Final Report

The CREAM Project

Technical and operational innovations
implemented on a European rail freight corridor

The CREAM Project has been
co-funded by the European Commission | 6th Framework
Programme

Title
The CREAM Project – Technical and operational innovations implemented on a European rail freight corridor

Date of publication
July 2012

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Design and production
Ahlers Heinel Werbeagentur GmbH
Lortzingstraße 1, 30177 Hannover, Germany

Publisher and copyright
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ISBN 978-3-00-037915-4

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CREAM is a research and development project in the field of rail transport, co-funded by the European Commission in the scope of the Sixth Framework Programme for Research and Technological Development (FP6). CREAM stands for “Customer driven Rail-freight services on a European mega-corridor based on Advanced business and operating Models”.

Coordinator‘s view

The relevance of a corridor approach for any kind of investigation or implementation activity in the railway sector has been introduced relatively recently. Right from the beginning one thing has been quite clear: In addition to the well investigated and homogenous corridors in Western Europe, like the corridor Rotterdam-Genoa, there are other corridors possessing quite diverse framework conditions.

An example is the transport corridor considered by the CREAM project. This corridor has an entire length of more than 3,000 km and draws a bow between Western and Central Europe and the Balkan states towards Turkey/Greece. In fact, the selected corridor stretches across Benelux countries, Germany, Austria, Italy, Slovenia, Hungary, Romania, Croatia, Serbia, Bulgaria, Turkey, F.Y.R. of Macedonia and Greece and thereby covers railway markets with rather diverse commercial, legal and technical operating conditions.

The CREAM corridor was defined and proposed on the basis of the corridor investigations conducted within the EU research project TREND (2005/2006). TREND analysed the situation on six European railway corridors and derived necessary actions. A main goal of TREND was to identify suitable corridors for subsequent EC funded implementation projects. Main selection criteria were the improvement potential and the expected transport volumes for rail freight.

On the considered routes towards Southeast Europe and beyond, rail freight played only a minor role in recent years, even though some elements would play in favour of rail: First, in many countries along the corridor traditionally a lot of freight transport was carried out on rail. Secondly, the large area of the corridor as a whole makes rail transport the best choice to cover long distances between these countries.

However, unfavourable framework conditions like decrepit or missing infrastructure, obsolete rolling stock, limited coordination between the actors, missing IT solutions and many more led to a shrinking market share of rail freight transport not only at international relations on this axis, but also in the respective national markets.

The railway companies’ first attempts to improve train operations on the corridor, such as the ZEUS initiative between 2003 and 2006, showed that in addition to their own endeavours, changes in the framework conditions and a direct cooperation among the market partners are needed.

Freight forwarders share a great interest in using rail instead of road on the corridor, also due to the manufacturers' rising demand to put a green label on their products. Nevertheless, the service quality and frequency of existing rail services that is necessary to compete with the cheaper and flexible road services was not sufficient. This was the situation before the CREAM project started to work on various components necessary to improve the overall situation for rail.

As initiator and coordinator of the CREAM project, HaCon thanks all consortium partners and their employees for their enormous efforts, all supporting stakeholders and associations for their interest and contribution and the market partners for their positive and mostly constructive "pressure". Special thanks goes to the European Commission for its institutional and financial support. This enabled the project partners to also work on measures from which they did not profit in the short-term but which are essential for a positive and sustainable development of the corridor and the related rail freight market in the future.

The CREAM project has given significant impetuses for this corridor and paved the way for further developments: Not only by accompanying and supporting the difficult and abrupt restructuring processes of the former incumbent railways in Southeast Europe but also by opening up new markets for rail. The continuous knowledge transfer within the consortium with all kinds and levels of experience led to a significantly accelerated development. As one of our partners from the Balkan countries stated right at the beginning:

"Company structures and business procedures which have been growing in Western European railways over a period of 30 years, have to be developed by the Southeast European railways mostly in less than three years and have to compete with the fast growing road transport market. However, we are happy to bear this challenge with the support of CREAM".

So besides measurable effects in terms of additional trains and tonnes, the well functioning cooperation even between competitors was one of the main characteristics of CREAM. This is what, we hope, will last also after the end of the project, enabling a continuation of the positive developments, initiated by CREAM.

Lars Deiterding
on behalf of the CREAM project coordinator HaCon

European Commission's view

Transport is one of the key drivers that shape the development of our society. Its essence as an engine for economic growth and social well-being cannot be denied. However, reconciling the ever-growing demand for transport with the need for a resource-efficient and overall sustainable evolution is an ever increasing challenge.

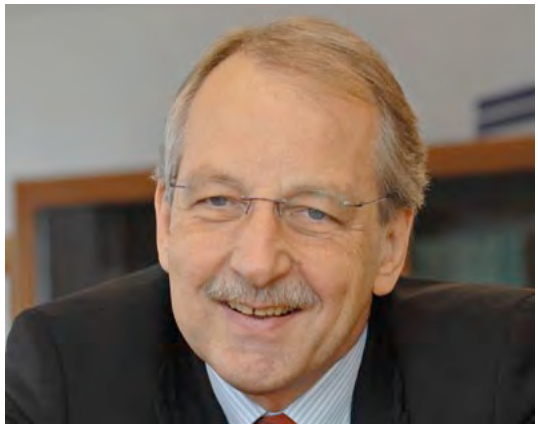
Rebalancing the transport sector, with a shift towards more environmentally-friendly forms of mobility, will be pivotal in such a context.

These global trends provide railways with a welcome opportunity to play a new and broader role in the European transport sector. However, to turn such an opportunity into reality, railways will have to create a whole new set of competitive advantages, moving towards a "best-in-class" service profile in the ever-evolving market place at large.

This requires moving well beyond the boundaries of the technological-oriented innovation that has been the trademark of railways since long. Novel business, organisational and logistic solutions as well as new partnerships will be essential to support such a search-for-excellence by the rail sector.

The CREAM project – developed within the Community's Sixth Framework Programme - has been one of the pioneering attempts to address this perspective in the rail freight sector. Through researching, promoting and field testing new organisational and collaborative ways on how railways could approach European-wide logistic operations, the project provided a groundbreaking contribution in support of a needed revolution in the business culture of railways.

In addition, by blending partners from within the Union and from candidate countries in South-East Europe, the project has equally paved the way for a more efficient integration of these latter countries both within



the European transport system and within the European research community.

My conclusion: the future of rail should be based on new visions building upon the entrepreneurship of the pioneers of the past, upon an ever-continuous questioning of the realities of the present, taking stock for a new more ambitious future. The fact that several collaborative activities that were launched in the context of the CREAM project will be continued subsequently to their wrap-up is a confirmation that innovation and creativity helps such goals in becoming reality.

I wish you an interesting reading!

Matthias Ruete
Director-General
EC Directorate-General for Mobility and Transport

Stakeholder‘s view

Ekol is experienced to develop sustainable and efficient supply chains for customers from the automotive, pharma, textile, chemistry and retail industry with transport flows between Turkey, Bulgaria, Romania, Italy, Germany, France, UK, Scandinavia and the Benelux. We take over the entire supply chain management including packaging, storage and distribution. We are depending on punctual and – even more important – reliable transport which covers almost the entire CREAM corridor.

Originating from using the ferry services from Turkish ports to Trieste (Italy) we could develop our own truly “multimodal” service with a combined ferry – train – truck routing and its massive use. During the CREAM duration we have expanded the frequency from initially one pair of trains per week to now seven pairs on the routing Trieste – Worms (Germany). We were even able to extend the services to the Worms – Arad (Romania) line (three pairs per week) so that we are now providing a couple of alternative routings in relation with Turkey and the Balkans. They can be chosen according to the performance and price requirements of our customers.

Carried out in accordance with our CREAM partners, these activities will be continued on commercial level to facilitate the satisfaction of our customers, the evolution of our company and the improvement of the industries’ carbon footprint. We wish to thank the European Commission and the CREAM Coordinators for their support which encourages us to continue in this direction.

Ahmet Musul
Founder and Chairman of Ekol

Project summary

CREAM is a European research and development project which was conducted in the period 2007– 2011. Its main objective was the improvement of rail freight between Western and Southeast Europe. Organisational improvements, technical innovations and competitive rail-based transport services have been developed and successfully implemented during the project. Rail freight transport has benefited from these improvements by shorter transit times, tweaked transport quality and an increase in the annual transport performance of more than one billion tonne-kilometres. The CREAM consortium comprised 30 partners from 13 countries – including railway companies, the International Union of Railways UIC, transport operators, technology providers, research institutes and consulting firms. The CREAM project has been co-funded by the European Commission.

The CREAM project was set up to respond to the increasing demand for rail-based logistic systems and to support the implementation of change in the European railway area, initiated by the European legislation. Against the benchmarking business models of logistic service providers, CREAM has defined advanced customer-driven business models for railway undertakings and intermodal operators. CREAM has analysed the operational and logistic prerequisites for developing, setting up and demonstrating seamless rail freight and intermodal rail/road and rail/short sea/road services on a Trans-European mega-corridor between the Benelux countries and Turkey/ Greece. On this basis the CREAM partners developed different business cases which were integrated into an innovative corridor-related freight service concept, with respect to:

- Innovative rail-based supply chains including intelligent rail and multimodal operation models
- A quality management system
- Interoperability and border crossing
- Integrated telematic solutions for train control, tracking & tracing of shipments and customer information
- Rail logistics for temperature-controlled cargoes
- New technologies for the transport of unaccompanied semi-trailers in intermodal transport

All project developments were designed for a very challenging transport corridor: This corridor incorporates completely new rail infrastructure dedicated to rail freight, congested industrialised and rural areas and passes EU member states, accession states and candidate countries. The transports considered involve different kinds of stakeholders including new entrant railway undertakings and customers from various market segments. The proposed solutions were field-validated in full-blown demonstrations within the lifetime of the project (2007 – 2011).

CREAM is een Europees onderzoeksproject dat is uitgevoerd in de periode 2007 – 2011. Het doel van het project was het bevorderen van het railgoederenvervoer tussen West- en Zuidoost-Europa. In het project zijn organisatorische verbeteringen aangedragen, technische innovaties ontwikkeld en concurrerende services voor spoorvervoer ingevoerd. Daardoor zijn transporttijden verkort, is de kwaliteit verbeterd en is de jaarlijkse transportcapaciteit op deze verbinding gestegen met een miljard tonkilometers. Het CREAM consortium bestaat uit 30 partners in 13 landen waaronder spoorwegondernemingen, de International Union of Railways UIC, railoperators, aanbieders van technologie, researchinstituten en consultancy bureaus. Het CREAM project is gefinancierd door de Europese Commissie.

CREAM est un projet Européen de recherche, conduit dans la période 2007 – 2011. Son principal objectif était l'amélioration du fret ferroviaire entre l'Europe occidentale et l´Europe du Sud-Est. Au cours du projet beaucoup de développements organisationnels, d´ innovations techniques et de nouveaux et compétitifs services de transport ferroviaire ont été élaborés et mis en œuvre avec succès. Le transport du fret ferroviaire a bénéficié de ces améliorations avec temps de transit plus courts, une meilleure qualité des transports et une augmentation de la performance annuelle de transport de plus d'un milliard de tonnes kilomètriques. Le consortium CREAM a été composé de 30 partenaires de 13 pays – y compris des sociétés de chemin de fer, l´Union Internationale des Chemins de Fer UIC, des opérateurs de transport, des fournisseurs de technologie, des instituts de recherche et de cabinets de conseil. Le projet CREAM a été co-financé par la Commission Européenne.

CREAM ist ein europäisches Forschungsprojekt, welches im Zeitraum 2007 – 2011 durchgeführt wurde. Es hatte zum Ziel, den Schienengüterverkehr zwischen West- und Südosteuropa weiterzuentwickeln. Im Projekt wurden organisatorische Verbesserungen, technische Innovationen sowie wettbewerbsfähige schienenbasierte Transportangebote entwickelt und erfolgreich eingeführt. Dadurch konnten kürzere Transportzeiten, Qualitätsverbesserungen und eine Steigerung der jährlichen Transportleistung von gut einer Milliarde Tonnenkilometern für den Schienengüterverkehr erreicht werden. Das CREAM Konsortium umfasste 30 Partner aus 13 Ländern – darunter Eisenbahnunternehmen, der internationale Eisenbahnverband UIC, Transportoperateure, Technologieanbieter, Forschungsinstitute und Beratungsunternehmen. Das CREAM Projekt ist durch die Europäische Kommission gefördert worden.

CREAM é un progetto Europeo di ricerca, condotto nel periodo 2007 – 2011, col principale obiettivo di migliorare le performance del traffico merci tra l´Ovest e il Sud Est europeo. Durante il progetto sono stati sviluppati e realizzati con successo miglioramenti dei processi organizzativi, innovazioni tecnologiche e servizi competitivi basati sull´utilizzo della rotaia. Il traffico merci su rotaia ha beneficiato delle suddette innovazioni ottenendo tempi di transito più brevi, migliorando la qualità del trasporto e aumentando di più di uno miliardo di tonnellate/km la performance di merci trasportate in un anno. Il consorzio CREAM é stato composto da 30 partner di 13 Paesi diversi, inclusi compagnie ferroviarie, la UIC – Unione Internazionale delle ferrovie, operatori logistici, fornitori di tecnologie, istituti di ricerca e società di consulenza. Il progetto CREAM é stato co-finanziato dalla Commissione Europea.

Evropski raziskovalni projekt CREAM, ki je deloval med letoma 2007 in 2011 in bil namenjen izboljšanju železniškega tovornega prometa med zahodno in vzhodno Evropo, je razvil in uspešno uvedel organizacijske izboljšave, tehnične inovacije in konkurenčne storitve železniškega tovornega prometa. Projekt je s tem skrajšal čas prevozov, izboljšal kakovost železniškega tovornega prometa in povečal letno uspešnost železniškega prometa za več kot milijardo tonskih kilometrov. Konzorcij projekta CREAM sestavlja 30 partnerjev iz 13-ih držav – vključno s prevozniki v železniškem prometu, Mednarodno železniško zvezo UIC, prevoznimi operaterji, ponudniki tehnologij, raziskovalnimi instituti in svetovalnimi podjetji. Projekt je sofinancirala Evropska komisija.

CREAM je bio europski istraživački projekt koji se provodio u razdoblju od 2007. – 2011. godine. Cilj je bio poboljšanje prijevoza željezničkog tereta između Zapadne i Jugoistočne Europe. U projektu su uspješno provedena organizacijska poboljšanja, tehničke inovacije kao i konkurentne usluge za željeznički teretni promet. U konačnom rezultatu ostvarene su kraće transportne linije, poboljšanje kvalitete i povečanje godišnjih transportnih usluga preko 1 milijarde tonakilometara za željeznički teretni promet. CREAM konzorcij obuhvaćao je 30 partnera iz 13 zemalja – između ostaloga željeznička poduzeća, međunarodnu uniju željeznica UIC, prijevoznike, tehnološke tvrtke, istraživačke institute i konzultantske tvrtke. CREAM projekt je sufinanciran od strane Europske komisije.

КРИМ је био европски истраживачки пројекат који је реализован у периоду од 2007 – 2011 године. Његов циљ је био да се побољша жељезнички теретни превоз између западне и југоисточне Европе. У пројекту, побољшање организације, техничке иновације и конкурентна железница – заснована на транспортних услуга била је развијена и успешно имплементирана. Железнички теретни транспорт је имао користи од ових побољшања кроз краћих транзитних времена, побољшање квалитета превоза и већи годишњи учинак транспорта више од 1 милијарде тон - километара. КРИМ конзорцијум се састоји од 30 партнера из 13 земаља - укључујући, жељезничка предузећа, Међународну железничку унију УИЦ, превозници, технолошких провајдера, истраживачких института и консултантских фирми. КРИМ је пројекат финансиран од стране Европске комисије.

КРИМ беше европски проект за истражување, која беше спроведен во периодот 2007 – 2011 година. Неговата цел беше подобрување на железничкиот товарен транспорт меѓу Западна и Југоисточна Европа. Во проектот, организациските подобрувања, техничките иновации и конкурентна железница - базирана на транспортни услуги беше развиена и успешно имплементирана. Железнички товарен транспорт има корист од овие подобрувања преку пократки транзитни времиња, подобрување на транспортниот квалитет и зголемување на годишната извршување на превоз на повеќе од 1 милијарда тон - километри. КРИМ конзорциумот е составен од 30 партнери од 13 земји – вклучително, железнички компании, Меѓународната унија на железници УИЦ, транспортни оператори, технолошки провајдери, истражувачки институти и консултантски фирми. Проектот КРИМ е кофинансиран од Европската комисија.

Το CREAM είναι ένα ερευνητικό ευρωπαϊκό πρόγραμμα ,υλοποιήθηκε την περίοδο 2007 – 2011, και αποσκοπούσε στη βελτίωση της σιδηροδρομικής μεταφοράς εμπορευμάτων μεταξύ της Δυτικής και Νότιο-Ανατολικής Ευρώπης .Οι οργανωτικές βελτιώσεις , οι τεχνικές καινοτομίες καθώς και οι ανταγωνιστικές σιδηροδρομικές λύσεις που αναπτύχθηκαν στο πλαίσιο του CREAM, είχαν σαν αποτέλεσμα την επίτευξη μειωμένου χρόνου ταξιδιών , καλύτερη ποιότητα και αξιοσημείωτη μεταφορά φορτίων προς το σιδηρόδρομο (αύξηση κατά 1 δις τόνους/χιλιόμετρο) . Στο εν λόγω ερευνητικό πρόγραμμα συμμετείχαν 30 εταίροι από 18 χώρες –μεταξύ των οποίων σιδηροδρομικές εταιρείες , η Διεθνής Ένωση Σιδηροδρόμων (UIC), μεταφορείς , ερευνητικά ινστιτούτα και εταιρείες συμβούλων. Το ερευνητικό πρόγραμμα CREAM ήτα συγχρηματοδοτούμενο από την Ευρωπαϊκή Επιτροπή.

A CREAM egy olyan európai kutatási projekt, melynek célja 2007 – 2001 között a Nyugat- és Dél-Európa közötti vasúti árufuvarozást fejlesztése volt. A projekt keretében szervezetfejlesztésekre, műszaki újításokra és versenyképes vasúti szállítási szolgáltatások fejlesztésére került sor, majd azok sikeres implementálására. Ezek az újítások kedveztek a vasúti árufuvarozásnak azáltal, hogy gyorsabb lett a tranzit idő, javult a szállítás minősége és az éves szállítási teljesítmény több mint 1 milliárd tonna-kmrel növekedett. A CREAM konzorcium 13 ország 30 partnerét (vasútvállalatok, UIC, operátorok, műszaki szolgáltatók, kutatóintézetek és tanácsadó cégek) tömörítette egybe, melyet az Európai Bizottság társfinanszírozott.

CREAM este un proiect de cercetare european, care s-a derulat în perioada 2007 – 2011. Obiectivul său principal a fost îmbunătățirea serviciilor de tranport feroviar de mărfuri între Europa de Vest și Europa de Sud – Est. Pe parcursul derulării proiectului, s-au dezvoltat și s-au implementat cu succes îmbunătățiri privind organizarea, inovații tehnice și servicii de transport feroviar competitive. Prin îmbunătățirile respective, transportul feroviar de mărfuri a beneficiat de durate de tranport mai scurte, o calitate superioară a serviciilor de transportul și o creștere a performanțelor anuale de peste 1 miliard de tone-kilometri. Consorțiul CREAM a fost constituit din 30 de parteneri din 13 țări, incluzând întreprinderi de transport feroviar, Uniunea Internațională a Căilor Ferate, operatori de transport, furnizori de tehnologii, institute de cercetări și firme de consultanță. Proiectul CREAM a fost cofinanțat de Comisia Europeană.

CREAM е европейски изследователски проект, реализиран в периода 2007 – 2011 година. Той целеше подобряване на железопътните товарни превози между Западна и Югоизточна Европа. В рамките на проекта бяха разработени и успешно реализирани организационни подобрения, технически иновации и конкурентоспособни железопътни транспортни услуги. Ползите за товарния железопътен транспорт бяха намаляването на транзитните времена, подобряването на качеството и увеличаване на железопътните превози с повече от 1 милиард тонкилометра. CREAM-консорциумът включваше 30 партньора от 13 страни, включително железопътни компании, Международния Железничарски Съюз (UIC), транспортни оператори, технологични доставчици, изследователски институти и консултантски фирми. Проектът CREAM бе съфинансиран от Европейската Комисия.

CREAM 2007 – 2011 yılları arasında yürütülen bir Avrupa araştırma projesidir. Amacı Batı ve Güneydoğu Avrupa arasında demiryolu yük taşımacılığının geliştirilmesi olmuştur. Projede kurumsal iyileşmeler, teknik innovasyonlar ve demiryolu ağırlıklı rekabetçi ulaştırma hizmetleri geliştirilerek başarılı bir şekilde uygulanmıştır. Demiryolu yük taşımacılığında bu iyileştirmelerden, kısalan transit süreler, iyileştirilen taşıma kalitesi ve taşıma performansında yıllık 1 milyar ton/km 'yi aşan artışla faydalar sağlanmıştır. CREAM konsorsiyumu demiryolu kuruluşları, Uluslararası Demiryolları Birliği (UIC), taşıma operatörleri, teknoloji sağlayıcıları, araştırma enstitüleri ve müşavirlik firmalarının yer aldığı 13 ülkeden gelen 30 ortaktan oluşmuştur. CREM projesi Avrupa Komisyonu ile ortak finanse edilmiştir.

Project objectives

The CREAM project refers to a pan-European transport corridor with an entire length of about 3,150 km. It draws a bow between Western and Central Europe and the Balkan states towards Turkey/Greece.

The “mega” corridor stretches across Benelux – Germany – Austria – Italy – Hungary – Romania – Bulgaria – Serbia – Turkey/Greece and links most relevant highly dense industrial and rural areas. In response to the expectations of the European Commission, the particular challenge within this corridor was to integrate not only traditional European member states but also new member states, accession states, candidate countries and potential candidate countries from the Western Balkan region. In consequence the CREAM project had to cope with different phases of progress that were accomplished with respect to implementation of change in the European railway area. Being aware of this issue, CREAM has also facilitated a knowledge transfer on good practices between the project partners.

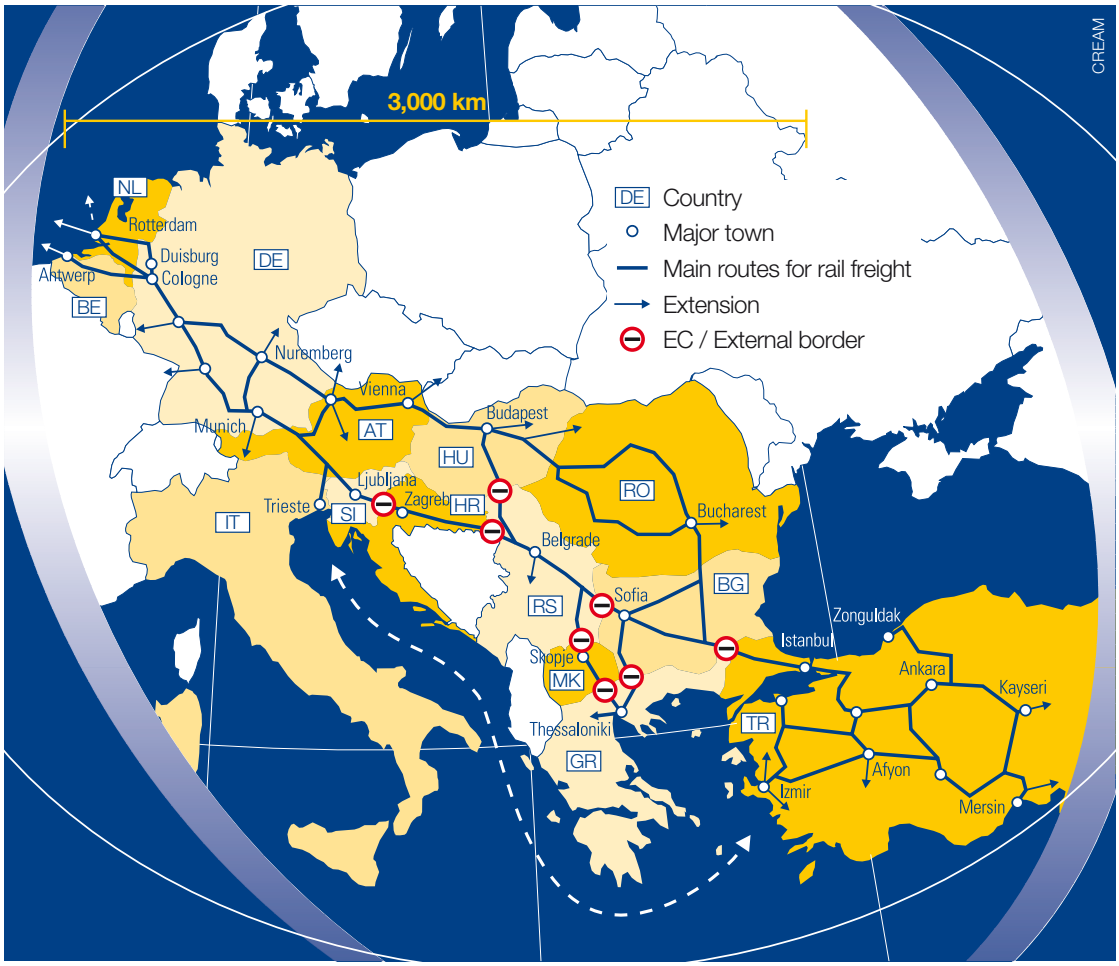


Figure 1: Map of the CREAM corridor (status: 2007)

The CREAM project's technological and operational activities have been identified by the stakeholders that are active on the corridor as infrastructure managers, railway undertakings, intermodal operators or customers. The activities led and will keep on leading to a further increase in rail freight transport on this important East-West freight corridor and thereby contribute to the EU transport policy goals.

The project activities were based on the corridor analysis and the Corridor Action Plan adopted in the framework of the TREND project. The analysis targeted all relevant points which had influence on performance and success of rail freight services:

- Market requirements with respect to different commodities and market segments;
- Mechanisms of cross border collaboration according to the cooperation or competition model;
- Operating procedures and agreements between infrastructure managers and railway undertakings, in particular with respect to border crossing;
- The quality of service defined as total transit time, punctuality and reliability;
- The availability of appropriate resources such as locomotives, waggons and staff;
- Integration with other modes of transport.

Following the good experience gained from projects like BRAVO on the Brenner route, intermodal transport was used as a benchmark and trail-blazer for conventional rail freight services which gained results in terms of operational key elements such as border crossing time and quality.

The market demand on the corridor required different (intermodal) freight service offers with respect to time and cost and thus alternative routings on the corridor. Besides different rail routings involving new infrastructures dedicated to rail such as the 150 km long Betuweroute, one option was also to offer a road-rail-sea connection via Adriatic ports and thus by-passing the long rail section through the Balkan states. Alternative routings were also an essential part of quality agreements in order to assure punctual delivery.

Consequently the sub-objectives were to:

- Analyse the market requirements for typical supply chains along the entire corridor – or parts of it – and derive a coherent set of templates on innovative rail freight services appropriate to tap the full potential of modal shift towards rail.
- Define advanced business models for setting up integrated, road competitive rail freight service offers, thereby considering EU plans of establishing a single European Railway Area and incorporating the experiences of new entrant railways and other transport mode operators on cooperation in international rail freight transport.
- Develop a coherent quality management system (QMS) and implement the necessary structural and organisational measures to ensure the monitoring of the most important quality criteria such as punctuality and reliability and the identification of necessary process improvements.
- Outline corridor-specific train operation concepts, able to absorb and bundle sufficient quantities of cargoes and to exploit the given resources in the most (cost) efficient way.
- Implement interoperability and improved border crossing procedures – thereby making use of multi-system locomotives (MSL) and joint border crossing operating centres wherever appropriate.
- Set-up integrated telematic solutions taking up the expanded infrastructure managers' information systems and supplementing them on corridor sections – mostly in Southeast Europe – by satellite-based (GPS) tracking and tracing systems.
- Analyse particular markets of temperature controlled cargo logistics and transport of semi-trailers in order to provide technical-operational concepts that allow facilitating the modal shift of the still road-dominated transport to intermodal road-rail transport.

The following figure shows how the technological components are embedded in innovative concepts and finally contribute to improve rail freight services within CREAM.

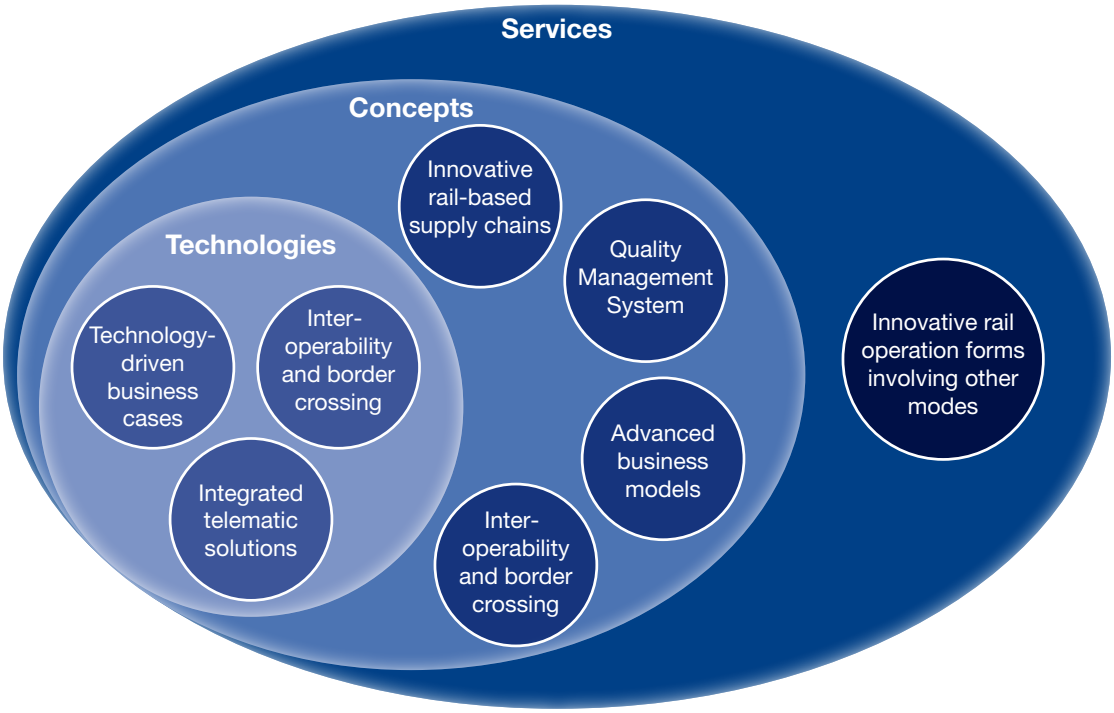


Figure 2: CREAM project components (work packages)

The CREAM project has been set-up by the stakeholders active and licensed to operate along the corridor which were committed to develop and implement the following demonstration activities:

- Advanced business models
- Quality Management System (QMS)
- Corridor-specific “String of Pearls” train operation form and rail/short sea multimodal services
- Improved border crossing procedures and innovative, interoperable traction schemes
- Integrated telematic solutions
- Temperature controlled cargo logistics and innovative rail transport services for conventional semi-trailers not fitted for crane handlings

Project consortium

The CREAM consortium involved infrastructure managers and licensed railway undertakings assuring operation of train services on the entire corridor including those countries where "open access" of the infrastructure is not yet assured.

The partnership involved also intermodal operators, freight integrators and rail freight customers which were already offering services on the corridor. Technology providers and consultants/researchers were "rounding up" the consortium.

An overview of the CREAM partners, their role (kind of company) and involvement in the project (project period) is depicted in the following table.

No	Partner name	Country	Project Period[1]	RU/IM[2]	IO[3]	Tech[4]	Con/ Scie[5]
1	HaCon	DE					■
2	Bulgarian State Railways (BDZ)	BG		■			
3	CFR Marfa	RO	– 12/2010	■			
4	Intercontainer Austria	AT	– 12/2009		■		
5	Knorr-Bremse	DE	– 09/2008			■	
6	KombiConsult	DE					■
7	Kombiverkehr	DE			■		
8	Lokomotion	DE	– 12/2010	■			
9	Rail Cargo Hungaria (RCH); formerly MÁV Cargo	HU	– 12/2010	■			
10	National Technical University of Athens (NTUA)	GR					■
11	Hellenic Railways (OSE)	GR		■			
12	Delft University of Technology/ OTB Research Institute (OTB TU Delft)	NL	– 12/2010				■
13	Keyrail; formerly BREM	NL	05/2007 – 12/2010	■			
14	Rail Cargo Austria (RCA)	AT		■			
15	DB Schenker Rail; formerly Railion	DE		■			
16	Railion Nederland	NL	– 12/2007	■			
17	Rail Traction Company (RTC)	IT	– 12/2010	■			

No	Partner name	Country	Project Period[1]	RU/IM[2]	IO[3]	Tech[4]	Con/ Scie[5]
18	DB Mobility Logistics; formerly Stinnes	DE	– 05/2008		■		
19	Turkish State Railways (TCDD)	TR		■			
20	Transport Route Wagon (TRW)	BE	– 04/2009		■		
21	Balnak	TR	– 12/2010		■		
22	Serbian Railways (ZS)	RS	– 12/2007	■			
23	Slovenian Railways (SZ)	SI	– 12/2010	■			
24	International Union of Railways (UIC)	FR	– 12/2010	(■)			■
25	PE Macedonian Railways Infrastructure (MZ); formerly Macedonian Railways	MK		■			
26	Ekol	TR	10/2008 –		■		
27	Eureka	DE	09/2008 –			■	
28	OZV	DE	01/2008 –		■		
29	Ökombi	AT	10/2007 –	■			
30	Voith Turbo	DE	03/2009 – 12/2010			■	
31	Inter Ferry Boats (IFB)	BE	04/2009 – 12/2010		■		

Figure 3: Listing of CREAM partners

1 Period of project participation: if blank = 01/2007 (project start month) – 12/2011 (project end month)
2 Type of company: Railway undertaking, Rail infrastructure manager
3 Type of company: Intermodal operator
4 Type of company: Technology provider
5 Type of company: Consulting company, scientific institute, association

Figure 4: CREAM partner delegates at kick-off meeting (Mainz, January 2007)

CREAM

The CREAM corridor and its rail freight market

In the framework of globalisation and separation of production and distribution of goods, the efficient arrangement of international transport chains becomes more and more important. Especially rail freight needs to take up the expectations of the logistics market on long distance transports and to provide competitive service offers. Next to infrastructure upgrades of railway lines and transshipment terminals, the development and implementation of innovative rail production methods is an important element to raise the attractiveness of rail freight. Moreover, such measures are capable to realise improvements in a shorter time frame apart from long-lasting railway infrastructure shortcomings specifically in Southeast Europe. As basis for all subsequent developments CREAM analysed the so-called "magic triangle" of rail transport on the considered corridor, that is describing the interference between infrastructure capabilities, potential transport services and market demand.

The operation of rail freight traffic depends mainly on technical and economical framework conditions. Therefore in a first step at project start in 2007 market potentials (transport flow analysis) and infrastructural condition have been analysed in detail. The infrastructure analysis refers mainly to the existing project partners' rail freight services and corresponding rail lines.

This included the admission and analysis of line characteristics and terminal locations (and their efficiency), as well as the infrastructure consistency along the corridor (see example for the section Nis-Istanbul in Figure 5). It turned out that the corridor and its lines provide for a challenging variety of operative conditions which are a burden for implementing seamless rail freight services.

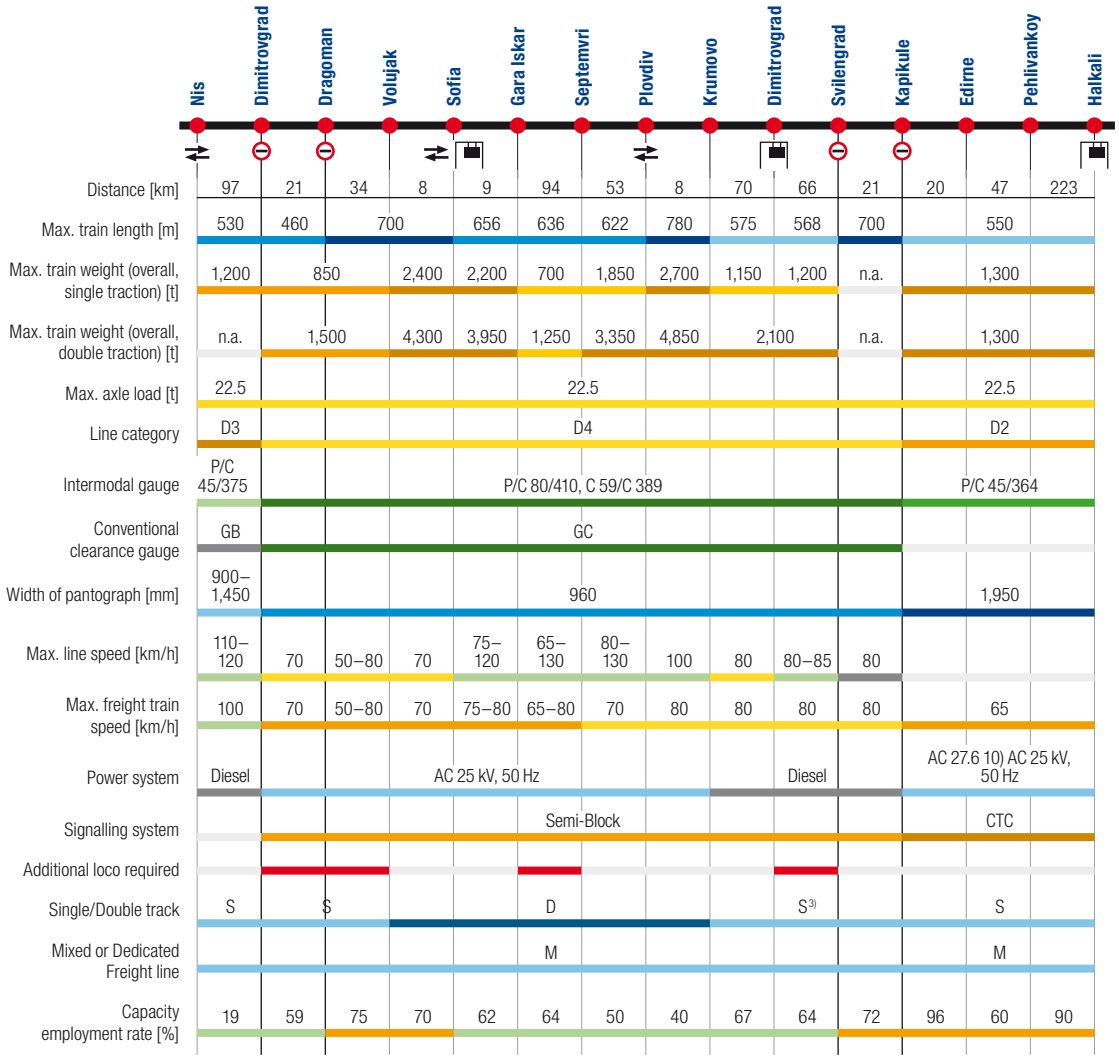


Figure 5: Technical and operational parameters on the main railway line between Nis (Serbia) and Istanbul-Halkali (Turkey)

Data sources:
BDZ, 08/2007 (line section Dimitrovgrad – Kapikule)
TCDD, 08/2007 (line section Kapikule – Halkali)
ZS, 11/2007 (line section Nis – Dimitrovgrad)

In parallel, a transport flow analysis, based on statistical data (NUTS-2 level), was conducted for the corridor and provided a regional specific overview of the future rail freight potentials.

By balancing these results, the basis had been generated for the subsequent development of an appropriate rail production scheme for the corridor.

Nomenclature of Territorial Units for Statistics (NUTS)

The Nomenclature of Territorial Units for Statistics (NUTS) was established by Eurostat which is the statistical office of the European Union situated in Luxembourg. Eurostat's task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.

The NUTS classification is a hierarchical system for dividing up the economic territory of the EU for the purposes of the

- Collection, development and harmonisation of EU regional statistics
- Socio-economic analyses of the regions:
  - NUTS 1: major socio-economic regions
  - NUTS 2: basic regions for the application of regional policies
  - NUTS 3: small regions for specific diagnoses
- Framing of EU regional policies.
  - Regions eligible for aid from the Structural Funds (Objective 1) have been classified at NUTS 2 level.
  - Areas eligible under the other priority objectives have mainly been classified at NUTS 3 level.
  - The Cohesion report has so far mainly been prepared at NUTS 2 level.

epp.eurostat.ec.europa.eu

Geographical coverage and route selection

Within the geographical area of the CREAM corridor about 20 international intermodal train services could be identified that had regular intervals in 2007.

Because of different starting and ending points of the traffic, three main routes within the South-Eastern part of the corridor were clustered.

These routes are:

- Corridor IV via Hamburg, Romania, Bulgaria, Turkey;
- Corridor X via Slovenia, Croatia, Serbia, Bulgaria, Greece/Turkey;
- the Tauern axis connecting the Northern Adriatic ports.

By taking the interval frequency as well as the route choice of the train relations into consideration, the sector specific use of the infrastructure by international, intermodal trains was calculated to get an understanding of the importance and the capability of the respective routes.

Besides these train connections, terminals along the routes and their equivalent equipment were considered and analysed.

Production logistic, central areas and transit hubs of the corridors

Because of the economic structure, production logistic's focal points of the corridor are located mainly in Western Europe; that means the Netherlands, Belgium, Germany and Austria. These are regions in which, as a result of the existing economic or population structure, transport volumes are already comparably high.

Before CREAM these regions were only occasionally connected with upcoming regions in Hungary, Slovenia and Romania or Halkali/Istanbul in Turkey and Salonika/Sindos or Inoi/Athens in Greece. The latter are important logistic areas in the Southeastern part of the corridor with a forecasted growth potential. In 2007, mostly direct trains were travelling between these regions; they brought goods of definite groups of waggons over a long distance directly to their destination.

Regarding a network of open rail services on the CREAM corridor, these locations have been identified as potential consolidation points, also referred to as gateways or hubs from a commercial point of view. There, additional traffic from surrounding areas commences or commodities from international long-distance trains are transferred to domestic services. This leads to an increased integration of Hungary, Romania, Bulgaria, Slovenia and Serbia, which have been mostly transit areas in the past. As shown within the CREAM project they can also act as "corridor gateways" in the future. In terms of an extended offer, through the integration of gateway systems they present potential areas for the connection of direct train traffic (network approach), so more flexible transport chains can be offered and new markets can be opened.

Infrastructural framework conditions

As regards an optimised production system and the commercial viability, the definition of corridor gateways is not only taking into account the potential market flows and the market requirements, but also the infrastructural conditions.

In order to find suitable gateways in relation to quality, interoperability and economy for intermodal transport chains along the CREAM corridor, the present infrastructure, the technical parameter of the production and the individual route sections have been analysed and prepared. Potential locations for gateways are technical and infrastructural breakpoints, where also regional market potentials and suitable terminals for combined traffic can be found or developed.

When analysing the present rail infrastructure along the CREAM corridor its characteristics were categorised under different segments: offer/market specific as well as technical and capacity specific.

The most important attributes are the maximum train length and weight allowances, the allowed speed for trains of combined traffic as well as the route electrification (various systems and non-electrified sections) which have been combined in an electronic multi-layer map to identify homogeneous sections between suitable gateways for the optimisations of rail freight production along the corridor.

Length of the train: The maximum allowed train length of a track section is important for the possible load referring to the number of waggons. This can be a crucial factor for the transport of goods with a comparably high "volume". The train length can be restricted by inadequate infrastructure length of block sections and passing tracks or by topographical reasons, e. g. in the mountains. The resultant maximum allowed train lengths are defined in national regulations and vary between some 500 and 700 m (including the length of the locomotive). The analysis showed a clear discontinuity of the allowed train length between Western and Southeast Europe.

Train weight: For the transport of goods with a comparably high "weight", the allowed train weight is a major competitive factor. Five weight classes referring to single traction had been defined. In Southeast Europe, especially in Bulgaria, Turkey and F.Y.R. of Macedonia, but also on the "Tauern route" (Austria/Italy) restrictions are found. The use of a second locomotive (double traction) can generally increase the maximum allowed train weight for the section, but this is also a question of costs.

Electrification: Different track electrification systems within Europe and the different signalling and train control (safety) systems are some of the most serious obstacles for seamless international rail freight traffic.

In order to overcome many different systems, it is either necessary to change the locomotive (takes time, requires coordination and creates cost) or to use multi-system locomotives that can be driven on different systems without problems, but cause accordingly higher costs for purchase and maintenance. These locomotives are equipped by the industry with country specific features which contain suitable current collectors, automatic train protection systems etc. and need to be homologated in any country concerned. Due to the higher costs involved, their use is only economically viable when the necessary advantages are gained through time and quality improvement.

There are four different electrical systems within the CREAM corridor, as well as non-electrified route sections that can only be driven by diesel tractions.

	Electrified sections		
		[kV]	[Hz]
Germany	AC	15	16,7
Austria	AC	15	16,7
Belgium	DC	3	–
The Netherlands	DC	1,5	–
Italy	DC	3	–
Slovenia	DC	3	–
Southeast Europe	AC	25	50

Figure 6: Rail energy systems on the CREAM corridor

Train speed: Even if the allowed maximum speed of a freight train is not the only factor influencing the travelling speed (because it also depends significantly on administrative and working processes, e. g. at border-crossings) this can be seen as an evidence for the present state of extension and maintenance of a route section.

As a result of the basic analysis of five speed classes between 39 km/h and 100 km/h, the picture is split into two parts: The route sections between the Netherlands and Belgium via Germany to the Austrian-Slovenian border as well as the Hungarian-Romanian border can be used continuously with relatively high speed of 100 km/h or more. On the remaining route sections, there are much tighter speed restrictions due to bad infrastructure conditions.

“Model train” processing analysis of the infrastructure

The consideration of single route characteristics and their occurrence on certain corridor sections can reflect the attributes and framework conditions of the CREAM corridor only to a certain extent. Therefore, five possible train variations – so-called model trains – were conceived in coordination with the involved intermodal operators to virtually follow the corridor routes and to uncover the main bottlenecks.

Rising transport volumes and the competition to road transport require effective rail services, on one side with regard to the capacity utilisation and on the other side from the economic point of view. Having this in mind, longer and/or heavier model trains were defined; raised step by step or combined in a different way in order to show on which route sections which problems might occur in the future, or limit already today the service parameters.

Model “Train A” with a weight of 1,200 t and a length of 500 m is equivalent to the average train travelling on this corridor today („Status quo variation“). Apart from a few sector parts in Southeast Europe on which, due to the topographic conditions, the train weight for single traction is too high, this train variation is able to be driven without problems over the entire length of the corridor.

“Train B”: The weight and length of the train were raised proportionally (calculated with the same average weight per waggon, but with a larger number of waggons) to a weight of 1,400 t and a length of 600 m. Especially the “Tauern route” and the Southeast European mountain areas show tremendous difficulties for operating trains with such a high train weight and a single locomotive. In addition, in Serbia, F.Y.R. of Macedonia and Turkey the length is a restricting factor.

“Train C” with a train length of 700 m and a weight of 1,600 t (target scenario) can currently not be operated in almost entire Southeast Europe. The train length creates a problem mainly in Slovenia, in parts of Hungary as well as in Bulgaria and Romania. On the “Tauern route”, in F.Y.R. of Macedonia, in Turkey and in parts of Bulgaria the train cannot travel on the routes because of both parameters. Whereas in almost the whole Western European area of the corridor, that means in Belgium, in parts of the Netherlands, in Germany and in large parts of Austria there are no obstacles for any of these train variations.

To complete the analysis, two further model trains were defined: a short and heavy one (“Train D”) and one with an increased length and lower weight (“Train E”). To operate “Train D” with a length of 500 m and a weight of 1,600 t there are only problems due to the weight on the mountain areas of the corridor (“Tauern-Route”, Serbia and Bulgaria), where on relatively short sections a second locomotive could be added. Operating “Train E” with 700 m length and a weight of 1,200 t creates problems in the Southeastern parts of Europe, especially due to the length but in some cases also due to both parameters (Macedonia, Bulgaria).

This step of the analysis also shows that there are considerable discrepancies between Western and Southeast Europe referring to the current state of rail infrastructure and its operative conditions for freight services. In this respect, new networked train production systems via so-called gateways for the international intermodal traffic have to be developed to be able to provide more economic and competitive offers based on the existing infrastructural framework conditions of the corridor. In the gateway concept the respective maximum parameters can be used between the gateway terminals or stations, while with direct trains the minimum parameter on only a section of the route limits the entire performance.

Transport flow analysis

In order to evaluate the potential of rail freight on the CREAM corridor, the existing road transport flows – as main competing mode to rail – have been analysed. For this purpose the cargoSTAT tool of K+P Transport Consultants, a German-based consulting company specialised in transport modelling, had been used. In fact, cargoSTAT is a complete and up-to-date European freight traffic database that involves multiple data sources including Eurostat. For the purposes of CREAM, cargoSTAT data from 2006, providing road transport flows between defined (NUTS 2) traffic zones, had been exploited. CargoSTAT provides figures on four "commodity groups" which in turn are corresponding to the "standard goods classification for transport statistics (NST)".

The regional structuring of the cargoSTAT transport data is based on the NUTS classification of Eurostat, referring to the EU member states including the new members Bulgaria and Romania, accession candidates such as Croatia and Turkey and the EFTA countries Norway and Switzerland. In summary, all CREAM-related countries are included into the cargoSTAT database, with exception of Serbia and F. Y. R of Macedonia, for which basic information had been provided by respective project partners from these regions.

Transport data in cargoSTAT is principally available down to NUTS 2 level, e. g. in Germany corresponding to administrative districts (German: "Kreise"). Nevertheless, not all countries are regionally disaggregated so far. Especially Bulgaria, Romania, Slovenia and Turkey are currently represented only on NUTS 0 level (traffic zone = entire country). For these countries, specific shares of transport flows were used for the analysis.

Transport flow analysis methodology

To evaluate that very extensive database, different filters were used.

First of all a national filter ("Filter 1") which extracts the transport flows between the CREAM involved countries.

The regional filter ("Filter 2") captures all traffic zones within defined catchment areas around the most important terminals for international intermodal transport. Based on an electronically produced map, essential terminals for combined traffic along the CREAM corridor were chosen and marked. The size of the catchment areas is represented by circles around these terminals with a radius of 75 km, to max. 150 km (see Figure 7).

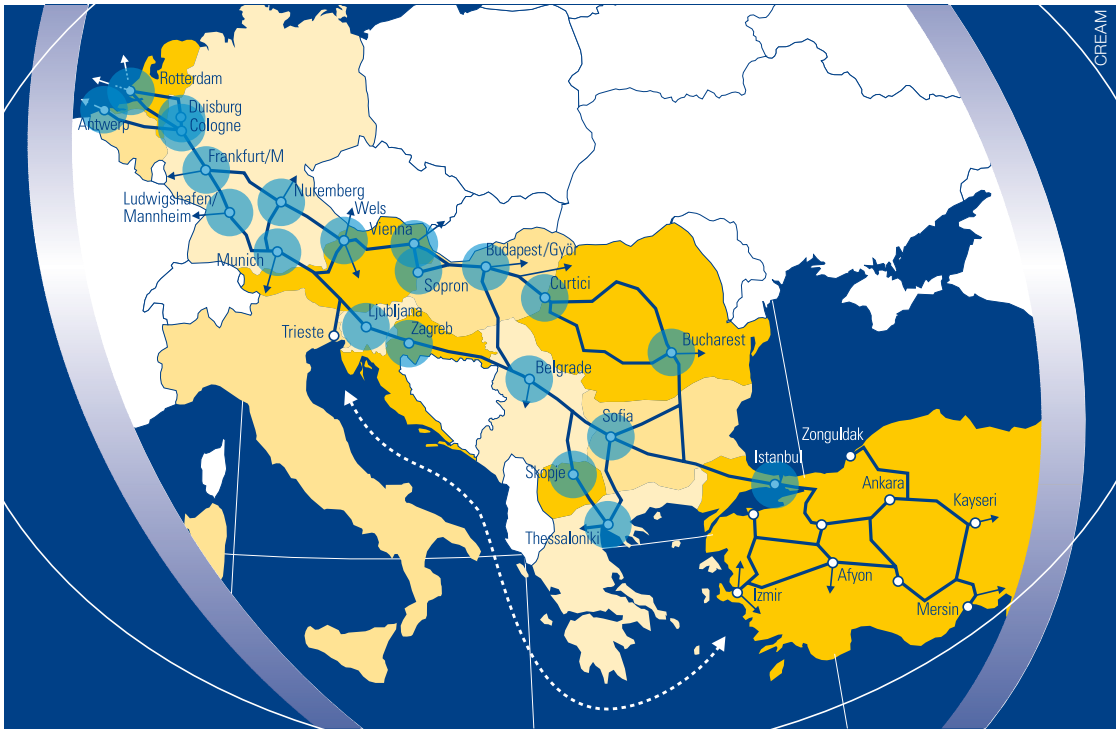


Figure 7: Relevant terminals and their catchment areas on the corridor (NUTS 2-level)

Depending on their matching correlation with these circles, a traffic zone is completely or partially included into further considerations. At this stage of the study, the transport flows between the relevant traffic zones could be identified in tonnes per year.

The third filter ("Filter 3") takes the distances between the dedicated terminals into account. Since particularly large transport distances are expected to show positive economic results, only transport flows with more than 1,000 km between the terminals were taken into account for the further calculations. In a next step the data base unit of the transport volumes, "tonnes per year", was transformed into "tonnes per week" and finally into "truck loads per week" in order to specify the number of waggon loads and trains resulting from a desired volume shift. This was done by using freight specific keys for truck load, depending on the respective commodity. For further calculations it was assumed that one truck load corresponds to one waggon load in combined traffic and that one "average" train consists of 30 loaded waggons (= 30 truck loads).

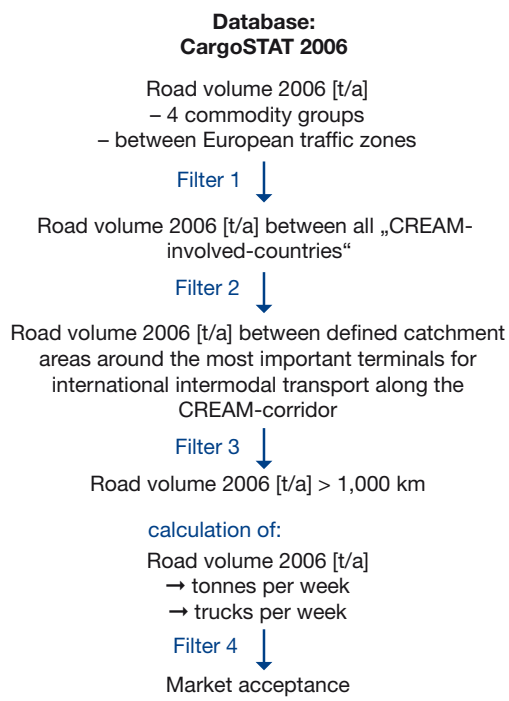


Figure 8: Approach for evaluating the cargoSTAT database

As a fourth filter ("Filter 4"), the grade of market acceptance was included. This figure stands for the share of the theoretically available volume which is likely to be actually acquired by innovative rail freight services on the corridor.

As a result of these four steps of filtering, the relevant volumes are represented by 15 % of road traffic between catching areas around relevant terminals with more than 1,000 km of transport distance.

Transport flow analysis results

The evaluation of results shows that especially the large consolidation points on the corridor have great potentials of generating further transport volumes. In the Western European area of the CREAM corridor, these are mainly the terminal regions Rotterdam and Duisburg/Cologne and in the Southeast European area Halkali/Istanbul as well as Athens and Thessaloniki. Additionally, also the terminal regions of the countries in between are evaluated to offer opportunities for rail freight traffic. These are particularly the regions around Munich, Vienna, Budapest/Györ, Ljubljana and Bucharest.

The analysis also shows a significant potential for distances between 1,000 km and 1,500 km, mostly connected to Ljubljana and Budapest/Györ as start/end terminal, and for distances of more than 2,000 km from/to Halkali/Istanbul and Athens on the one side and Rotterdam, Duisburg and Cologne on the other.

Some of the destinations with a reasonable transport volume were already served by existing rail freight services – mostly company block trains. In such cases it would have been generally sufficient to gain the full potential of rail freight volumes by extending the frequency of these services and by making them available for other customers. Those destinations which were not covered by existing concepts or those which did not show a sufficient quantity of transport volumes for building a direct full trainload connection were proposed to be included and served within a new and innovative corridor related rail production concept to be developed in the project, as this is the only chance to integrate the respective regions/terminals and to shift freight from road to rail. Within CREAM, the new concept that is based on the hub-and-spoke or gateway approach, is also referred to as "String of Pearls" concept. This concept aims at connecting the Southeastern part of Europe with the established intermodal production systems in Western Europe.

An accumulation of the potential number of trains on the corridor shows that with the underlying assumptions about 2,000 additional trains per year are possible, considering the above explained market share of 15 % which could be shifted from road to rail.

In 2007 it had been expected, that the economies and the transport market in Southeast Europe would grow rapidly. However, the economic crisis, which started just after the market analysis had been concluded, showed negative impacts for the rail freight transport business on the CREAM corridor. Thanks to various developments and initiatives, conducted by the pro-

ject partners in the scope of CREAM, the effects of the crisis could not be stopped but alleviated considerably. Especially the measures focussing to meet the requirements of the logistics market played a significant role for the successful implementation of new services, but also for preventing existing services during the crisis from being cancelled. This was remarkable especially against the background of increasing price pressure due to dropping freight rates of road transport.

It was of paramount importance as, independent from the crisis, the road freight traffic is setting standards and has to be seen as the benchmark for new offers. Besides the costs (ideally under the level of transport by trucks, which was not possible during the crisis), the requirements are mainly short transport time, high transport quality (understood as punctuality and reliability) and, especially on this corridor, the transport safety. Service aspects like the possibility of "tracking and tracing" became more and more important, too.

Competitive transport prices can only be offered by rail freight traffic if existing train capacities are used at large proportion. This means a steady high capacity utilisation of the trains, as well as the usage of the present route capacities and capabilities, concerning the weight and length of the trains.

In this respect, several investigations and successful developments have been done by the CREAM partners. But it has to be mentioned that some of the potential implementations only make sense and are commercially viable in combination with general improvements. For example the use of expensive multisystem locomotives to avoid loco changes at the border only makes sense, if the border stopping times required for administrative and commercial procedures have been eliminated or significantly reduced, as well.

Due to the geographical scope on one side and the partly very bad service quality on rail in the past on the other, also a multimodal combination of short sea and rail was taken into account when investigating the corridor and its transport market.

The role of the ferry services has also been emphasised during the political crisis in the former Yugoslavia region. After the political situation had been stabilised and the land route through F. Y. R. of Macedonia, Serbia, Hungary and Austria was operational again, the ferry still held a significant part of its attractiveness and provided a cost-effective alternative for trucks travelling between Southern Greece and Italy or Central Europe.

Additionally to the services from Greece to Italy also the share of connections to Turkey was growing due to the increase of Turkish – European trade and the historically good relation to the port of Trieste. This was conducted especially by Ro-Ro transport as it is easier to organise and operate. The lines starting from Haydarpasa, Ambarlı and Çesme link Turkey via Trieste/Italy with Central Europe. To use rail at least for a share of the transport volume, special RoLa services from Trieste to Salzburg have been implemented by Ökombi and Alpeadria, with the financial support of the Austrian government.

A competitive service for the unaccompanied transport of intermodal transport units (containers, swap bodies and in particular semi-trailers) on this route, using rail as an highly productive integral component also for longer distances in Western Europe, was lacking and has therefore been developed by the CREAM partners.

Conclusions

The CREAM corridor is distinctive due to its challenging infrastructural and administrative conditions, but shows a high potential for rail based transport solutions. To extract and use this potential, projects like CREAM have to show the right path for improvements. In parallel all actors, like the national governments, the European Commission and also the involved stakeholders have to work continuously on the improvement of the framework conditions.

Organisational improvements

Quality management for international freight trains

The acceptance of new and extended rail transport offers is to a great extent dependent on a sufficient transport quality offered to the customers. Experiences have shown that for this purpose coherent quality management procedures are necessary. In general, such procedures would be implemented as part of a quality management system (QMS). With respect to CREAM, the total set of QMS components, including quality assurance, quality measuring and monitoring procedures, had to be configured individually to the specific situation of line sections, cargo and customers. In the following the CREAM approach for a corridor wide QMS for international freight trains is described.

The road transport sector has set up a high standard of transport quality corresponding to the expectations of operators, shippers, industry etc. on today's transport services. Faced with the necessity to provide a competitive transport performance, it is obvious that also the rail freight sector needs to establish, maintain and continually improve appropriate quality assurance measures. Already in 2005/2006, within the EU research project TREND[1], the quality of rail transport on different European transport corridors has been investigated. Major deficits have been identified, in particular for the existing connections between Western Europe and Southeast Europe which are to a great extent congruent with the rail corridor considered by the CREAM project.

Due to growing industries in the Southeast European countries, it is expected that international transport volumes will increase remarkably on this corridor. To secure a high modal share of rail transport, it is crucial that rail transport will eliminate the main identified quality deficits and offer high quality standards in line with the main customer requirements.

The CREAM approach for an improved quality management

The CREAM project tackled this issue by developing a corridor-wide quality management system (QMS). This QMS refers to international – mainly intermodal – freight trains on the CREAM corridor that corresponds to a large extent with the pan-European transport corridors IV, VIII and X.

1 TREND (2005/2006), Towards new Rail freight quality and concepts in the European Network in respect to market Demand, EC co-funded project (FP6), www.trend-project.com

Main idea behind this Corridor QMS is to implement harmonised procedures and clearly defined responsibilities for the interfaces between cooperating partners. The QMS is based on the definition and implementation of a Quality Manual, describing all relevant processes required for achieving the targeted quality objectives.

The process descriptions within this manual represent documentations on mainly intercompany procedures, related to planning and operation of international freight trains. Company internal processes, however, which are related to resource management and product development etc., are defined in detail within the range of each Company QMS and are not supervised by the Corridor QMS (cp. Figure 9). The interface processes are agreed by the involved transport chain partners, providing details on the responsible persons and determining definitions on how to carry out, to steer and to improve related tasks.

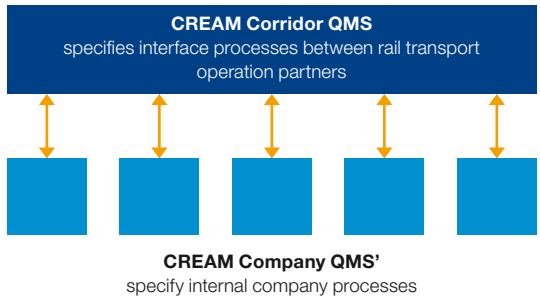


Figure 9: Main purposes of Corridor QMS and Company QMS

As a result it is expected that a common corridor related QMS will help to reach and maintain a high level of quality for the rail freight services on the CREAM corridor. This refers mainly to the expectations of the customers:

1. Cost-efficient, scheduled and reliable transport in terms of delivering a constant punctuality of train arrivals
2. safety and security in terms of ensuring a reliable and damage free transport of load units and
3. the functioning of agreed information flows.

The CREAM partners have therefore agreed on a set of general quality criteria and indicators (cp. Figure 10).

Quality Criteria	Indicator
Transport Time	Transport speed on basis of FTE timetable
Punctuality	Share of trains, arriving within an agreed threshold (delay)
Reliability (train)	Share of trains, arriving within an agreed threshold (maximum delay)
Reliability (load)	Share of transported waggons which are not detached from the train
Information (planning)	Share of correct information in planning processes for modifications in the transport (timetable/traction, ...), submitted within an agreed time period
Information (transport documents)	Share of correct pre-information of transport document data, submitted to relevant offices at border a minimum time period prior to train arrival
Information (train run)	Share of correct train run information, submitted within an agreed period (threshold)
Information (operated waggons)	Share of correct information on detached waggons, submitted with an agreed timeline
Flexibility	Time period for accepting orders of special trains and cancellations
Safety	Share of transported waggons which are derailed during transport
Security	Share of load units (containers/swap bodies), affected from an incident
Quality of transport document management	Share of trains which are affected in operation due to missing documents

Figure 10: Quality criteria/indicators as defined in CREAM Corridor QMS

However, in practice the importance of these quality criteria will be ranked differently for each individual train service, depending on the kind of cargo and customers. Some quality requirements which are of high priority for one service might be assessed for another service as not important at all. Besides this, different rail services will in general not feature the same operational characteristics due to differences e. g. in the technical and organisational parameters of the rail routes, the composition of partners and the technical standards of communication tools and information technologies. Consequently it has been evaluated as not appropriate to integrate all agreed specifications in just one all-encompassing document for the corridor. Therefore, the CREAM corridor quality manual is composed of one general document (Part I) which contains explanations and definitions valid for all selected rail freight services, and several individual service handbooks (Part II) for each selected rail freight service.

The service handbooks are written as practical guidelines how to conduct the operational interface processes between the respective cooperation partners. They contain:

- general data related to the train service (e. g. on served relation, train numbers, operating partners),
- information on the days of operation and train schedules,
- detailed process descriptions on the relevant interface processes and information flows especially in case of irregularities during train operation such as train delays and waggon detachments,
- specifications of quality criteria and objectives,
- descriptions of quality control methods (e. g. for train monitoring) and
- all relevant contact details (members of the quality group, contact data for issues during train operation, contacts for planning phase).

Quality measures and related handbooks have been developed and implemented on different routes on the corridor: Cologne – Köseköy, Genk – Oradea, Ljubljana – Halkali, Bucharest – Halkali, Munich – Ljubljana, Bucharest – Sopron and Pirdop – Olen. Following examples show how the CREAM project activities contributed in different ways to remarkable quality improvements:

Quality initiative Cologne-Köseköy

Since 2004, the Cologne-based European distribution centre of Ford and the Ford Otosan factory in Köseköy (Turkey) are connected with a regular block train service. In this intermodal train concept, material for the production of various Ford models is transported to Turkey. In the opposite direction the train is mainly loaded with empty frames and goods from third party shippers.

OMFESA, a 50:50 joint venture between Transfesa (DB Group) and OMSAN Lojistik, is contractor of the transport. Schenker Automotive GmbH RailNet (SAR), as sub-contractor of OMFESA holds the overall responsibility for organising and performing the transports.

The OMFESA traffic to Turkey SAR comprises roughly 350 trains per year over a distance of more than 2,500 km. The train has a transit time of approximately 110 hours. Each train has a capacity of 520 m and 1,200 tonnes which is equal to 16 special high-speed flat waggons of Transfesa (UIC classification Laagrss), each loaded with two Transfesa 13.60 m MegaKombi swap bodies.

Figure 11: Ford train at Cologne Niehl harbour

Due to massive delays of trains in consequence of persistent performance problems in Serbia in summer 2008, at customer request, trains were switched to the route via Hungary and Romania from October 2008 to improve the quality again. In addition, the trains have benefitted from the quality initiative and the cooperative partnership facilitated within the CREAM project.

In 2009, the CREAM quality handbook for this service was implemented. It focuses on the quality criteria train punctuality, free of damage transports and reliability of agreed information flows.

These information flows are facilitated by a web-based train management platform, the so-called “Türkeiplattform” of Vienna-based DB Schenker RLF. It is accessible for all operating partners to exchange information on train cancellations, to monitor the trains in real time, to document waggon detachments and attachments and to generate appropriate quality statistics. These quality statistics will be used as discussion basis for the annual quality meetings and for continuous quality improvement measures to be initiated by SAR.

As a result, the trains are operated today with reliable and competitive transport times. Fast solutions are

guaranteed by the partners in case of problems occurring during transport, e. g. due to waggon detachments, and the information flows between partners and towards the customer work just perfectly.

Quality initiative Genk-Oradea

Since September 2006, an intermodal train connection was offered between Genk (Belgium) and Oradea (Romania). Over a total distance of 1,616 km the train passed five countries in a transit time of approximately 45 hours. During the project the train operated with a frequency of up to 3 departures per week and direction.

In 2008, the train service started to suffer from a dramatic quality decrease and was thus almost cancelled. The most urgent obstacles identified were huge delays of partially more than one day and high numbers of vandalism and theft. CREAM has taken up the challenge of solving these problems as part of the project activity on quality management. Upon the initiative of the contracting carrier of this train service, TRW (later IFB), and the CREAM project coordinator HaCon a series of quality meetings were conducted, involving all stakeholders: intermodal operators (besides TRW/IFB their Austrian cooperating partner ICA), all railway undertakings (B-Cargo, Railion – now: DB Schenker Rail, RCA, MÁV Cargo – now: RCH and CFR Marfa) and the main customer Essers/Centrum Transport. During the quality meeting the following problems and solutions have been discussed:

- Operational problems occurred due to unclear responsibilities within companies for handling such issues. **Solution:** A 24/7 contact list was established for all partners.
- Essers/Centrum Transport required reliable and prompt information about delays and the expected arrival time at the final destination. **Solution:** A common information procedure was agreed between the operating partners. This is composed of GPS tracking data provided by TRW/IFB indicating the current train position and delay and supplementing information from the railways on the reason of delay, time value of the additional delay and the expected time at the next interchange point.
- Procedures of handling waggons with technical problems have been identified as inappropriate. **Solution:** It was agreed that all railway undertakings apply the CIT 20 formal report of informing the waggon owner on such incidents. Besides, unclear responsibilities and ineffective procedures for repairing waggons with technical defects at Hegyeshalom border crossing could be resolved.
- Huge problems have been stated due to vandalism and theft. **Solution:** A new security concept had been introduced which includes the locking of swap bodies with new night-visible seals and the deployment of safety guards on critical line sections.
- Train delays were often caused by missing resources at locomotive interchange points. **Solution:** The loco circulation plan was optimised. On pilot basis interoperable traction could be realised temporarily between Aachen and Püspökladány, passing a distance of approximately 1,500 km and three networks, using either an ÖBB class 1116 or a MAV class 1047.

The International Rail Transport Committee CIT

The International Rail Transport Committee (CIT) is an association of some 200 railway undertakings and shipping companies which provide international passenger and/or freight services. 120 organisations are members in their own right, 80 organisations are linked indirectly by being members of CIT associate members. The CIT is an association under Swiss law and is based in Berne.

The CIT is supporting international rail freight business e.g. by

- implementing the legislation applicable and in particular the CIM Uniform Rules concerning international goods traffic by rail and by
- simplifying and standardising the working relationships between transport undertakings and between them and their customers. The CIT produces various reference documents to support this work: agreements, basic contractual documents, manuals and forms. The CIT 20 form is the formal report documenting incidents occurred to waggons.

www.cit-rail.org

In 2009, a quality contract was concluded between TRW/ICA and Centrum Transport which includes penalties in case of failures in providing the agreed quality. In parallel, the quality manual and the service handbook had been implemented, documenting the agreed quality measures and interface procedures.

Meanwhile the service has changed the destination in Romania and serves the Railport Arad, located next to Curtici border station.

Quality initiative Ljubljana-Halkali

The Bosporus-Europe-Express, initiated within the CREAM project by Kombiverkehr, Adria Kombi and their Turkish joint venture Europe Intermodal connects the transshipment terminals Halkali in Istanbul and Ljubljana Moste. Ljubljana also serves as a gateway to the comprehensive intermodal network of Kombiverkehr with direct connections to Munich, Duisburg and Cologne.

As a result of the quality initiative, conducted in the scope of the CREAM project, the involved operation partners managed to realise enormous service improvements. Making use of the experience from a demonstration trip in March 2009, which had covered the distance between Ljubljana and Halkali in only 35 hours, considerable service improvements could be transferred into regular operation. With the timetable change in December 2009, the regular transit time could be reduced from 61 to only 46 hours (cp. Figure 12) – this is faster than a truck.

Rail operation across four borders and over a distance of 1,545 km is a complex business. To retain control, a GPS monitoring has been introduced within the CREAM project. Further improvement steps are discussed in a quality group which meets on a regular basis. To maintain and further extend the service quality, the partners implemented a dedicated quality handbook in June 2010. “The handbook will secure smooth operations of the interfaces at borders and terminals. This is the key for competitive transport times”, says Igor Hribar, Cargo Director at Slovenian Railways SZ.

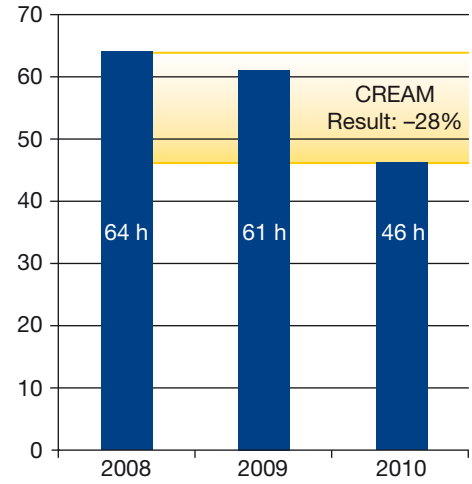


Figure 12: Rail transport times of the Bosporus-Europe-Express Ljubljana – Halkali in the period 2008 – 2010

Comment: Graphics shows average FTE schedule times for both directions.

The CREAM partners’ commitment to provide high quality rail transport

The evaluation of the pilot quality initiatives shows that a consistent implementation of the QMS will create a win-win situation for all partners involved in the transport by achieving better quality especially with regard to punctuality and reliability and by optimising the use of resources and thereby raising cost efficiency of rail transport services.

On 4 November 2010 in the course of the CREAM Conference in Brussels, high level representatives of the CREAM project partners formally signed a Management Commitment, in which they agree to follow and further maintain the implementation of the commonly agreed CREAM corridor related quality management system. This signing ceremony does not only conclude and emphasise the successful project work on quality related issues but also marks the start to a cooperative partnership of CREAM partners outside of a project with the joint goal of securing high quality standards in international rail transport in the long term.

Management Commitment for the implementation of a CREAM corridor related Quality Management System

The Quality Management System has been agreed upon by all involved partners. Its proper application is a decisive factor to reach the ambitious quality objectives set up by the CREAM partners for rail freight services in the scope of the project.

By their signatures the respective companies put in force the CREAM Quality Manual as the main element of this corridor related Quality Management System and commit themselves to align all activities with the defined processes and procedures. Furthermore, they commit themselves to integrate as many international freight train services as possible into this Quality Management System.

Signed on 4 November 2010
in Brussels by:

Bulgarian State Railways – BDZ EAD, CFR Marfa S.A., DB Schenker Rail Deutschland AG, GySEV Zrt., Lokomotion Gesellschaft für Schienentraktion mbH, PE MZ Infrastructure, MZ Transport JSC, Rail Cargo Austria AG, Rail Cargo Hungaria Zrt., Rail Traction Company S.p.A., Slovenske železnice, d.o.o. (SZ), Turkish State Railways (TCDD), TRAINOSE S.A., ADRIA KOMBI D. O. O., Inter Ferry Boats N.V. and Kombiverkehr GmbH & Co KG.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Brussels, November 2010

Figure 13: Signatories and signed "Management Commitment for the implementation of a CREAM corridor related Quality Management System" (Brussels, 4 November 2010)

Implementing the Betuweroute

The Betuweroute is a new railway line, dedicated to freight services which has been built as part of the Trans-European Transport Network (TEN-T). In fact the line between Rotterdam and Zevenaar nearby the German border had been opened by Queen Beatrix of the Netherlands on 9 June 2007. CREAM dedicated a separate project activity to the issue of integrating this new infrastructure into the operational rail freight networks on the corridor. As a result different operational improvement measures for international rail freight services have been developed and implemented within the CREAM period.

The Betuweroute is a 160 km long dedicated double track rail freight line composing of 112 km parallel to the A15 motorway and 48 km of harbour line within the port of Rotterdam connecting the marshalling yard of Kijfhoek with the new and growing terminals on the Maasvlakte (at North Sea coast). At Zevenaar the line connects with the traditional route via Emmerich to Oberhausen (Duisburg) in Germany. The Betuweroute is equipped with a 25 kV, 50 Hz electric supply on both the harbour line and the A15 corridor. The harbour line is equipped with ERTMS/ETCS level 1 while the A15 corridor is equipped with ERTMS/ETCS level 2 as a security system. The Betuweroute is part of the Dutch strategy to increase intermodal rail share in the port hinterland traffic from 13 % to 20 % and the entire intermodal rail volume by factor 6 in the time horizon 2009 – 2035.

The commercial exploitation of the Betuweroute, connected with tasks such as capacity management, traffic control and maintenance, is in the responsibility of the CREAM project partner Keyrail. Keyrail is a joint venture of ProRail, the Port of Rotterdam and the Port of Amsterdam.

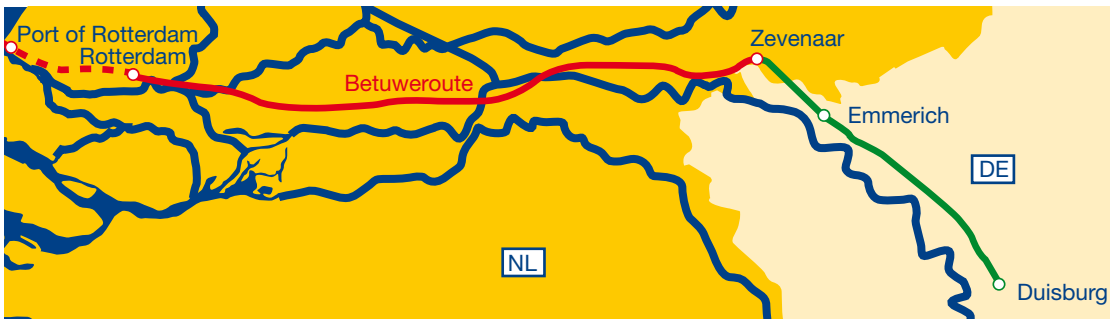


Figure 14: Betuweroute Rotterdam-Zevenaar + Extension Zevenaar-Duisburg

Embedded in this strategy the main objective to be realised within the CREAM framework was to develop an implementation plan for rail freight services on the new line to secure a high service level right from the start. In this respect four activities need to be highlighted:

- Chain management ("Ketenregie" in Dutch language)
- Train information system (in Dutch: SPoor INformatie Systeem = SPIN)
- Training of involved staff
- Extension of services

Chain management

The management of the entire process chain, including loading/unloading of trains, the short-haul train runs between different sidings and Kijfhoek marshalling yard and the main train runs to connected European corridors, is called “chain management”. Its primary objective is to increase the punctuality particularly of intermodal rail freight services on the harbour line and to conduct related installations in order to effectively use resources (locomotives, train drivers), terminal capacity and rail infrastructure capacity (corridor rail lines, shunting yard) and thus increase the quality of the entire rail product.

The pilot chain management incorporates all relevant stakeholders such as the stevedoring/container terminal operator ECT, the intermodal terminal operator RSC Rotterdam, the rail operators European Rail Shuttle (ERS), DB Schenker Rail and Veolia as well as the intermodal operators Hupac and Intercontainer next to the Port of Rotterdam Authority and Keyrail.

Among these partners it has been mutually agreed to

- optimise the operational processes with 10 “golden” operational rules
- share operative information and maintain an improved transparency towards an integral planning and re-planning of train slots and to
- create a mindset and stick to the rules: taking into account the effect of actions (or lack of) on respective chain partners

The integrated planning of train time tables and terminal slots involves a procedure for the initial (annual) time table planning including its periodic updates. This procedure is based on the following principles:

- Combine planning data of terminal slots, shunting yards and corridor time tables (long haul trains) in one process
- Create an overview of all 1,300 weekly trains (status 2010) and sort out the conflicts
- Propose solutions for conflicts
- Finalise integrated planning by a stable time table

Figure 15: Intermodal train at Duisburg-Ruhrort

Figure 16: Traffic control centre Kijfhoek

Figure 17: Freight train on the Betuweroute

Train information system SPIN

The exchange of operative data between these stakeholders is required in order to maintain the mutual information level and to depict and negotiate any deviation from the planned time table. For that purpose a train information system (SPIN = SPoor INformatie Systeem) has been agreed upon, developed and implemented during the CREAM project period. The tool includes relevant information such as train number, transport relation, rail/intermodal operator, traction provider, transport direction (to coast/to hinterland) and date of operation as well as operative times at various agreed handling points. Operative times are for instance arrival/departure of the train, the start/end time of unloading/loading, availability periods of locomotives and the handing over of papers between the agents, including the number of loading units to be loaded/unloaded) in the respective intermodal terminals. The system also documents any deviation from the planning. In this case a new planning can be negotiated between chain partners.

By means of the integrated planning and implementation of SPIN the punctuality of rail services (to the hinterland) increased from 73 to 85 %, while in the opposite direction (towards the port of Rotterdam) it increased from 58 to 80 %. Since also the costs for chain partners were reduced significantly, the transparency increased and the rail product became better. Finally, about 80–90 % of the goals have been achieved.

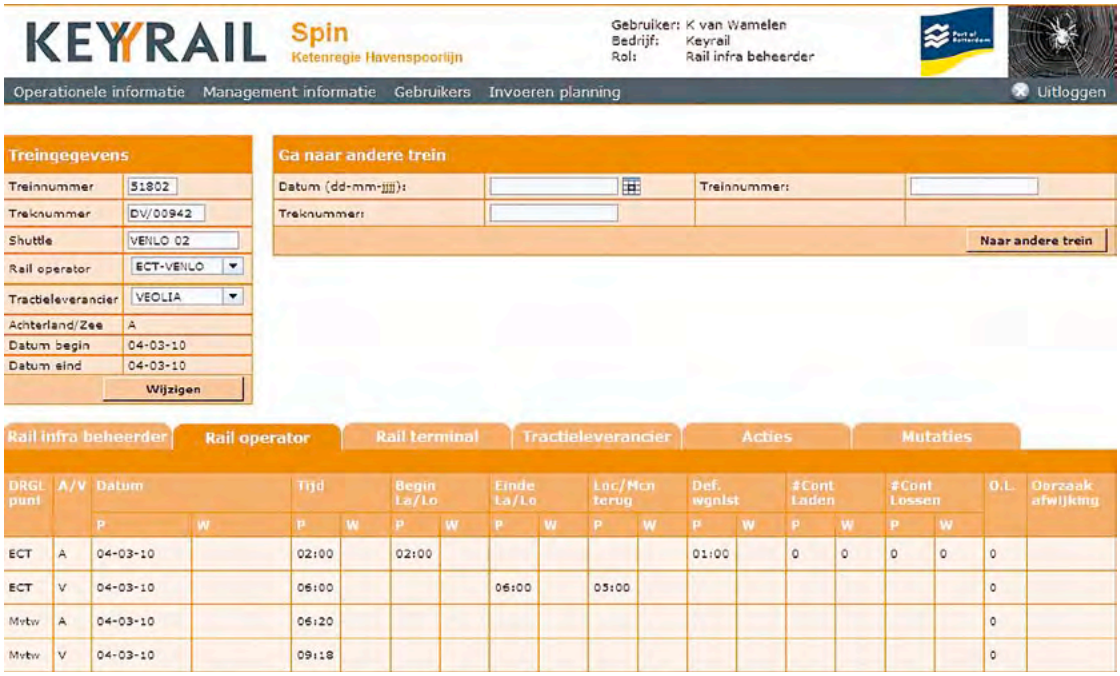


Figure 18: IT system SPIN – Train data entry mask

Source: Keyrail

Training of involved staff

The introduction of new technologies, modified procedures and processes required changes in the way actors organise and carry out their work, how they cooperate and communicate. These changes were accompanied and prepared by specialised instruction (training courses). A training concept was developed by Keyrail using a dedicated risk analysis and creating the following results:

- Identification of improved processes that require a training of the involved staff, e. g. rail traffic controllers, train drivers (on driving, signalling and train control), fire-fighters (on 25 kV), maintenance workers (on hand-held terminal) and all parties involved with chain management (SPIN)
- Deduction of detailed requirements for the staff training
- Development of a training concept, considering training measures, tools, objectives and schedules
- Selection of potential training candidates and performance of training events, involving e. g. more than 250 persons

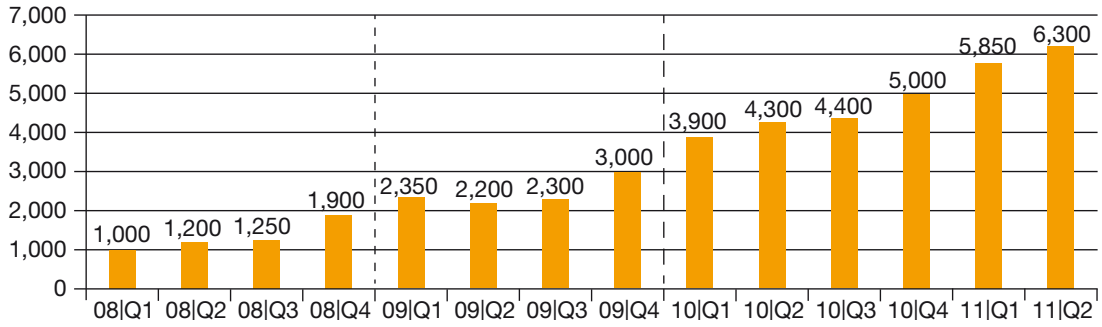


Figure 19: Quarterly train numbers passing the A15 track of the Betuweroute [trains/quarter]; Q1/2008 – Q2/2011)

Source: Keyrail

Extension of freight services

One of the pilot rail operators using the Betuweroute was Kombiverkehr with its services to/from the German hinterland: The operational concept connects the intermodal terminals Rotterdam Euromax, ECT Maasvlakte, RSC Rotterdam, Duisburg-Ruhrort Hafen (DUSS), DeCeTe Duisburg and Container Terminal Dortmund (CTD). Scandinavian countries, France and the Iberian Peninsula as well as Southern and Eastern European countries are linked via the gateway terminal DeCeTe Duisburg. Kombiverkehr opts activating its own railway license and using the Betuweroute with own and rented waggons, leased locomotives and hired drivers and was able to increase the punctuality to more than 90 %. The service quality was maintained and thus the frequency of services could be increased to two daily shuttle trains in either direction: one for maritime and one for continental cargoes allowing independent circulation of rolling stock. These trains have been integrated in the overall “String of Pearls” operation concept, also developed within the project.

The increase of regular train services is mirroring the success of the implementation strategy and the performed measures.

Interoperable traction schemes

In the past decades, market trends in the international logistics and transport sector were driven by a growing importance of dividing production to different sites and countries as well as distributing products to international sales markets. In consequence, international transport flows have been growing, leading to an increasing need for smoothing and shortening border crossing operations and transit times between countries. This is true especially for East European countries, which have been "closed" within their own economies for quite a long time, without real connections to the markets abroad. Today, we have a huge internal market within the European Union, comprising 27 member countries and further countries about to become members in the next years. Consequently, the issue of interoperability in rail transport is a key issue in the transport policy of the EU and has therefore also been considered by CREAM.

For many years it had been common practice for the railway undertakings involved in CREAM to change traction units at border stations. Therefore it was an ambitious challenge to introduce interoperable traction schemes on the CREAM corridor. It turned out that even locomotives of the latest generation which fulfil the various technical requirements have in general not been operated across borders. This is because border crossing procedures still often require a huge amount of time and political restrictions – e. g. based on the history of the Balkan countries – do not allow cross-border operations with the same locomotive. Furthermore, the length of the CREAM corridor and the number of crossed countries with specific railway infrastructure operating conditions make it in general very complex and expensive to perform interoperable services over the entire transport distance.

Major obstacles are differences in the electrical power systems, in the train protection systems and in the pantograph widths. Above this, many lines or line sections are not even equipped with electric power, so that trains have to be pulled by diesel locomotives. Other constraints concern different languages of staff from different operation partners and authorities. Above this, homologation procedures for locomotives, which are still not harmonised between countries, are complicated, time-consuming and as a result very expensive.

Investigating opportunities for interoperable operations

A central task of the CREAM project was to elaborate suitable interoperable rail operation schemes adapted to the specific characteristics of the corridor and the rail services considered. In the scope of this project activity possibilities for the employment of multi-system-locomotives were evaluated.

CREAM made significant progress in this field, extending interoperable traction on the corridor with a step-by-step approach on basis of existing pilot trains. The project also responded to latest EU directions, willing to stimulate the railway market opening. This process requires harmonised systems, eliminating compatibility problems of transport operations, caused by different versions of traffic control systems.

For the process of extending and demonstrating interoperable services on the CREAM corridor various steps had to be carried out:

1. Identification of main routings (Northern branch via Romania which is equivalent to the pan-European corridor IV and Southern branch via Serbia which is equivalent to the pan-European corridor X) and analysis of infrastructure parameters of lines and line sections with regard to interoperable traction

2. Selection of specific train services operating on these routings
3. Evaluation of technical requirements for interoperability on selected routes and deduction of required locomotive equipment under consideration of ERMTS/ETCS implementation on respective lines
4. Technical and economical assessment of interoperability concepts – definition of requested types of multi-system-locomotives where applicable or synchronised use of single-system-locomotives
5. Specification of interoperability concepts (employment scheme, typing and quantifying of resources)

RU	class	NL	DE	AT	HU	RO	MK	BG	TR	GR	SI	RS	HR
RNL	1600	■											
	6400	■	■										
	66	■	■	■	■	■	■	■	■	■	■	■	■
RDE	182		■	■									
	189	■	■	■	■	■	■	■	■	■	■	■	■
	140		■	■									
	185		■	■									
ÖBB	1044		■	■									
	1116		■	■	■	■	■	■	■	■			
	1216	■	■	■	■	■	■	■	■	■	■	■	■
MÀV	V43				■	■	■					■	■
	V63				■	■	■					■	■
	1047		■	■	■	■	■	■	■	■			
CFRM	EA5100				■	■	■	■	■	■		■	■
	DA2100	■	■	■	■	■	■	■	■	■	■	■	■
	LDH1250	■	■	■	■	■	■	■	■	■	■	■	■
RTC/LM	189	■	■	■	■	■	■	■	■	■	■	■	■
	182		■	■	■	■	■	■	■	■			
	140		■	■									
	EU43		■	■							■		
SZ	541	■	■	■	■	■	■	■	■	■	■	■	■
BDZ	43/46				■	■	■	■	■	■		■	■
	6	■	■	■	■	■	■	■	■	■	■	■	■
	7	■	■	■	■	■	■	■	■	■	■	■	■

Figure 20: General technical suitability of locomotive types for interoperability (status: 2008)

The analysis comprised present operation models and the types of interoperability in place. The results have shown that at project start full interoperability with locomotives and drivers was already practiced in cross-border traffic Germany/The Netherlands and Germany/Austria. At that time technical interoperability only with locomotives was already practiced in cross-border traffic Austria/Hungary, Austria/Slovenia, Hungary/Romania and Austria/Italy.

To actually give birth to further interoperable services, negotiations between railway undertakings for the circulation of multi-system locomotives started. These were concerned to train services, already in operation on the CREAM corridor. Concretely, the following relations were discussed:

- Mannheim – Inoi
- Lambach – Thessaloniki
- Genk – Ordea
- Wels – Halkali
- Cologne – Köseköy
- Zeltweg – Vintu de Jos and
- Munich – Ljubljana

Interoperability on international long-distance train services

As a result, the partners managed to demonstrate interoperable traction schemes on the routes Genk – Oradea, Zeltweg – Vintu de Jos and Munich – Ljubljana:

In conjunction with the annual time table change, in December 2009 interoperable traction was introduced for the intermodal train service Genk – Oradea (train numbers 40672/40673) between Aachen and Püspökladány, using either an ÖBB class 1116 or a MÁV class 1047 locomotive. This section has a length of approximately 1,500 km and crosses the network of three infrastructure managers: DB Netz (Germany), ÖBB Infrastructure (Austria) and MÁV (Hungary). In 2009, twelve round-trips were successfully operated during the demonstration phase applying this new traction scheme. As a result the technical feasibility of the concept could be proved. However, the concept was not transferred into regular service, as interoperable locomotive circling was economically not expedient.

In 2009, Rail Cargo Austria has obtained the safety certificate for Romania. Shortly after, the company started to operate train 41360 between Zeltweg and Vintu de Jos without any locomotive change in between. Within the core demonstration period between December 2009 and February 2010 more than 28 train runs were operated interoperable. Over the entire route the trains were hauled by an ÖBB class 1116 locomotive, thereby passing Austrian, Hungarian and Romanian rail networks.

Intermodal trains between Ljubljana Moste CT and Munich Riem (train numbers 41860/41861) are operated in general without changing the locomotive on the route. This interoperable traction concept has been realised by deployment of multi-system locomotives type 541 from Slovenian Railways SZ, homologated for Slovenia, Austria and Germany, and by application of a technical trust agreement between Austria and Slovenia, minimising the stopping times at Jesenice border station. The traction services for Austria and Germany are provided by Lokomotion. As a result of the joint and successful efforts in implementing interoperable traction and due to a strict quality management the trains show a punctuality rate of above 90 %.

Figure 21: Interoperable train Munich – Ljubljana at Jesenice border station

Heavy trains on the Tauern line

The train service Munich-Ljubljana was also used as a test field to develop and demonstrate a new technical concept for operating heavy trains on hilly sections. In July 2009, it could be managed that a train with 1,954 gross tonnes passed the Tauern line. It is worth mentioning that never before a train of this weight was pulled up the north ramp of this Alpine pass, which possesses a long incline section with a gradient of 25.5‰. On these sections the traction units are assembled as follows: 1 pulling loco in the front of the train + 2 locos in the middle of the train + 1 pushing loco at the end.

Figure 22: Heavy train on the Tauern line operated according to the new traction composition developed by Lokomotion

It has to be acknowledged, that this form of traction requires additional shunting, more traction resources and cannot be combined with the interoperable concept presented before. Therefore, it has been applied only in exceptional cases for heavy trains with a weight in the range of 1,800 to 2,000 tonnes. Nevertheless, the average train weight in north-south direction could be raised to more than 1,500 tonnes.

Meanwhile, this form of traction has been accepted by ÖBB Infrastructure also for regular services and is offered by ÖBB to all other traction companies operating trains on this route, too.

Cross-border operations Bulgaria/Romania with retro-fitted locomotives

In 2009 and 2010 the DB Schenker Rail domestic branches in Romania and Bulgaria were provided with a fleet of used locomotives from Germany class 232 and Denmark class EA 3000. All locos were transferred in special block trains from Denmark and different places in Germany to Romania and Bulgaria (see also Figure 23).

Figure 23: Transfer of DB Schenker Rail locos to Romania in May 2009; pulled by multi-system "CREAM" locomotive of Lokomotion

Due to specific technical requirements of the domestic power and safety systems and missing homologations in the respective countries, putting these locomotives into operation turned out to be a real challenge. After providing numerous additional documents and conducting some technical modifications on the locomotives, the homologation processes were finally concluded successfully in summer 2010 both in Romania and Bulgaria. Furthermore, class 232 diesel locomotives got the homologation in Hungary in December 2010.

In a next step towards interoperability test runs were conducted between Oradea (Romania) and Püspökladány (Hungary) on basis of the intermodal train connection between Genk and Oradea. However, due to contractual obligations this traction concept was not transferred into regular operation.

In contrast, plans to realise interoperable locomotive circulation between Bulgaria and Romania were realised successfully. Since March 2011 a regular block train service has been operated with two weekly roundtrips, transporting gypsum plasterboards between Liubenovo (Bulgaria) and Bucharest (Romania).

Conclusions

Interoperability is a key issue of the European transport policy which aims at promoting a single European rail area. CREAM has responded to this issue and searched for opportunities to set up interoperable services. The investigations have shown that this was and still is no easy task. Putting interoperability into practice on the CREAM corridor was often hampered e.g. by long border station stopping times, long and inefficient turn-around times of locomotives due to low frequency of transports, insufficient availability of interoperable locomotives, long-lasting homologation procedures for locomotives and inappropriate market conditions in some countries. Also it turned out, that the current conditions are in general not appropriate to operate long-distance train services with just one locomotive.

However, the experience of CREAM also shows that it is favourable to reduce the number of operational interfaces and to introduce interoperability section wise. Locomotive changes shall be concentrated at operational points of interest such as shunting yards, terminals, maintenance workshops and/or locomotive depots. In contrast locomotive changes at legal and administrative interfaces such as border stations shall be minimised.

If traction schemes are designed according to the specific framework conditions of train services and related train routes, interoperability has the potential to generate a number of benefits. These are a better productivity by optimised exploitation of traction resources, a higher flexibility, reduced shunting costs, improved reliability of train services, reduced border stopping times and consequently transit times and reduced border station occupation times, leading to a higher station capacity.

Thus it lays in the interest of all three stakeholder groups to introduce interoperable traction schemes: infrastructure managers (higher capacity), railway undertakings (better use of rolling stock) and customers (sharter transit times).

Streamlining border crossing procedures

Lack of interoperability, deficits in the operational coordination of border crossings and priority rules to the detriment of rail freight on a multi-purpose passenger/freight rail network are among the main reasons for non-competitive time-tables and unreliable rail freight services. The CREAM project seeks to achieve a major progress on all these issues. Specifically improved border processing procedures are expected to lay foundations for an improved quality standard of rail freight in the rail corridor, considered in CREAM.

Border crossing processing time is a critical factor for the performance of customer-driven rail production systems such as the so-called "String of Pearls" concept of CREAM. In order to ensure that new envisaged intermodal rail services, to be integrated in this concept, can be supplied and operated at road-competitive transport times and quality standards it is paramount to at least accelerate border crossing procedures or, preferably, make them vanish. Consequently, CREAM examined both approaches:

Streamlined border crossing procedures (minimum solution): In correspondence with an improved freight train quality – also tackled within CREAM – responsibilities and processes have to be clearly defined and border control centres have to be established where appropriate.

Elimination of border crossing processes and stops (optimum solution): A change of locomotives and – if reasonable – loco drivers shall not be enforced at the border stations between two countries or networks but at economically and operationally reasonable break-points, e.g. at hub terminals, where various services are merging. The elimination or minimisation of border stops also facilitates an economic deployment of multi-system locomotives in cross-border traffic.

Rail freight border crossing categories

As a basis for optimising border crossing processes of rail transport and reducing related border stopping times, the conditions at 20 railway border crossings on the CREAM corridor have been analysed in detail. In this process the legal, technical and organisational backgrounds on each side of the border had been considered. In a systematic approach border crossings with similar characteristics have been grouped in categories, making comparisons and joint improvement approaches for border crossings of the same category possible. For the initial categorisation the following questions have been posed:

- Are technical and/or commercial trust agreements in place?
- Do the rail sections at both sides of the border feature the same (harmonised) operational standards?
- Is it mandatory to conduct customs checks or border police controls?
- Are rail border processes consolidated in just one common border station or are two or more separate border stations used for these processes?

Depending on the answers to these questions, each border crossing was allocated to one of three categories A, B or C (see Figure 24). In this categorisation A is standing for the highest, C for the lowest level of harmonisation/integration. Figure 25 depicts the results of the evaluation. Six border crossings have been allocated to category A, five border crossings to category B and nine border crossings to category C.

	Category		
	A	B	C
Common border crossing	+	O	–
Mutual trust			
technical	+	O	–
commercial	+	O	–
Operational standards harmonised	+	O	–
Customs check/border control necessary	–	O	+

+ yes O partially – no

Figure 24: A/B/C categories of rail border crossings (for initial clustering)

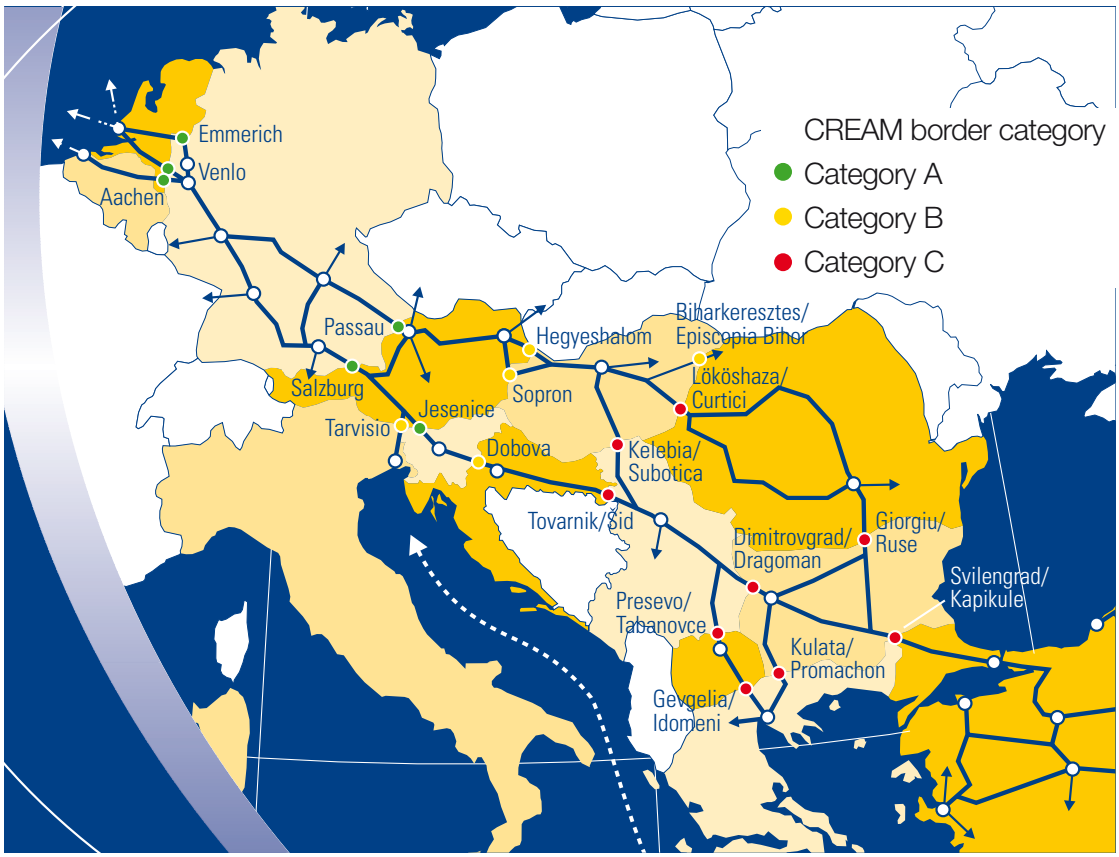
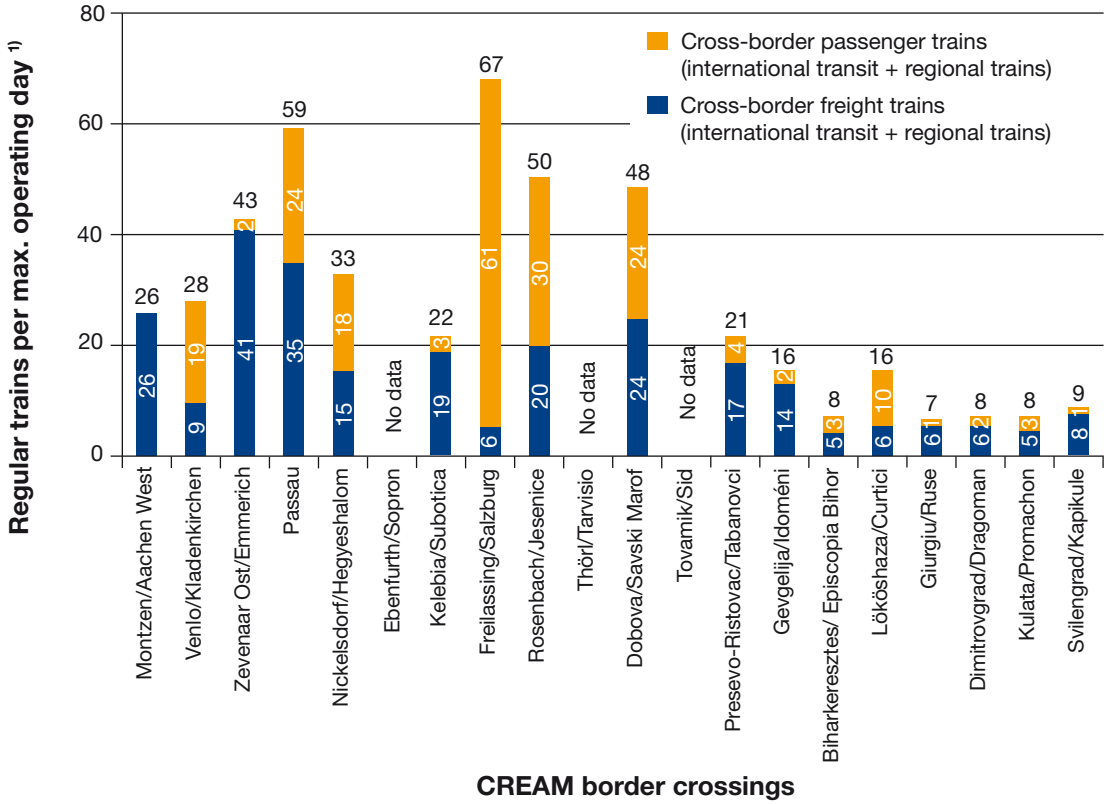


Figure 25: A/B/C categorised rail border crossings on the CREAM corridor

Methodology of detailed border crossing analysis

For the detailed analysis of each border crossing a comprehensive data collection was conducted comprising all relevant technical, operational, administrative and legal parameters. As it is essential that the results for these heterogeneous border crossings are comparable, specifically to ensure transferability of good practices, all information has been sorted in a common analysis structure. Main issues documented and investigated were the rail volumes passing the border, the technical framework, the legal/administrative framework, border crossing processes and border crossing times (comparing minimum requested, scheduled and actual times). By exploiting these results, main impediments have been derived and recommendations for potential improvements have been elaborated within the project.

Rail volumes: These refer to the number of trains operated on border sections in general according to the annual FTE timetable for the year 2009 at a maximum operating day. Train figures are displayed by direction distinguishing between international passenger trains, regional passenger trains, international freight trains and regional freight trains. The figures show that the traffic conditions are very diverse. The CREAM corridor comprises border crossings with a high throughput such as Freilassing/Salzburg (up to 134 trains per day in both directions; thereof 12 international freight

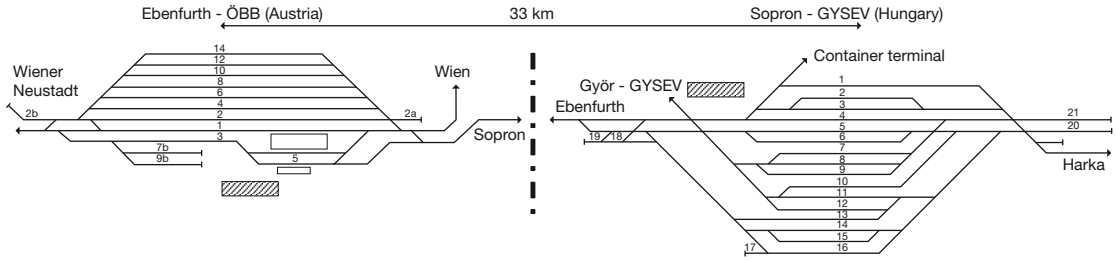


1) Average value per direction
German borders: Only trains of DB Schenker Rail were considered

Figure 26: Cross-border train volumes (status: 2009)

trains) and Passau (up to 162 trains per day; thereof more than 60 international and almost 30 regional freight trains) and border crossings with comparably low traffic figures such as Biharkeresztes/Episcopia Bihor (up to 15 trains per day; thereof 10 international freight trains) and Giorgiu/Ruse (up to 14 trains; thereof 4 international and 8 regional freight trains). Figure 26 shows the average quantity of trains per direction.

Legal/administrative framework: All international and national regulations with relevance to freight train operations at respective borders are listed. Specifically it had been checked if appropriate border crossing agreements are in place. Especially trust agreements have the potential to accelerate border crossing processes remarkably.



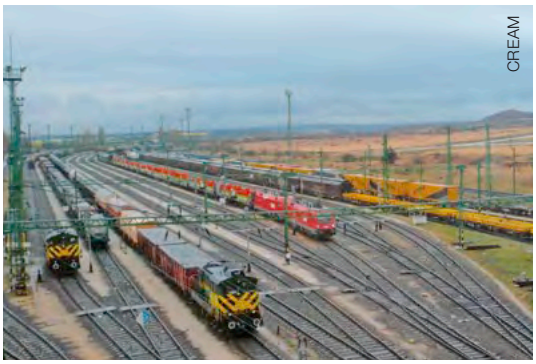


Figure 27: Border crossing Ebenfurth/Sopron (example)

Technical framework: For each considered station a principal track scheme has been elaborated to display the general infrastructure situation at respective locations (cp. Figure 27). In addition, information has been compiled on technical line parameters, facilities such as repair shops, technical data and functions of station tracks and staff resources involved in the border processes. Resuming this compilation it can be said, that there are in general sufficient resources both in station tracks and staff. Therefore, only in exceptional cases the technical framework conditions might be a factor responsible for extended border crossing times.

Border crossing processes: To structure and compare the processing of freight trains at different border crossings with diverse conditions, so-called standard processes have been agreed upon, referring to typical tasks to be carried out for transferring a freight train from one side of the border to the other side. This listing includes 31 individual processes which are assigned to one of four project clusters (cp. Figure 28):

1. Pre-border processes,
2. Transport document processes,
3. Train operating processes and
4. Customs and authorities procedures

Tasks/Processes before train arrival		
Process cluster	**N°**	**Standard process**
(1) Pre-border	1.1	Info about train arrival
	1.2	Preparation-meeting for train arrival
Tasks/Processes after train arrival		
(2) Transport documents	2.1	Check of consignment list by RU
	2.2	Input of commercial data into IT system
	2.3	Input of technical data into IT system
	2.4	Calculation of freight
	2.5	Elaboration of waggon list
	2.6	Elaboration of a brake sheet
	2.7	Handing over papers to the train driver
(3) Train operation (with respect to border crossing)	3.1	Take over train and train papers
	3.2	Commercial train check
	3.3	Uncoupling locomotive from the train
	3.4	Technical train check
	3.5	Compilation of notes for technical/commercial repairs
	3.6	Technical and commercial repairs
	3.7	Control of technical and commercial repairs
	3.8	Elaboration of a shunting list
	3.9	Sorting out damaged waggons
	3.10	Coupling locomotive to the train
	3.11	Brake test
	3.12	Fixing tail signal
	3.13	Adding the transit labels to the waggons
	3.14	Solving additional problems
	3.14	Preparation for train departure
(4) Customs/Authorities	4.1	Processing of custom papers (by RU)
	4.2	Handing over papers to customs
	4.3	Processing of the papers by customs
	4.4	Customs train check
	4.5	Receiving papers from the customs
	4.6	Border police control
	4.7	Phyto-sanitary control

Figure 28: Standard processes for freight trains crossing borders

In the following, all tasks needed to handle a freight train at individual border stations without considering exceptional events, such as waggon detachments or technical locomotive defects, are allocated to the previously defined standard border processes. To display how the scheduled border stopping time is used, these standard processes are assembled in a process sequence chart. This chart shows

- which standard processes are carried out when processing a freight train
- which company and which staff is in charge to conduct the respective process
- what is the required (theoretical) time value to conduct the respective process
- in which sequence are processes carried out and
- as a result what is the minimum required total (theoretical) border stopping time

As an example Figure 29 shows the planned process sequence of an average freight train at Hegyeshalom border station passing the border from Austria to Hungary. At stations that feature considerable differences in the technical procedures between different train types (intermodal, single waggonload), separate tables have been elaborated.

N°	Standard process	done by		–10	0	10	20	30	40	50	60	70
1.1	Info about train arrival	MAV Infra	Station coordinator		5							
3.1	Bring in the documents and consignment notes	ÖBB	Preparer		5							
3.3	Uncoupling locomotive	MAV Cargo	Shunter		5							
3.10	Coupling locomotive	MAV Cargo	Shunter			5						
3.2	ÖBB commercial check	ÖBB	Preparer			20						
3.4	MAV technical check	MAV Cargo	Waggon examiner			30						
4.6	Checking by the authorities	Austrian/Hungarian authorities	Border police			30						
2.1	Train listing	MAV Cargo	Preparer			30						
2.4	Checking the accounting in advance	MAV Cargo	Preparer			5						
3.1	Hand over ÖBB accounting to MAVC	ÖBB	Preparer			15						
3.1	Take over ÖBB accounting from ÖBB	MAV Cargo	Preparer				5					
2.4	Accounting the consignment notes	MAV Cargo	Preparer					20				
2.2	Listing the commercial data	MAV Cargo	Preparer					35				
3.11	Brake test	MAV Cargo	Waggon examiner					30				
2.7	Delivering the consignment notes	MAV Cargo	Preparer								5	
3.15	Order of departing	MAV Infra	Station coordinator									15
	Critical process sequence duration [minutes]							**75**				

Figure 29: Sequence and duration of standard processes (Example: Hegyeshalom/direction AT > HU; status: 2008)

Freight train operating times

To secure that the analysis results have a high practical relevance, all analyses have been done on the basis of real trains operated by the project partners. To get a picture of the offered transport times and time share of border crossings, schedules of in total 22 freight trains have been analysed. The routings of these trains represent almost the entire rail corridor considered by the project.

The analysis was based on the annual FTE train schedules for the year 2008. The results show that freight trains are scheduled with a train speed between 20 to 40 km/h. The time share of stops at border crossing stations is in the range of 5 – 35 %. Main operational stops e.g. for changing the locomotive require a time share of up to 20 % in the total transport time. The average running speed between main stops is between 30 and 60 km/h.

In other words: Train stops at border stations can influence the overall rail transport time considerably. In fact, time shares of up to 35 % of border station stops in the total transport time reveals a great potential of accelerating rail transport times just by shortening border processes.

Forum Train Europe (FTE)

FTE is a European association of railway undertakings and service companies based in Berne (Switzerland) that promotes cross-border rail freight and passenger traffic in Europe. In this role FTE supports its members actively with an international production planning process. In this respect, international coordination conferences are organised for harmonising their members' production planning and train path requests both for passenger and freight traffic.

www.forumtraineurope.org

FORUM TRAIN EUROPE

However, the average actual border stopping times, measured during regular train operations, are in general considerably longer than scheduled and minimum required (= total "theoretical" standard process sequence). Average delays have been identified for numerous rail services (sometimes in a range of 1 – 3 days) resulting to a certain extent from a missing timetable awareness of border staff. In general, it was discovered that at borders where the level of cooperation between railway undertakings is high, the passage of the border is much faster than at borders where cooperation is comparably loose.

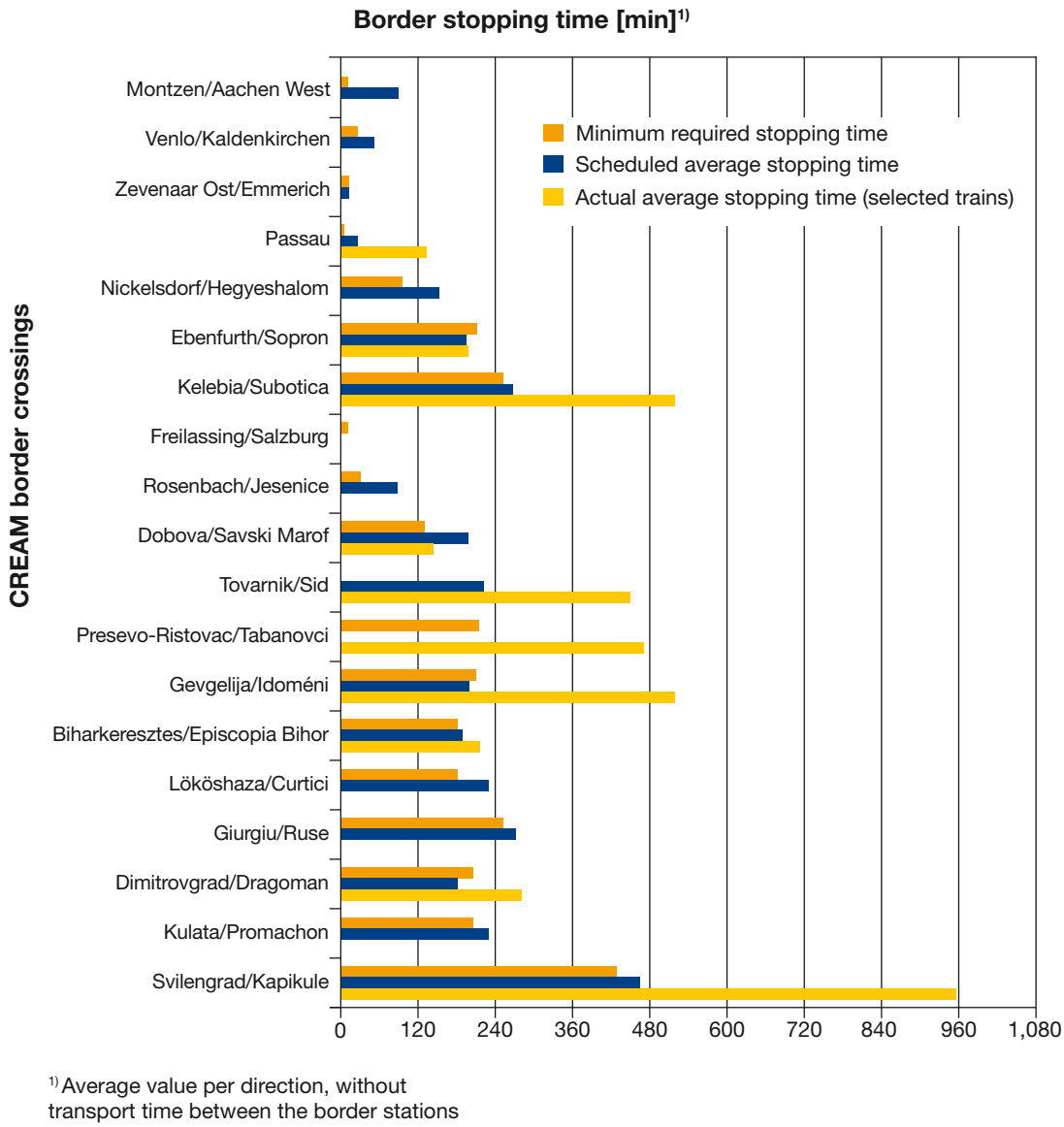


Figure 30: Border-crossing times of freight trains on the CREAM corridor (status: 2008/2009)

Exploiting the analysis results

On basis of the detailed analysis' findings the validity of each initially assigned border crossing category has been verified by assessing the following criteria (+ = yes, o = partially, – = no):

- Is a common border crossing station in place?
- Are freight trains operated according to mutual trust agreements?
- Are operational standards harmonised?
- Are governmental controls disposed?
- Is the minimum required border stopping time (= total sequence of standard processes) per direction less than 30 minutes (+), in the range between 30 and 180 minutes (o) or above 180 minutes (–)?

The detailed analysis results show that border crossings initially assigned to the same category (A/B/C) exhibit generally similar conditions. In fact, almost each category assigned to a border crossing at the time when the investigations started was confirmed after the analysis had been concluded. Just for two border crossings (Tovarnik/Sid, Tarvisio) due to a lack of data it was not possible to give a validated assessment.

Border crossing	Common border crossing	Mutual trust agreement	Operational standards harmonised	Governmental controls	Minimum requested border stopping time per direction	Verified border crossing category
Montzen/Aachen West	+	+	–	+	+	A
Venlo/Kaldenkirchen	+	+	–	+	+	A
Zevenaar Ost/ Emmerich	+	+	–	+	+	A
Passau	+	+	+	+	+	A
Nickelsdorf/ Hegyeshalom	+	–	–	O	O	B
Ebenfurth/Sopron	+	–	O	O	–	B
Kelebia/Subotica	–	–	–	–	–	C
Freilassing/Salzburg	+	+	+	+	+	A
Rosenbach/Jesenice	+	+	–	+	+	A
Dobova/Savski Marof	+	O	O	–	O	B
Tovarnik/Sid	n.s.	–	+	n.s.	n.s.	(C)
Presevo-Ristovac/ Tabanovci	–	–	+	–	–	C
Gevgelija/Idoméni	–	–	O	–	–	C
Biharkeresztes/ Episcopia Bihor	O	–	O	O	O	B
Lökösházа/Curtici	–	–	O	O	O	B
Giurgiu/Ruse	–	–	O	O	–	C
Dimitrovgrad/ Dragoman	+	–	n.s.	–	–	C
Kulata/Promachon	O	–	–	O	–	C
Svilengrad/Kapikule	–	–	O	–	–	C

Figure 31: Overview of CREAM border crossing assessment (categorisation)

+ fully applicable *– not applicable*
O partially applicable *n.s. not specified*

To identify main obstacles and improvement potentials, each individual border crossing was assessed against 22 criteria considering "general aspects", "resources and technical aspects" and the "operational organisation". For this assessment it has been distinguished between "impediments with severe negative effects" (= very high improvement potential), "impediments with considerable negative effects" (= considerable improvement potential) and "no impediment".

In summary the conditions at category A, B and C border crossings can be characterised as follows:

Category A border crossings show (almost) no impediments with "severe" negative effects. Occasional impediments with "considerable" negative effects mainly refer to the resources and technical aspects. For instance rationalisation of railway infrastructure, personnel and rolling stock resources lead to bottleneck situation in case of increasing volumes. Changes of energy and signalling systems at category A border crossing points between Germany and the Netherlands/Belgium require multi system locomotives or loco changes at the border stations.

Category B border crossings in general also show no impediments with "severe" negative effects. Some impediments with "considerable" negative effects refer mainly to resources and operational organisation in single cases (lack of line locomotives, inadequate management of waggon detachments, operational problems due to missing pre-information about train arrivals, high effort of manual data input and control).

Category C border crossings show numerous impediments with "severe" and "considerable" negative effects, resulting from all criteria clusters. To mention are double border stations with double performed processes in case of EU-/non-EU-borders, exogenous effects such as delayed train arrivals or infrastructural deficiencies at border connecting lines (e. g. construction works), technical aspects especially different energy and/or signalling system and occasionally also a lack of resources. Further considerable organisational problems result from extra shuttle services between border stations, lacking coordination between railway operators and authorities as well as insufficiencies of information flows and data exchange methods.

To boost the level of cooperation and to optimise the interfaces between the interacting parties at the border, the CREAM project initiated bilateral initiatives at seven concrete border crossings (cp. Figure 32), thereby exploiting the findings from the comprehensive analysis work of CREAM. Main strategic starting point for improvement measures at borders are operational and organisational issues, since these effects are often not caused by exogenous impacts but "home-made" and therefore under the responsibility of the railway undertakings involved in the project. The improvement activities, conducted during the project lifetime, have basically been focussing on electronic data exchange methods, procedures for advanced notifications of train arrivals (pre-information) and on a streamlined process organisation within the relevant border stations.

Further improvements of course require optimised interfaces also with partners outside the project. Therefore these initiatives generally seek to involve further stakeholders such as infrastructure managers, authorities and relevant customers to develop and implement improved procedures.

Resuming the project work, CREAM has built a strong fundament to improve the conditions of railway border crossing. However, even at the end of CREAM there is still a long way to go to really practice seamless freight train traffic across borders.

Focus:

- Streamlining processes
- Pre-information
- Electronic data exchange

Figure 32: CREAM border crossing improvement initiatives

Figure 33: Hegyeshalom station sign

Figure 34: Border station Curtici (March 2009)

Technical developments

Tracking of trains and waggons by GPS or simple tracking methods

In line with increasing information needs in the logistics sector, rail transport customers call for efficient tracking and tracing solutions. In correspondence to these needs, CREAM analysed different technical solutions based on GPS or simple tracking technologies and evaluated their applicability on the CREAM corridor. The results have been integrated in a comprehensive information management concept and were demonstrated under different operation conditions.

International freight trains require information flows that enable every stakeholder to get the information they need at the right time. An analysis of the information exchange on the CREAM corridor, however, showed significant information deficits. Several train operators requested better and more up-to-date notifications of delays and changes in the schedule or the routes of their trains. Due to slow implementation of TAF TSI and missing interfaces for open data exchange between infrastructure managers (IM) and railway undertakings (RU), independent data sources like GPS become interesting for train operators.

Main goals of the CREAM project activity on telematics technologies were therefore to analyse the demand for a better information supply of rail freight movements and to develop and demonstrate innovative tracking and tracing technologies as well as services.

Eureka evaluated different possibilities for locating and status monitoring of trains. Basically the evaluation contained a comparison of simple tracking methods (RFID and GSM-location based services) in comparison to established satellite navigation based methods (GPS/GSM). The combination of GPS positioning and GSM data communication in a telematics unit offers the best independence from railway infrastructure at a feasible cost/benefit ratio. According to different customer requirements, the GPS/GSM tracking solutions were designed for tracking of waggons as well as for locomotives.

The study of simple tracking methods had to compare quite different approaches.

GSM Location Based Service (LBS), for instance locates a GSM module by analysing its radio signals, received with the GSM base station infrastructure. This method could meet the railways' requirements, but the service was only offered within the territory of a certain GSM provider. The lack of any Europe-wide LBS service excluded this method from a further evaluation within CREAM.

Another simple tracking possibility is the use of radio identification methods. Widely established technologies are RFID and ZigBee. Due to strict conventions of RFID standards and energy constrains with ZigBee, Eureka decided to base the further evaluation on a general purpose WPAN network, operated at the license free frequency of 868 MHz.

Tracking data, generated by different technologies, typically use different communication lines, protocols and of course different data structures. A customer-oriented tracking data service, however, requires a simple and versatile interface. Therefore the work contained also the development of an XML Interface called NavXML.

GPS/GSM telematics for waggon tracking

Prior to any technical development a comprehensive evaluation of the railways' tracking requirements had been worked out. A closer look to the requirements showed, that the potential railway telematics market could not be satisfied by a "one device fits all"-unit. The basic function of "positioning" was of course requested by all, but for numerous applications the additional detection of other events (e. g. marshalling shocks) are very important. Therefore, Eureka decided for a concept with a telematics baseboard and an additional sensor-board, which is optional. Present users (DB, ÖBB, …) of NavMaster devices requested a compatibility of the new CREAM telematics with the large number of NavMaster units they already had installed on their waggons. Therefore, every "NavMaster 1" function had to be taken over to the CREAM-Generation NavMaster and also the housing has been retained unchanged.

One of the main innovations of the CREAM generation baseboard was the implementation of GPRS communication. Due to reduced availability of GPRS compared to SMS communication, the NavMaster-team implemented GPRS with an automatic fallback to SMS communication in case GPRS is not available.

Figure 35: NavMaster GPS device for waggon tracking

Another innovation was the implementation of a field bus interface on the new baseboard. After an intensive study of established industrial bus systems, the development team chose the widely used CAN bus, but enhanced it by an additional interrupt line. This creation, named “LinkLine”, is ideal for battery operated systems, fulfils the highest EMC/EMI standards and shows a very high availability. The qualification of LinkLine according to railway standards (EN0155…) was successfully proven. LinkLine combines a master controller (NavMaster) with up to 15 distributed slave units (e.g. sensor modules), all linked to one single bus cable. Such a modular concept offers a high flexibility to realise waggon specific installations with a small set of standard modules. The investment and installation cost for this very simple bus-type cabling is significantly lower than a standard signal cabling.

This new sensor-board module offers various signal inputs such as two digital inputs to connect switches like door-contacts. Two analogue inputs, together with sensor powering, can be served by voltage and also current sensor types. Two tamper loops were included to detect broken cables to external sensors. An internal three axis acceleration sensor was included, to offer a detection of impacts, exceeding a predefined weight-threshold. This function is often requested from shippers of car parts like engines. Beside the shock detection with flexible thresholds, alternatively a 2.4 g shunting shock sensor is also configurable. This sensor requires no energy for operation and is therefore ideal for constant shock detection. The sensor board may also be ordered with an “external power input” to operate the NavMaster by an external voltage of 8 to 32 volt DC. The power control logic automatically switches over to the internal NavMaster battery, if external power is missing.

CREAM

Figure 36: GPS tracking of ISU test trains on the route Wels – Halkali

A small, but vitally important issue of this project activity was the development of a versatile NavMaster mounting holder. The analysis of the customer requirements showed a severe conflict of goals between anti-theft protection and the possibility of an easy service exchange of the NavMaster devices at the waggons. Most NavMaster 1 generation units were directly welded to the body of the waggons. But many years later (seven and more) it appeared that a battery exchange is more complicated than it should be. The new CREAM "telematics holder" consists of a low cost U-shaped metal holder which is welded to the waggon and a mounting set to screw the NavMaster to the U-holder. This screw connection is additionally protected and can only be dismantled with a special tool. After such a preseries mounting holder was cracked in Bulgaria in 2009, the construction of the theft protection was modified. Since 2010, no further CREAM NavMaster devices were stolen on the corridor.

Over a period of more than four years several trains were regularly tracked. Their precise position data helped the dispatchers to recognise delays at an early stage and gave other work packages a profound data source to analyse the timing of current processes.

GPS/GSM telematics for locomotive tracking

Originally the work focussed on train tracking methods which are based on the principle of installing telematics on certain waggons of the train composition. For international trains with changing locos this is the only appropriate tracking concept. Interestingly, however, the project showed that tracking is also very useful for locomotives operated on domestic networks. Based on the new versatile NavMaster baseboard and sensor-board a loco tracking version was developed in short time. This system consists of a NavMaster LT telematics unit, a railway approved GPS/GSM antenna and a power converter that connects the NavMaster to the on-board power of the loco. This power converter also contains a galvanic isolation that prevents interference of the loco electronics by the NavMaster. The telematics unit is also equipped with an own long-term battery. In case the locomotive electric is switched off, the tracking unit transmits a "Power off" event message to the control centre. Additionally, the NavMaster reduces its message interval from every five minutes to energy saving one message per hour. This ensures that the loco battery is never discharged by NavMaster and that also haul drives are visible for the dispatchers.

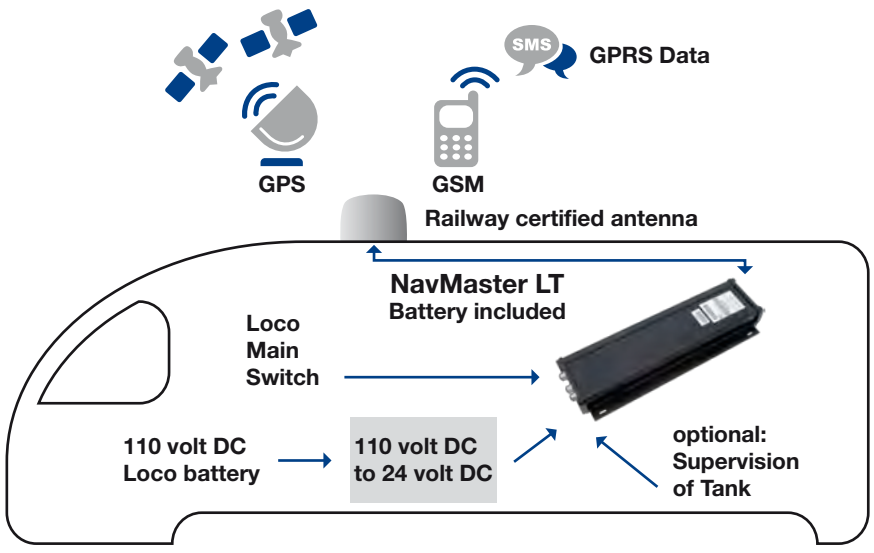


Figure 37: NavMaster LT – Locomotive tracking and supervision concept

Source: Eureka

The first installation of the loco tracking system was done for the Romanian traction provider "Logistic Service Danubius" which is today DB Schenker Rail Romania. A number of EA3000 electric locos and also several type 232 diesel locomotives were equipped with the telematics system. Besides transmitting the current position, the messages also contain the current speed and GPS mileage. Diesel locos were additionally equipped with a tank level sensor that transmits its level in litres, when the loco is switched off or on.

Figure 38: NavMaster LT – Installation of telematics system in Romania.
A: Roof mount GPS/GSM antenna. B: Installation of electronic fuel tank sensor.
C: NavMaster LT in electrical cabinet

Tracking server and tracking data service with NavXML

All NavMaster telematics messages are transmitted to the Eureka tracking server as SMS or GPRS package data. The tracking server checks incoming data, validates the contents and reformats the contained information to NavXML formatted files. The data preparation also includes a Geo-Matching, where the contained GPS position is searched in Eureka's Railway-Station-Database. The name, direction, distance and UIC station code of the next identified railway station is added to the NavXML file. An additional matching process may also be configured with a database of customer specific Points-of-Interest, like factories or customer sites.

The next data processing step is data distribution. A survey showed that the project partners had very different requirements for a further use of the tracking information. Some of them requested the NavXML data files only and integrated them directly into their operational IT solutions. The data transmission is realised as a simple FTP service. As NavXML is following the widely used XML standard, the data interface could be realised with small effort.

Several users asked for the integration of NavMaster tracking data into the international train monitoring system Train Monitor, which has been also developed within the scope of CREAM. Consequently, a direct transmission link to Hacon's Train Monitor server was added to Eureka's data distribution process, using NavXML data structures.

Data visualisation with aJourOnline internet portal

Companies with smaller or specific fleets or changing requirements for tracking data usage require a versatile tool of tracking data visualisation. The internet platform aJourOnline is exactly serving these demands. The development of this tool was not part of CREAM, but several project partners have used it for the tracking of their waggons and locos. The easy-to-use application offers tracking data as text data in the message list, as well as visualisation of the vehicle positions directly in a Google Maps window. Switching from the map display to Google's satellite view could very often answer difficult location questions. Position messages with additional information like mileage, speed or locomotive-on/off events are displayed in the message list as value or symbol. A data export function to MS Excel offers an easy way to make specific post-analyses of position and additional information.

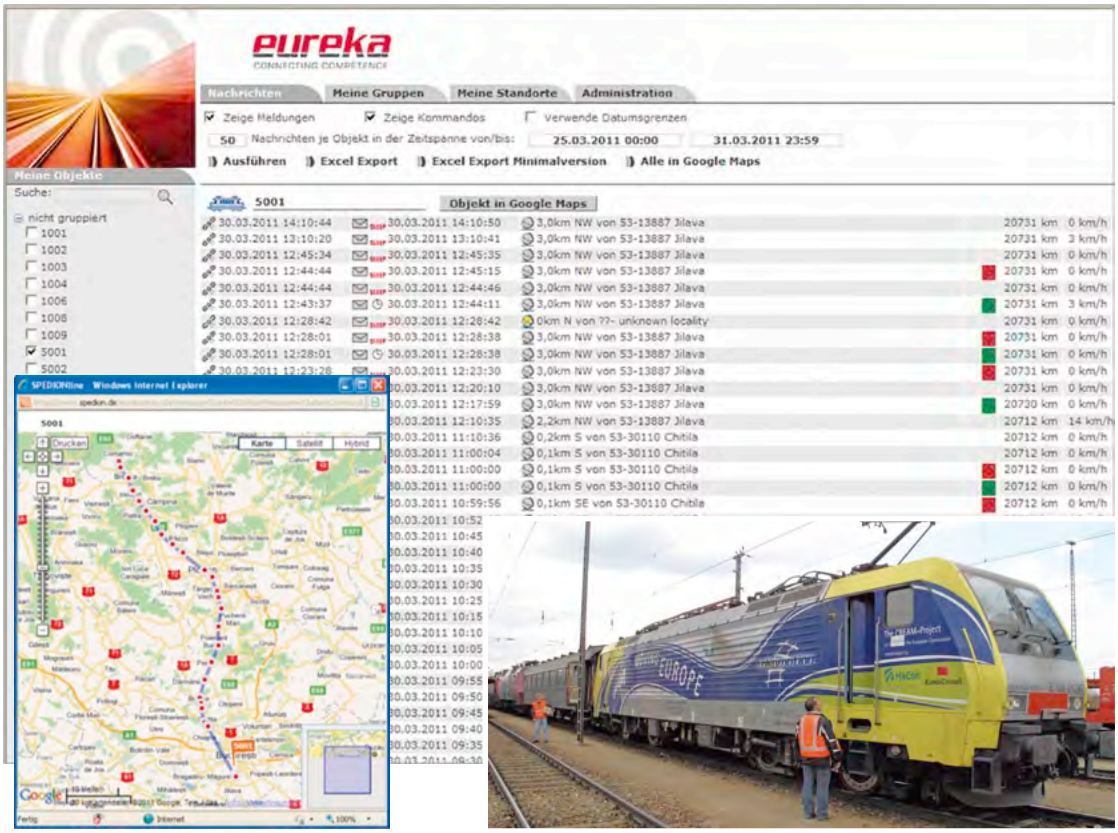


Figure 39: Visualisation of NavMaster tracking data with aJourOnline portal

Source: Eureka/CREAM
Map data © Google maps

WPAN tracking

A simple tracking mechanism was evaluated within CREAM, based on radio communication principles. The basic idea was to have small, battery operated radio devices (WPAN-TAGs), which are identified by other devices like mobile GPS/GSM telematics or stationary installed hot spots. Such a system could be used to identify the presence of specific loads (equipped with WPAN-TAGs) by waggon side mounted telematics devices (with a WPAN-Interface). Therefore, a communication distance was aspired of minimum more than a waggon length and optimally several 100 metres. Prototypes of 868 MHz WPAN-TAGs were developed and four test units have been produced. A basic communication protocol was developed within CREAM to test the stability and range of the data links. Practical tests have shown that a waggon distance can nearly be ensured and a range of 200 m can be reached with a high probability in a railway station.

Figure 40: WPAN reading tests at a container terminal

Spin-offs from the CREAM project

During the CREAM project, Eureka had another development project ongoing, called RodoTAG "Intelligent Wheelset Monitoring". This project could significantly benefit from the research and demonstration results of the WPAN-TAG development.

RodoTAG® wireless mileage counter

Detailed knowledge about the actual mileage of wheelsets and waggons is essential for modern freight waggon maintenance management. The RodoTAG® sensor module represents a cost-efficient and easily mountable device to determine and record the usage of individual wheelsets and waggons.

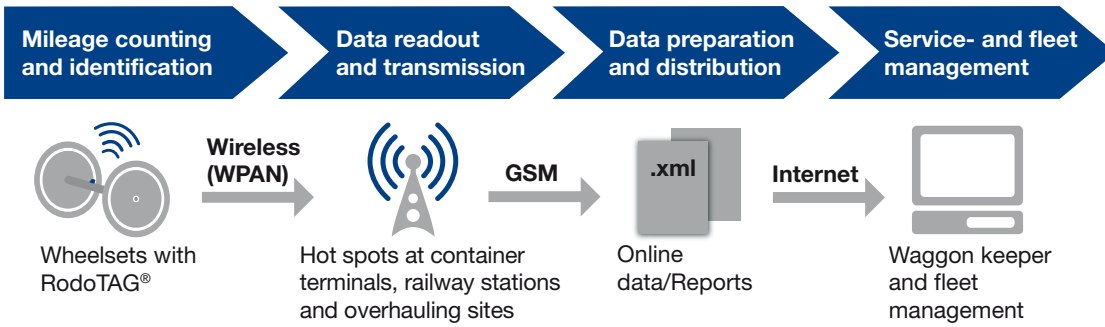


Figure 41: Simple (WPAN) tracking and mileage counting

Source: Eureka

RodoTAG® consists of compact, one-piece sensors which are mounted on the wheelset shaft and hot spots or telematics units receiving the sensor's encrypted mileage data. This data is subsequently transmitted to a data server, where it is calibrated with the wheelset diameter, converted to XML format and forwarded to the service management software of the waggon keeper. Optionally the waggon and wheelset performance may also be provided as monthly reports.

Being installed on a wheelset, the RodoTAG® sensor module measures and stores the total mileage and the mileage of each day in its internal memory. The sensor's maintenance-free and self-sufficient operating time is around eight years. An integrated data radio for wireless data transmission is free of licensing and registration throughout Europe and many neighbouring countries. When the waggon stands in the receiving range (approx. 200 m) of a hot spot, the RodoTAG® automatically transmits its stored data.

Mounting the sensor, which weighs only 230 g, is done within a few minutes and is quite uncomplicated. The sensor and the counter weight are fixed with two screw clamps on the wheelset shaft. The contact surface of the shaft itself is covered with special protection strips. More importantly, the RodoTAG® fits any shaft (Ø 160–180 mm).

Figure 42: RodoTAG® – Wireless wheelset monitoring device

The following customer benefits will be realised by RodoTAG®:

- Documentation of the long-term wheelset performance (according to requirements of railway authorities)
- Reduction of service costs (extension of maintenance intervals in case of low mileage)
- Reduction of repair costs (on-time maintenance of waggons with high mileage)
- Process and cost optimisation on basis of wear-related cost calculation
- "Pay per use" billing for leasing models based on daily mileage (including proof of use)
- Automated identification of waggons and wheelsets by hot spots (simple tracking)

Ongoing and planned developments

Eureka has a vital interest to gain profitable products and services from the CREAM research findings. Practical test results and the experience gathered from operations within and after CREAM have introduced additional requirements and ideas to optimise the developed solutions. Several hardware and software modifications are currently carried out or have already been finalised. Of course the market demand determines which priority is given to respective upcoming development steps. Therefore, Eureka is faced with a next major challenge to achieve a significant cost reduction for the whole tracking service, consisting of hardware, software and operational cost.

IT system “Train Monitor”

A long-standing deficit in rail transport is the availability of status information to smoothly integrate rail transport into today’s logistics processes. Developments in recent years have improved the situation e. g. on transalpine corridors. However, all in all the conditions continued to be poor for international rail freight, especially on the routes between Western Europe and Southeast Europe. The IT system “Train Monitor” closes existing information gaps by integrating train operation data from numerous sources, showing automatically calculated values for the estimated time of arrival (ETA) and providing a train data base for quality statistics and operation analyses.

One of the most long-standing deficits in rail transport is the “information Bermuda triangle”. Still, rail customers are often confronted with the fact that, as concerns information on the status of their shipment or train, they are “cut off” from their cargoes as soon as the train has left the station. With the development of improved rail operation systems and communication software, the situation has considerably improved e. g. on transalpine corridors. The CREAM corridor has to cope with extremely different levels of operational and communication systems installed by rail infrastructure operators and railway operators in the countries involved.

To raise the information level for rail freight as a prerequisite for integrating rail in today’s logistics, the project partners followed a two-fold strategy. This strategy backs on an improved information management which includes the agreement on clear responsibilities and interface procedures and improved commitment of railway staff to guarantee a “man-powered” tracking and tracing of trains. In addition, the project partners worked on technology-based solutions such as linking existing train control and management information and GPS-sourced data in one appropriate IT system. The latter are intended especially for the monitoring of high quality rail freight service which are requiring particular care or security.

During the project work it proved to be useful to integrate outcomes of the related project activity on GPS-based tracking and tracing into one common system, being able to supply the required real time information to the customer independent from its sourcing (terrestrial or GPS).

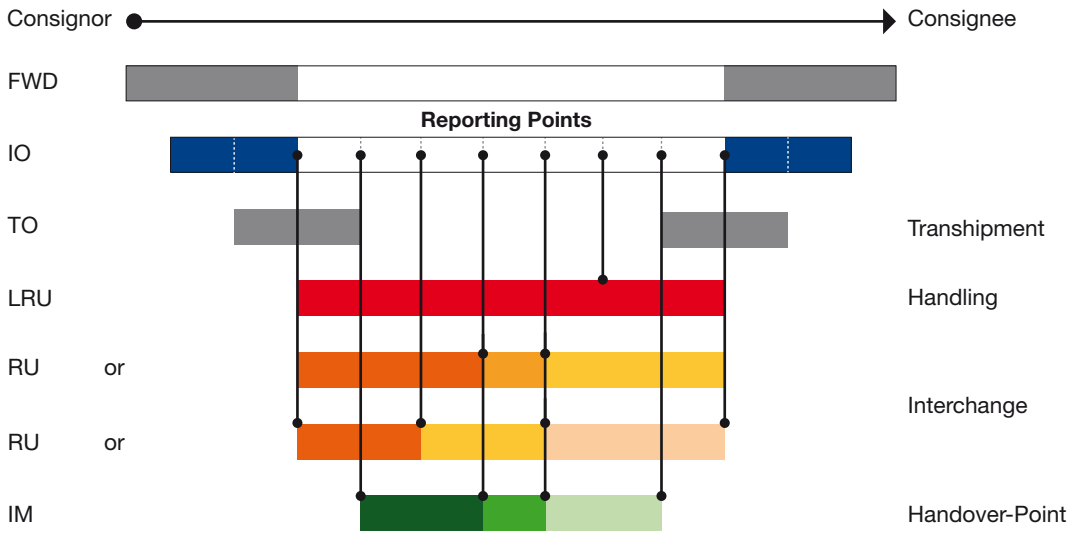
General requirements

In a first step, general requirements regarding rail transport related information and data exchange methods have been defined by the CREAM partners. This includes user requirements of the rail freight customers (especially intermodal operators), obligations with respect to the TAF-TSI[1,2] definitions and regulations and necessary adaptations in different regional clusters along the corridor to secure the availability of real-time data from different sources as a major prerequisite for continuous transport monitoring.

In practice, the following specifications have been identified for the development of a joint train monitoring tool:

1. The monitoring of trains follows the business models applied, thus the sharing of responsibilities between the customers (e. g. the intermodal operators), the railway operators and the infrastructure managers.
2. The specifications of such a train monitoring tool are based on the information needs of intermodal operators as main supplier of high quality rail services. Thus such a tool shall provide:
   - real time information on the train position,
   - event-based information e. g. on the delay reasons,
   - an interface for automatically processing data into “in-house” EDP systems,
   - up-to-date information according push principle (minimum every 10 minutes),
   - a calculation function for values of the estimated time of (train) arrival (ETA) and
   - absolutely secure handling of data with respect to user rights.
3. The estimated time of arrival (ETA) is defined as the expected train arrival time at the station where the train run terminates, while the ETA availability is defined as the time in the transshipment terminal, when the loading unit or cargo is expected to be ready to be picked up by truck. In accordance with the stepwise implementation concept the project work has been concentrated on the determination of ETA (arrival) information.
4. The respective interfaces between transport chain partners are defined in the TAF-TSI (see Figure 43). Mandatory reporting points are thus handover, interchange and handling points, but – depending on the length of the intermediate sections (distance and time) – additional reporting points can be agreed upon. Technically, e. g. in Germany and Austria, information at each signalling post can be obtained and processed further.
5. Existing monitoring practices and EDP capabilities have to be considered for cluster-specific data integration from different sources.

1 TAF-TSI: Technical specification for interoperability relating to the telematic applications for freight
2 Commission Regulation (EC) No 62/2006 of 23 December 2005 concerning the technical specification for interoperability relating to the telematic applications for freight subsystem of the trans-European conventional rail system (2005)



FWD = Forwarder; IO = Intermodal Operator; TO = Terminal Operator; LRU = Lead Railway Undertaking; RU = Railway Undertaking; IM = Infrastructure Manager

Figure 43: Reporting points according to TAF-TSI/Data responsibility

Source: BRAVO

Existing train monitoring and communication systems along the CREAM corridor

Train operators are in general responsible for all issues related to operating trains. According to current regulations, they are also the owners of related train tracking & tracing information which is often generated by infrastructure managers' IT control systems. The analysis of existing practices and EDP capabilities of the railway operators concerned shows fundamental differences in the availability of detailed data to be exchanged for international train runs. The involved CREAM partners, however, demonstrated interest in a joint platform for the exchange of information originating from different sources and communicated by different means.

For this reason, the existing systems and monitoring procedures along the CREAM corridor were analysed and evaluated with respect to their possibilities in being exploited for a common international monitoring tool. The analysis was based on the knowledge of the lead contractors for this specific topic, HaCon and Kombiverkehr, as well as data provided by the UIC or gathered by the different partners in the respective countries along the corridor. The investigation of IT systems and monitoring practices was based on some key questions:

1. Is data acquired and compiled manually or automatically?
2. Does the system provide electronic interfaces, specifically to the UIC hosted system Use-IT?
3. What is the distance between reporting points of train run data?

The international train monitoring tool Use-IT of UIC railway operators

The UIC Combined Transport Group (GTC), made up of major European railway operators, established the Use-IT (Uniform System for European Intermodal Tracking and tracing) system (Lambert, 2008)[3] which made it possible to follow combined transport block trains on agreed routes in real time. Use-IT exchanges information via different IT interfaces with existing systems of railway operators and related network operators. Within the FP6 research project BRAVO (2007)[4] it has been proved for the Brenner corridor between Germany, Austria and Italy by a pilot, that the system is also able to distribute information to other partners/ systems in the transport chain. The CREAM partners have concluded, that the Use-IT system is an appropriate basis for the development of a joint international monitoring platform of railway operators along the selected transport corridors, as the system is an already established platform directly usable for GTC member railways and as it fulfils the main requirements as initially agreed upon (such as provision of real time information, electronic interfaces, compliance with TAF-TSI, assurance of data security).

During the project the CREAM partner SZ has developed and implemented an interface for exchange of train running data between their company monitoring systems and Use-IT, thereby transmitting data of trains operating on the Slovenian rail network. However, no further CEE railway joined Use-IT for technical and commercial reasons[5]. For the monitoring of trains of the connected railway operators in Germany, Austria, Italy and Slovenia, the Use-IT system serves as data source for the intermodal operator monitoring system Train Monitor.

Train Monitor

Train Monitor is a web-based software system for the monitoring of train movements, developed by HaCon. It is well suited for being used on the entire transport corridor considered by CREAM. Train Monitor has been adapted to the specific needs of the intermodal transport operator Kombiverkehr and integrates information on process steps connected with train handlings inside the transshipment terminals. However, thanks to the modular system architecture it can easily be adapted for other operators and railway companies.

During the project period the system has been piloted and introduced at Kombiverkehr, granting access to specific information/trains to their partners such as new-entrant railway operator Lokomotion (e. g. for the route Munich – Ljubljana) and the cooperating intermodal operator Adria Kombi (for the route Ljubljana – Halkali). For demonstration and testing purposes the system was also opened for all interested parties in- and outside CREAM to view the system for a limited time period.

Train Monitor EDI concept

The EDI concept is based on the idea of integrating train operation data from different sources in one system. It is thereby making use of train operation data, received from other IT systems of infrastructure operators and train operators, GPS tracking data of locomotives or waggons and data manually entered into the Train Monitor system. With the GPS2train function locomotive and waggon related GPS data is allocated to train runs.

Data from all described sources are stored in a central train run database. This database provides all information needed for the real time transport monitoring, for ex-post transport monitoring and for statistical calculations to determine the estimated time of arrival.

3 Lambert, E. (2008), Presentation on Use-IT (Uniform System for European Intermodal Tracking and tracing), Prague, 06 March 2008

4 BRAVO (2007), Brenner Rail Freight Action Strategy Aimed At Achieving A Sustainable Increase Of Intermodal Transport Volume By Enhancing Quality, Efficiency And System Technologies, EC co-funded project (FP 6)

5 Meanwhile Rail Net Europe has developed an improved IT system for international train monitoring: RNE Train Information System (Formerly: Europtirails)

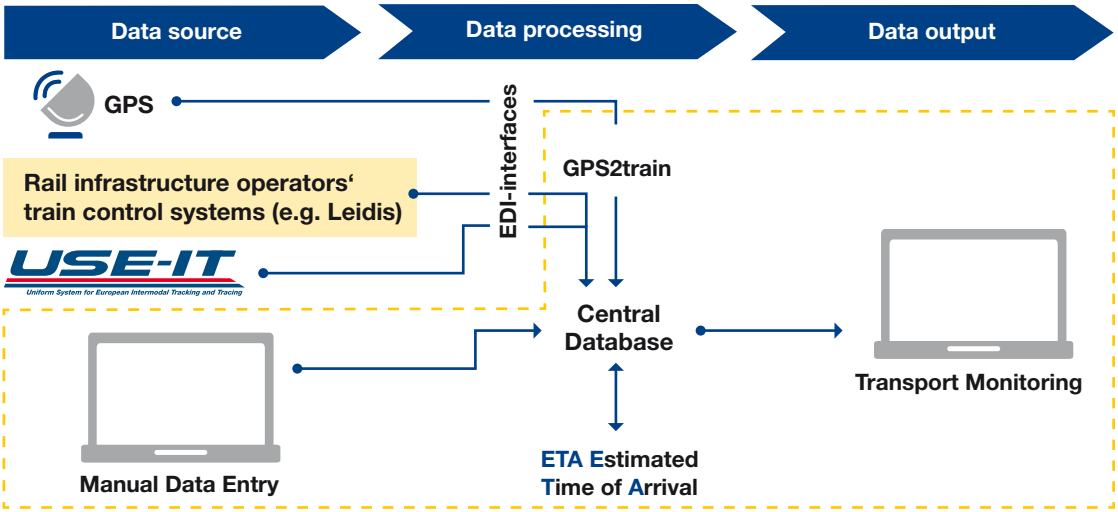


Figure 44: Train Monitoring EDI concept

Data sources/interfaces

Train Monitor integrates train operation data from all possible sources. In this context three types of sources can be distinguished:

1. Other IT systems: data transmission to Train Monitor via standardised EDI interfaces (e. g. according UIC leaflet 407-1) (UIC, 2009)[6] ; in general data transfer is done by using the http transfer protocol.

   Interfaces to the following systems have been demonstrated within the project:

   – LeiDis (DB Netz, Germany)

   – Aramis (ÖBB, Austria)

   – Use-IT (GTC railway operators DB Schenker Rail, RCA, Trenitalia and SZ)

2. GPS: Information from GPS devices is sent to a GPS communication server in the GPS-specific NavXML format and transferred to Train Monitor via appropriate EDI interfaces in XML data format.

   Interfaces have been realised for data generated by the newly developed "CREAM generation" NavMaster GPS devices of Eureka which are attached to waggons (Kombiverkehr/Adria Kombi) or locomotives (DB Schenker Rail Bulgaria and Romania). Waggon and locomotive related data is translated to train tracking information.

   For optimal processing of GPS data, messages are linked to stations.

3. Manual data entry: In addition to the data received via electronic interfaces, the system provides user interfaces to enter data directly into the system. Such data can be train operation data e. g. at border crossing stations or data related to terminal processes conducted before train departure or after train arrival.

Optimal for monitoring high quality train services is the usage of data from infrastructure operators' control systems as these systems in general provide updated real time data in relatively short time intervals. As one of the first IT systems Train Monitor was served by interfaces for Austrian (Aramis) and German (LeiDis) networks. It thereby receives standardised messages of type 2002 "running advice" according to UIC leaflet 407-1.

6 UIC Leaflet 407-1 (2009), Standardised data exchange for the execution of train operations, including international punctuality analysis

Estimated Time of Arrival (ETA)

The estimated time of arrival will be determined by making use of statistical data on already terminated train runs. On this basis, an ETA formula has been developed which is taking into account the statistical distribution of remaining trip times to defined destination points and stations and further conditions e.g. the current delay. The ETA calculation can be regarded as a black box; modifications in the ETA formula can easily be adapted.

Train Monitor modules

Train Monitor consists of three functional modules: RealTime for tracking and tracing of currently running trains, HIM (HAFAS Information Manager) for exchanging additional operational information and File&View to store data appropriately and to exploit this data for ex-post analysis purposes (cp. Figure 45).

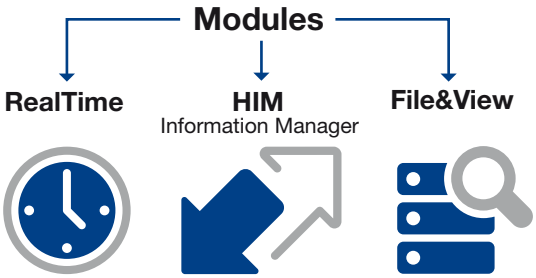


Figure 45: Train Monitor modules Source: HaCon

Tracking & tracing module (RealTime)

The RealTime module compiles and displays all data, received from different data sources, needed to track international train runs in real time. Different viewing options (screens) – all of them refreshed automatically every minute – are provided to support the staff in the transport monitoring and dispatching centres according to their individual needs:

With the train overview table clearly arranged information on the status of the current train operations is provided. This table basically contains information which identifies the train (train number, departure/arrival station, date of planned departure), indicates the current status (last message point, time, delay) and gives an estimation on the arrival time at the final destination (ETA). The train overview can be configured individually by a train filter or a column sorting function.

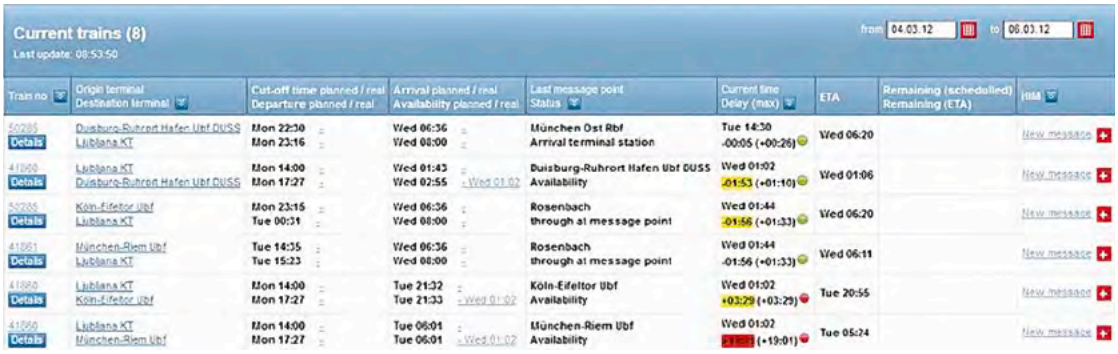


Figure 46: Train Monitor: train overview Source: HaCon/Kombiverkehr

Another viewing option is the map view (see Figure 47), which shows the current position of all trains listed in the tabular train overview on a map. This is done by linking train run messages for stations with corresponding station reference codes. It is further possible to zoom in and out to follow specific train movements or to get a better overview on the overall operational situation. Trains are displayed by train numbers; a tooltip shows further information on the served relation and the current deviation from the timetable.

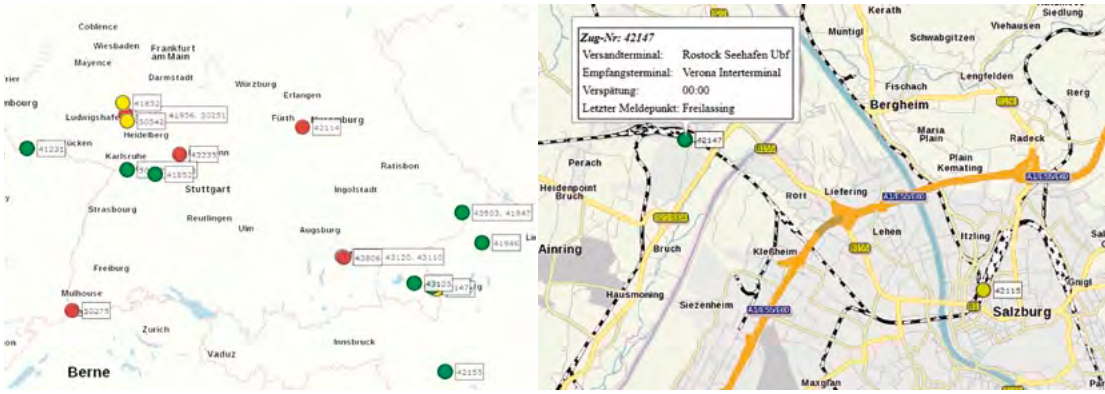


Figure 47: Train Monitor: map view

Source: HaCon/Kombiverkehr
Map data © PTV

Arrival boards of selected terminals (cp. Figure 48) show status information of the trains (on the way, arrived, train ready for unloading) and relevant terminal times e. g. on the planned, estimated and actual availability of the loading units for unloading. With this information it is possible to optimally dispatch the trucks for the last-mile operations.

Terminals

DE Ludwigshafen (Rh) BASF Ubf — Close — Full screen — Delete

Status	Train no	Origin terminal	Arrival (planned)	Train availability (planned)	Status	Last message point	Delay	HM
	41211	Bayonne C.E.F. Intermodal	01:31	02:15	arrived	Saarbrücken Rbf Nord	+08:28	
	41201	Irún	01:31	02:15	arrived	Ludwigshafen (Rhein) BASF Ubf	-00:30	
	50216	München-Riem Ubf	02:36	03:15	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	50215	Duisburg-Ruhrort Hafen Ubf DUSS	02:36	03:15	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	50221	Hamburg-Billwerder Ubf	04:11	04:45	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	50231	Dörpen Ubf	04:34	05:15	arrived	Ludwigshafen (Rhein) BASF Ubf	+04:57	
	50231	Coevorden BE	04:34	05:15	arrived	Ludwigshafen (Rhein) BASF Ubf	+04:57	
	42134	Verona Quadrante Europa	05:29	06:00	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	41255	Port Bou	06:01	07:00	arrived	Ludwigshafen (Rhein) BASF Ubf	+00:37	
	43086	Busto Arsizio (Gallarate)	08:08	09:00	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	50249	Lübeck-Skandinavienkai Ubf	09:28	10:30	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		
	41956	Wels Vbf CCT	10:56	11:30	Train ready for unloading	Ludwigshafen (Rh) BASF Ubf		

Figure 48: Train Monitor: terminal arrival board

Source: HaCon/Kombiverkehr

Information management module (HAFAS Information Manager HIM)

In addition to the simple tracking of train movements, the system offers a platform for exchanging further train information with the HAFAS Information Manager HIM. For the first time, rail transport providers can access all relevant operating data using just one software system. The new system helps to keep an overview also in difficult operating situations. This allows operators to achieve competitive transport times with an optimal use of resources. Should there, however, be a deviation, their customers will be informed reliably and even earlier with support from Train Monitor.

Information to be exchanged with the support of the HIM module can be events relevant for operating a train such as irregularities or waggon detachments. New entries (events) are generated by filling a graphical entry form. This entry will be stored in the database and afterwards published through different distribution channels which are Train Monitor itself (display in RealTime train overview), notifications to recipients e. g. via email and interfaces to other IT systems.

Statistics module (File&View)

All data on already operated trains is stored in a data base. On this basis it is possible to analyse already operated train runs in detail and to generate individual quality statistics. Quality statistics can be generated for different trains operating on one route.

Conclusions

To improve the information level needed for ensuring high quality rail transport on international transport links, a new IT system "Train Monitor" has been developed and implemented. This system can be regarded as a virtual rail transport management centre, connecting all relevant partners.

Train Monitor is a web-based software system for the monitoring of train movements. Train Monitor has been adapted to the specific needs of the intermodal transport operator Kombiverkehr and integrates operating information from the transshipment terminals. However, thanks to the modular system architecture it can easily be adapted for other operators and railway companies. The system is composed of the three modules: RealTime (tracing current train movements), HIM (exchange of information on irregularities and waggon detachments) and File&View (train run data storage & statistics). Besides this, the system enables a multi-client access, backs on a sophisticated user access management for keeping secured data confidential and supports a number of languages (e. g. German, English, Italian, Slovenian, …).

Train Monitor thereby exhibits all relevant characteristics for being used on the entire transport corridor considered by CREAM.

Innovative transshipment system for conventional semi-trailers "ISU"

More than 85 % of the semi-trailers operated on the routes between Western Europe and Southeast Europe are standard road semi-trailers. Since January 2011 ÖKOMBI – a company within the Rail Cargo Austria Group – offers an ecological alternative to the single mode long-distance truck transports: a regular, intermodal block train service between Wels (Austria) and Curtici (Railport Arad, Romania), also called ISU Sprinter. This train service backs up on the ISU technology, which facilitates the transshipment of semi-trailers that are not equipped for crane handlings. Within the framework of CREAM the system has been continuously improved, demonstrated and finally put into operation.

In Southeast Europe the dominating road transport equipment are semi-trailers, which are for the most part not specifically equipped for intermodal transport. In order to attract these transport flows to rail transport an innovative intermodal concept has been improved, implemented and operationally validated.

The innovative transshipment system for conventional road-only semi-trailers abbreviated "ISU" after its German name "Innovativer Sattelanhänger Umschlag" was already designed and tested within the FP6 project BRAVO. It was decided to continue the work with a market survey that shows potential routings in particular in Southeast Europe, the technical development of the loading equipment and the realisation of pilot trains within the scope of CREAM.

The main technical and operational advantage of the ISU system is that it can be integrated into the existing intermodal transport system without major changes, neither to the processes nor to the equipment. By this evolution of the intermodal transport system, road-only hauliers and those with mixed fleets can be attracted to intermodal transport without further investments on their side.

The ISU components

The basic ISU components are wheel grippers (cp. Figure 49) that are able to support each wheel of the semi-trailer and a cross beam (cp. Figure 51) that locks the king-pin of the respective semi-trailer, thus only ordinary and available parts of the loading unit are used for handling operations.

To bring the grippers and the cross beam into the right position for handling, the semi-trailer has to pass a loading platform (cp. Figure 50) that is either laid out on the ground (with the option to move it inside the terminal or between terminals) or is built permanently into the ground in case of transport relations being served steadily over a longer period. The loading platform can be used in either direction and is designed in such a way that ordinary road trucks can pull (or push) the semi-trailer onto the platform.

Figure 49: ISU equipment: wheel grippers

Figure 50: ISU equipment: loading platform prepared for truck/trailer

Figure 51: ISU equipment: cross beam under king pin

Figure 52: ISU loading platform and ropes connected to the crane spreader

In order to lift a semi-trailer from the platform onto the pocket waggon or from the waggon onto the platform, a rope-equipped auxiliary frame (cp. Figure 52) is connected to an ordinary intermodal spreader using the twist locks. On the one hand the ropes are strong enough for carrying the capacity of fully loaded semi-trailers. On the other hand they are flexible and protected to be mounted to the grippers and beam without damaging the tarpaulin or side walls of the semi-trailers.

Commonly available waggon types designed for "Megatrailers" (this is a special European configuration of semi-trailers with an extended internal height of three metres) such as the T3000, the T5 and the TWIN waggon can be used for the ISU technology with only minor adaptations that can be performed "on-site". The new technical components are focused on the terminal not on the waggon. Without large infrastructure investments the ISU components can be installed in any existing intermodal terminal. The basic working procedures within the terminals do not have to be changed. The components can easily be transported between terminals if the desired transport relations are changing. A further "automation" of the processes – including a connection to the crane management system – would be possible.

The ISU loading process

A typical loading process – which can be carried out by gantry crane or reach stacker – consists of the following steps:

1. The grippers and cross beam are positioned in the ISU ramp (either from the last "unloading" process or as an empty lift from the waggon), waiting for the terminal tractor or road truck to pull (or push) the semi-trailer on it.
2. Once the semi-trailer is positioned on the ramp with the grippers under the wheels, the handling device lifts the cross beam and a ground man assists its inauguration into the king-pin.
3. After the king-pin is fixed, the lift is continued and the entire semi-trailer is lifted to the next (empty) waggon.
4. There it is lowered to the loading platform and the ground men release the locking between the grippers/beam and the ropes.
5. Afterwards, the handling device travels to the next (loaded) waggon and lifts the semi-trailers in the opposite direction.

Terminal simulation and field tests

A simulation based on the process description and real time data depicted from multiple test loading procedures was carried out by NTUA in order to validate different layout options and operational scenarios with respect to the optimum procedures.

The test results and the simulation showed that loading with reach stackers (as it is performed in Wels or Halkali) is generally possible, but less efficient compared to gantry crane operations (as it is performed in Vienna, Wels or Stara Zagora) in particular due to the smaller speed when travelling within the terminal to reach the next available waggon from the loading platform. The duration of a typical handling is about 5–6 minutes and said to be optimised with trained employees after they have gathered some experience with the equipment.

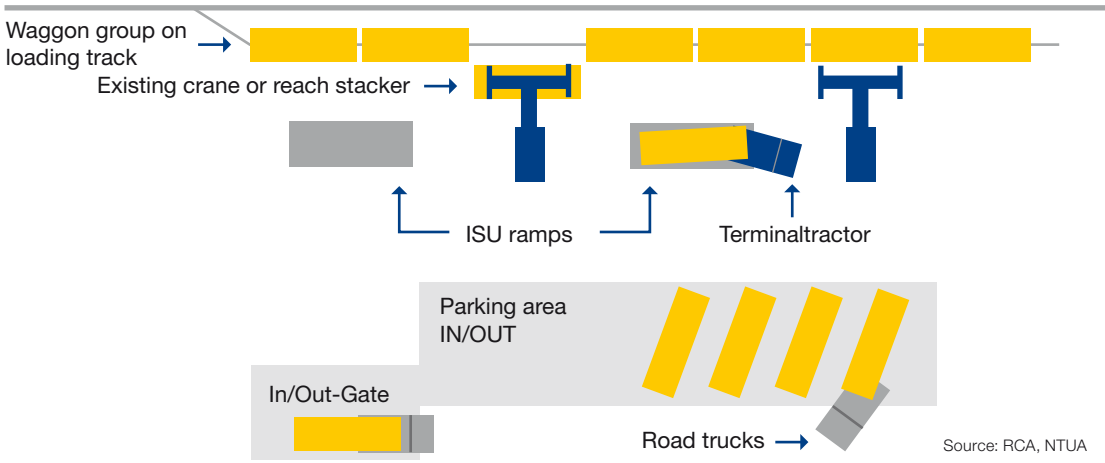


Figure 53: Potential terminal layout for ISU transshipment operations

Figure 54: ISU test transshipment in Istanbul-Halkali (November 2009)

Figure 55: ISU test transshipment in Stara Zagora (June 2010)

Conclusions

While the technical and operational capability could be demonstrated, the pilot trains performed between Wels (Austria) on the one hand and Halkali/Istanbul (Turkey), Stara Zagora (Bulgaria) and Curtici (Railport Arad, Romania) on the other hand had "usual" problems at border stations and the punctuality could only be increased after RCA organised the entire traction on their own. The feedback from the market to both RCA and Ökombi was quite positive and has encouraged the two companies to continue the development in the technical direction (automated spreader) and commercial direction (identifying terminal-to-terminal relations where the ISU system could by applied either as a dedicated train or a mixed train with intermodal-fitted semi-trailers, swap bodies and containers).

In 2011, the ISU system finally has proved its commercial feasibility as part of the regular intermodal rail connection between Wels (Austria) and Curtici (Railport Arad, Romania), running with up to two departures per week and direction.

Rail Cargo Austria/Ökombi: driving forces for the ISU system

The business unit "Terminal Services" of Rail Cargo Austria AG (RCA), Austria's leading rail carrier and logistics service provider, was the main driver in the technical development of the ISU transport system. RCA was also responsible for conducting test loadings and field operational tests. RCA, jointly with Ökombi GmbH as an intermodal operator, is developing commercial transport offers, making use of the ISU system. RCA operates eight intermodal terminals in Austria. Ökombi is the largest provider of accompanied combined transport services in Austria.

www.railcargo.at

Rail Cargo Austria
Ein Unternehmen der ÖBB

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ÖKOMBI
Rail Cargo Austria Group

Intermodal semi-trailer for glass loads "FLOATRAILER"

Opening up the market of plate glass for intermodal transport: this was another issue treated by CREAM. The project partners conducted related market studies and analysed the framework conditions going along with capturing this kind of transport. They also outlined a technical solution, which foresees to adjust semi-trailers specialised in plate glass transport and to retrofit them for combined road-rail transports. Based on the concept developed by the German forwarding company Offergeld, a prototype semi-trailer has been designed, built and demonstrated within the framework of the CREAM project.

The transport of plate glass requires fast, efficient and weather-protected (covered) loading and unloading between storing facilities and trucks. The inloader design (German: Innenlader), developed in the 1970s, responded to these needs. That time the Offergeld group was one of the first companies using such special semi-trailers for their road transports. The CREAM project activity on developing and building a customised semi-trailer for unaccompanied intermodal transport of plate glass was conducted under the lead of Offergeld which involved the trailer manufacturer Faymonville and was supported by Kombiverkehr.

Technical concept

At project start a number of design goals and principles were defined, to be taken into account for the development of a new semi-trailer for glass loads, which is also capable of intermodal transport:

- Design a new weight-optimised modern glass frame (the L-frame)
- Ensure suitability for road-rail transport on all modern pocket waggons on European rail networks
- Use standard components
- Replace expensive single-wheel suspension
- Include new braking and suspension control systems
- Increase torsion stiffness
- Reduce weight of the unit and the frame to optimise payload capacity

In addition, due to basic needs such as the ability of carrying heavy loads with a high centre of gravity and the ability to self-load and unload a full frame with glass, a completely new set of forces had to be taken into consideration when developing the new design.

Source: CREAM/ Offergeld

Figure 56: "FLOATRAILER" design

The new trailer design contained also some of the original inloader features. In particular the L-frame, carrying the load, was integrated in the new concept and re-designed: its angle has been changed to allow a better weight distribution. In comparison, the conventional design does not optimise an equal left-right weight distribution at increased loads. In addition, the new L-frame design is better integrated into the overall trailer/frame configuration to allow improved weight reductions. Finally, the relevant design targets were met and the intermodal plate glass trailer prototype was completed mid 2010.

Testing and presenting the prototype FLOATRAILER

On 8 September 2010 in Genk (Belgium) and only four days later in Worms (Germany), test loadings were carried out with different waggon types (TWIN and T 3000) and handling equipment (gantry crane and reach stacker) to demonstrate railway officials the compliance with the intermodal P359 gauge. Finally, the official codification plate has been granted that allows the FLOATRAILER to run on rail lines in Europe with the same or higher code class.

Figure 57: FLOATRAILER test loading by reach stacker (Genk, 8 Sep 2010)

Figure 58: FLOATRAILER test loading by gantry crane (Worms, 12 Sep 2010)

The weight tests to determine the load per tyre at almost maximum total weight were performed successfully and showed the wanted result.

As a result, the concept and pictures were presented to the railway community during “Innotrans” exhibition and congress in Berlin on 22 September 2010. Also in September 2010, the glass industry and logistics “family” saw the FLOATRAILER prototype for the first time during the Glasstec trade fair for glass production, processing and products in Düsseldorf. Finally, the participants of the CREAM conference had the opportunity to view the prototype itself on 4 November 2010 in Brussels.

Figure 59: FLOATRAILER interior/presentation during CREAM conference

CREAM

Figure 60: FLOATRAILER at CREAM conference in front of the Royal Academy of Belgium

Conclusions and outlook

The weight comparison between today's "road only" inloader and the new FLOATRAILER demonstrates its main advantages: in intermodal traffic about 26.75 tonnes of net glass can be transported compared to 22.5 tonnes for one mode road transports.

The next step towards a commercial usage is to perform test runs between different intermodal terminals to experience the acceptance by the terminals' crew and the behaviour during rail transport. These have already been started e.g. on the connection between Bettembourg (Luxembourg) and Le Boulou (France) and will be extended in 2012.

Already during the CREAM project time, a second trailer manufacturer, the German company Langendorf, built an inloader which is equipped for crane handlings and can be used in European wide rail transport, too.

The success story written during the CREAM project is therefore the continuation of the inloader concept that became necessary in the early 70s when the glass manufactures started commercialising the "jumbo size" glass plates (6.00 x 3.21 meters). It further demonstrates that "going the intermodal way" is possible for almost all commodities.

Dual-power locomotive concept “FUTURA”

The use of diesel locomotives for long haul rail services has been popular for some years now. This became problematic when the fuel prices started to incline dramatically and it is expected that they will grow even further in the future. Many customers therefore feel the demand for dual propulsion locomotives – whereby they want to use electric power for long haulage and thermal energy for sections without overhead wires as well as pre- and post-haulage – without having to maintain multiple railway traction units at various places in Europe. For environmental reasons, many European communities tend to forbid combustion driven locomotives in their cities, too. In 2008, Voith projected to design and test a dual propulsion locomotive – with sustainability issues in mind.

A detailed analysis of the locomotive market shows that approximately 1,200 mainline diesel locomotives are used for domestic and cross-border traffic only in Germany. These internal combustion engine traction units (with power ranging between 1,800 and 3,200 kW) are frequently used in point-to-point traffic; the diesel locomotive achieves independence from the different power supplies and above all from the need to use additional diesel traction at the end of line terminal points which are not electrified in most cases. A large part of the network is electrified – sometimes for historical reasons, occasionally due to performance requirements and frequently for political reasons. Electrification has been on the increase again for the last two years, with dedicated expansion programmes in place.

The gap between the energy costs for diesel and electrical traction has grown over the last five years: At the beginning of 2008, the energy costs per kilometre for a 1,300 t freight train were approximately € 5 for 4 – 5 l diesel and approximately, € 1.70 for 15 – 17 kWh (15 % recuperation taken into account).

Two of the major locomotive leasing companies and Deutsche Bahn estimate that between 60 % to 75 % of track and significantly more than 80 % of the required power for a train journey in some cases is covered by diesel locomotives “under” catenary wire, making electrical traction a possibility, albeit an expensive one.

Development objectives

In March 2009, Voith started to develop a dual-propulsion locomotive that should be able to haul a full freight train in both electrical and thermal traction mode. Elaborating the technical design for such a locomotive is an ambitious project, considering the complexity within the vehicle, the operating conditions when switching between electrical and thermal traction and the homologation procedures in conformity with EU regulations. Having in mind the limited time frame and limited financial resources of a research project such as CREAM, Voith opted for a step-by-step approach. In a first step a detailed technical concept was elaborated and presented in late 2009. On this basis Voith started to build a test carrier which should be used for comprehensive technical tests. The test results would be exploited for the later construction of a prototype. The plans for the test carrier were based on a generally approved locomotive, which had to be converted into a test vehicle. In a further step the required drive technology should be fitted into the existing vehicle. The “Futura Concept” test vehicle and the aimed at serial locomotive was planned with the following technical parameters (cp. Figure 61).

Unit	Dimension	Futura Concept	Futura Serial Locomotive
Operating mass	t	126	120–132
Maximum speed	km/h	120	160
Traction effort	kN	410	450
Engine power	kW	4,400 electric 1,200 diesel	5,600 electric 1,450 diesel
Electricity supply		15 kV 16.7 Hz	15 kV 16.7 Hz 25 kV 50 Hz
Wheelset arrangement		Co'Co'	Co'Co'
Power transmission		AC/AC – single axle control with slip control	AC/AC – single axle control with slip control
Dynamic brake power	kW	4,400	5,600
Homologation			in European countries

Figure 61: Planned technical characteristics of dual-power locomotive

Source: CREAM/Voith

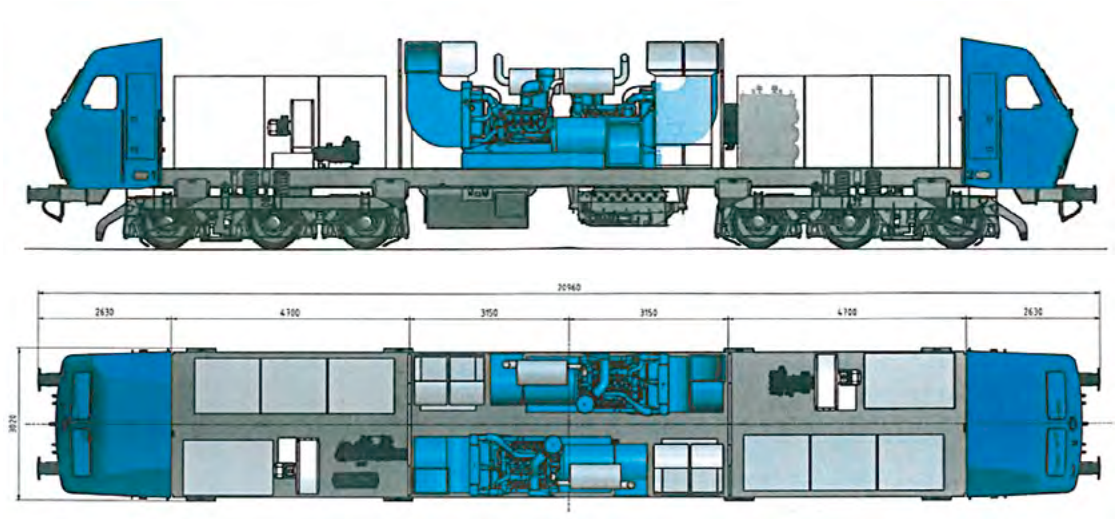


Figure 62: Conceptual design of dual-power locomotive

Source: CREAM/Voith

Development results

The first part of the test carrier had been substantially completed. The basic locomotive (DE 1024) was purchased in August 2009 by Voith Turbo Lokomotivtechnik and since then has been overhauled and converted. In addition, a sub-assembly layout/arrangement has been prepared in various stages of detail with reference to this test vehicle and to the later prototype. The status in August 2010 was that there is a locomotive with a fully modified chassis and converted body, painted in the EU-CREAM livery.

Figure 63: Test carrier of dual-power locomotive

The implementation of the second step, which was the installation of the drive technology, has encountered unforeseeable difficulties.

Contrary to the initial and justified expectations, Voith Turbo Austria, specialised in drive systems, was unable to manufacture an inverter for a locomotive capable of meeting the technical requirements of this project. Consequently, Voith looked for alternative sources to purchase such an inverter. However, it became clear that none of the approached companies was prepared to supply Voith with the core parts of the electrical equipment free of restrictions and under realistic terms. As a consequence, essential parts and the test vehicle as a whole could not be designed or built.

Outlook

In view of these insuperable difficulties, Voith did not see any realistic chance of continuing and concluding the development of the "Futura" dual-power serial locomotive. In the meantime, the manufacturer Bombardier has delivered a test carrier of a dual propulsion locomotive for passenger transport that demonstrates the general need of the initial concept.

New and improved rail freight transport offers

"String of Pearls" network of open intermodal rail services

Improving the rail freight system on the transport corridors between Western and Southeast Europe and subsequently generating more volumes for the environmental friendly rail transport – these were the main operative goals of CREAM. Therefore, the CREAM consortium integrated main players of the transport business on this axis, which on the one hand supported each other in finding new technological solutions and on the other hand ran services, each in their own responsibility.

A core component of CREAM was the development of an efficient rail operation system for intermodal services that should be able to reconcile various transport flows along the selected corridor between the Benelux countries on the one side and Turkey and Greece on the other. During the project the system had been developed and continuously extended according to the so-called "String of Pearls" concept. Finally, at the end of 2010, the resulting CREAM network is composed of numerous open, unaccompanied intermodal rail services as it is displayed in Figure 64. The "String of Pearls" concept is characterised by the following elements:

- **The Strings:** combination of existing and new open shuttle train services, developed on basis of dedicated service extension axes;
- **The Pearls:** consolidation points (gateway or hub terminals), enabling bundling and reconciliation of various transport flows;
- The **"Strings"** linking the **"Pearls":** an efficient rail operation system for intermodal services on the corridor or on parts of it.

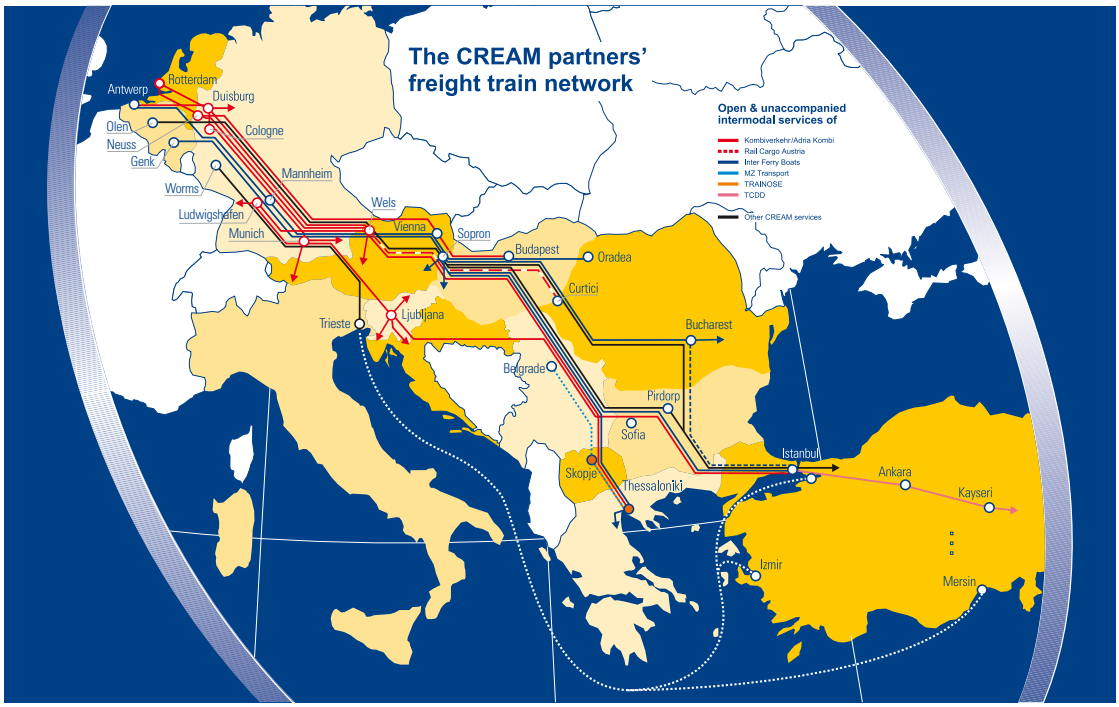


Figure 64: CREAM networks of open and unaccompanied intermodal rail services (status 11/2010)

The motivation to develop this "String of Pearls" concept is based on different factors:

1. The expected growth of trade and goods transport on the CREAM corridor will provide a sufficient potential of freight volumes to feed a network of intermodal road-rail transport services.
2. Several partners had already experiences in operating long-distance trains on the CREAM corridor. Thus, they recognised the chances and strengths that such a new concept would offer, being also aware of the challenges they had to cope with when building up this concept.

In the following, several successfully implemented open and unaccompanied intermodal rail connections of CREAM project partners that form the "String of Pearls" network are highlighted. Open services hereby mean intermodal rail services that are offered by intermodal operators to multiple customers such as forwarders and other transport operators.

IFB network expansions towards Southeast Europe

CREAM partner IFB, an independent member of SNCB Logistics and specialised in intermodal transport all over Europe, invested significantly in the development and extension of its rail network towards Southeast Europe during the lifetime of CREAM. To achieve and maintain a high quality level for their customers, IFB operates its corridor trains with local operational and commercial assistance. Within the project, IFB was focussing on two relations: Antwerp – Sopron and Genk – Oradea.

Antwerp – Cologne – Vienna – Sopron, the gateway to Germany, Austria and Southeast Europe: In March 2010, IFB started a new connection between Antwerp (terminals Mainhub and Combinant) and Sopron (Hungary) with stops in Cologne and Vienna and further antennas in Austria. At the moment, IFB operates three connections per week (departure on Monday, Wednesday and Friday), but it is intended to increase the frequency to a daily departure as soon as possible. The stops in Cologne and Vienna offer the possibility to serve also customers in Germany and Austria.

From the start of the service in March 2010 until December 2010, in total 145 trains were operated, making a modal shift of over 144 million tkm possible. That means environmental and social benefits of about 2.9 million euros and 9.7 million kg of air pollution emission that were avoided[1].

Genk – Oradea (Romania) via hub Sopron (Hungary), the connection towards the Balkans/Southeast Europe: Next to the aforementioned new rail connection from Antwerp to Sopron, the IFB original direct rail link between Genk and Oradea was modified by integrating a stop in Sopron since February 2010. The Genk-Oradea connection, covering a distance of over 1,600 km, originally started in 2006 by IFB predecessor TRW as Trans-Romanian Express "T-REX". In the hub terminal Sopron the units can be loaded or unloaded to serve the regions of Vienna, Bratislava and Budapest or transferred to linked rail connections towards the whole Balkan area. This means an important boost for the whole West-Eastern axis and permits IFB to serve the customers for the regions of:

- Budapest, Székesfehérvár and other terminals in Hungary,
- Bulgaria (Poduyane, Ruse, Stara Zagora),
- Greece (Thessaloniki, Inoi, Athens),
- F.Y.R. of Macedonia (Skopje),
- Austria (Vienna, Graz, Villach),
- Romania (Arad, Oradea, Curtici, Bucharest) and
- Turkey (Halkali).

As the three weekly departures (from Genk on Tuesday, Friday and Saturday) are already completely booked, the frequency shall be increased to four departures per week. To fulfil the customer-oriented quality approach, the Genk – Oradea features GPS-Monitoring, continuous quality management with regular organised quality groups and offers the customers unique value added services. At the end of 2011, the connections from and to Romania moved to the Railport Arad, a new terminal built near the Hungarian-Romanian border just next to Curtici border station.

1 According to Marco Polo specifications and BMVBS, German Ministry of Transport calculation methods

The qualitative network represents a direct access to more than 20 destinations in Middle and Southeast Europe and means an important competitive advantage for IFB. As a result of IFB's activities, more than 990 trains of IFB have been running during the lifetime of the project from 2007 until 2010, making a shift of over 900 million tkm possible. This leads to a benefit of over 18 million euros environmental and social benefits, corresponding to over 60.2 million kg of avoided air pollution emission[2].

The "Bosporus-Europe-Express" Ljubljana – Halkali

The "Bosporus-Europe-Express" (BEEX), implemented by Europe Intermodal, a joint venture of Kombiverkehr and Adria Kombi, integrates Halkali, Istanbul's largest container terminal, into the European block train network of both operators. At the start-up on 30 March 2008, the frequency of the first commercial trains initially was once a week in both directions between Ljubljana (Slovenia) and Halkali, providing a continuous connection of five to seven days transit time between Turkey and Western Europe, depending on the final destination. The joint use of the gateway systems of Kombiverkehr and Adria Kombi, a combination of domestic and international trains, delivers considerable benefits for the haulage industry.

Main gateway terminals or hubs are Ljubljana and Munich (Germany). Ljubljana offers connections from and to Slovenia, Hungary, Austria and even North Italy. Munich is connected with Ljubljana via shuttle train service and three departures per week ("Adria Express") at the start-up, providing connections to other terminals in Germany as well as to further Northern and Western destinations such as Rotterdam or Antwerp. Thus, the ARA-ports, Germany, Slovenia and Turkey are well connected by this service.

Figure 65: Intermodal train on the way across the Alps

2 According to Marco Polo specifications and BMVBS, German Ministry of Transport calculation methods

In 2008, the frequency of the Ljubljana – Halkali shuttle train service could be increased to two departures per week in both directions. In order to further raise the attractiveness to customers and the quality standard on operational level the CREAM partner SZ (Slovenian state railway undertaking) and their traction partners managed to realise enormous service improvements. Being object of a demonstration trip in March 2009, which had covered the distance between Ljubljana and Halkali in only 35 hours, considerable service improvements could be transferred into regular operation. With the timetable change in December 2009, the regular transit time could be reduced from 60 to only 45 hours – which is faster than a truck. Rail operation across four borders and over a distance of 1,545 km is a complex business. To keep control, a GPS monitoring has been introduced within the CREAM project. Further improvement steps are agreed in a quality group which meets on a regular basis. To maintain and further extend the service quality, the partners implemented a dedicated quality manual in 2010. "This manual will secure smooth operations at the interfaces of borders and terminals – the key for competitive transport times", says Igor Hribar, Sales and Marketing Advisor of Slovenian Railways SZ.

"This manual will secure smooth operations at the interfaces of borders and terminals – the key for competitive transport times."

Igor Hribar, Slovenian Railways SZ

"With this new concept we are able to provide higher flexibility and faster transit times for transports between the Rhine/ Ruhr area and Southeast Europe."

Ulrich Bedacht, product manager Southeast Europe, Kombiverkehr.

Since February 2010, Kombiverkehr and its Slovenian intermodal partner Adria Kombi have therefore increased the capacity of the route Ljubljana – Munich from three to five weekly departures in each direction and extended the service from Ljubljana to Duisburg and Cologne with also five departures and only an operational stop in Munich East (München Ost), thereby enormously relieving the Munich-Riem terminal bottleneck. In Munich East, only a group of waggons with local shipments will be attached or released. The direct train Ljubljana – Halkali meanwhile was increased to three departures accordingly. Through these changes the transit time was shortened to only four days on many routes, depending on the final destination.

"With this new concept we are able to provide higher flexibility and faster transit times for transports between the Rhine/Ruhr area and Southeast Europe", explains Ulrich Bedacht, product manager Southeast Europe at Kombiverkehr.

From the start of the service in March 2008 until December 2010, in total over 350 trains were operated between Ljubljana and Halkali, making a modal shift of over 272 million tkm possible on that particular route and even a modal shift of over 420 million tkm, if rail pre and on carriages are also considered in the calculation. Those 272 million tkm shifted from road to rail lead to environmental and social benefits of over 5.4 million euros and 18.3 million kg of air pollution emission that were avoided[3].

3 According to Marco Polo specifications and BMVBS, German Ministry of Transport calculation methods

Integrating Rotterdam and the Betuweroute into the CREAM service network

The outstanding correlation between the various technical and operational innovations developed within CREAM shows splendidly the integration of the Betuweroute into the CREAM service network.

But first things first: Due to poor quality with permanent and significant delays from the former traction provider on the route Rotterdam – Duisburg, in 2007 Kombiverkehr opted to activate its own railway license and to run this service not only as an intermodal operator but also as a railway undertaking in cooperation with Rotterdam Rail Feeding (RRF). The first train from Rotterdam (RSC terminal) to Duisburg (Ruhrort Hafen DUSS terminal) under Kombiverkehr/RRF responsibility started in October 2007. Immediately, Kombiverkehr was able to increase the punctuality to more than 90 %. In 2008, a cooperation with Europe Container Terminal (ECT) in Rotterdam was started and the terminal was connected not only to Duisburg but also to the Container Terminal Dortmund (CTD). In 2009, Kombiverkehr completed its service package and even started to serve also the DeCeTe terminal in Duisburg, eventually connecting the intermodal terminals Euromax, ECT Maasvlakte and RSC in Rotterdam with the terminals Ruhrort Hafen DUSS and DeCeTe in Duisburg and CTD in Dortmund. The frequency of the services could thereby be extended to daily departures in either direction at that time. This was the start-up of the so-called "Betuwe-Express", now providing efficient gateway connections to further origins/destinations all over Europe, for instance from and to Slovenia and even Turkey. This was made possible by the various routings from and to Duisburg, connecting Ljubljana with a direct shuttle train or with the Munich – Ljubljana service by using Munich as a further hub. Being always keen on enlarging capacity in response to the growing demand on these routes, the frequency of the Rotterdam – Duisburg/Dortmund services could be increased to two daily shuttle trains in either direction.

Since 2010 KombiRail, the new railway undertaking within the Kombiverkehr group, is responsible for conducting rail transport over the entire distance between Germany and the Netherlands. In fact, KombiRail is the 33rd railway undertaking that has received the license for the Netherlands and one of the first companies providing traction services on the new Betuweroute. For these operations own and rented waggons, leased locomotives and hired drivers are used. Thus, Kombiverkehr was one of the pioneers in exploiting the Betuweroute.

Innovative technology makes temperature controlled combined transport possible

Before 2008, when the forwarding company Mainsped, a specialist in international mainline transport between Germany, Italy and Spain, first started to use integrated road-rail transport for sensitive goods, no one would have thought of temperature controlled cargo to be carried on intermodal road-rail services.

However, there was and still is a sharp increase in shipments of goods that need to be transported at specific temperatures. Previously such shipments had bypassed intermodal road-rail transport. New technology could change all that. Kombiverkehr started transporting temperature-controlled goods on trains of its international block train network in April 2008 for their customer Mainsped. "Up to now, there have been no craneable thermo-trailers, whilst rail transport has lacked both in energy supply for refrigeration units and any way of controlling and monitoring temperatures," reported Armin Riedl, managing director of Kombiverkehr, in 2008. "These problems can now be considered as resolved."

The breakthrough came when insulated semi-trailers, equipped for crane handlings, entered the market. In this context Mainsped, in collaboration with Kombiverkehr, successfully ran a six-months field test on behalf of the pharmaceutical group Sanofi-Aventis. "We looked around the marketplace for proven individual components, put them together and came up with a new solution," said Ulrich Banse, managing director of Mainsped.

Figure 66: Transshipment of MAINSPED thermo trailer

The new trailer is equipped with an autonomous power supply for its refrigeration unit and a remote control for monitoring the temperature within the so-called 'Thermokoffer'. "Similar technology has already been tried and tested in Norway, but virtually nothing has been known about it in central Europe and it is now being used in international intermodal road-rail transport for the first time," explained Riedl furthermore. The thermo-unit maintains a constant temperature of between two and eight degrees Celsius inside the trailer, as required by the consignor, and is supplied by its own fuel tank underneath the trailer. The unit also houses a remote data modem which regularly transmits temperature data from the vehicle to the assigned freight forwarder's dispatch team. Not only can the temperature be monitored this way, it can also be regulated by remote control at the same time. It is even possible to adjust temperatures.

Trials conducted between October 2007 and March 2008 subjected consignments of sensitive pharmaceutical goods to and from Italy to a wide variety of climatic conditions, in which the technology proved itself without exception. Since April 2008, as a result of these positive findings, additional Mainsped semi-trailers have been moving temperature-controlled freight from the same customer on trains between Ludwigshafen and Budapest on the CREAM corridor. The capacity of the fuel tank allows the trailers to complete an entire circuit by rail without filling up. Trailers leaving Ludwigshafen on a Monday are unloaded in Budapest in the middle of the week and are back in Ludwigshafen by Friday, without having had to refuel in between. According to Riedl, "Kombiverkehr regularly works with customers to test technical innovations. We are certain that the proven combination from semi-trailer manufacturer Schmitz and refrigeration unit supplier Thermo King provides the breakthrough for temperature-controlled shipments in road-rail combined transport."

The innovative operation concept, developed within the framework of CREAM, is designed to inspire more ways of transporting temperature-controlled freight in the future on the basis of cost-effective, standardised and reliable individual components. Other demonstrators have already started and the CREAM solution is constantly transferred to other services and corridors.

Sofia: A new spot on the intermodal map

Bulgaria has tried to transform from a centrally planned to a well-performing market economy. But only in the last few years it could experience a strong growth. The economy could recover and the industrial basis of the country could be reinforced and extended, when it was coincided and hit by the global economic crisis and domestic structural problems. But even though, Bulgaria has become an attractive asset in Eastern Europe for foreign direct investments.

As concerns intermodal road-rail transport, the main share is made of international and transit traffic, with the latter reaching about 80 % of the total volume in 2007 for instance. This shows that Bulgaria has benefited from the boom of European economy and global trade, e. g. by the enormous growth of traffic from and to Turkey, where in recent years great efforts have been made to shift some of the volumes from road to rail.

During CREAM it was realised that Bulgaria has more potential than catching only transit volumes. The development of the overall intermodal transport system is one of the priorities of Bulgaria's transport programme, supplied by many projects to recommend the con-

struction of terminals starting with Sofia as a hub. Thus, many feasibility studies have been performed for the construction of a terminal in the Sofia region, concluding that the construction of such a terminal in Sofia is an economically and socially sound investment for Bulgaria.

However, in practice the establishment of an efficient transshipment facility for intermodal loading units in the Sofia region seemed to be a matter of years. In consequence, the CREAM partners and further stakeholders, involved in the Bulgarian transport market, jointly formulated and signed a declaration to support the development of intermodal transport in Bulgaria and specifically call for a capable container terminal for the Sofia region. In October 2009, this declaration was handed over to the Bulgarian government, the national rail infrastructure manager of Bulgaria NRIC and for information also to the European Commission.

Figure 67: CREAM signatories of the "Declaration on the improvement of intermodal transport in Bulgaria" (Vienna, 25 March 2009)

Back row from left: D. Vamvakopoulos (TRAINOSE), M. Gaidzik (HaCon), K. Zöchmeister (Rail Cargo Austria), K. Langendorf (DB Schenker Rail Deutschland), R. Bamberger (Logistic Services Danubius); front row from left: P. Popov (BDZ Cargo), R. Mertel (KombiConsult), T. Struyf (TRW)

Only one year after the declaration was handed over, the empty niche in the Bulgarian market of intermodal road-rail transport could be filled by the first private intermodal terminal in Yana near Sofia. It is part of the plans of the terminal operator Ecologistics, the logistics division of one of the country's leading industrial recycling companies, Ecometal, to develop Ecometal's Yana railway station into a multimodal logistics centre. At the start-up, Yana terminal is equipped with two 450 m railway tracks and two reach stackers. As a first outcome, the first container block train for the Yana intermodal terminal ever was received on 17 September 2011, coming from Ljubljana with 24 container-loaded railway waggons. The arrival of the first container block train at the Yana station in Sofia is the result of a joint project between the state-owned company BDZ Freight Services EOOD and a private company, Ecologistics EOOD, for the creation of a new transport service – transport from Ljubljana to Sofia by a train unit with 40-feet containers.

For a long period, container block trains had only passed Bulgaria due to the lack of capable intermodal transport terminals. Now Sofia is a spot on the intermodal map again and has become a part of the intermodal "String of Pearls" network linking Western and Southeast Europe.

The Balkan link

In Western Europe intermodal road-rail transport is a well established system. Dense networks are operated under the commercial responsibility of intermodal operators such as Kombiverkehr, Intercontainer Austria or Inter Ferry Boats (IFB). Linking these services with Southeast Europe and building a "String of Pearls" operation network on the CREAM corridor is the major goal of the CREAM project. For this purpose, the CREAM partners MZ and OSE in collaboration with the main railway carriers in the Former Yugoslavian Republic of Macedonia (MZ Transport) and Greece (TRAINOSE) have established a transport offer on the axis Belgrade – Skopje – Thessaloniki.

Skopje – Thessaloniki: The basis of this concept is the container train between Skopje (Tovarna container terminal) and Thessaloniki (port), which has been restarted and extended within the CREAM project up to four departures per week and direction. Most units are containers for ships from and to the port of Thessaloniki, but it is also possible to transport containers and swap bodies destined for the Greek market. To establish this train in a medium perspective, comprehensive improvement actions have been initiated in close cooperation between the two involved railway carriers. In this context, two main action fields were tackled:

- Border Crossing: Organisation of improved cooperation for handover of trains, implementation of information exchange before train arrivals at the border Gevgelija/Idoméni (see Figure 68), harmonised brake regulations and improvement of transport document management.
- Quality Management: Installation of a dedicated quality group which works on the implementation of a quality manual and a train monitoring concept.

Figure 68: Container train at Gevgelija border station

Next improvement steps are for instance the introduction of electronic data exchange between MZ and TRAINOSE and the further strengthening of the cooperation between both railway undertakings in order to improve the border crossing at Gevgelija-Idomeni.

From the start of the service in December 2008 until December 2010, a total of over 800 trains was running between Skopje and Thessaloniki, making a modal shift of almost 146 million tkm possible on that short route. 146 million tkm shifted from road to rail mean environmental and social benefits of about 2.9 million euros and 9.8 million kg of air pollution emission that were avoided[4].

Belgrade – Skopje: To link the Skopje – Thessaloniki service with other intermodal networks, MZ offers an open train connection between Belgrade and Skopje on demand. The trains from Belgrade stop in Skopje-Trubarevo shunting yard, where it is possible to transfer waggons to other trains.

Throughout the project a total of over 270 trains were running between Belgrade and Skopje, making a modal shift of over 89 million tkm possible, equal to social benefits of about 1.8 million euros and an avoidance of 6 million kg of air pollution emission[4].

4 According to Marco Polo specifications and BMVBS, German Ministry of Transport calculation methods

The effects

The results prove that the project partners were right in their decision to choose the described "String of Pearls" approach for developing their rail transports towards Southeast Europe. In fact, the modal shift effects in terms of transport performance achieved, exceeded all expectations. They were realised first of all by the "String of Pearls" network but also by further CREAM related international rail freight services of the project partners along the corridor (e.g. Multimodal rail/short sea transport service Turkey – Italy – Germany, copper anode train Bulgaria – Belgium). Figure 69 shows that just in 2010 2.68 billion tonne kilometres (tkm) were hauled by the CREAM partners' international rail freight services. Compared to 1.66 billion tkm in 2006, the year before the CREAM project started, this is a surplus of more than one billion tonne kilometres, shifted from road to rail. The initial goal of shifting 200 million tkm to rail within this reference period has thereby been surpassed by five times. With the shift of additionally one billion tonne kilometres towards rail in one year, environmental and social benefits with an amount of some 20 million euros have been achieved. This corresponds to over 68.6 million kg of avoided air pollution emission[5].

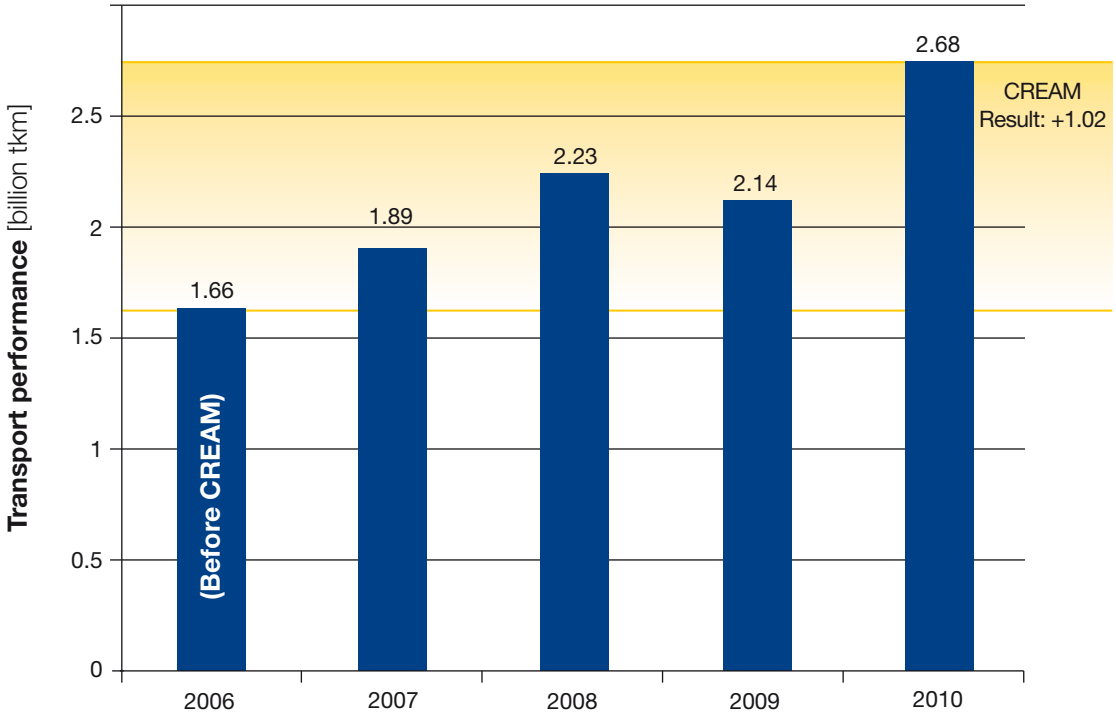


Figure 69: Transport performance of CREAM partners' international rail freight services on the corridor (for the years 2006 – 2010)

5 According to Marco Polo specifications and BMVBS, German Ministry of Transport calculation methods

Multimodal rail/short-sea transport service Turkey – Italy – Germany

Turkish trucks travel up to 7,000 km in each round-trip on their journey to and from Western European countries. Ekol Logistics has developed an effective and environmentally friendly alternative to this practice. A new intermodal transport system which reduced the share of land transport to only 2,000 km.

Since 2008, Ekol Logistics, in cooperation with the CREAM project partners Kombiverkehr, Lokomotion and RTC, is conducting transports between Turkey and Western Europe according to a completely new organisation form. This new intermodal transport service, developed as part of the CREAM project activities, is mainly based on short sea and rail transport service and is using the route Turkey – Italy – Germany.

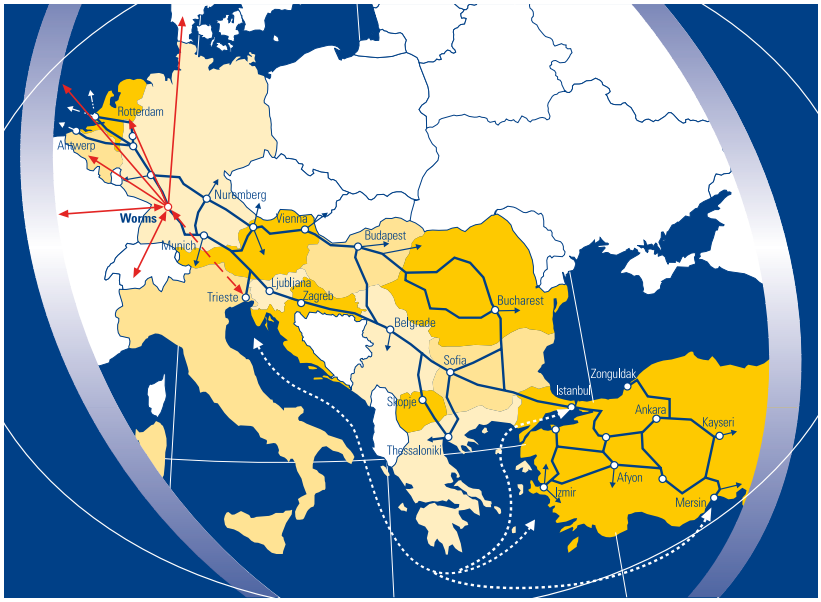


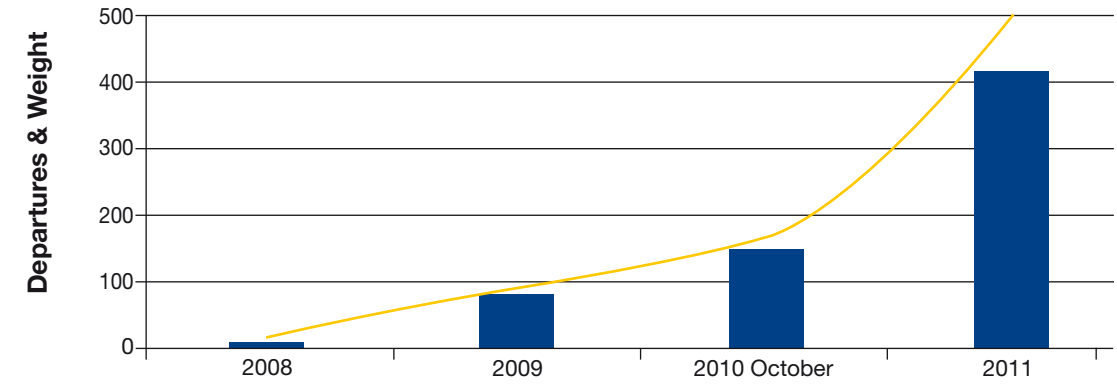
Figure 70: Routing of multimodal transport service Turkey – Germany (status: December 2010)

The intermodal service concept

Originating from the use of ferry services between the Turkish ports in Istanbul, Izmir and Mersin and the Italian Port of Trieste, the multimodal concept now exhibits an innovative combination of these ferry boat connections on one side and a shuttle-train connection between Trieste and Worms (Germany) on the other side.

In detail, the new transport concept works like this: Turkish commodities are loaded to semi-trailers, capable for being used in intermodal transport, and are hauled to Istanbul, Izmir and Mersin ports. There the semi-trailers are loaded on board of Ro-Ro vessels and are transported to Italy in a 3 days ship passage. After having arrived in the Port of Trieste, the semi-trailers are transshipped onto the intermodal block train towards Germany. The train trip to its destination, the intermodal transshipment terminal in Worms, requires a transit time of less than one day. From Worms or via Ekol's distribution centre in Heppenheim the semi-trailers are transported with German registered trucks to destinations in Germany or other Western European countries such as Benelux countries, France, United Kingdom, Switzerland, Denmark, Ireland and Spain.

After the selection of appropriate consolidation terminals, port terminals and a rail traction provider, the first multimodal service between Turkey and Germany started successfully in October 2008. Having started with initially one weekly round trip, the frequency could be extended stepwise from year to year up to seven weekly round trips at the beginning of 2012.



	2008	2009	2010 October	2011
Tonnes	14	76	144	400
Departures	18	92	175	506

Figure 71: Transport development (departures/volumes) of multimodal transport service Turkey – Germany (status: January 2012)

Source: EKOL

Economical and ecological achievements

Seven weekly roundtrips mean: Better coordination between rail and ferry services and more flexibility for all involved parties, e.g. in terms of locomotive, waggon and trailer turnarounds, and, of course, customer satisfaction by offering daily and reliable deliveries. The shuttle train between Worms and Trieste is carried by the two private railway undertakings Lokomotion and RTC under the control of Kombiverkehr.

Figure 72: Ekol trailers loaded on Kombiverkehr pocket waggons (Trieste, October 2008)

Figure 73: Ekol train on the Tauern line pulled by the "CREAM" locomotive of Lokomotion

With the new multimodal approach, the total average roundtrip distance covered by land transport could be limited from 7,000 km by road to only 2,000 km by rail, thus saving a distance of about 5,000 km via road, equal to about 1,600 litres fuel. Remarkably, the same roundtrip duration of about 15 days could be maintained. Each trailer roundtrip operated according to the new concept equals to emission savings of some 5,520 kg CO_2, 25.86 kg NO_x, 3.98 kg NMHC (non-methane hydrocarbons) and 0.17 kg of particles. With roughly 400 train roundtrips that have been conducted since start in 2008 until end of 2011, greenhouse gas emissions could be reduced e. g. by 69,900 tonnes of CO_2 and 327.3 kg of NO_x.

Further advantages of this green logistics transport solution are:

- Noise reduction
- Less transit documents for passing international roads
- Minimisation of negative effects due to bad weather conditions
- Nonstop driving during weekends
- Same lead time for standard service considering other transport models

Expectations for the future

Following the benefits that intermodal transports stand for, Ekol is very keen on extending its intermodal services constantly and has been able to launch an alternative route between Turkey and Western European destinations, involving a new shuttle train service between Worms and Arad (Romania) just at the beginning of 2012 with already three departures per week. So far, due to long travel times on rail, the distance between Arad and Turkey will be covered by road transport. In the near future, Ekol intends to use a Ro-Ro-connection between Constanta (Romania) and Pendik near Istanbul, to establish a second multimodal rail/short sea transport chain between Turkey and Germany.

"By linking the different modes of transport, we exploit the advantages of each of them and still offer our customers a complete service from a single source."

Ahmet Musul, CEO of Ekol Logistics

As soon as the second multimodal connection will have been completed in the course of 2012, Ekol is weekly offering ten multimodal road-rail services in each direction, operated according to the new concept. One can say, this is a success story of its own.

Ekol Logistics

With a fleet of 1,400 vehicles and 3,500 employees Ekol Logistics is recognised as one of the leading integrated logistics service providers in both Turkey and Europe. Ekol operates nine freight centres in the greater Istanbul area with storing capacities of 130.000 square metres. Moreover, they have branches in all important economic centres of Turkey like Bursa, Izmir, Denizli, Ankara, Adana and Samsun. In Heppenheim, Germany, they opened their first local branch in the 1990s for coordinating all European activities. Some of Ekol's customers are for example Adidas, BASF, Benneton-Beymen, Braun, 3M, Marks & Spencer and Mercedes.

Since being founded in 1990, Ekol is aiming at providing efficient and sustainable transport services. As an active member of the CREAM consortium, Ekol succeeded in transferring main parts of transport onto railways and short sea and thereby achieving positive effects both from the economical and the ecological point of view.

www.ekol.com

Copper anode train Bulgaria – Belgium

For more than ten years, DB Schenker Rail is in charge of organising rail transports of copper anodes between Pirdop in Bulgaria and Olen in Belgium. In 2007, as a consequence of permanent quality problems, the customer of this transport, which was at that time Cumerio (meanwhile merged into today Aurubis AG), started to look for alternative transport solutions. To regain customer satisfaction and to prevent this transport from being lost for rail, a new production concept and comprehensive quality measures have been successfully developed and implemented in the scope of different CREAM project activities.

Since 1997, DB Schenker Rail, a member of the CREAM consortium, is responsible for organising the rail transport of copper anodes between Pirdop (Bulgaria) and Olen (Belgium) for the Hamburg-based Aurubis AG (formerly Norddeutsche Affinerie). Aurubis is Europe's largest copper producer and the No. 2 in the world. At 13 locations in seven countries the company is producing more than one million tonnes of copper and copper products each year. Pirdop is a modern production site within the Aurubis group, producing anodes, cathodes and sulphuric acids with some 800 employees. From Olen the copper anodes are transported to other Aurubis production sites in Belgium and Germany for further processing.

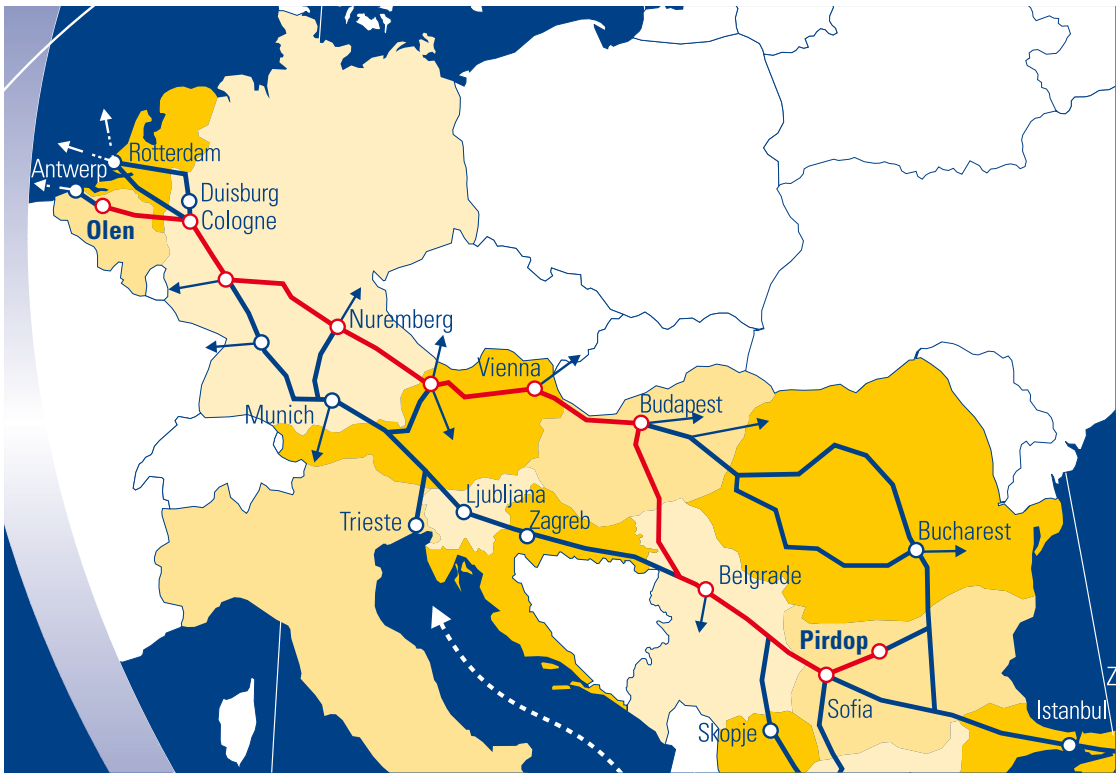


Figure 74: Routing of copper anode train Pirdop-Olen (status: May 2010)

Initial situation

Due to massive quality problems, the train service between Pirdop and Olen was integrated in the CREAM project work and completely re-organised. In the scope of the project work a new waggon concept has been elaborated. The decision to implement this new concept was driven by two main factors:

- The technical conditions of the Smmps waggons of BDZ were insufficient. After two derailments in Germany in 2006 and 2007, the German railway authority "Eisenbahn-Bundesamt" required a technical check for the train at the Austrian/German border to obtain the permission for running on the German rail network. In consequence, DB Schenker had to reorganise border processing between Austria and Germany. This comprised the allocation of dedicated staff to Passau border station, to conduct technical train checks. As working hours of technical border staff and actual arrival times often did not match, additional delays of more than ten hours were not a rarity, thus affecting the quality of the entire service.
- The availability of rolling stock was low. BDZ had allocated only 180 waggons to this train service. Thus, there was no flexibility to run additional trains for the customer in case of growing production outcome. In fact, Aurubis announced a potential increase of transport volumes from 80,000 tonnes up to 120,000 tonnes per year.

UIC codification of goods waggons

The international system for the classification of goods waggons was agreed by the UIC in 1965 and subsequently introduced into the UIC member countries. With this system each waggon type can be identified uniquely by a UIC designation, made of a capital letter in the first place and several small letters. The capital letter indicates the general waggon type; the small letters give information on further technical characteristics.

For instance "Smmps" means:

- Special flat waggon with bogies (S),
- Loading length less than 15 m (mm),
- Loose gravity discharge hopper; underside of floor ≥70 cm above top of rails; lifting gear cannot be used; no slatted floor; no sides; no end wall (p),
- Permitted in trains up to 100 km/h (s).

www.uic.org

Figure 75: Transport of copper anodes on Smmps open flat waggons

The H-waggon-based production system

In order to meet the expectations of this important customer – which calls for good quality at reasonable prices – DB Schenker Rail, in cooperation with BDZ Cargo, has developed an intelligent train production concept which started operation with the annual 2010 timetable in December 2009.

The core idea behind this concept is to deploy a different kind of rolling stock, namely H-waggons. These waggons are generally moved within the single waggon production system to destinations in Greece, Turkey or Bulgaria, then transferred to Pirdop (Bulgaria) and made available for the block train operation from Pirdop to Olen (Belgium).

To switch from Bulgarian (Figure 76) flat waggons to the H-waggons it was necessary to introduce a new loading scheme and modify the loading process in Pirdop (cp. Figure 76).

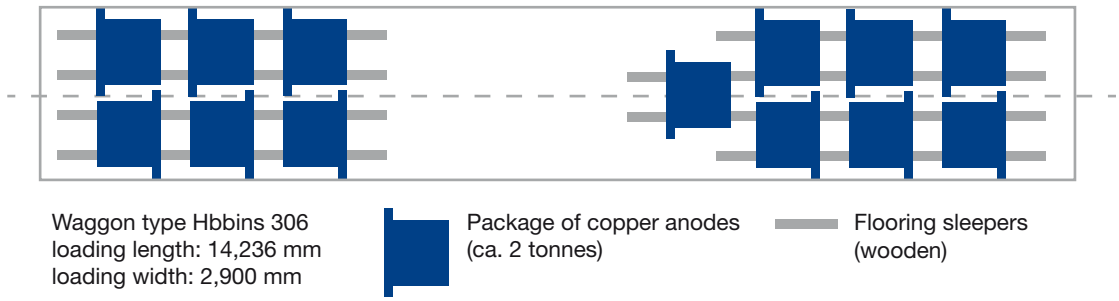


Figure 76: New loading scheme of copper anodes on H-waggons

Figure 77: Test loading of copper anodes in Pirdop

Based on the demand of Aurubis, the DB Schenker subsidiary Fertrans RailControl located in Vienna (Austria) dispatches the required number of waggons from different places in Southeast Europe. For this purpose, they cooperate closely with the fleet management of the customer service centre from Duisburg (Germany).

Numerically this means:

- Operation of 200 freight waggons per month
- Annual transport volume of 75,000 tonnes on the Pirdop-Olen relation
- Elimination of annually 12 empty train runs between Greece and Western Europe

The introduction of the new concept has been accompanied by comprehensive quality measures, elaborated and coordinated with the cooperation partners in the framework of the CREAM project. As a result, a dedicated quality handbook for this service has been implemented in March 2010 including clear descriptions on the interface processes between the operating partners. It serves as a practical guideline for the operational staff.

“We are very satisfied with the strong commitment of our partners in implementing the new concept”, says Dirk Zender, project manager at DB

Schenker Rail. He reports that “the quality measures show their effects, the service could be re-integrated in the trust agreement between Austria and Germany and transport times could be cut remarkably.”

Conclusions

Now that covered sliding-wall H-waggons are used for the transport from Pirdop, not only is the risk of theft minimised, but Smmps waggons returning empty is also a matter of the past. Also, the experience made with this new operational concept shows that the special customer requirements relating to flexibility, reliability and transport speed are served much better.

Production volumes at Pirdop are subject of huge and short-term fluctuations. Despite not being able to predict transport volumes in the long term, DB Schenker Rail manages to ensure a sufficient flow of empty waggons to Pirdop to feed the block train towards Belgium.

Copper is a valuable metal and its market price is subject to strong fluctuation. This places tough demands on freight operators, as delays in the transport chain not only affect production, but also cause additional costs. Ensuring punctuality and reliability is therefore another important challenge. Despite a careful route planning frequent border crossings along the route specifically between Bulgaria, Serbia, Hungary and Austria often involve unexpected difficulties. However, due to the long term experience of DB Schenker in managing such demanding train services, their international network and the measures developed and implemented within CREAM the train is operated to the complete satisfaction of the customer.

All in all, the copper anode train is just another example for the successful project work of CREAM, having paved the way to innovative and improved railway services, especially in areas which will keep on growing in the future.

DB Schenker Rail Bulgaria rail transport for Aurubis

When transporting products from Bulgaria to Germany and Belgium, DB Schenker cooperates with partner railway undertakings in Bulgaria, Serbia, Hungary, Austria and Belgium. In order to offer continuous and reliable transport chains through Southeast Europe to international customers, such as Aurubis, in May 2010 DB Schenker Rail has set up its own national branch: DB Schenker Rail Bulgaria EOOD, which at the same time acquired a traction licence. Today, DB Schenker Rail Bulgaria EOOD independently transports copper concentrate every day – mainly originating from mines overseas – from the Black Sea port of Burgas to Pirdop, some 300 kilometres away. At the copper refinery, Aurubis then turns the loose concentrate into copper plates with a copper content of more than 99 % (these are actually the copper anodes).

www.dbschenker.bg

DB SCHENKER

Container train Istanbul – Tehran – Islamabad

The CREAM Corridor has an entire length of more than 3,000 km, drawing a bow between Western Europe and the Balkan states towards Turkey/Greece. But the project goals reach beyond this corridor. An increase in rail freight transport, especially towards Eastern corridors where infrastructural and operational improvements are most needed, shall also be accomplished. For many reasons, these corridors suffer from delays in transport market developments, compared to central European ones. Therefore, the railway connection Istanbul-Islamabad, established on a regular basis in 2010, is an especially pleasing achievement.

In correspondence to the goals of the CREAM project, Turkish state railways TCDD contributed to an initiative which is not only remarkable from the technological point of view, but has also political and humanitarian implications: A freight railway connection between Istanbul and Islamabad.

In April 2008, during the 7th Ministerial Meeting of Economic Cooperation Organisation (ECO) in Antalya, it was decided to run a test train between Turkey and Pakistan via Iran. The intended route covers a total distance of 6,599 km: 2,006 km on Turkish territory, 2,603 km in Iran and 1,990 km through Pakistan. Turkish and Iranian railway networks are constructed in standard gauge of 1,435 mm. Border crossing procedures between these two countries are conducted at Kapiköy border station. In Pakistan railway tracks have a gauge of 1,676 mm. Therefore containers have to be transhipped between standard and broad gauge waggons at Zahedan border station in Iran. Authority checks are conducted at Taftan station on Pakistani side of the border.

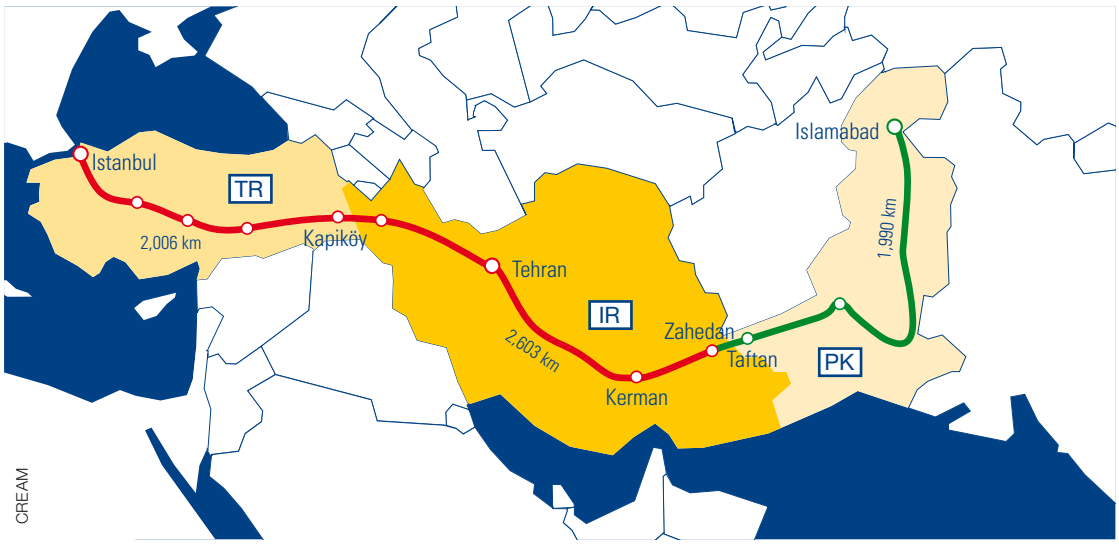


Figure 78: Routing of container train Istanbul – Islamabad

First test trains

As a result, Turkish State Railways (TCDD), Iranian Railways (RAI) and Pakistan Railways (PR) jointly prepared and ran a pilot train which departed from Islamabad on 14 August 2009 and arrived in Istanbul 13 days later. This direct rail transport connection could be performed only after the missing railway line Kerman – Bam – Zahedan with a length of 540 km length was opened on 9 June 2009.

The second test run started in Istanbul on 2 August 2010 in the opposite direction and covered the total distance in only eleven days.

Figure 79: Demo train Islamabad – Istanbul via Tehran (August 2009)

Figure 80: Demo train Istanbul – Islamabad via Tehran (August 2010)

Regular ECO container train service

Since this second test run in August 2010, the ECO container train service is operated on a regular basis. This operation started with one departure per month in each direction and has been extended to up to one departure per week. Main commodities transported with this new container train service are textile products, cotton and medical equipments from Pakistan to Turkey and engines, chemical products, paper products and humanitarian donation material in the opposite direction. The train runs with a maximum length of 420 metres and a maximum gross weight of 850 tonnes.

The most important and relevant advantages of the new rail freight service highlighted by the involved partners are:

- the provision of fast and reliable transports between Islamabad, Tehran and Istanbul at reasonable costs
- an improved connection between Pakistan and India to Europe via Turkey
- its strengthening impact on Turkey's bridge position between Europe and Asia and
- the enhancing of both commercial and social relations between the countries along the corridor

"The new ECO container train has accelerated transports from European countries to Pakistan enormously."

Ahmet Nedanli, Astra Logistics

Conclusions

The ECO container train service represents a great advantage for the business community of Pakistan, Turkey and Iran because otherwise the containers would have to travel first via ship and then by road or rail to their final destinations. This way of transporting the goods is quite expensive and requires at least a month instead of only about 11 days. Furthermore, it contributes to the economic growth encouraging business and promoting national integration. The service is continuously being improved thanks to the cooperation of all involved stakeholders. The CREAM project partners are proud having contributed to this sustainable initiative reaching beyond their original targeted corridor. In fact, the Istanbul – Islamabad train represents a natural prolongation of the project's objectives, not only in terms of geography but also for the concepts developed.

Astra Logistics

Since 1999, Astra Logistics is providing freight forwarding services in the fields of sea freight, air freight, road transport and rail freight. Astra Logistics has recognised railway transport as an important component within their integrated logistics services. Since Astra Logistics has been established, it is doing widespread business in domestic rail freight. However, meanwhile they have extended their engagement in international rail transport, particularly with East Europe, CIS (former Soviet Republics) and Middle East countries. Astra Logistics holds the commercial responsibility for the ECO container train between Istanbul and Islamabad via Tehran and also organises shipments beyond Pakistan through their local office in Islamabad.

www.astragrup.com

Dissemination and use of CREAM project achievements

The preceding chapters provide a comprehensive description of the CREAM project activities and achievements. This section provides a consolidated overview on the specific exploitable results the CREAM project has generated.

CREAM corridor related Quality Management System (QMS)

The QMS has been set up to achieve better quality especially with regard to punctuality and reliability and to secure an optimised use of resources and therewith providing efficient services. Main tool of this QMS is the CREAM Corridor Quality Manual that consists of one document providing all relevant definitions and further general information on the CREAM Corridor Quality Management System ("Part I") and several individual service specific handbooks for initially eight dedicated high-quality rail freight services on the CREAM corridor ("Part II"). These handbooks include a documentation of train service specific information, e.g. train schedules, processes/instructions, quality criteria/quality objectives, quality control methods, quality monitoring groups and company key contact persons. The QMS backs on harmonised procedures and clearly defined responsibilities for improving the interfaces between the partners. It describes all relevant processes required for the delivery of the targeted quality objectives. The quality manuals are in use and suitable to be extended to other rail services.

"String of Pearls" network of open, unaccompanied intermodal rail freight services

A core component of CREAM was the development of an efficient rail operation system for intermodal services that should be able to reconcile various transport flows along the selected corridor between the Benelux countries on the one side and Turkey and Greece on the other. During the project, the system had been developed and continuously extended according to the so-called "String of Pearls" concept. Finally, at the end of 2010, the "String of Pearls" network consisted of numerous open, unaccompanied intermodal rail services. The "String of Pearls" concept is characterised by the following elements:

1 The Strings: combination of existing and new open shuttle train services, developed on basis of dedicated service extension axes.

2 The Pearls: consolidation points (gateway or hub terminals), enabling bundling and reconciliation of various transport flows.

3 The "Strings" linking the "Pearls": an efficient rail operation system for intermodal services on the corridor or on parts of it.

The "String of Pearls" concept is applied by the CREAM partners to extend their service networks and cooperate with regional partners.

Multi-mode rail/short-sea concept between Turkey and Western Europe

This new operational concept is an innovative combination of a shuttle-train connection between Worms and Trieste and ferry boat connections between Trieste and Istanbul/Izmir/Mersin in Turkey. Starting with one weekly round trip of the shuttle-train connection, directly after the end of the project (status: March 2012) it could be extended to seven round trips per week. These seven weekly roundtrips led to more flexibility for all involved parties, e.g. in terms of locomotive, waggon and trailer turnaround, and an improved coordination between rail and ferry service. The shuttle train between Worms and Trieste is operated by the two private railway undertakings Lokomotion and Rail Traction Company. Main advantages of this green logistics solution, basically driven by the customer Ekol, are the following:

1 Reducing negative environmental impacts;
2 Passing international roads with less transit documentation;
3 Eliminating negative effects due to bad weather conditions;
4 Nonstop driving during weekends and
5 Same lead time for a standard service considering other transport modes.

Ekol continues working according to that concept.

Operational concept for extending intermodal transport beyond the corridor to Central Turkey/Middle East

Based on a detailed analysis of the TCDD rail freight transport and logistics activities and opportunities, recommendations were elaborated for the development of intermodal transport beyond Halkali towards Central Turkey/Middle East. Practically a container train connection has been established on the route Istanbul – Tehran – Islamabad. A first demonstration run between Islamabad and Istanbul was conducted in August 2009, and a second demonstration run between Istanbul and Islamabad in August 2010. Since then, regular departures could be realised up to one departure per week and direction.

Integration concept for the Betuweroute

An implementation plan was elaborated for the operative integration of the new dedicated rail freight line connecting the Port of Rotterdam with its hinterland ("Betuweroute"). In this respect, technical and operational aspects were considered. The plan covers measures on interoperability (including training of loco drivers), line capacity management (focus: chain management concept "Ketenregie"/IT platform SPIN "SpoorINformatiesysteem"), safety issues and a maintenance concept. More and more trains and train operators are using the Betuweroute according to the developed principles. The Betuweroute has also become a part of the European rail freight corridor 1 Antwerp/Rotterdam – Genoa.

Optimised (interoperable) rail traction scheme with reengineered diesel and electrical locos

A new traction concept was elaborated for the DB Schenker Rail entities in Romania and Bulgaria, making use of used and re-engineered locomotives: From Germany diesel locomotives class 232 and from Denmark electric locomotives class EA 3000. These locos passed the homologation procedure in Bulgaria and Romania in 2009 and in Hungary at the end of 2010. In a first step, they have been introduced on the cross-border railway line between Oradea (Romania) and Püspökladany (Hungary) in the "CREAM" train service Genk – Oradea ("T-Rex"). In subsequent periods, the locos have been transferred to the regular loco pools of DB Schenker Rail Bulgaria and DB Schenker Rail Romania and are deployed in regular interoperable services in Hungary, Romania and Bulgaria. Main advantages are reduced cross-border operation times and reliable availability of locos due to reduced number of loco changes.

Optimised (interoperable) rail traction scheme with multi system locos

Based on a detailed analysis of border processes and interoperability, suitable locomotives, trained drivers and optimal interchange points were identified and an cross-border improvement concept was developed for trains operating on the Tauern axis (Germany – Austria – Slovenia). Since 2009, Lokomotion and Slovenian Railways (SZ) operate intermodal trains ("Adria Express", train numbers 41860, 41861 and 41863) between Munich and Ljubljana in an interoperable way. The improvement of traction schemes for this service covered a further aspect: Based on theoretical calculations, the train weight could be increased up to 2,000 tonnes. This could be achieved by a new traction assembly, positioning two locomotives in the middle of the train.

Improved handover of trains on the route Germany – Austria – Italy

Lokomotion and Rail Traction Company improved their handover processes considerably by introducing a new software system which supports railway undertakings in exchanging and creating documents needed for cross-border rail operations. The system is used in daily operations.

Streamlining concept for border crossing operations

Following a comprehensive analysis of 20 rail border crossings along the CREAM corridor, operational and organisational improvement measure bundles were implemented at seven border crossings: Hegyeshalom, Dobova, Gevgelija - Idoméni, Curtici, Giorgiu - Ruse, Dimitrovgrad - Dragoman, Kulata - Promachon. The measure bundles consist in general of improvements related to streamlining border processes (e.g. by shortening process times and optimising process sequences), pre-information on train arrivals and delays and electronic data exchange of commercial and technical train and waggon data.

The results and action plans can be transfered into practical use in the subsequent years.

Concept for a dual-propulsion locomotive

Voith Turbo Lokomotivtechnik constructed a test carrier of a locomotive with dual-propulsion – diesel and electric energy – to be used on electrified and non-electrified sections of the European rail network providing full train traction forces in both modes. "Under catenary" electric energy with limited local emissions can be used, while in non-electrified sections like at some network sections, at border crossings or at railway stations and intermodal terminals the diesel engine can be used and auxiliary machines are not required. Even if the prototype could not be completed within CREAM, Voith has supported bringing the dual-propulsion concept to the highest attention of the European rail industry.

Optimised GPS-based telematics for tracking & tracing

The self-sufficient NavMaster telematics system has been developed particularly for the use in railway environment. Its conformity according to all common railway standards was tested and proven within CREAM. The reliable battery technology and the extremely robust housing allows maintenance-free operation for more than six years. Several different housings and extension boards enable the NavMaster to be used on waggons, swap bodies, containers and even locomotives. The implementation of GSM SMS and also GPRS communication allows reliable and with GPRS also low cost data transmission throughout Europe. NavMaster offers a large number of functions and parameters to configure the device to the requested operational mode. A reconfiguration is possible at any time by a remote setup via GSM. The device transmits its positions, sensor data and status information in a highly packed data format to the Eureka tracking server. After verification, the telematics data is preprocessed as XML data files (called NavXML). Customers may receive the NavXML files directly via internet data exchange and process them in their own IT solutions or use Eureka's aJourOnline internet portal for visualisation and tour analysis.

Data radio link between wireless modules, waggon telematics and/or stationary hot spots

This technology offers the possibility that wireless WPAN sensor modules communicate with a waggon GPS/GSM telematics device that is equipped with a WPAN transceiver. If such a telematics device is not installed at the waggon, the WPAN sensor modules are also able to transmit their data via stationary installed hot spots at railway stations to the control centre. The data radio is compliant to standard ETSI EN 300 220 for short range devices using a frequency of 868 MHz. Practical tests showed a high communication reliability around long waggons and even to 200 m departed hot spots. The implementation of a very energy effective communication protocol enables the WPAN modules also to operate an integrated sensor (e.g. accelerometer) on a single battery for many years.

International rail transport information and communication system ("Train Monitor")

Train Monitor is a web-based software system for monitoring train movements. It has been developed for railway companies and transport operators. Train Monitor offers these companies the opportunity to access real time information of their domestic and international trains using just one software system. In collaboration with Europe's leading provider of intermodal rail-based transport solutions Kombiverkehr, the system has been designed according to the specific needs of combined transport and integrates operating information of the container terminals. However, thanks to the modular system architecture it can be easily adapted to other rail transport companies. The system consists of three modules: RealTime (providing also information on the estimated train arrival "ETA"), the HAFAS Information Manager HIM and File&View. Train Monitor supports operators und railway companies to operate their trains in the best way so that they can deliver high transport quality with minimum operation costs. Train Monitor is in daily use and will be extended continuously.

Concept for temperature controlled cargo in intermodal transport

The concept for temperature controlled cargo in intermodal transport comprises the procurement of innovative road-competitive piggyback thermal semi-trailers with self-sustained diesel supply, generator and integrated GPS/GMS control module as well as pilot implementations that were carried out on intermodal services Ludwigshafen – Wels – Budapest.

Intermodal transport system for conventional semi-trailers not equipped for crane handlings ("ISU")

Based on the research work of preceding projects (SAIL, BRAVO), an improved Innovative Semi-trailer handling Unit ("ISU") has been developed and demonstrated in regular intermodal train services. The ISU system allows for handling of semi-trailers not specifically equipped for intermodal transport in conventional intermodal services by only small adjustments in (mobile) handling equipment. The handling equipment was constantly optimised and demonstrated, starting with a couple of test loadings and test trains, and finally operating on a regular basis. The advantages are: use of ordinary road-only semi-trailers, compatible with intermodal terminals and pocket waggon, integration into existing intermodal train services, low investment in (mobile) equipment (auxiliary spreader, loading ramp, cross beam and wheel grippers).

Customised semi-trailer for unaccompanied intermodal transport of plate-glass

A prototype semi-trailer for plate glass loads in combined road and rail traffic ("FLOATRAILER") has been developed, built and tested with respect to loading/unloading, terminal handling and rail transport on different occasions. Optimal load-weight ratio and safety features allow secure shifting transports off the roads onto conventional large size pocket waggon. The development was initiated and coordinated by Offergeld; the construction was done by the trailer manufacturer Faymonville. Already during the development of the FLOATRAILER a second manufacturer has developed a similar semi-trailer; thereby today two types of an intermodal plate-glass semi-trailer are available to road hauliers and freight forwarders.

Acknowledgements

The CREAM project generated numerous achievements that are expected to influence the rail freight business for the next years. This success was only possible due to numerous persons, who have been involved as part of the project team or have supported the project work of CREAM in a friendly and cooperative way. Therefore the project coordination team of HaCon and KombiConsult says THANK YOU to all below listed colleagues and friends and to all other supporters, who are not mentioned by name!

Fernando Aguirre-Arribas, Martin Aichinger, Omur Akbayir, Orhan Akcay, Simeon Ananiev, Ana Maria Andrei, Iuliana Mirela Anghel, Krassimir Anguelov, Maria Antova, Hermann Aschauer, Alexander Atanassov, Ozgur Can Aydin, Lütfi Aygüler, Dirk Baerbock, Andreas Bader, Athanasios Ballis, Ralf Baltes, Reinhard Bamberger, Dejan Ban, Sinisa Baricevic, Wolfgang Bauschulte, Victor Behrends, Barbara Bil, Gary Bleier, Janós Boda, Dimitar Boev, Murat Boğ, Lars Bohn, Frank Brinkman, Jan Brockmann, Christoph Büchner, Sven Budde, Frédéric Buyse, Pedro Castro, Ibrahim Celik, Omer Simsek Ceri, Ivaylo Chonev, Hulya Cilgi, Detlef Clausen, Alexander Clemens, Antonio Colaco, Guus de Mol, Besir Deari, Guido Decker, Birte Dehne, Lars Deiterding, Gheorghe Delca, Michael den Brok, Daniela Depalma, Oliver Derkovski, Nicole Dettmer, Mariana Nicoleta Diaconescu, Vanya Dimitrova, Sonja Dimitrovska, Franz Dirnbauer, Plamen Drenski, Georgi Drumev, Christian Epple, Erdin Erengül, Pulat Erginbas, Thomas Ernst, Frank Erschkat, Dirk Esters, Andreas Exter, Fritz Farke, Milica Laurentiu Ferbinteanu, Heinz Fikar, Richard Fischer, Klaus Fischler, Claudia Fraticelli, Jan Fricke, Kai Fricke, Marian Gaidzik, Niklas Galonske, Nadya Ganeva, Liubomir Garchev, Sandra Gehenot, Kurt Genseleiter, Ovidiu Giurumescu, Rolf Goosmann, Gernot Graner, Rene Gregor, Anke-Maria Grewe, Francesco Grotti, Wera Grühn, Bruno Guillaumin, Tunc Gürsel, Zoltan Gyulai, Ferhat Haciimamoglu, Tobias Haneklaus, Markus Hasinger, Alex Hatebur, Caspar Heine, Stefan Heinen, Michael Hetzer, Johannes Hildebrandt, Andreas Hilden, Jürgen Hipp (†), Andrej Hočevar, Franz Hochstrasser-Baumgartner, Arno Hoepner, Annemieke Hol, Igor Hribar, Ilia Hristov, Stefanie Hübe, Jaap Huizinga, Sylke Hußmann, Eduard Ianco, Hasan Ilhan, Lyubomir Iliev, Mahmut Ince, Cristina Ionescu, Niels Jäger, Daniel Jähn, Zoltán Jerney, Magdalena Jovanova, Uta Kadow, Thorsten Kain, Emin Karaman, Svenja Karcher, Abdullah

Kartal, René Keppler, Nam Seok Kim, Kunka Kirkova, Thomas Knechtel, Rumyana Koleva, Yasin Komur, Ivo Konstantinov, Patrick Koolen, Bianca Koorevaar, Imre Kovács, Vera Kratochwil, Heiko Krebs, Hinrich Krey, Denis Krumpak, Mónika Kurdi, Angelina Kurisheva, Gianbattista La Rocca, Klaus Langendorf, Antonios Laskaris, Hélène Lebreton, Holger Leitel, Kurt Lewandowski, Bernd Lüttge, John Lutz, Gustav Manding, Mihail-Victor Manole, Edoardo Marone, Miriam Mascolo, Marjan Masic, Marjan Matevski, Paolo Mattera, Federico Meda, Siets Jan Meijer, Christian Menendéz, Janez Merlak, Rainer Mertel, George Micu, Krsto Mingovski, Rumen Mitev, Sebastian Müller, Hristo Monov, Rainer Müller, Claus Müller-Haude, Georg Musyl, Oya Mutlu, Ahmet Nedanli, Nenos Nenopoulos, Clemens Neumann-Paeseler, Szilárd Neuschl, Nikolce Nikoloski, Marco Nock, Johannes Offergeld, Mehmet Özal, Halim Özgümüs, Selcuk Özuyar, Konstantinos Papadopoulos, Julia Paschek, Oana Patraulescu, Wilhelm Patzner, Hasan Pekin, Mustafa Pekmezcan, Kirsten Peppmüller, Hristo Petkanov, Hristo Petkanov, Petko Petkov, Kai Petri, Marjan Petrusevski, Bruno Plankensteiner, Susanne Pohl, Penchov Popov, Erich Possegger, Dimitris Potoglou, Markus Rasing, Markus Reichert, Valentin Raykov, Felicia Riedl, Armin Riedl, Ljubisa Ristic, Reiner Rodig, Selma Saka Sezer, Gerhard Salhenegger, Harald Rotter, Konstantinos Sandalcidis, Dirk Schade, Ingmar Schellhas, Nico Schilder, Theodor Schlickmann, Susanne Schmidt, Dr. Harald Schmittner, Dietmar Schratt, Maik Schröder, Andreas Schulz, Frank Schulze, Dennis Schut, Serra Sen, Metin Seven, Serkan Sezek, Evi Sfakianaki, Angelika Sievers, Eugen Sima, Jana Šingliarová, Sjoerd Sjoerdsma, Ulrich Solbach, Werner Sommerfeld, Klaus-Uwe Sondermann, Ulrich Sontheim, Martin Souczek, Holger Späthe, Andreas Stajerits, Maria Stavreva, Dimitar Stefanov, Marko Stjepanovic, Markus Stoltenberg, Tony Struyf, Stephan Sünderkamp, Volker Sustrate, Tamás Szász, Nicolae Mugurel Tanasuica, Hans Tandetzki, Tarzan, Alpaslan Taylan, Mehmet Tekin, Johan ter Poorten, Oliver Thomas, Inge Tietje, Anthon Timm, Cees Tommel, Trajce Trajanovski, Koen Triangel, Veska Trifonova, Tekin Tuzsuz, Eva Maria Uecker, Roelof van der Molen, Ruby van der Sluis, Ronny van Petegem, Dimitros Vamvakopoulos, Dirk van Vreckem, Jean-Pierre van Vyve, Marc Vierke, Aikaterini Vitou, Jaap Vleugel, Dimitar Voynov, Dragan Vujovic, Till Waldow, Jochen Walz, Jochen Weber, Christian Weis, Jan Weiser, Frank Weppner, Hans Georg Werner, Enno Wiebe, Bart Wiegmans, Bilal Yigit, Hakan Yilmaz, Boris Žebalc, Dirk Zender, Nóra Zentai, Athanassios Ziliaskopoulos, Karl Zöchmeister

Glossary

The glossary contains explanations on the most often used abbreviations.
Further abbreviations are explained in the respective articles.

AC	Alternating current
ARA	Antwerp, Rotterdam, Amsterdam
AT	Austria
BRAVO	Brenner Rail freight Action strategy aimed at achieving a sustainable increase of intermodal transport Volume by enhancing quality, efficiency and system technologies
BE	Belgium
BG	Bulgaria
CAN	Controller Area Network
CIM	Uniform Rules concerning the Contract of International Carriage of Goods by Rail, fr.: Règles uniformes concernant le Contrat de transport international ferroviaire des marchandises
CIT	International Rail Transport Committee, fr.: Comité international des transports ferroviaires
CO_2	Carbon dioxide
CREAM	Customer-driven Rail-freight services on a European mega-corridor based on Advanced business and operating Models
CT	Container terminal
DC	Direct current
DE	Germany
EDI	Electronic data interchange
EDP	Electronic data processing
EFTA	European Free Trade Association
EMC/EMI	Electromagnetic compatibility/Electromagnetic interference
ERTMS	European Rail Traffic Management System
ETA	Estimated time of arrival
ETCS	European Train Control System
FP6	6th Framework Programme for Research and Technological Development by the European Commission
FTE	Forum Train Europe, www.forumtraineurope.org
FTP	File transfer protocol
GPS	Global Positioning System
GPRS	General Packet Radio Service
GR	Greece
GSM	Global System for Mobile Communications
HR	Croatia
HU	Hungary
IM	Infrastructure Manager
ISU	Innovative transshipment system for conventional road only semi-trailers, ger.: Innovativer Sattelanhänger Umschlag
IT	Italy, Information Technology
LBS	Location-based service
LT	Locomotive tracking
MK	Former Yugoslav Republic of Macedonia (F.Y.R. of Macedonia)
MSL	Multi-system locomotive
NL	The Netherlands
NMHC	Non-methane hydrocarbons
NOX	Nitrogen oxide
NST	Standard goods classification for transport statistics, fr.: Nomenclature Uniforme de Marchandises pour les Statistiques de Transport

NUTS	Nomenclature of Territorial Units for Statistics, fr.: Nomenclature des unités territoriales statistiques
Q	Quarter of the year
QMS	Quality Management System
RFID	Radio-frequency identification
RO	Romania
RoLa	Rolling motorway, ger.: Rollende Landstraße
RoRo	Roll-on/Roll-off
RS	Serbia
RU	Railway undertaking
SI	Slovenia
SMS	Short Message Service
TAF TSI	Technical specification for interoperability relating to the telematic applications for freight
TEIV	Trans-European Railway Interoperability Ordinance, ger.: Transeuropäische-Eisenbahn. Interoperabilitätsverordnung
Ten-T	Trans-European Transport Network
TR	Turkey
TREND	Towards new Rail freight quality and concepts in the European Network in respect to market Demand
WPAN	Wireless Personal Area Network
XML	Extensible Markup Language
ZEUS	“Projekt zur Zusammenarbeit der europäischen Schienengüterverkehrsunternehmen”, a project initiated by Railion with the purpose of intensifying the collaboration of different European railway operators (BDŽ, ČD, CFR MARFA, GYSEV, HŽ, JŽ/ZTP, MÁV, MZ, OSE, Railion, RCA, SŽ, TCDD, ZSSK)

List of figures

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Traffic • Software • Service

KombiConsult

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KEYRAIL

UIC

БДЖ BDZ

CFR MARFA

Slovenske železnice

Lokomotion
Gesellschaft für Schienentraktion mbH

Rail Traction Company

Rail Cargo Austria
Ein Unternehmen der ÖBB

Rail Cargo Hungaria
Rail Cargo Austria Group

DB SCHENKER

TPAINCE

IFB
member of DB Logistics

kombi verkehr

ÖKOMBI
Rail Cargo Austria Group

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TCDD

BALNAK
LOGISTICS GROUP

EKOL

OFFERGELD
LOGISTIK

TU Delft
Delft University of Technology

The CREAM Project has been co-funded by the European Commission | 6th Framework Programme

ISBN 978-3-00-037915-4