two-level hierarchical concept is not new to management control systems and can be proposed for the case under study.

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National control centres can co-ordinate all the subordinate ERCs, but does not need to be explicitly added to the basic Corridor operating model, as the formers' behaviour is also the result controlled by each national entity.

5.3.18 **System Evolution**

The possible evolution of a traffic management system from a monitoring system to a problem solving system is illustrated simply by figure 5.3.11 below.

The first stage shows the collection of required data from the railway network. The opportunity exists to reshape the data capture to remove some current weaknesses. For example, a rethink of the requirements will lead to a better definition of the data required, a reassessment of the motives for capturing the data is possible, and more focus on the causes of problems rather than the symptoms would offer valuable feedback to planning and engineering organisations.

The second stage is related to the processing of raw data and its conversion into usable information. Two particular categories are, information to technical and end users to aid their understanding of the situation and, information which enables action to be taken, so-called "actionnable information". This actionnable information can be used in the third stage for decision support and problem solving for the structured elements of a problem. It removes some existing barriers such as traditional thinking, "sacred cows", intuition, and poor decisions. Problem solving may also become less dependent on manual experience. The resulting solutions avoid elements of resistance to change, protecting vested interests, misguided contractual data and poor performance. They may be implemented manually or in some cases automatically as appropriate.

The shaded areas in the figure 5.3.11 illustrate that the evolution is not completed in a wholly serial fashion with stage 1 being completed before starting on stage 2. A complete (or part cycle of development) by capturing a sub-class of data from the network, processing it into information and using the information to solve a subset of problems is feasible before returning to capture more network data at the start of a later cycle of development.

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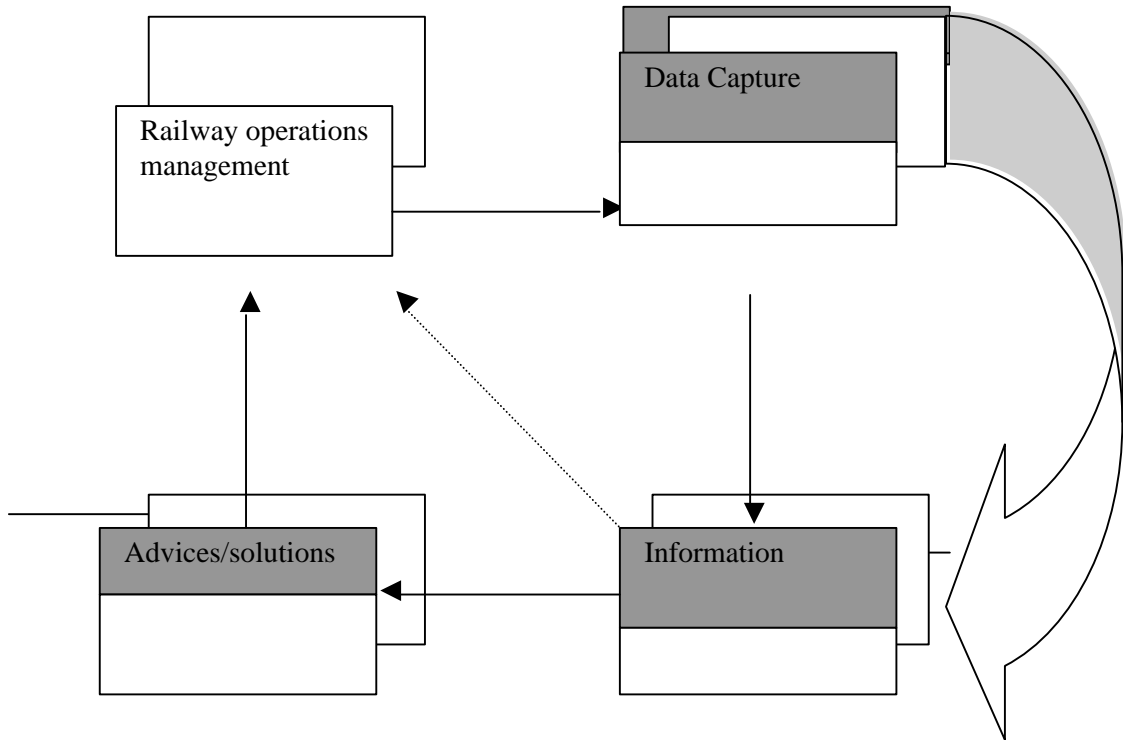


Figure 5.3.11 : Evolution cycle

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5.3.19 **European Added-value**

Each layer of the national traffic management organisations adds value to the management of railway operations, either working independently or in conjunction with other activities. In broader terms, on a European level, then similar scope for additional value would exist were individual national centres to work jointly with their counterparts in other countries. To allow Optirails to offer genuine benefits, it must generate value beyond what is achievable from national centres working collaboratively in some way, if this were possible without a higher level. Otherwise, the justification for the high level system is unlikely to exist, and the way forwards would be to link the national centres together on the same level.

The additional value offered by Optirails has been identified by this project as follows;

- A system acting to ensure that the requirements of international trains from their origin to their destination are positively met (rather than by default or last resort) by accepting the role of prime agent for international trains from origin to destination.
- A system facilitating the collaboration between national states and individual actors for the common good of a specific international corridor encouraging shared damage to planned services of particular national states, taking account of different network capabilities, in order to achieve the overall effectiveness of a specific corridor.
- A system providing a repository of corridor-wide information available to all parties involved in the operation of the corridor.
- A system attempting to forecast and predict the current state of operations for the benefit of subsequent networks operations along the corridor.
- A system capable of problem solving taking an impartial view of corridor-wide operations.
- A system establishing and maintaining a corridor-wide model of current operations for use in rapidly responding with a corridor-wide perspective on operational problems.
- What is the value versus the one-stop-shop?

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5.3.20 **User Requirements**

A formal User Requirements specification does not exist at present for a pan-European Traffic Management system. In order to set some direction to the specification of functional requirements, a process was carried out to identify the contents of systems needed to meet the overall objectives for pan-European Traffic Management. The process was predominantly based on an analysis of the objectives set down in section above.

5.3.21 **The business models**

The definition of business models for the project recognises that an activity contains a number of various elements and relationships working together. Each combination of elements and relationships represents a different business model. The table 5.3.1 shows in the shaded areas the potential range of business models for a pan-European Traffic Management system identified by this project, with regard to the technical scope and relationships to national systems.

5.3.21.1 *Range of Options*

The options considered for Optirails range from a data monitoring system implemented to capture data on train operations for analysis offline to a system offering optimised solutions and in some cases directing national organisations to implement them. These options have been assessed in terms of their individual contributions to meeting the requirements identified by the project. The analysis showed that the options offering a high level of information sharing and collaborative working achieved the best match in providing the features needed to meet the objectives of a pan-European system.

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		Relation to National Systems	Relationship to National Systems with Optirails as a player (able to offer solutions)		
Business Models → ↓ Options	Monitoring	Information	Advise	Recommend	Directive
Monitoring	Periodical reports (off line)				
Centralised Information		Inform online			
Path Assembly		Inform online			
Negotiation with actors		Facilitate to improve			
Optirails as an initial player			Yes	Yes	
Full Tools			Yes	Yes	Yes

Table 5.3.1 Relationships with infrastructure

5.3.22 Technical/relationship phasing

The phasing of the project will represent a key element in the set of functions. The progress of a pan-European traffic management system will depend on overcoming technical challenges, politics and the accepted added value offered.

For example, in moving from a monitoring based system to a centralised information dissemination system, the key issues will be attitude of the national railways towards the system and the added value offered. The technical challenge does not dominate this decision. However, in moving to a system which is expected to generate high quality solutions to problems then the technical challenges faced will be a significant factor, but irrespective of success in meeting the challenges, the acceptance of the solutions by the national railways remains an issue. This may prevent the progress to a directive system.

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These distinctions have been recognised by the project. The starting point on the "staircase" , to a full system (i.e. what is to represent the first implementation of the traffic management system within 5 years) and the subsequent step improvements with respect to time cannot be judged at this stage.

5.3.23 The strengths and weaknesses of current processes

Ideally, the strengths and weaknesses of the current processes should be analysed with technical and end users in order to understand them clearly and ensure that they are reflected in the requirements of the new system. That is, the new system builds on the strengths and avoids current weaknesses. At the current stage of this project the understanding of these issues is based on the experience and knowledge of the project team and on a recent survey carried out among several different parties involved in transport. High-speed passenger services, where they are present across Europe are increasingly successful and have some strong features in the way they are operated. The case is not the same for Freight services. They suffer from a lack of attention both in pathing and resourcing requirements leading to unattractive levels of reliability.

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5.3.24 Summary of Functions

SYNTHESIS OF FRS															
FUNCTIONS		OPTIONS						Term			Class			M + S	Present function depending
Number	Title (simplified)	1	2	3	4	5	6	S	M	L	M	P	N		on related function
111	Reference Timetable	X				(1)		X			X			✓	
112	Contracted Timetable	X						X			X			✓	111
113	Capture of train position	X						X			X			✓	112, 114
114	Train status definition	X						X			X			✓	112, 113, 116, 117 and 118
115	Capture of delays causation	X						X			X			✓	113, 114
116	Data collection on network status	X							X			X			
117	Analysis of divergences between ref. Timetable and contracted Timetable	X						X			X			✓	111, 112
118	Analysis of service quality	X						X			X			✓	111, 114, 115
119	Real use of the corridor	X						X				X			111, 114, 117, 118, 120, 123
120	Capture of forecasts made by Railways / IMs	X						X			X			✓	111, 121
121	Analysis of forecast accuracy	X						X			X			✓	113, 115, 116, 120
122	Analysis of the "border effect"	X						X			X			✓	112, 113, 114

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123	Train actual technical composition	X						X			X			✓	111, 113, 114
124	Train load information (freight trains)	X							X		X				123
125	Train occupation (passenger trains)	X							X		X				
211	Location of the train	?	X					X			X			✓	111 to 113
212	Status of the network (capacity limitation)	?	X						X			X			116
213	Route used by train	?	X						X		X				111 to 114 and 116
224	For a specified train: time, delays, Next train at the border	?	X					X			X			✓	113, 114, 120, 121
215	Train delayed information causes	?	X					X			X			✓	113, 114, 115
216	Planned reduction in infrastructure	?	X						X		X				116
217	Requirement for access on infrastructure	?	X						X		X				111, 112, 116, 123 and 124
218	Information on actual running (one a given day)	?	X					X			X			✓	113, 114, 115
219	Route availability parameters between locations	?	X						X		X				116
220	Path access available	?	X						X		X				111, 112, 116, 123 and 124
311	Path assembling without scientific optimisation	?	?	X				X ⁽²⁾			X			✓	Evolutionary use arriving at final situation using functions of OPTIONS 1 + 2
411	Driving traction diagram (stock roster and type of motive power)	?			X			X			X			✓	111, 112
412	Crew Roster	?			X			X			X			✓	111, 112
421	Info. about delays (schedule divergence with Timetable)	?	?		X				X		X				111 to 115, 214, 711, 412
422	Info. about delays resulting of network anomalies	?	?		X				X		X				111 to 116, 216, 411, 412
423	Info. concerning problems resulting of compo. Anomalies	?			X				X		X				111 to 115 and 123, 124
424	Info. about no respect of traction diagram or traction type	?			X				X		X				111 to 115, 123 and 411

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425	Info. about divergences between ref. and contracted Timetable	?	?		X			X			X			✓	111 to 114, 117, 119, 121 and 215
426	Following-up of service quality	?			X			X			X			✓	111 to 115, 118, 411, 412 and 421
427	Info. concerning effect at the border crossing	?	?		X			X			X			✓	111 to 123 except 116, 411 and 412, 214
428	Info. about management running resulting of train occupation (passenger train)	?			X				X		X				125
429	Info. about resolution of path assembling problems	?	?	?	X				X		X				Function of OPTIONS 1 + 2 + 3
611	Info. collected / Visualisation of running	?	?	?	?			X			X	X			Functions of OPTIONS 1 + 2 + 3 + 4
612	Detection of potential conflict	?	?	?	?			X			X	X			Functions of OPTIONS 1 + 2 + 3 + 4
613	Conflict resolution	?	?	?	?			X			X	X			Functions of OPTIONS 1 + 2 + 3 + 4
614	Fluidity of traffic	?	?	?	?			X			X	X			Functions of OPTIONS 1 + 2 + 3 + 4
															Class:
	(1) OPTION 5: Procedures	S:	Short term					M:	Mandatory		5 years	?			The present function from OPTION X
	(2) Partially (evolution situation)	M:	Medium term					P:	Prefered		10 years				depends on OPTION(S)
	M + S: Mandatory class + Short term	L:	Long term					N:	Nice to have		15 years	✓			Mandatory function + short term
	OPTION 1: Collecting data and monitoring														
	OPTION 2: Centralised information per corridor														
	OPTION 3: Path assembling without scientific optimisation														
	OPTION 4: Solutions from negotiations with actors														
	OPTION 5: Preliminary solutions														
	OPTION 6: Conflict detection / conflict resolution														

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5.4.25 **Cost/Benefit Analysis Method**

5.4.25.1 *General*

The cost-benefit analysis is performed on a supposed implementation of the OPTIRAILS system on the Rotterdam-Gothard-Giaio Tauro corridor. Therefore, this will be the geographical perimeter considered for the calculations.

The present analysis is a comparison of the existing situation in the corridor versus a supposed future situation where OPTIRAILS system is first implemented and then operated. So the following states will be taken into account :

Sb : existing situation, observed today in the corridor (year 1999). The economic conditions of year 1999 will be considered, expressed in Euros.

S0 : reference situation. It is the existing (or "do-nothing") situation projected over the period of analysis.

S1 : "with-project" situation. It is the situation where the system is implemented, generating costs and benefits.

The calculations are made for a 30 year period. This is the traditional time period considered for such an analysis. It permits to take into account all the impacts linked to the project.

In order to calculate a financial balance, the supposed owner of the system has to be determined. In this analysis, it is considered that the entity, which owns the system, is a consortium of the infrastructure managers concerned by the corridor. In this hypothetical situation, the infrastructure managers of Holland, Switzerland, Germany and Italy pay for implementation and operation of the system on one hand, and receive financial benefits through fares paid by train operators that will circulate in the corridor.

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5.4.25.2 *Results*

Results of economic evaluation of OPTIRAILS project have been expressed with the traditional following indicators:

- Financial and Economical Internal Rate of Return (FIRR/EIRR)
- Net Present Value (NPV)
- The NPV accounts for the sum of the yearly cash-flows over the 30-year-study period. The cash flows are discounted following the 8% rate, recommended by the European Community. The project is considered profitable, on an economic point of view, if the NPV is positive.
- The FIRR and EIRR are the discounting rates which brings the NPV to zero. The project is financially profitable if the FIRR is higher than 8%.

These two indicators have been calculated for the financial analysis on the one hand, and the socio-economic analysis on the other hand.

Financial analysis results

The following table recalls the results of the financial analysis:

Financial analysis results
(thousands Euros)

Year	1	5	10	20	30
Costs	737	742	756	307	307
Incomes	0	440	880	1 100	1 100
Cash flows	-737	-302	+124	+793	+793

These results lead to the following values:

NPV = 774 000 Euros
FIRR = 10 %

Therefore, OPTIRAILS project is financially profitable at the 8% discounting rate, and stays profitable up to a 10% value.

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Socio-economic analysis results

The following table recalls the results of the socio-economic analysis:

Socio-economic analysis results
(thousands Euros)

Year	1	5	10	20	30
Costs	737	742	756	307	307
Time savings	0	170	332	396	379
Economy on passenger external costs	0	77	168	338	492
Economy on freight external costs	0	231	507	1 020	1 483
Total economy	0	478	1 008	1 754	2 354
Cash flows (Economy – Costs)	-737	-264	+252	+1 447	+2 047

These results lead to the following values :

NPV = 3 572 000 Euros
EIRR = 15%

OPTIRAILS project is therefore also profitable for the collectivity, on the socio-economic point of view.

5. *SCIENTIFIC AND TECHNICAL ORGANISATION OF THE PROJECT*

Sensitivity of results

The sensitivity of the Financial Internal Rate of Return to variation of costs and incomes has been tested. So, if costs and incomes vary from – 30% to +30%, the FIRR takes the following values:

Values of financial FIRR

		COSTS						
		-30%	-20%	-10%	-0%	+10%	+20%	+30%
I	-30%	10%	8%	6%	4%	2%		
N	-20%	12%	10%	8%	6%	4%	3%	2%
C	-10%	15%	12%	10%	8%	6%	5%	4%
O	-0%	17%	14%	12%	10%	8%	7%	5%
M	+10%	19%	16%	14%	12%	10%	8%	7%
E	+20%	21%	18%	15%	13%	11%	10%	8%
S	+30%	23%	20%	17%	15%	13%	11%	10%

6. CONCLUSION

6.1 *About the Optirails project*

Phase 1 of the Optirails project is concerned with establishing a view of the current situation with regard to managing international rail traffic in Europe and with identifying the functional requirements of a pan-European traffic management system. The purpose of the pan-European traffic management system is to improve the reliability of getting international trains to their destinations. However, many of the activities involved are often considered as something of a black art. Whereas many aspects of railways have benefited from advances in technology, the operations management generally has not. Customers expect quality of service and value for money. If things go wrong, they want to be told promptly what has happened, what is being done about it, what the affect will be and what they should do. A pan-European traffic management system is required to meet these challenges Europe-wide for international services. The system must effectively manage train service delivery and be the source of information to satisfy customers. It is for the traffic management system to determine what has happened, to identify what the consequences will be, what is going to be done about them, and to identify what services customers can expect during the time the problems remain.

Effective management begins with the availability of good information both real-time and background information, sufficient to form a model of the state of current operations. This model is the starting in dealing with situations. Without it, managers` opportunities to act quickly are impeded, and skilled staff are constrained to passive roles of monitoring and recording the outcome of specific events. This does not lead to an effective operations management. The step change is needed which enables the data captured on the current situation to be used in predicting what are the likely consequences and in determining the most appropriate corrective measures to be taken.

Thus the Optirails project does not start from strong foundations in terms of building on advanced or engineered traffic management systems. Much work has been done within the railway sector on capturing data for analysis at some later stage. However, the techniques that enable this data to be used to affect improvements in real-time management are only, at best emerging in industry generally and are little used within the railway industry. In many cases they are not welcomed, with operators preferring to use long established manual processes.

It is unlikely that Optirails will be able to lead the industry in these respects. More likely, is the higher-level management process waiting for the national developments. Thus, much of the thinking on the

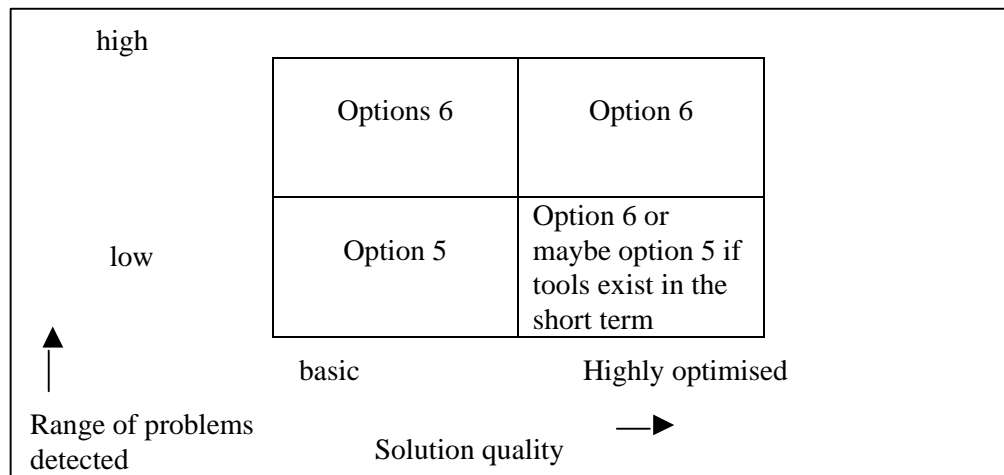
6. CONCLUSION

Optirails project has had to be in isolation from hard experiences within the national organisations which places it within a research remit rather than a development remit, building from existing systems.

6.2 Background thinking on the project

There is no clear cut off between options until we have decided what is possible in the short to medium term and the longer term.

The diagram 6.1 attempts to show this.



The principle is that we want Optirails to be a profitable system as possible in the shortest term. However, we have to recognise the barriers related to the identification of problems, to have tools capable of high performance solutions, and to manage the early complexity of the system in order to increase our chance of the first implementations being successful.

The equation is to provide a system whose scope and capability offer value against a system in which its complexity is controlled in the first implementation in order to reduce the risk of technical failure, and which is politically acceptable to National Players

The following questions and statements reveal much of the thinking behind the work of the project:

- A consideration of both the technical and organisational aspects of a pan-European system is needed within the project Optirails. Being asked to produce a functional requirements specification technology alone. Procedural aspects of OPTIRAILS which may

6. CONCLUSION

too early presents the danger of placing too much emphasis on the set down the shape of the organisation of OPTIRAILS with other players and which may govern the processes of developing information, disseminating information, guaranteeing the value of the information, the decision taking, agreement to share disbenefits etc and seeking the common good need to be included in the overall framework. The procedures cut across all options.

- What are the EU attempting to solve at the European level?
- What is involved?
- The "big" picture for international traffic management is needed within which the limits for Optirails can be set.
- The potential users and their needs are required to be identified.
- Optirails must add value at the European Level in Interoperability and integration.
- The development and implementation steps to a "full" Optirails system are needed.
- The project will anticipate happening National organisations and their processes becoming more common across Europe and helping the implementation of Optirails.
- The roles of the parties involved, relationships, information exchanges etc need to be identified at some stage. However, some frameworks of possible systems are needed in order to judge who are the potential players. This process will need to be iterative. The thinking on proposed systems needs to be established in order to gain the confidence and interest of the rail industry. From this will flow the identity of users and their needs.
- To start with, a consideration of some scenario systems is required taking into account an organisational point of view of the high level structure.
- What are the major goals of these systems?
- What is the model from each country which will support Optirails?
- What are the interfaces?
- What kind of operations will Optirails include at the centre and what intervention can it make at the National level ? OPTIRAILS must enable National systems to work together as one organisation for the benefit of the corridor, similar to the way organisations within a country work together without necessarily one of them being the leader. The model of signallers and route controllers within a country equates to national systems and OPTIRAILS at the European level.
- How much do we need to know about the National traffic in each country?
- Although the project team are in favour of selecting 1 scenario system and taking it forward as indicated below, EU/UIC requested that a full range of options should be considered and specified.

6. CONCLUSION

- Scenario systems (the business models) have been taken forward as follows,
 1. The scenario: Description of the proposal and main goals and core functions (given as short, medium or long term)
 2. Its position in the European level. What value does it add ?
 3. The type of problems solved and the potential impact
 4. The information exchange
 5. Likely technical users and their requirements
 6. The type of tools required.

- It has been agreed that Eurocontrol may offer guidance in concept, mission, organisation and evolution but that its tools and the problems it was seeking to solve are different to Optirails.
- Optirails is seeking to achieve considered decisions on train management.
- The main market driver for freight traffic is to increase the average speed achieved.
- A key issue affecting service delivery across Europe is the ability to forecast ahead to predict the impact of disturbances. Broad estimates of forecasted arrival times at borders might only be possible from the level of detail within OPTIRAILS. If this is the case, then the opportunities for positive action based on reliable estimates, and for optimised solutions will be greatly diminished.

- In considering Freight traffic, on which greater emphasis should be given, the project should
 - Concentrate on logistic supply chain and not just on the railway itself,
 - Recognise that Railways do not know how to manage an international corridor,
 - Recognise that fixed planned paths are wrong, and that flexibility in constrained schedules is needed,
 - Propose that Slacks are the most appropriate optimisation criteria. We should seek to maximise the available time between schedules and achieve a tolerable estimated time of arrival,
 - Aim at early arrival of freight trains by slotting them between the no-go periods of high density traffic to arrive early. Freighters are therefore different from passenger trains,
 - seek dynamic management of paths,
 - Propose that the priority of a train would increase, as the slacks available to it decrease.

6. CONCLUSION

6.3 Methodologies

6.3.1 Methodology for defining requirements

A methodology was defined to identify the requirements for Optirails in the absence of a formal User Requirements Specification. This process contained the following steps:

- Top down and bottom up approaches

Top down approach:

- Interpretation of the objectives, i.e. what does interoperability mean in a traffic management sense?
- Decomposition of objectives to identify the features needed,
- Mapping of features on to proposed options to evaluate those offering the highest contribution to the objectives.

The results of this process are given in the table mentioned next page.

Bottom up approach:

- Brainstorm on technical and end users,
- Designed proforma setting down user, needs and functionality descriptions see below.

a) Interpretation of Objectives

The objectives for Optirails were stated as follows;

Objective 1. To achieve interoperability in traffic management

Objective 2 To develop a single market

Objective 3 To deliver efficient and effective rail corridors

b) Decomposition of Objectives

Decomposition of Objective 1; to achieve interoperability in traffic management

- Identify Origin and Destination
- Monitor train progress
- Seamless borders
- Continuous (e.g. no discontinuities) process change
- Information exchange
- Communication structure
- Harmonised procedures
- Multilingual staff
- Consistent monitoring and information dissemination

6. CONCLUSION

- Predict problems and identify solutions independent of borders.
- Corridor-wide maintenance, cleaning, fuelling scheduling
- Corridor-wide crew scheduling
- Equity in decision criteria between freight and passenger trains and between national and international trains
- Contracts with >1 operators
- Border priority systems
- Overview of cross border needs
- Corridor - wide thinking and decision making

Decomposition of Objective 2

Not appropriate to decomposition

Decomposition of Objective 3 to achieve efficient and effective Rail corridors

- Minimise delay and deviations from plans, international and national.
- Promote corridor-wide planning
- Exploit corridor-wide technology
- Cost effectiveness
- Information provision
- Corridor -wide connections awareness
- Corridor -wide service delivery
- Strong links with national centres and simple cross-border links.

c) Mapping Features

OPTIRAILS OPTIONS VS OBJECTIVE FEATURES

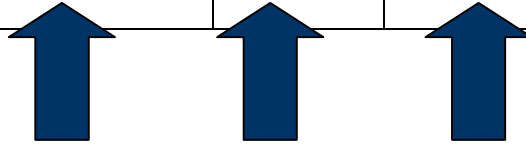
Objectives Features	Full tools	Solutions through negotiation with actors	Non scientific path assembly	Centralised Information	Optirails as early actor	Monitor system
Identify Origin/Destination	y	Y	y	y	y	n
Monitor Train in Progress	y	n	n	y	y	n
Seamless borders	n	Y	n	y	n	n
Information exchange	n	Y	y	y	n	n

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Communications structure	n	y	n	y	n	n
Harmonised procedures	y	n	y	n	y	n
Consistent monitoring and information dissemination	n	y	n	y	n	n
Predict problems and identify solutions independent of borders.	y	n	n	n	y	n
Corridor-wide maintenance, cleaning, fuelling scheduling	y	y	y	n	y	n
Corridor-wide crew scheduling	y	y	n	n	y	n
Minimise delay and deviations from plans, international and national.	y	y	y	n	y	n
Promote corridor-wide planning	y	y	y	y	y	n
Information provision	n	y	y	y	n	y
Corridor-wide connections awareness	n	y	y	y	n	n

6. CONCLUSION

Corridor -wide service delivery	y	y	y	n	y	n
Strong links with NNSCs and simple cross-border links.	n	y	y	y	n	n
Y	10	15	12	11	10	1
N	7	2	5	6	7	16
Objectives Features	Full tools	Solutions through negotiation with actors	Non scientific path assembly	Centralised Information	Optirails as early actor	Monitor system



Highest contributors to objectives

Y= the option offers the required feature

N=the option does not offer the required function

The above table shows that the features offered by each technical option are as follows:

Option 1: monitoring system

- provision of information

Option 2: Centralised information system

- Identify origin/destination
- Monitor train progress
- Seamless borders
- Information exchange
- Communications structure
- Consistent monitoring and information
- Promote corridor wide planning
- Information provision
- Corridor wide connections awareness
- Strong links with NNSC and simple cross border links

6. CONCLUSION

Option 3: Non scientific path assembly

- Identify origin/destination
- Information exchange
- Harmonised procedures
- Predict problems and identify solutions
- Corridor wide maintenance, fuelling, cleaning
- Minimise deviations from plan
- Promote corridor wide planning
- Information provision
- Corridor wide connections awareness
- Corridor wide service delivery
- Strong links with NNSC and simple cross border links

Option 4: Solution through negotiation with actors

- Identify origin/destination
- Seamless borders
- Information exchange
- Communications structure
- Consistent monitoring and information
- Predict problems and identify solutions
- Corridor wide maintenance, fuelling, cleaning
- Corridor wide resource scheduling
- Minimise deviations from plan
- Promote corridor wide planning
- Corridor wide connectional awareness
- Corridor wide service delivery
- Information provision
- Strong links with NNSC and simple cross border links

Options 5 & 6: Solutions by Optirails

- Identify origin and destination of train
- Monitor progress
- Harmonised procedures
- Predict problems and identify solutions
- Minimise deviations from the plan
- Promotes corridor -wide planning
- Promotes corridor -wide service delivery

6. CONCLUSION

d) requirements proforma (example)

6.3.2 User-led requirements definition

USER TR1 Infrastructure Manager
 NEED 2 Optimise infrastructure utilisation
 NEED 3 Minimise delay

Functionality ref.			FUNCTIONALITY DESCRIPTION	Class			Term				
User	Need	Ref.		Core System	Sub-systems interfaces	1 mand.	2 useful	3 nice	ST	MT	LT
TR1	2&3										
		1	Calculation of predicted runs	x		x			x		
		2	Conflict detection	X		x			x		
		3	Conflict solving and information to Optirails centre	X		x				x	
		4	Automatic modification of theory	X			x			x	
		5	Calculation of optimised speed to follow schedule and transmission to driver	X	x		x			x	
		6	Automatic transmission of route setting instructions to stations		x		x			x	
		7	Automatic transmission of route setting instructions to ETCS		x		x			x	
		8	Electrified lines : take into account real-time power-supply capabilities in the previous functions	X	x			x			

6. CONCLUSION

6.3.3 Cost/Benefit Analysis Method

The cost-benefit analysis is performed for implementation of the OPTIRAILS system on the Rotterdam-Gothard-Giaio Tauro corridor. Therefore, this will be the geographical perimeter considered for the calculations.

The present analysis is a comparison of the existing situation in the corridor versus a supposed future situation where OPTIRAILS system is first implemented and then operated. So the following states will be taken into account :

- Sb : existing situation, observed today in the corridor (year 1999). The economic conditions of year 1999 will be considered, expressed in Euros.
- S0 : reference situation. It is the existing (or "do-nothing") situation projected over the period of analysis.
- S1 : "with-project" situation. It is the situation where the system is implemented, generating costs and benefits.

The calculations are made for a 30 year period. This is the traditional time period considered for such an analysis. It permits to take into account all the impacts linked to the project.

In order to calculate a financial balance, the supposed owner of the system has to be determined. In this analysis, it is considered that the entity which owns the system is a consortium of the infrastructure managers concerned by the corridor. In this hypothetical situation, the infrastructure managers of Holland, Switzerland, Germany and Italy pay for implementation and operation of the system on one hand, and receive financial benefits through fares paid by train operators that will circulate in the corridor.

The preliminary Cost/benefit analysis is included based on a fairly general view of potential benefits from the system. Improved service delivery of international traffic is forecast to halt the decline in this market sector offering both commercial and socio-economic benefit. Set against the cost estimates the rates of return have been calculated as follows,

for FIRR a value of 10% with NPV = 774 000 euros,
for EIRR a value of 15 % with NPV = 3 572 000 euros
(the baseline for profitability in Europe is set at 8%). These results, which are to be considered as orders of magnitude, nevertheless, show a potential profitability for such a project. They will be consolidated during the coming Optirails II project.

ANNEXES

1. LIST OF PUBLICATIONS

2. PRESENTATIONS

3. GLOSSARY

ANNEX 1 : LIST OF PUBLICATIONS

During the working period from 1st January 1999 to 29 February 2000, the 13 partners of the OPTIRAILS Consortium performed their allocated tasks in order to produce the following documents.

- **Workpackage n°1 (Analysis of existing status of ERTMS).**
WP leader ITALFERR, April 1999
 - volume 1/5 : Main Report
 - volume 2/5 : General description of the used and foreseen functions and technologies for trains management.
 - volume 3/5 : Survey of ERTMS works
 - volume 4/5 : Survey of the present traffic management in Europe
 - volume 5/5 : Future architecture of ERTMS
- **OPTIRAILS Newsletter n°1, WP4 Leader: TRADEMCO, July 1999**
- **Workpackage n°2 (Assessment of methods and tools)**
WP leader SYSTRA, September 1999
 - volume 1/5 : Main Report
 - volume 2/5 : Frameworks, Models and Theoretical Approaches
 - volume 3/5 : Methods, Tools and Cases in the Railway Field
 - volume 4/5 : Functional Terms of Reference
 - volume 5/5 : Scenario and Pre-Feasibility Study
- **Progress Report n°1, Project Coordinator, SYSTRA, September 1999.**
- **Workpackage n°3 (Project Design and Feasibility Assessment)**
WP leader AEATR, February 2000
 - volume 1/2 : Main Report
 - volume 2/2 : Documentation
- **Workpackage n°4 (Dissemination of results)**
WP leader TRADEMCO, February 2000
 - volume 1/5 : Main Report “Major Findings and Recommendations”
 - volume 2/5 : Conceptual / Idealised Framework, Potential Pan-European Model, Exception cases.
 - volume 3/5 : Tools, Methods (Criteria, Performances, Solutions)
 - volume 4/5 : Functional Requirements Specifications
 - volume 5/5 : Cost Benefit Analysis

ANNEX 1 : LIST OF PUBLICATIONS

- **OPTIRAILS Newsletter n°2**, WP4 Leader: TRADEMCO, February 1999.
- **Final Consolidated Progress Report**, Project Coordinator, SYSTRA, April 2000.
- **Exploitation and Dissemination Report**, Project Coordinator: SYSTRA, April 2000.
- **Final Report for Publication**, Leader: SYSTRA, April 2000.
- **OPTIRAILS User's Forum** was held in Athens on October 14 and 15, 1999 and was attended by 59 participants.
- **Presentation of OPTIRAILS project at the Annual Infrastructure Managers Meeting**, UIC, Paris 17 November 1999.
- Together with the International Union of Railways (UIC) and the Directorate General for Transports and Energy of the European Commission (EC-DG TREN), two seminars have been organised, namely:

1) The New Challenge for ERTMS and GSM-R

At the UIC Conference, which took place in Paris, on 25 and 26 November 1999, the first results of workpackages 3 "Project Design and Feasibility Assessment" were presented by AEATR to some 400 policy makers, railway directors, experts, scholars and consultant from all over Europe.

The contribution of OPTIRAILS was the conference: Pan-European Traffic Management, Providing European end-to-end Traffic Management (ETML)

2) Shaping the future of Rail III

At the second seminar, which took place in Paris, 27-28 January 2000, an overview of OPTIRAILS was presented by SYSTRA to 100 railway policy makers, experts, scholars and consultants from all over Europe.

The contribution of OPTIRAILS was related to the following topic : "European Traffic Management Layer : OPTIRAILS overview".

ANNEX 2 : PRESENTATIONS

2.1. *OPTIRAILS User's Forum (Athens)*

2.2. *Seminar n°1 : the new challenge for ERTMS and GSM-R (Paris)*

2.3. *Seminar n°2 : shaping the future of rail III (Paris)*

ANNEX 2 : PRESENTATIONS

2.1. OPTIRAILS User's Forum (Athens)

2.1.1.1. General

The OPTIRAILS User's Forum was held in Athens on October 14 & 15, 1999.

The Greek Railways offered the conference room at the top floor of their headquarters and TRADEMCO organised the event.

In this two-days forum, the OPTIRAILS concept and the relevant project progress was presented to an audience of fifty persons involved in the railway business and consulting. Besides the Greek Railways who were hosting the event, we had participants from FS, DB, NS, SBB, SNCF, BDZ, Czech Railways, Yugoslavian Railways, SIEMENS, ADTRANZ and consulting firms like SYSTRA, TRADEMCO, TIFSA, CSEE, SOFRAVIA, VTT.

The opening introduction was given by Mr. G. Gustafsson, Director of Infrastructure in UIC, covering the historical background of the UIC and EU-DGVII steps to achieve the operations of an integrated Pan-European railway traffic management system, on the established Trans European Network.

During the first day, the Project Manager, Mr. M. Genête from SYSTRA, presented the Project Overview and the objectives of OPTIRAILS. The Workpackage leaders presented their works on the analysis of existing train management systems and the survey of ERTMS works as well as the assessment of traffic management methods and tools, determining the specification requirements of the management system to be developed.

During the second day, the presentation of the OPTIRAILS business models clarified the proposed steps to introduce the system, stand alone at the beginning and integrated into the ERTMS/ETML (Management Layer) in the future.

The functional requirements of the system as determined by the project work was the last presentation during the forum, followed by the round table where questions were posed from the audience to the speakers, clarifications were given and fruitful ideas were exchanged.

The forum achieved to pass the idea of an integrated pan-European railway traffic management system operating on the international rail

ANNEX 2 : PRESENTATIONS

corridors, showing that knowledge, technology and equipment to support it are already available. Now, Railway people, Infrastructure Managers and Train Operating Companies have to be willing to collaborate for this vision.

2.1.1.2 Forum Preparation

The stage of the User's Forum has been to present the OPTIRAILS work to a selected audience, according to a list of potential participants and to exchange ideas on the OPTIRAILS concept, the implementation method to be followed and the Functional Requirement Specifications.

The invitation letter was sent to more than one hundred people in the Railways, including Infrastructure Managers, train operating companies, administrative bodies and the railway equipment industry.

The invitation letter was accompanied by the OPTIRAILS Newsletter No1 and a letter signed by Mr. G. Gustafsson and Mr. Colaço on behalf of UIC and DG VII, who supported the event. The programme of the forum was also attached to the invitation as well as a booking form for the Forum.

The invitation was sent in early August and a month later a reminder followed.

To those who kindly informed us that were unable to participate an additional letter was sent, asking them to indicate any person in their company being interested in OPTIRAILS to address the invitation to him.

2.1.1.3 Programme

The programme of the OPTIRAILS User's Forum is presented in the next page.

ANNEX 2 : PRESENTATIONS

OPTIRAILS User's Forum

Programme

Thursday, 14 October 1999

14:30	Registration	
15:00	Opening Session - Welcoming	TRADEMCO Hellenic Railways (CH)
15:20	ERTMS-ETCS Presentation	UIC
15:50	OPTIRAILS Consortium Presentation	TRADEMCO
16:00	OPTIRAILS Project Overview	SYSTRA
16:20	Coffee Break	
16:40	Survey on ERTMS works	ITALFERR
17:20	Discussion	
17:30	Traffic Management Methods & Tools	SYSTRA
18:00	Traffic Management Methods & Tools	FS, SNCF
18:30	Discussion	

Friday, 15 October 1999

9:00	Briefing of 1st day's sessions	TRADEMCO
9:15	OPTIRAILS Business Models	AEA Technology / SYSTRA
9:50	Discussion	
10:30	Coffee Break	
10:50	Functional Requirements	AEA Technology
12:00	Discussion	
12:30	Round Table	
14:00	Closing of Forum	TRADEMCO, SYSTRA
14:30	Lunch Buffet	
16:00	Departure of participants	

ANNEX 2 : PRESENTATIONS

2.2. Seminar n°1 : THE NEW CHALLENGE FOR ERTMS and GSM-R

The two-days conference was held by UIC at the Hilton/Paris on the 25 & 26 November 1999. The 20-minutes presentation was given by Mr. Tony Annis from AEATR, on the following subject:

« Pan-European Traffic Management ;

Providing European end-to-end Traffic Management (ERTML) »

In order to deliver a high quality service, then high levels of reliability are needed. Reliability includes punctuality, correct and timely information, low levels of equipment failure, all elements working together. Unreliability can be judged in two ways, in the form of equipment failures, and in terms of service degradation when things go wrong. Engineering developments will contribute to more reliable equipment, but traffic management systems are needed to manage the effects of disruption from the many external events that can affect railway operations.

Never has it been more important to effectively manage rail operations than in today`s customer-focussed and highly competitive transportation environment. The product needs to become more attractive to potential customers, and when this is achieved, new capacity will be required to enable rail to recapture its market share.

Several member states have begun to invest in the style of Traffic Management Systems capable of predicting potential conflict and in some cases calculating solutions. Examples are the SURF system in Switzerland and the Control Centre of the Future installed in the UK.

These will deliver better service delivery within each country, but the European dimension for trans-European transportation will remain. As in the airline industry with EUROCONTROL, the issue of effective rail flows across Europe is an important one. A champion of international trains is required to provide the commitment necessary to deliver service quality.

The EU are committed to sustaining the effectiveness of Rail to passengers and shippers of goods, in order that it can be an attractive option in the transportation sector. Being successful will help mitigate some of the negative aspects of alternative transport modes, and will

ANNEX 2 : PRESENTATIONS

contribute to the access needed for many areas of Europe to grow and develop.

Passenger traffic is growing successfully. However, railways which are successfully growing are beginning to suffer problems of congestion. Congested national railways will be no friendly to international trains. Much remains to be done for freight. Rail needs to do more to boost freight. It is not acceptable for regional and intercity trains to be scheduled first and for freight to have what is left over. This is beginning to change with a greater defence of freight paths emerging.

The existing European Rail Traffic Management System (ERTMS) developed so far in Europe is mainly safety, train control and communications.

A layer to manage train operations (ERTML) is missing.

The 4th Call of the RTD programme of DG VII has commissioned work with the goal of identifying the functional and technical requirements for a Pan-European rail traffic management system within the ERTMS framework.

The overall aim of ERTMS/ERTML is the harmonisation between national systems to the overall benefit of trans-European corridors. The European layer may well consider the national systems as "black boxes" dealing with the problems of their own rail networks, but the European layer must drive the local choices where appropriate to ensure the overall common good for the corridor.

The main objectives of the envisaged system are;

- To deliver the contracted plan
- To promote interoperability (in operations term)
- To establish efficient and cost-effective rail traffic corridors
- To offer uniform supply to the rail market

The general requirements of a system to achieve these objectives are as follows:

- The capture and maintenance of data to produce a real time model of current operations.
- The means of making the information in the model available to the players involved either dynamically or by request.
- Methods of analysis of the current conditions to identify potential conflicts requiring action.
- Decision support tools able to generate solutions or to assist players in formulating solutions.

ANNEX 2 : PRESENTATIONS

The success of the daily plan is a matter of properly managing all the resources to ensure that they are in the right place at the right time. The key to this is information management and the communications infrastructure. Systems that meet the general requirements given above are the foundation on which to build.

The work of the EU and UIC is vested in a project called OPTIRAILS I. The current work is concerned with specifying the functional requirements of a Pan-European Traffic Management System. A further project, OPTIRAILS II has been commissioned to produce a Systems Requirement Specification. This project is due to start in January 2000.

The underlying principles guiding much of the work on OPTIRAILS include:

- ❑ The system proposed must offer added-value at the European level.
- ❑ It must be acceptable to the member states operations organisations.
- ❑ It must be capable of evolving along with the development programmes of the member states.
- ❑ It must be affordable.
- ❑ It must be capable of an implementation within 5 years.
- ❑ It should concentrate on real time control (not on planning).

Optirails I has completed a survey of the current and planned supporting systems and infrastructure in several member states. Also it has identified possible methods and tools needed to meet the general requirements.

Currently, work is being done to identify the functional requirements.

The project team, in connection with defining the functional requirements, is addressing a number of issues. These include, user requirements, the relationship with the national operations centres and the scope in functionality and approach of potential systems.

Others include, the implementation of systems on the basis of specific corridors, the degree to which a common infrastructure exists across Europe to support the developed system, restricting the activity (at least in the early stages) to Infrastructure Manager activities alone, the involvement of others players (cf TOCs, end Users, FOCs, Maintenance, Planners), what particular type of problems should be tackled, and the likely success in forecasting in order to provide a proactive approach to problems and some optimisation in decisions.

ANNEX 2 : PRESENTATIONS

Optirails is seeking to bring to Europe-wide operations what ETCS has brought to Europe-wide signalling and to play its part in the delivery of a quality rail service.

The programme of the seminar “The New Challenge for ERTMS and GSM-R” is presented in the following page.

ANNEX 2 : PRESENTATIONS

Day One: 25 November 1999

08:00 - 09:00 **Arrival - registration (Hilton Hotel)**
09:00 - 09:15 **Welcome - Introduction to the conference** Ph. Roumeguère (UIC)
Exhibition brief

ROUND TABLE

CONFERENCE CENTRE: HILTON HOTEL,

Chairman : G.W. Gustafsson (UIC)

09:15 - 10:15

Railways' commercial and operational expectations

FACILITATOR:
A. Colaço (EC - DG Transport)

Video: ETCS Test Vienna-Budapest
Questions

PARTICIPANTS:
F. Lacôte (SNCF)
M. Moretti (FS SpA)
B. Ôstlund (BV)
R. Te Pas (NS)

10: 15 - 11:15

Exhibition Opening Ceremony by Ph. Roumeguère
Coffee break at the UIC sponsored by Siemens

PRESENTATIONS FROM RAILWAYS

CONFERENCE CENTRE: HILTON HOTEL

Chairman : A. Lagana (FS SpA)

11: 15 - 11:35

Commercial impact of ERTMS
- Introduction of ERTMS in the UK
- Benefits and Risks

R. Gisby (Railtrack)
West Coast Route Modernisation Project (UK)

11:35 - 11:55

Expectations of the GSM-R system
- Range of Applications
- GSM-R contractual situation in Germany
- Network rollout
- Supply of mobile equipment
- Introduction of new features

L. Lengemann (DB AG)
T. Sauter (Mannesmann ARCOR)

11:55 - 12:15

Providing European end to end traffic management (ETML)

T. Annis (AEATR)

12:15 - 12:30

Questions

12:30 - 14:30

Viewing of exhibition
Lunch at the Hilton Hotel sponsored by NORTEL Networks

ANNEX 2 : PRESENTATIONS

RESPONSES FROM GSM-R INDUSTRY

CONFERENCE CENTRE: HILTON HOTEL

Chairman : J.P. Henninot (SNCF)

14:30 - 14:50

How GSM-R industry perceives the railways market

C. Robillard (Nortel Networks)

- GSM & GSM-R markets : the supplier standpoint
- GSM-R & the need for interoperability of railway networks
- What railways can expect from the evolution of GSM

14:50 - 15:10

GSM-R: **H-J. Marx (Siemens AG)**

The basis for an interoperable European Railway Network

- GSM-R developed within MORANE
- The trans-European high speed rail system requires GSM-R
- The EU directive : application and consequences
- Extension to conventional lines
- The economic case for a quick decision on implementation

15:10 - 15:30

Questions

15:30 - 16:30

Viewing of exhibition

Coffee break at the UIC sponsored by Siemens

RESPONSES FROM ERTMS INDUSTRY

CONFERENCE CENTRE: HILTON HOTEL

Chairman : I. Dobson (Alstom / UNISIG)

16:30 - 16:35

Introduction to UNISIG

I. Dobson (Alstom UNISIG)

16:35 - 16:50

UNISIG & ECSAG:

R. Davis (Railtrack ECSAG)

A fruitful cooperation of business

C. Frerichs (Siemens AG)

partners to finalise the ETCS specifications

16:50 - 17:05

Class 1 test process for ERTMS

F. Camurri (Ansaldo Signal)

17:05 - 17:20

Standardisation process for ERTMS

B. Gedda (Adtranz)

17:20 - 17:30

Questions

17:30

Closure of Day 1

G.W. Gustafsson (UIC)

17:40 - 18:30

Viewing of exhibition

18:30 - 20:00

Cocktails at the Hilton Hotel sponsored by DB Cargo & EEIG ERTMS Users Group, FS SpA, SNCF

ANNEX 2 : PRESENTATIONS

Day Two: 26 November 1999

WORKSHOPS - HILTON HOTEL & UIC (PLEASE SEE INFORMATION SLIDES ON THE DAY FOR LOCATION)

- 9:00 - 9:40** GSM-R workshop
G1: Spectrum planning, frequency management and coverage at boundaries
ERTMS workshop
El: ERTMS interoperability through EMSET trials
R. Matassini (Ansaldo Signal)
L. Giles (EPT)
A. Planells (Dimetronic Signals)
J. Tamarit (CEDEXICETA)
- 9:50 - 10:30** **G2:** The practical application of the interoperability directive
E2: ERTMS Class 1 Interoperability
U. Dräger (Alcatel)
E. Parent de Curzon (EC - DG Transport)
B. Stamm (Siemens AG)
- 10:30 - 11:15** Viewing of exhibition Coffee break at the UIC sponsored by UNISIG

WORKSHOPS (CONTINUED)

- 11:15 - 11:55** **G3:** Transition from existing systems to GSM-R
P. Fischer (KAPSCH)
C. Spaans (NS)
E3: Implementation - making the transition from existing systems to ERTMS operation
M. Falchi (RFF)
D. Lancien (SNCF)
- 12:05 - 12:45** **G4.:** GSM-R system design
M. Jentsch (Mannesmann ARCOR)
W. Breitling (UIQ)
A. Chiappini (Ansaldo Signal)
F. Kollmannsberger (DB AG)
S. Shirlaw (Alstom)
E4.: TSI - Achieving interoperability through European Standardisation
- 12:45 - 14:30** Viewing of exhibition
Lunch at the Hilton Hotel sponsored by UNISIG

CLOSING SESSION

CONFERENCE CENTRE: HILTON HOTEL

- 14:30 - 15:30** Prospects for meeting the challenge
Chairman : C. Kessell (~RACAL Fieldforce)
President, IRSE
C. Traverso (EEIG ERTMS Users Group)
T. Buffenoir (SAGEM)

ANNEX 2 : PRESENTATIONS

2.3. Seminar n°2 : SHAPING THE FUTURE OF RAIL III.

The two-days conference/seminar was held by UIC in Paris.

The 20-minutes presentation was given by the OPTIRAILS Project Manager, Mr. Maurice Genève from SYSTRA, on the title : “European Traffic Management Layer (ETML) – OPTIRAILS”.

This presentation gave a broad overview of the project, major issues were enlightened and relationships with the future OPTIRAILS II project were displayed.

The seminar program is indicated herewith.

ANNEX 2 : PRESENTATIONS

Shaping the Future of Rail III Conference organised by DG Transport, UIC and CER Paris, 27 + 28 January 2000

Day 1 : 27th January 2000

Day Chairman :		G.W. Gustafsson, UIC
08:00 – 9:00	Arrival – Registration	
9:00 – 09:05	Welcome and opening address	G.W. Gustafsson
Session A : Pricing & Charging		C. Sikow-Magny, DG Transport
09:05 – 09:25	Revenue Effects of Social Marginal Cost	Dr. R. Roy
09:25 – 09:50	External cost of Transport (abstract)	M. Maibach, INFRAS
09:50 – 10:20	Overnight Express, the first European high speed freight/passenger service connecting Amsterdam and Milano	J.T. Poorten, Railion
10:20 – 10:50	Coffee break	
10:50 – 11:20	Pricing European Transport System	Prof. C. Nash, University of Leeds S. Suter, ECOPLAN
11:00 – 11:30	Train Prices for Infrastructure Use	A. Knibbe, PriceWaterhouseCoopers
11:50 – 12:00	Discussion	
12:00 – 14:00	Lunch break	
Session B : Benchmarking		M. Howard, CER
14:00 – 14:30	Profitability of Rail Transport and Adaptability of Railways (PRORATA)	M. Brown, Halcrow-Transmark
14:30 – 15:00	Performance Indicators	M. Rushton, Booz Allen Hamilton
15:00 – 15:30	Coffee / Tea break	
15:30 – 16:00	Infracost III	Dr J. Lüking, R+R Burger und Partner AG
16:00 – 16:30	Discussion	
16:30 – 16:45	Conclusions of the Day	G.W. Gustafsson

ANNEX 2 : PRESENTATIONS

Shaping the Future of Rail III

Conference organised by DG Transport, UIC and CER

Paris, 27 + 28 January 2000

Day 2 : 28th January 2000

Day Chairman :		J. Anselmo, DG Transport
08:00 – 9:00	Arrival – Registration	
Session C : Safety / Human Factors		A. Lundström, DG Transport
09:00 – 09:15	Passenger survivability and evacuation	D. Kay, AEA Technology
09:15 – 09:30	Safety in Alpine Tunnels	H.P. Vetsch, Alp Transit Gotthard AG
09:30 – 10:00	Safety regulations and standards	M. Spackman, NERA
10:00 – 10:30	Coffee break	
10:30 – 10:45	UIC Safety Platform (Safety Directors)	M. Taboulet, SNCF
10:45 – 11:15	Human factors in cross-border traffic (HUSARE)	R. Wiedenmann, TÜV Rheinland Y. Mortureux, SNCF
11:15 – 11:30	UIC MMI Programme	A. Michel, UIC
11:30 – 12:00	Discussion	
12:00 – 14:00	Lunch break	
Session D : Capacity management / Path allocation		C.H. Lundström, CER
14:00 – 14:30	European Traffic Management Layer – ETML (OPTIRAILS)	M. Genête, SYSTRA
14:30 – 15:00	Train Path Allocation / FTE	B. Kuypers, PWC
15:00 – 15:15	Freight Information in the Rail Environment (FIRE)	E. Kuhla, TransportOnline
15:15 – 15:30	Discussion	
15:30 – 16:00	Coffee / Tea break	
16:00 – 16:30	5 th FP; new projects started after 1 st call + priorities for 2 nd and 3 rd call	J. Olsen, DG Transport
16:00 – 16:45	Discussion	
16:45 – 17:00	Conclusions of the Day	J. Anselmo, DG Transport

ANNEX 3 : GLOSSARY

3. Glossary of terms and abbreviations

Actionable Information	Information leading to direct required actions
Actors/players	Any people/organisations involved or with a reasonable interest in the train service delivery
Actual Timetable	The timings delivered on a specific day
Business Model	There are two parts to this definition; a) the business model includes the elements of the business needed to achieve the business proposal together with their relationships and interactions b) the business proposition is what the business is aimed at achieving
Centralised system	System with functionality and operations driven from one geographical location
Common good	An equitable solution amongst players which best meets the service delivery requirements
Contracted Timetable	An adaptation of the reference timetable taking into account specific customer contracts, operating, and maintenance constraints
Corridor	A route ignoring regional and national border organisation
Crew Roster	The programme of crew allocation to services
Cross-border discontinuity	Disruption to efficient service delivery at the border (for example, poorly linked train paths either side of the border)
Damage	Any shortfall in the delivery of the contracted timetable
Distributed System	System with functionality and operations driven from several different, but co-ordinated locations
Driving traction diagram	The program of locomotive allocation to train services
End User	Recipient of service delivery
Idealised/concept system	A system excluding the constraints of implementation and current technology
Local	Used to describe problems, constraints, tools which exist or are applied within a sector of a national railway network
Logistic supply chain	General organisation of moving goods around including its cost-effectiveness, balancing inward and outward loads, all modes.
Numerical hardness	Requiring very large amounts of computations

ANNEX 3 : GLOSSARY

Pan-European	Any aspect of the project applied jointly to >1 individual member state
Path Assembly	Joining up of individual train paths to extend path in terms of time and space
Performance Regime	Framework of expected performance in service delivery
Rail Traffic Management System.	A system managing train service delivery
Railway Future Predictor	Tool capable of predicting the future status of rail operations and infrastructure
Real-time problems	Problems occurring during service delivery
Reference Timetable	The timetable covering a period of time equivalent to summer, winter etc.
Scheduled Timetable	The running timetable for a particular day
Seamless border	Processes common within a country are no different in effectiveness or operation at the border. There is no discontinuity in service delivery at the borders.
Service delivery	The actual provision of transport services (all modes)
Slack	Free time in achieving latest admitted arrival time.
Status of the Network	Physical and operation condition of the railway network (including infrastructure failures, free capacity for train paths, levels of congestion)
Target Timetable	A timetable to best suit customer needs following disruption to the scheduled timetable
Technical user	User connected with service delivery (all modes)
Tools	Software or other device to process data to yield information, advice or control decisions
Train Path	Train route defined in time and space
Unstructured problem	Not expressible in algebraic form

ANNEX 3 : GLOSSARY

AID	Arranged Immediate Deal
ARS	Automatic Route Setting
AVI	Automatic Vehicle Identification
BELIFRET	BELgium Italy France FRET (a freight corridor organisation)
Bfo	Bahnhofsfahrordnung
BIGS	Best Infrastructure Guaranteed Speed
BZ	BetriebsZentrale; operation centre (of DB AG)
CAP	Capacity reference. A definition in the form CAP-x for identifying path schedulability, where x is the number of independent paths which are theoretically available to reschedule, ahead of current train position and current moment.
CCF	Strategic Control Centre in UK
CEN	Comité Européen de Normalisation
CENELEC	European Committee for Electrotechnical Standardisation (Comité Européen de Normalisation Electrotechnique)
CP	Portuguese Railway company (Caminhos de ferro Portugueses)
DB AG	German Railways (Deutsche Bahn AG)
DB Netz	German Railways Infrastructure Manager
DEED	Delay Evolving to End Dossier
EAS	Ein-und AusgabeStation
EC	European Commission
ECA	European Corridor Area
ECC	European Regional Control
ERA	European Regional Area
ERC	European Regional Control
ERRI	European Rail Research Institute
ERTMS	European Rail Traffic Management System
ESTW	Elektronische StellWerke; electronic signal boxes
ETCS	European Train Control System
ETML	European Traffic Management Layer
EU	European Union
EUROPE	European Railways Optimisation Planning Environment
FFB	FunkFahrBetrieb ; Radio Controlled Operation
FFFIS	Form-Fit Functional Interface Specification
FFFS	Form-Fit Functional Specification

ANNEX 3 : GLOSSARY

FICS	Flexibility in Constrained Schedules
FIS	Functional Interface Specification
FOC	Freight Operating Company
FRS	Functional Requirements Specification
FS	Italian Railways (Ferrovie Dello Stato)
FZB	FunkZugBeeinflussung ; Radio Train Control
GSM	Global System for Mobile Communications
GSM-R	Global System for Mobile Communications - Railways
HMI	Human Machine Interface (see MMI)
ICE	InterCity Express train
IM	Infrastructure Manager
IMC	Infrastructure Management Corridor
ISF	Incentive Speed Factor
ISO	International Standardisation Organisation

LeiBIT Leitsystem zur Betrieblichen Informations Verteilung; operational information distribution

LeiDis-S/K Leitsystem zur Disposition auf Strecken und in Knoten (new name for the system which includes the present RZü-functionality and its extension); Management for lines and nodes

LeiPro Leitsystem zur Prozessanalyse (statistical system); operational process analysis

LZB	LinienZugBeeinflussung: Automatic Train Control
MACS	Minimum Allowed Commercial Speed
MARCO	Multilevel Advanced Rail Conflict Resolution and Operation control
MIGS	Maximum Infrastructure Guaranteed Speed
MMI	Man Machine Interface (see HMI)
MORANE	Mobile Radio for Railway Networks in Europe
NLZ	NetzLeitZentrale; network management centre (of DB AG)
NNSC	National Network Supervisory Centre
OSS	One Stop Shop (a freight international transport organisation)
RAM(S)	Reliability, Availability, Maintainability, (Safety)
RBC	Radio Block Centre
RBL	Rechnerunterstuetzte BetriebsLeitung (Computer aided operation management);
RZü	Rechnergestützte Zugüberwachung; computer aided train monitoring
SAC	Schedule Area Current

ANNEX 3 : GLOSSARY

SAI	Scheduling Area Initial
SAM	Schedule Area Management
SAS	Schedule Area Surplus
SEA	Schedule Evaluated Area
SEC	State Event Condition
SNCF	French Railways (Société Nationale des Chemins de fer français)
SRS	System Requirements Specification
STM	Standard Traffic Management
SURF	Système Unifié de Régulation Ferroviaire (standardised rail traffic control system)
TMS	Traffic Management System
TOMS	Train Operator Maximum Speed
TRIO	Transportation Railways Innovative Optimisation
TRIP	Transportation Railways Integrated Planning
TRIS	Teleconferencing Railways Information System
VIS	Virtual Infrastructure Strategic controller
VIT	Virtual Infrastructure Tactical controller
WP	WorkPackage
ZFI	ZugFahrtInformation (Train Operation Information)
ZN800	ZugNummernmeldeanlage (Train Number Display System)