IJR International Journal of Railway
Vol. 1, No. 4 / December 2008, pp. 134-142

The Korean Society for Railway

Meeting the Demands for Major International Traffic Flows through Railnet Austria's Maintenance and Capacity Planning Regime

R. Herbacek*†, K. Petri*, and B. Ertl*

Abstract

Serving as a strategic crossing point for major corridors in Central Europe, Railnet Austria's Infrastructure Network incurs continual increases in international traffic flows and is therefore subject to accumulating traffic congestion with potential restrictions to infrastructure access. This imposes challenges towards preserving open access to Railnet Austria's existing railway network and hinders quality infrastructure service during maintenance, repair, and upgrading. Through Railnet Austria's experiences, the economic viability of a railway network can be sustained through maintaining open access with good quality service of planned trainpaths, thus representing new challenges for future infrastructure maintenance and capacity planning. Railnet Austria's Capacity Management Department has proven that these challenges can be accommodated more effectively through recent technological developments in data warehousing and software development.

Keywords : *Maintenance, Capacity*

1. Today's Challenge

The growth of international traffic volumes on Railnet Austria's railway network is important to its economic viability in future years, and presents the need to maintain a high level of service through infrastructure maintenance, repair, and upgrading. These measures however introduce restrictions to infrastructure access through reduced travel speeds, track closures, and many other obstructions that hinder quality service for international traffic flows. Fig. 1 illustrates Railnet Austria's importance to Europe with its international corridors.

2. Capacity Measurement

In order to maintain good quality of service with all trainpaths and each infrastructure restriction, Railnet Austria uses the methodology for measuring line capacity from the International Union of Railways (UIC leaflet 406) with IT support to quickly determine the degree of capacity for timetables along heavily traveled sections. Fig. 2 illustrates a section with traffic congestion over 24 hours on its busiest corridor from Germany through Austria (Vienna) towards Hungary and Slovakia.

This congested corridor along with others demonstrates Railnet Austria's need to effectively manage infrastructure restrictions by minimizing delays and keeping its railway network open for the maximum amount of time. This can only be achieved through technological developments in data warehousing and software development.

3. Technological Development in Data Warehousing and Software Development

The changes in Railnet Austria's company structure have resulted in a new regime for infrastructure maintenance, repair, and upgrade measures, along with the management of infrastructure restrictions and railway traffic. Each maintenance, repair, or upgrade item is predefined with the required timeframe and spatial infrastructure boundaries. Recent technological developments in data warehousing and software development managed by Railnet Austria's Capacity Management Department enables a more precise understanding of planned trainpaths by defining electronically timeframes and spatial infrastructure

† *OEBB, Vienna, Austria
E-mail: robert.herbacek@oebb.at (R. Herbacek)
E-mail: klaus.petri@oebb.at (K. Petri)
E-mail: bryan.ertl@oebb.at (B. Ertl)

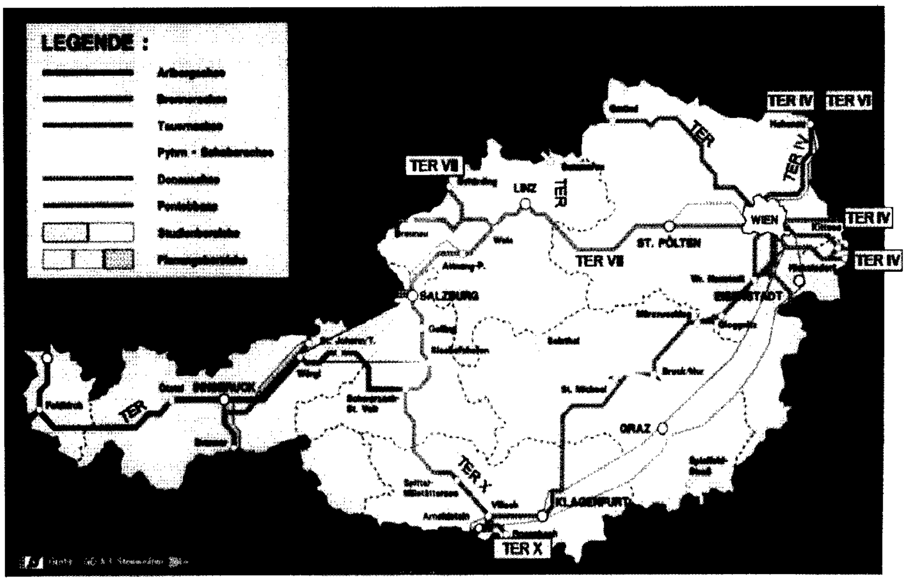


Fig. 1 International Corridors through Austria

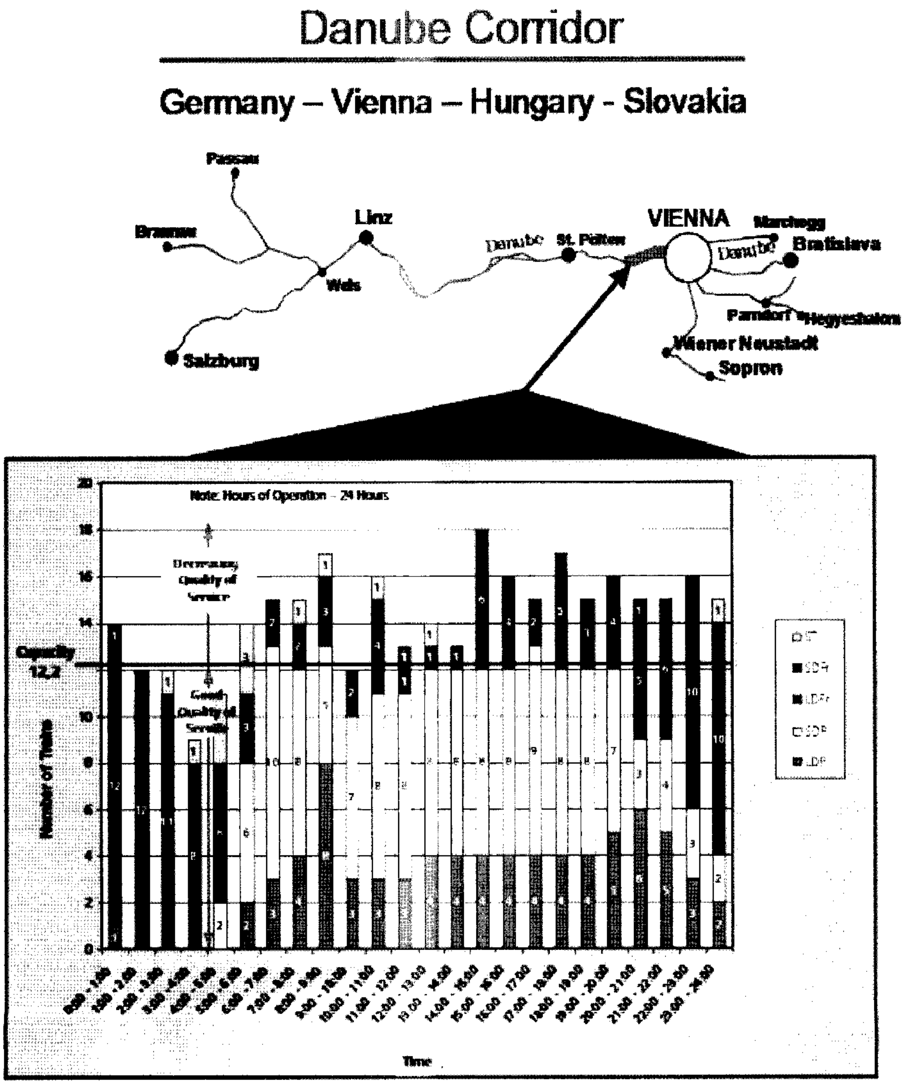


Fig. 2 Congested Corridor Section

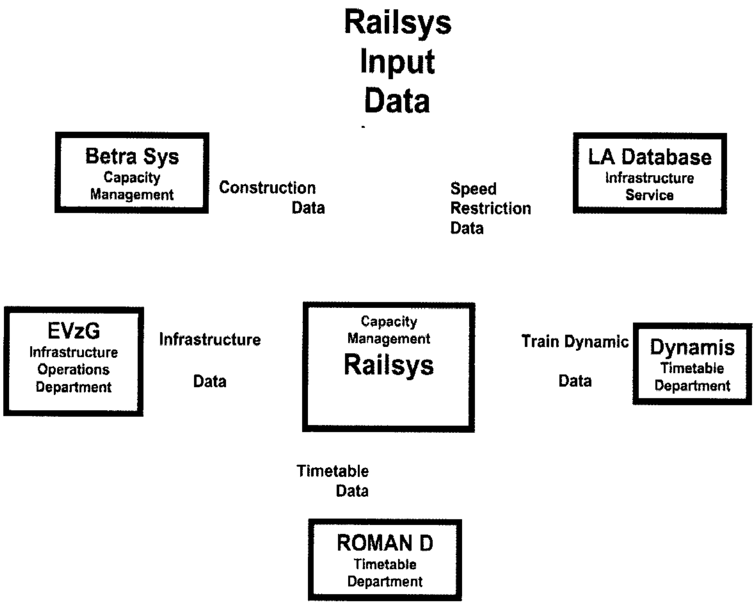


Diagram 1

boundaries required for maintenance, repair, and upgrades using a software, RailSys.

RailSys incorporates Railnet Austria's entire infrastructure network, timetable, train dynamic information along with all construction and infrastructure restriction information by interfacing with software and databases from other departments (see Diagram 1).

Planned Railway Network Development

The basis for analyzing Railnet Austria's railway network with day to day infrastructure restrictions requires Railsys to have a planned railway network, which includes infrastructure, timetable, and trainpath dynamic data. The infrastructure data is developed electronically on a micro-level, where each infrastructure component such a signal or switch is taken into consideration. These components include the attributes required for operating railway traffic and use the physical characteristics of each train along with time reserves to construct all planned trainpaths from a timetable electronically. By interfacing with a software from our Infrastructure Operations Department (EVzG), this infrastructure database can be imported on a microscopic level. Similarly, Railsys interfaces with two software products from our timetable department, "ROMAN D" and "Dynamis", to obtain timetable data and corresponding information on trainpath dynamics.

Actual Railway Network Development

Using the planned railway network as a basis, Railsys

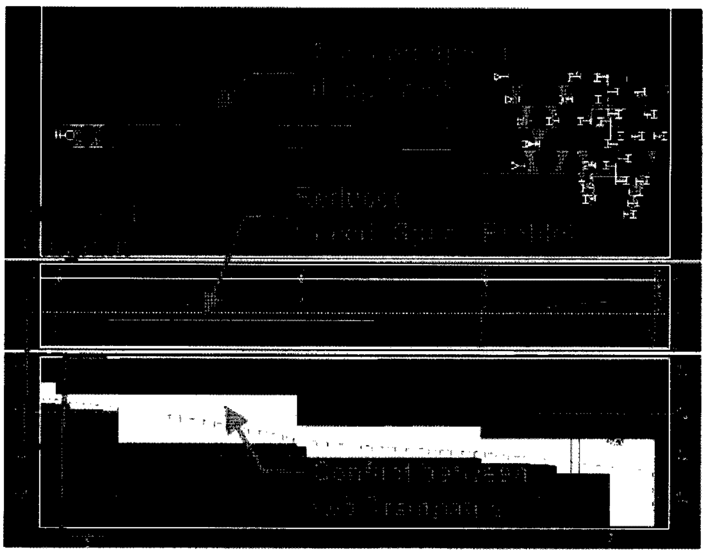


Fig. 3 Impact of lowering a Speed Section

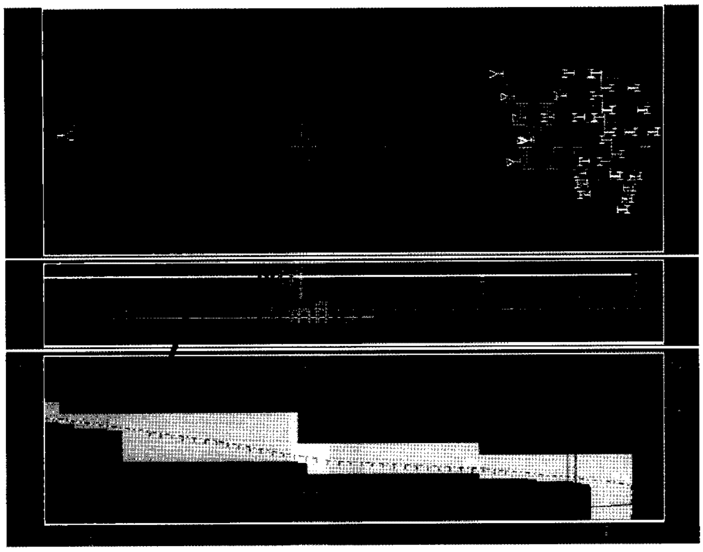


Fig. 4 Redirecting Trainpaths

interfaces with two databases managed by our Infrastructure Service Department, "Betra Sys" and "LA Database". Using "Betra Sys", Railsys obtains all infrastructure restriction data regarding construction such as track closures. With "LA Database", Railsys obtains data on track conditions, such as reduces speeds of travel.

3.1 Case 1 - Analyzing Impacts to Rail Operations from Deteriorating Track Conditions

Case 1 is an example of analyzing the impacts to two trainpaths from infrastructure restrictions towards travel speeds. Using infrastructure restriction information such as reduced speeds from "LA Datenbank", Railsys incorporates the speed reduction along a particular length of track and automatically recalculate the dynamics of all affected trainpaths. Fig. 3 illustrates a 1-Kilometer section and the impacts of lowering a speed from 100 km/h to 40 km/h due to deteriorating track conditions.

The upper part of Fig. 3 illustrates the infrastructure outlining a two track section with the 1-Kilometer Section highlighted in purple. This section is illustrated underneath as a "green" line in a Speed-Distance Profile. The same section highlighted in purple is illustrated in the bottom portion of Fig. 3 as a background in a trainpath diagram. This section of reduced speed of travel automatically recalculates the dynamics of corresponding trainpaths (highlighted in blue and yellow) and results in conflicts highlighted in white, thus demonstrating that the planned timetable for this section is no longer functional.

Using this profile, trainpaths can be dragged and dropped to an area where no conflicts (white shaded areas) are illustrated (See Fig. 4). For more congested sections, areas of multiple track can be utilized by redirecting train-

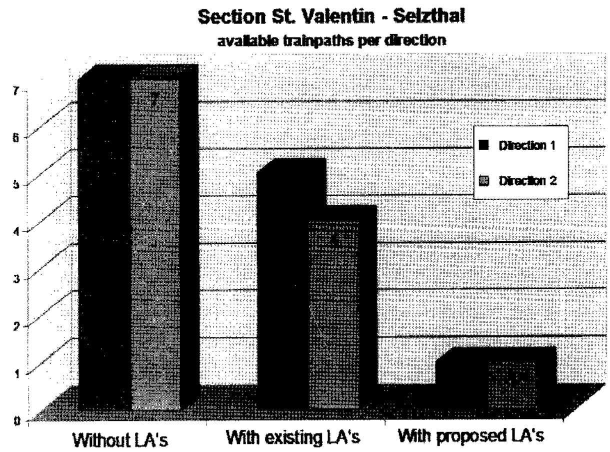


Fig. 5 Impacts to Capacity from sections with reduced speeds (LA's)

paths on other tracks to prevent conflicts.

The result using this procedure is to quickly develop an understanding of how such speed reductions can lower capacity (trainpaths). Fig. 5 illustrates the impacts of existing and proposed sections with reduced speeds referred to as "LA's" on the capacity in trainpaths.

3.2 Case 2 - Analyzing Impacts to Rail Operations from both Deteriorating Track Conditions and Construction

Building upon Case 1, Case 2 is an example of analyzing the impacts to multiple trainpaths from both reduced speeds of travel and track closures. Fig. 6 illustrates a section of double track with a trainpath profile along one track according to our timetable. The representative track is highlighted in the upper portion of the figure in yellow, while all trainpaths are represented in one direction in the

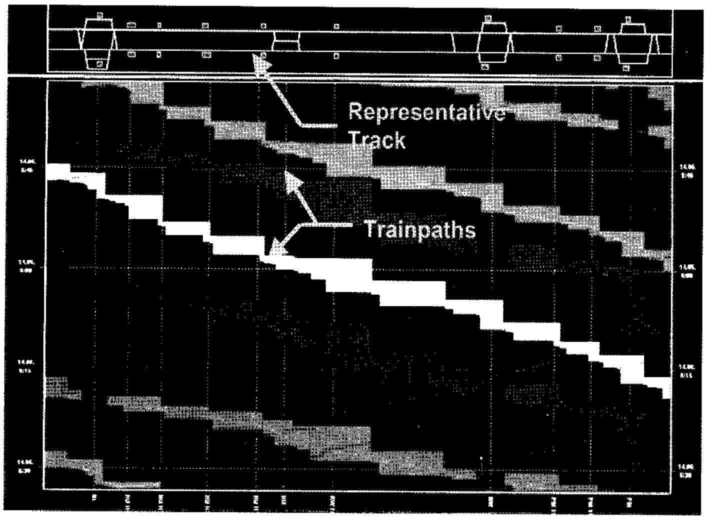


Fig. 6 Double Track and Trainpath Diagram

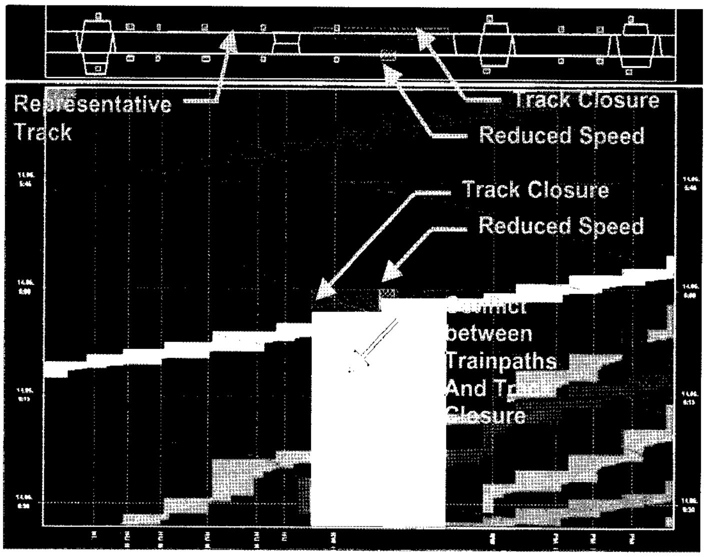


Fig. 7 Double Track and Trainpath Diagram with Reduced Speed and Track Closure

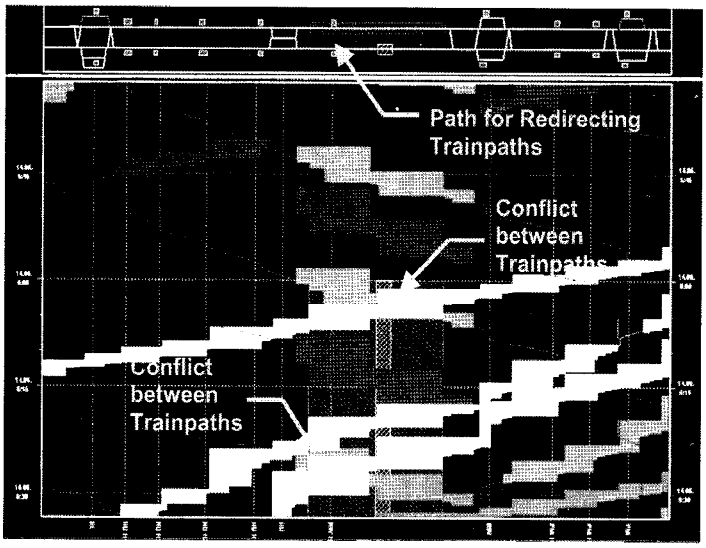


Fig. 8 Redirected Trainpaths onto lower Track

Fig. 9 Trainpaths for Re-Routing or Removal

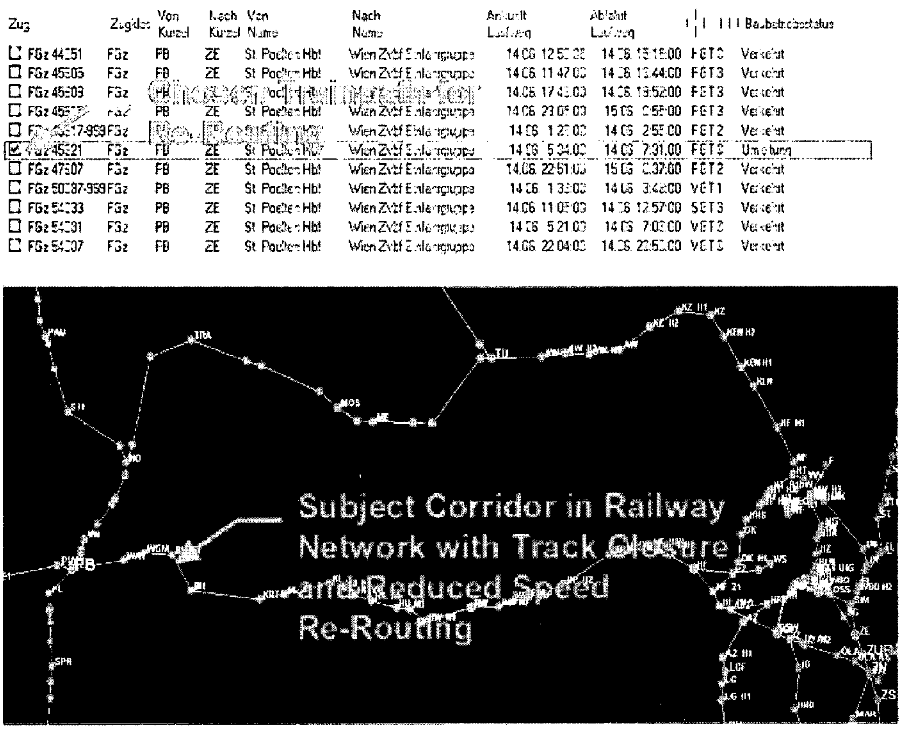


Fig. 10 Re-Routing Function and Subject Corridor with Track Closure and Reduced Speed

bottom portion.

Using Betra Sys and La Datenbank, both information from track closures and reduced speeds can be inputted along this stretch of track, which is illustrated in Fig. 7. In the upper portion of Fig. 7, the section of track closure is highlighted on the upper track with a purple box and the section of reduced speed is highlighted on the lower track with a yellow box. The representative track is that with the track closure highlighted in yellow. Both section of reduced speed of travel and track closure is highlighted in the background on the bottom portion of the figure. The Conflict between the track closure and trainpaths is illustrated in a white highlighted area.

To manage this particular case, the trainpaths on the upper track can be re-routed onto the lower track. Fig. 8 illustrates a trainpath profile of the lower track with the re-routed path highlighted in the upper portion of the figure in yellow. By re-routing these trains, Railsys automatically recalculates the travel time of all trainpaths based on infrastructure and trainpath dynamics. The results illustrate that the measure of redirecting all trainpath results in new conflicts between trainpaths traveling in opposite

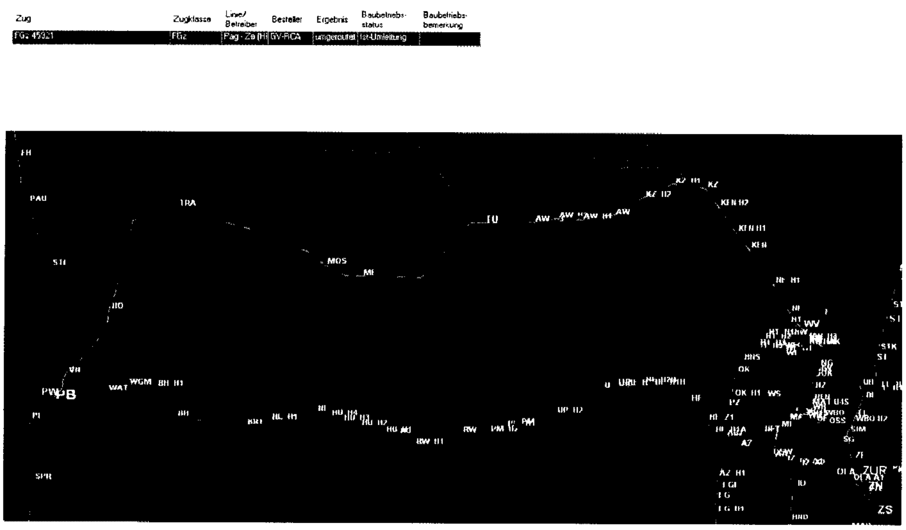


Fig. 11 Re-Routing Function with Chosen Corridor for Re-Routing Trainpath

directions on the same track.

Resolving these conflict areas can be done either through re-routing or by canceling trainpaths. The disclosure of this information through Railsys allows the Railway Operations Planner to negotiate new solutions with clients. Hence, clients can be informed early enough before such infrastructure measures take place, and therefore re-plan any trainpaths subject to changes. Fig. 9 illustrates a possible decision with clients to remove one trainpath and re-route another trainpath (both grey coloured).

The chosen route within a railway network for re-routing trainpaths is carried out in Railsys using a "Re-Routing Function" called "Um-Routen". Fig. 10 illustrates this function with a list of trainpaths for the subject corridor and chosen train for re-routing. The subject corridor is that with both track closure and reduced speed and is highlighted in yellow.

Fig. 11 illustrates the chosen route within a railway network for re-routing the trainpath.

Those trainpaths without conflicts are also subject to negotiation with clients by disclosing information on delays or other timetable alterations. Railsys can automatically illustrate such information in illustrative or tabular form. Fig. 12 illustrates a stringeline diagram output from Railsys with the horizontal axis along the length of track and vertical axis over elapsed time. The shaded area indicates the section of track length subject to either track closures or reduced speeds. Each stringeline has the identification of trainpath along with elapsed time, whereby the delay from the infrastructure restriction is illustrated in brackets. This information enables the Railway Operations Planner to disclose this information to clients

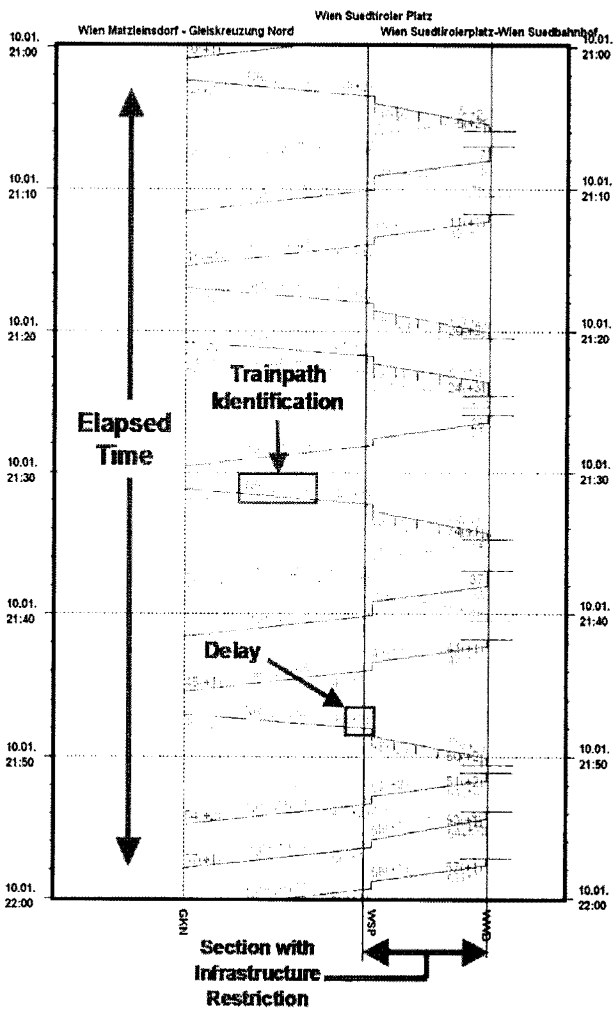
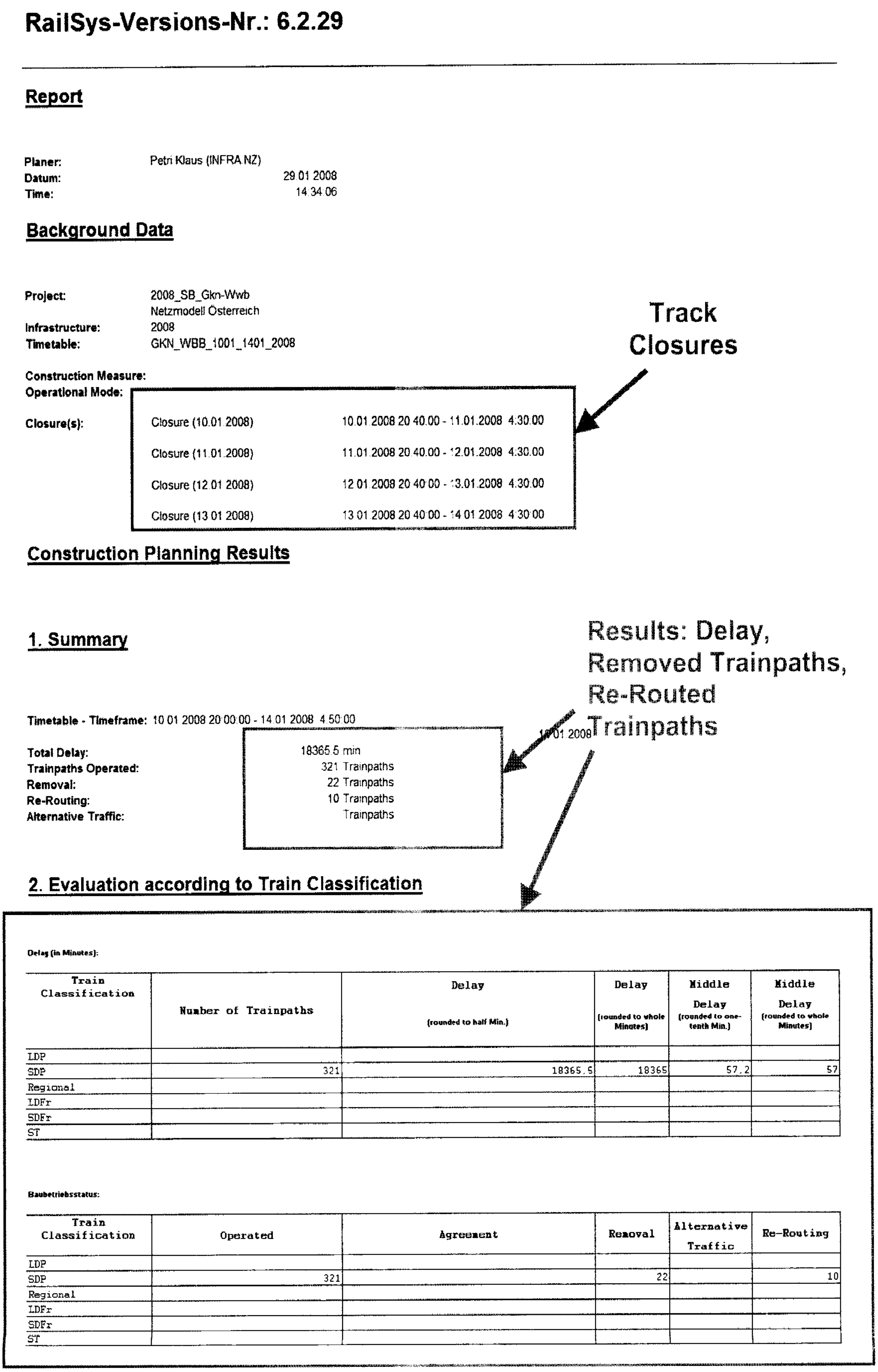


Fig. 12 Railsys - Stringeline Diagram Output

and re-negotiate trainpath alterations.

In addition to a stringeline diagram output, Railsys can



RailSys-Versions-Nr.: 6.2.29

Report

Planer: Petri Klaus (INFRA NZ)
Datum: 29 01 2008
Time: 14 34 06

Background Data

Project: 2008_SB_Gkn-Wwb
Netzmodell Österreich
Infrastructure: 2008
Timetable: GKN_WBB_1001_1401_2008

Construction Measure:
Operational Mode:

Closure(s):

Closure (10.01 2008)	10.01 2008 20 40.00 - 11.01.2008 4:30:00
Closure (11 01 2008)	11.01 2008 20 40.00 - 12.01.2008 4:30.00
Closure (12 01 2008)	12 01 2008 20 40 00 - 13.01.2008 4.30 00
Closure (13 01 2008)	13 01 2008 20 40 00 - 14 01 2008 4 30 00

Construction Planning Results

1. Summary

Timetable - Timeframe: 10 01 2008 20 00 00 - 14 01 2008 4 50 00

Total Delay:	18365 5 min
Trainpaths Operated:	321 Trainpaths
Removal:	22 Trainpaths
Re-Routing:	10 Trainpaths
Alternative Traffic:	Trainpaths

2. Evaluation according to Train Classification

Delay (in Minutes):

Train Classification	Number of Trainpaths	Delay (rounded to half Min.)	Delay (rounded to whole Minutes)	Middle Delay (rounded to one-tenth Min.)	Middle Delay (rounded to whole Minutes)
LDP					
SDP	321	18365.5	18365	57.2	57
Regional					
LDFr					
SDFr					
ST					

Baubetriebsstatus:

Train Classification	Operated	Agreement	Removal	Alternative Traffic	Re-Routing
LDP					
SDP	321		22		10
Regional					
LDFr					
SDFr					
ST					

Fig. 13 Results Summary

summarize the results in tabular form (See Fig. 13).

4. Conclusion

The automation of managing infrastructure restrictions with increased international traffic flows has enabled Railnet Austria to maintain a high quality of service. A more precise understanding of trainpath-behavior enables railway experts from Capacity Management to respond quickly with the responsible department for infrastructure maintenance (Infrastructure Services) regarding the management of infrastructure restrictions in cooperation with maintenance management. Most importantly, Capacity Management can maintain a higher quality of service by responding quickly to clients and preserving customer satisfaction for international traffic.

Reference

1. UIC Leaflet 406, 1st Edition 2004, International Union of Railways (UIC), Paris.