Timetabling on European Corridors

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Summary

The Path Allocation Re-engineering of Timetable Networks for European Railways (PARTNER) project aims to demonstrate a new way of train path allocation and assembly along international corridors towards a faster and more coordinated railway infrastructure capacity management. PARTNER will assist two neighbour infrastructure managers to develop a common understanding of the effects of international train paths.

The results of a survey of European infrastructure managers and railway undertakings are one basis of the project work that is discussed in the present chapter. Further, the chapter explains how PARTNER will create a timetable planners virtual network where heterogeneous workstations share information directly, without the need of dedicated central servers.

1. Introduction

The liberalisation of the European railways is aimed to force the revitalisation and the growth of the market share in passenger and freight transport. The European Commission has developed a framework of new regulations and directives in the so called railway packages.

One regulation contains the Directive 2001/14/EC that settles the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure. According to international rail market forecasts, an increase in market demands of country-to-country traffic flow is to be expected. This is underlined by the extension of the European high speed railway network for passenger trains and the establishment of trans-European networks. Current forecasts suggest that a high level of capacity management will be needed to prioritize the investments so as to improve the infrastructure and cope with the traffic increase in the long term. From the perspective of infrastructure managers, a central objective will be to provide railway paths considering the demands of their customers. However, train planning across borders meets increasing difficulties as train planners are faced with the current infrastructure. Moreover, each infrastructure manager has their own priorities

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and regulations within their own national boundaries, resulting in additional constraints to the usual activities of capacity management and timetable design.

Against the background of the existing national and international timetable planning processes, the project Path Allocation Re-engineering of Timetable Networks for European Railways (PARTNER) was launched in October 2003. PARTNER aims to demonstrate a new way of train path allocation and assembly along international corridors towards a faster and more coordinated railway infrastructure capacity management.

Most importantly, this will help to provide new train paths for international freight trains with advanced scheduling algorithms based on mathematical programming (optimisation) techniques, specifically suited for long distance corridors. In addition, a new software application should help to fulfil the requirements of the short term paths-requests (e.g. customers of international freight trains). Another part of the project investigates the socioeconomic dimensions of access to infrastructure in a competitive environment.

PARTNER brought together researchers of four European countries from academic institutes and industrial enterprises, including Siemens Informatica (Italy) and Siemens-PSE (Austria), the SME Futura Sistemi, the Universities of Bologna, Tilburg, Genova and Santiago de Compostela, and a User group with supporting Infrastructure Managers (RFI as project participant; OeBB and DB Netz have expressed their interest). The German Aerospace Center's Institute of Transport Research is the project co-ordinator. The project duration is 24 months. The European Commission supports the project under the auspices of the 5th Framework.

PARTNER draws havely on the experience gained in previous 4th EU-RDT Transport and Telematics projects, such as EuROPE-TRIS and TRIP.

2. Procedure

2.1 Survey of the European railway undertakings and infrastructure managers

The survey was carried out to learn more about the current situation in timetabling, especially details about the needs to adapt the international paths during a timetabling period and the daily practice. Further, we wanted to collect information about contact persons in the European countries and the most commonly used planning systems and processes.

The survey started in the middle of February and was completed in mid March 2004. The survey was carried out by the German Aerospace Center, Institute of Transport Research as an independent institution. Two different questionnaires were used, one for the infrastructure managers and the other for railway undertakings. The operators of combined road-rail transport and forwarders also received the questionnaire for railway undertakings because these parties make also offers for rail transports.

The questions have been carefully chosen to ensure that all important information for the further project work would be of high quality. The knowledge and contacts of the project participants helped to get the contact addresses. Further information was collected from the web sites of the European organisations Rail Net Europe, Forum Train Europe, International Union of Combined Road-Rail Transport Companies, Community of European Railways and Infrastructure Companies and the European Rail Freight Association.

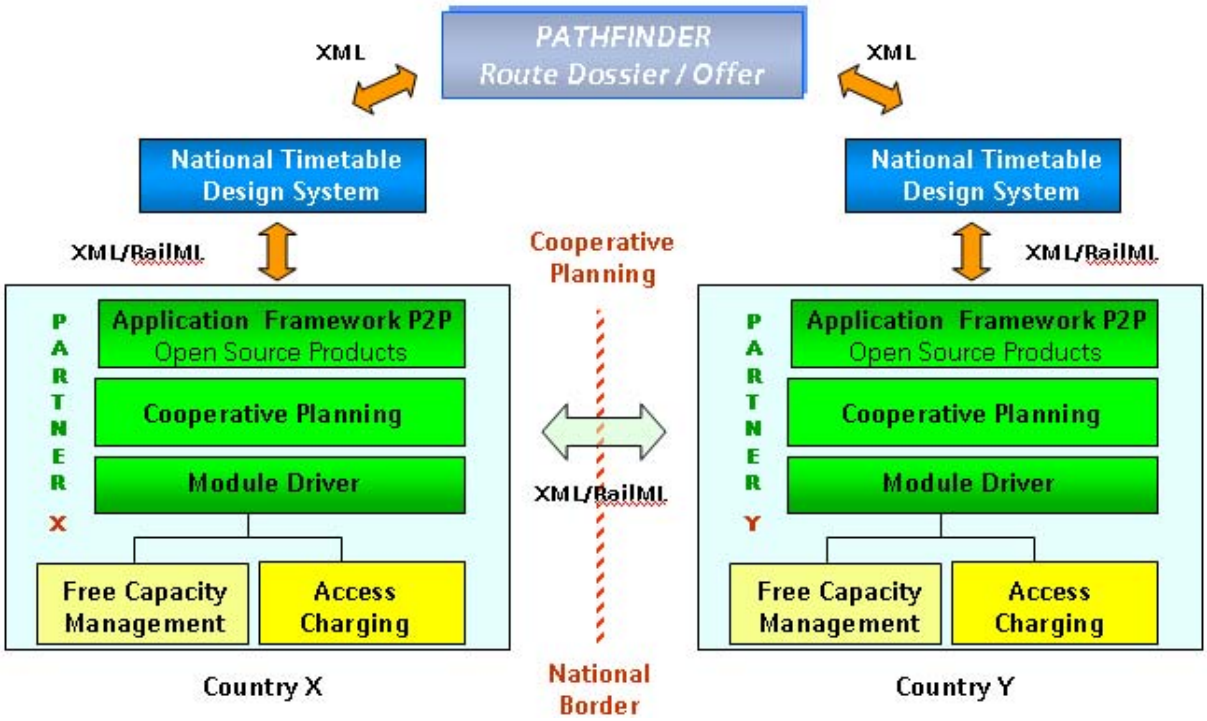
2.2 Determination of the user and technical requirements

The results of the survey were used along with the existing experiences of the timetabling process to describe the user demands. These demands were in the following procedure discussed with representatives of two infrastructure managers (Rete Ferroviaria

Italiana and OeBB paths management). Further, we organized a workshop for infrastructure managers during the INNOTRANS at Berlin in September last year. There we presented the first project results and tried to get additional suggestions for our project work.

One result of these steps was the general idea of how to structure the basic PARTNER solution in the existing environment (figure 1). This step should ensure that the infrastructure managers who will apply the PARTNER software solution can continue using their national timetable planning systems.

Figure 1: PARTNER basic structure of interfaces



Source: Siemens PSE

PARTNER documents are written using open standards like the eXtensible Markup Language (XML) and relying upon current initiatives on railways data standardization from RailML.org. They will keep the presentation elements separate using different localised style sheets, thereby allowing the system to show the user document contents in a way they are accustomed to. The choice of XML was also driven by the need to achieve a higher level of interoperability between PARTNER, the existing national legacy systems for timetable design, and the specialized algorithmic tools. This should help to achieve a high level of user acceptance and to provide interfaces to other systems like to PATHFINDER, the common platform for infrastructure managers and railway undertakings to exchange timetabling data under promotion of Rail Net Europe. To ensure platform independence, which is vital to interoperability among heterogeneous workstations, PARTNER desktop shall be implemented in Java, while its communications architecture shall build on top of JXTA.

3. First project results

3. 1 Results of the survey with European infrastructure managers and railway undertakings

We obtained a response rate of 41 percent of infrastructure managers and 16.5 percent of railway undertakings. In table 1 are shown some details about the assignment of countries.

Table 1: Participation rate of the infrastructure managers and railway undertakings

Country	Infrastructure Managers		Railway Undertakings	
	Interviewed	Response from	Interviewed	response from
EU Countries incl. Norway and Switzerland	20	9	76	14
former accession countries	8	2	13	1
non EU countries	6	3	7	1
Total	34	14	96	16

The participants included eight railway undertakings and five operators of combined road-rail transport, one other transport operator and two sellers of railway transports. They came from ten different European countries. Thirteen railway undertakings are active in the freight market and six have experiences for the rail passenger transport.

The following figure 2 shows the number of infrastructure managers representing smaller and bigger rail network extensions.

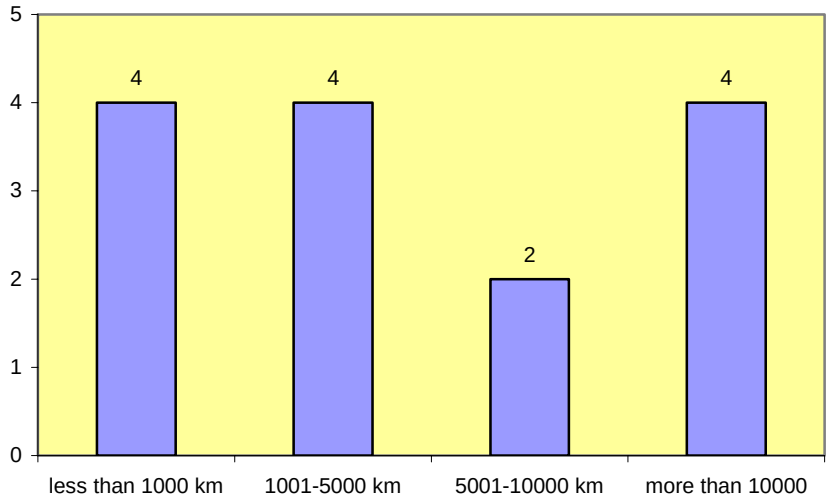


Figure 2: The number of infrastructure managers managing different rail networks by size

A well-balanced spectrum of interests is also noticed within the group of railway undertakings, which reflected passenger as well as freight transport. The criteria are the number of international trains crossing one or more European borders that are managed by these railway undertakings and their transport performance considering new rail operators as well as the railway operators with a long history. Despite the small number of respondents, the answers can be regarded as representative of the views of infrastructure managers and railway undertakings. The number of paths correlates with the extension of the network. Generally speaking, a central conclusion to be drawn from the survey is that there is a high demand for planning new paths or adapting existing paths. The project members assume that

the number will accordingly increase during the next years based on the economic development in a larger European Union and the ongoing liberalisation in the railway sector.

One part of the survey was aimed at the current process of timetable design and path allocation between two or more independent infrastructure managers with regard to international route planning and the tools used to support this process.

All infrastructure managers said that they already use software products for timetabling and also all infrastructure managers saw the need for the international paths coordination to improve and thought that software applications are necessary. The requirements of the developments in the European rail market were described in the next table 2.

Table 2 Due to open railway markets, the path allocation process will in any case require (response of infrastructure managers)

response	yes	no	don't know
more labour force	7	5	2
improved CAD tools	12	1	1
improved processes	14	0	0

Twelve of the fourteen infrastructure managers expressed familiarity with PATHFINDER for international timetabling and eight of them already use PATHFINDER. At present, infrastructure managers contact other infrastructure managers and vice versa with regard to cross-border timetable design mainly by phone, by e-mail, by facsimile or at joint meetings. Twelve infrastructure managers as well believe that a computer-based workflow will improve the process and eleven infrastructure managers would be prepared to share other timetable information. Most of the infrastructure managers are willing to share information about space capacity with others to advance the process of international route planning.

The conclusion to be drawn from these answers is that there exists scope for a higher degree of cooperation for more data exchange in the international timetable process. It is therefore to be concluded that there is an interest in using new software tool or systems like the one addressed bv PARTNER.

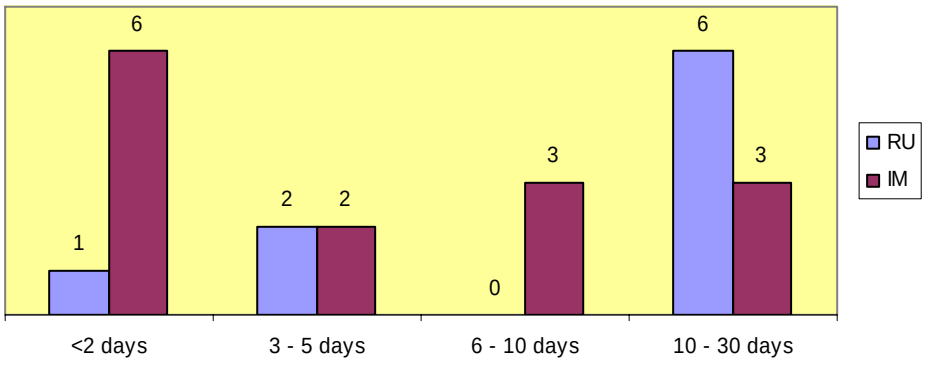


Figure 3: Comparison of the infrastructure managers and railway undertakings estimation of the necessary time to respond to a short notice for a new international train path

Further, by comparing the answers of railway undertakings and infrastructure managers it is evident that there exists a wide difference between these two interest groups concerning the estimate of the necessary average time to respond to a request on short notice for a new international train path (figure 3).

That difference can be partly explained by the fact that several infrastructure managers have remarked that they in some cases miss additional data from railway undertakings to start

the domestic timetable process. When they cannot obtain these data by the neighbour infrastructure manager, they either have to ask the domestic railway undertaking (which will haul the train) or give back the request to the neighbour infrastructure manager to add the necessary data.

The majority of the involved railway undertakings and infrastructure managers want to manage faster planning or re-planning (adaptation) of timetables. Railway undertakings appear to be more eager in this regard. The participants who answered 'YES', which included most of the infrastructure managers (8 of 14) and the majority of railway undertakings (10 of 16), expressed that this "time to respond" can be reduced to within 24 hours.

Another part of the questionnaire was aimed at characterizing the activities falling under the allocation of rail capacity and charging on international routes from the point of view of business process management. This provided a foundation for the following steps and workflow of PARTNER.

One of the objectives of PARTNER is to make a suggestion for a charging method that is based upon some generalized formula. In order to understand the current charging methods and to get a clearer picture of what a 'fair' charging method should look like, we wanted to learn more about the current situation.

We found that the opinions of infrastructure managers and railway undertakings are in general similar. The majority of the respondents think that a charging system should vary according to "the type" and "the weight of the trains". With regard to the "time of the day" and "the expected congestion of the route" there was more disagreement. While the majority of both groups still emphasized a willingness to consider these aspects, 40 % of railway undertakings believed that they should not be included in a fair charging system.

Otherwise we uncovered two differences between the opinions of infrastructure managers and railway undertakings. Most infrastructure managers wanted to retain the national charging rules, but the majority of railway undertakings felt the rules should be changed. The other point is that the majority of infrastructure managers refuse to impose penalties on slower trains that impose lower speeds on faster trains on the same line section. 56% of Railway Undertakings think that this rule would be desirable. From the above sample, we may conclude that the railway market has not yet achieved full convergence about the infrastructure managers and railway undertakings views about the path charging on international corridors. These results have had also influence to the project work.

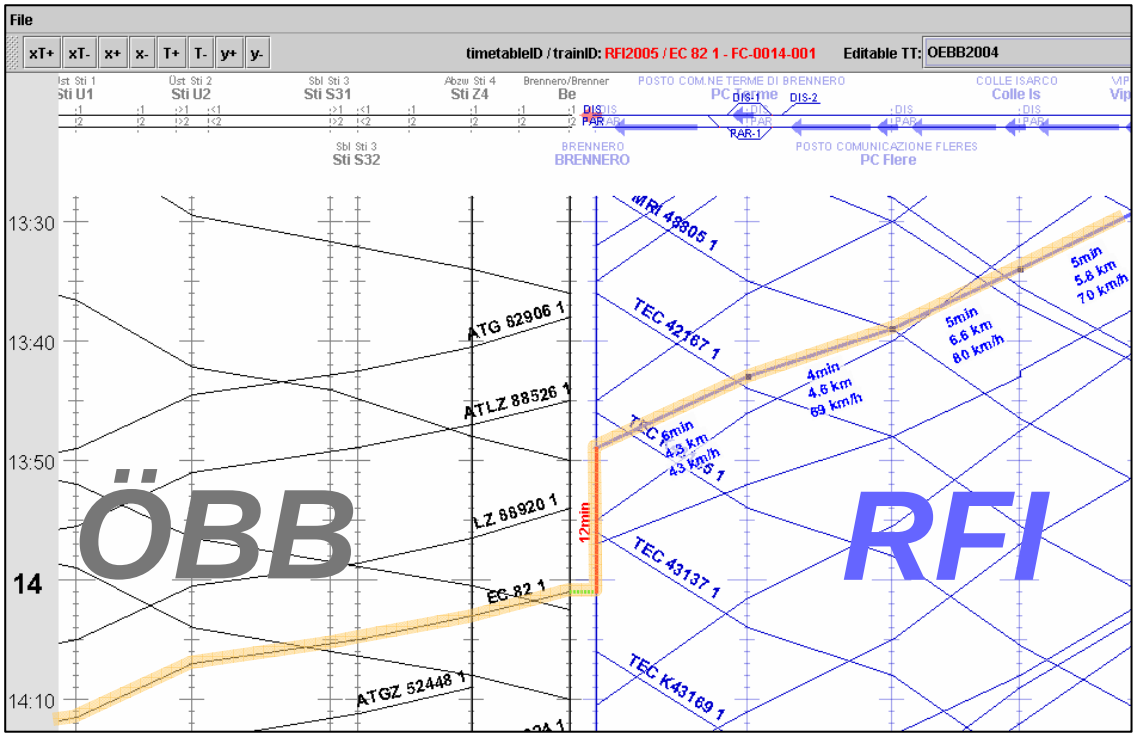
3.2 Tools of PARTNER

Based on the gained experiences PARTNER will allow its users to collaboratively edit shared documents describing line network data and train timetables. Thus users, by applying different train patterns (kind of rolling stock characteristics) and timetable patterns (generic train running times), will be able to re-arrange the existing train paths to go for improved capacity management. Moreover, PARTNER will support the grouping of documents to build different scenarios, thereby making what-if analyses easier. PARTNER will assist two neighbour infrastructure managers to develop a common understanding of the effects of international train paths on each local timetable system. Central to PARTNER is the idea of creating and managing a shared design space where a team of timetable planners shall meet, discuss, trade and mediate in achieving their common goal of building a train path across national borders.

Documents may be created, copied, and edited to detail a specific aspect of the world, not taking into account other aspects but simply referencing other documents where they are described. Document contents are synchronized across different workstations using a file sharing peer-to-peer approach. Specialized graphical objects (user interactive influence) are

used to manipulate document contents, e.g. the train graph interactive influence shown in figure 4.

Figure 4 Sample train path user for a cooperative planning screen OeBB-RFI



PARTNER provides ways to organize implicit knowledge about how people solve recurring train timetable problems in the form of train patterns.

A train pattern is a relationship between:

- a reference configuration for trains with common technical characteristics (a.k.a. reference train)
- a railway network reference configuration for trains running along that line (tracks, stations, stops, signalling and speed profiles) (a.k.a. reference route)
- a reference configuration for possible timetables representing allowable time-ways for trains of that kind running along that line configuration (a.k.a. basic running times)

Train and line characteristics represent the context of the timetable design problem being considered. Trains running along the line are considered as a system of forces which occurs repeatedly in that context (i.e. the recurring problem). Train timetables are the solution of the recurring problem. Their configuration allows the forces acting in that context to resolve themselves in a feasible way.

PARTNER train patterns are intended to capture solutions, not just abstract principles or strategies. PARTNER users, by applying different train patterns (e.g. rolling stock characteristics) and timetable patterns (e.g. basic train running times), will be able to re-arrange the existing train paths to go for improved capacity management. As individuals begin to share information, expertise, best practices, and content about cross-border timetable problems in the form of train patterns, the network's potential value in terms of knowledge will increase. The likelihood of finding answers increase exponentially as such a network expands.

Currently, two kinds of tools are under development from the Universities of Bologna and Tilburg (in assistance with Genova and Santiago): one for train timetable problem

solving, another for infrastructure access charging. With the help of advanced scheduling algorithms based on mathematical programming techniques, a first test of train capacity on the line Brenero-Bologna with 48 stations and 54 trains was carried out. The sample solution of the new scheduling algorithm allows four more trains to run by lower influence on existing paths.

Otherwise the determination of a common method based on existing charging methods and economic foundation will enable economic studies for access to infrastructure, in a competitive environment.

To increase the level of interaction among a virtual team of timetable planners, PARTNER shall also leverage the now widely available technologies like Internet chat, instant messaging and video conferencing. The multimedia support is optional. PARTNER does not plan to spend effort to develop a specialized audio/video conferencing software, but leverage upon existing commercial off-the-shelf packages or other ones available in the public domain. PARTNER, being built on top of peer-to-peer (P2P) technologies, will create a timetable planners virtual network where heterogeneous workstations share information directly, without the need of dedicated central servers.

4. Conclusion

The PARTNER project is realizing a new solution for internationals timetabling. In the final phase of the next months we will demonstrate the workability of the system and the user acceptability. We plan to conduct an evaluation for assessing performance and PARTNER exploitability as a commercial product.

Based on the existing experiences and a state-of-the-art overview, the project members could commonly develop a new customer oriented solution which will help to pave the way for a common European railway system.

5. References

1. State-of-the-Art and User Needs in Capacity Management and Access Charging; Report of project PARTNER, May 2004; download at www.rail-partner.org
2. User and Technical Requirements, Specification for Demonstrating and Testing, Report of project PARTNER, October 2004