





Capacity KPIs and visualisations Portfolio

Deliverable	Portfolio
Date	26.03.2024
Version	1-00



optimising railways

[1] General structure

Paths and TCRs

Pétange – Belval (LU).

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



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National passenger train

train N

[1] General structure

Paths and TCRs

Bertrix – Aubange (BE).

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



This TCR (8 am > 3 pm) is planned on track 2. If it's allowed by the infrastructure topology and signalling, in this situation, trains will run on both directions, using only track 1. So TCR will impact both directions and not only Aubange > Bertrix.



Inter regional passenger train Regional passenger train

National passenger train

VR

N

TCR

[1] General structure

Paths and TCRs

Kleinbettingnen – Luxembourg (LUX).

20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

A capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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Paths and TCRs

Essen – St-Mariaburg (BE). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



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[1] General structure

Paths and TCRs

Arles – Tarascon (FR). 20.09.2022

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▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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TOP

TCR

[1] General structure

Paths and TCRs

Zoufftgen – Thionville (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

A capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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[1] General structure

Paths and TCRs

Valenciennes – Aulnoye (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



[1] General structure

Paths and TCRs

Toul – Neufchâteau (FR).

20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



[1] General structure

Paths and TCRs

Montzen – Botzelaer (BE). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



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[1] General structure

Paths and TCRs

Sedan – Lumes (FR).

20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

A capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.





Paths and TCRs

Réding - Saverne (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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Paths and TCRs

Lille – Tourcoing (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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Paths and TCRs

Longuyon – Mont-Saint-Martin (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.



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CORRIDOR NORTH SEA - MEDITERRANEAN



Paths and TCRs

Thionville – Apach (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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Paths and TCRs

Haumont – Aulnoye (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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[1] General structure

Paths and TCRs

Ambérieu – Lyon (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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[1] General structure

Paths and TCRs

Mâcon – Villefranche-sur-Saône (FR). 20.09.2022

This image is from the Proof of Concept, for the specific assumption, see PoC deliverable.

▲ capacity consumption attributed to the different trains is another capacity representation, and can be calculated with different methods.

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Anvers – Thionville (by a chosen itinerary, not the most frequent)

AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)

12 13 14 15 16 17 18 19 20 21 22 23 0 (+1) 10 11 km ANTW-ND-B2 64.2 39.3 MUIZEN 21.7 Only freight 21.1 trains on L27 **LEUVEN 107.5** 28.9 Some freight trains during day but OTTIGNIES 28.9 most freight trains during night in BE 23.9 Systematic passenger FLEURUS 52.8 offer during all day in BE 38.7 MANAGE 43.7 25.8 MONS 39.9 15.9 QUEVY-FR 76.2 17.5 - NA AULNOYE-AYMERIES 215.6 40.7 HIRSON 122.6 Freight trains during night on 79.4 TCR générique Artère Nord-Est V 1110 during day on Artère Nord-Est **SEDAN 158.5** Passenger trains around 69.5 Sedan during Passenger peak hours trains around LONGUYON 228.0 Thionville during day 49.2 THIONVILLE 188.0 9 10 11 12 13 14 15 16 17 18 19 20 21 22 230(+1) n

Significant findings about freight trains

TCRs during day on Artère Nord-Est

High number of itineraries used

High density of passenger traffic in Belgium

15.09.2022







[1] General structure

Anvers – Thionville (by a chosen itinerary, not the most frequent)

Significant findings about freight trains

TCRs during day on Artère Nord-Est High number of itineraries used High density of passenger traffic in Belgium



15.09.2022



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[1] General structure

Anvers – Thionville (by a chosen itinerary, not the most frequent)

Significant findings about freight trains

Here TCR > 50 days in BE : important TCR impact TCRs during day on Artère Nord-Est High number of itineraries used High density of passenger traffic in Belgium



15.09.2022



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10

11 12 13 14 15 16 17 18 19 20

21 22 23 0 (+1)

Aulnoye

Longuyo

Thionvill

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THIONVILLE 188.0

Significant findings about freight trains [1] General structure **AVAILABLE** Not so much freight traffic but in France it's "construction" process phase, and a lot of freight CAPACITY AT A Thionville – Basel (by the chosen trains seem to be added during "adaption" phase **GIVEN MOMENT** TCRs during night on the route itinerary, not the most frequent) Long stops at Mulhouse (2022)High density passenger traffic on Plaine d'Alsace 23 0 (+1) 15.09.2022 12 13 15 19 20 21 22 THIONVILLE 188.9 UCKANGE 177.6 Passenger trains WOIPPY 160.2 METZ-VILLE 154.3 5.9 around Metz 22.2 REMILLY 132.1 TCR during night 65.3 <> Saarbrucken between Reding and Strasbourg REDING (CHANTIER) 66.8 22.8 Passenger trains SAVERNE 458.0 around Strasbourg 21.7 MOMMENHEIM 479.7 12.7 VENDENHEIM 492.4 HAUSBERGEN 497.2 TCR during night 4.8 between Strasbourg 23.3 and Basel ERSTEIN 19.8 23.4 Synoptic plan of the alternative Thionville outes Thionville - Basel with frontiers - and preferred itinerary selected SELESTAT 43.2 22.6 COLMAR 65.8 High density passenger offer on Plaine d'Alsace Reding with few freight paths 71.6 BALE-ST-JEAN 137.8 2 3 11 12 13 14 15 16 17 18 19 20 21 22 230 (+1) 0 1 10



by the IM working group)

Nancy

Woippy – Avignon (by the chosen itinerary, not the most frequent)

AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)

15 16 17 18 19 20 21 22 230 (+1) km WOIPPY FAISCEAU 163.5 32. **ONVILLE 332.8** Passenger trains 42.8 around Metz LEROUVILLE SUD (BIF) 1.0 25.8 BIF DE TOUL SUD 1.6 Most often (but not 39.5 NEUFCHATEAU 70.9 on this date) TCR during day between 75.7 Toul and Dijon CULMONT-CHALINDREY_RELAIS 389.1 72.7 Medium density passenger traffic between Dijon and Lyon, PERRIGNY-TRIAGE P2 0.1 which allows freight traffic 64.3 NONE WANKING AND COMMON CHALON-SUR-SAONE 382.2 57.6 TCR during night in Passenger trains Bourgogne (freight by Bresse) around Lyon **MACON 439.7** 66.5 LYON-VAISE (DEPOT) 506.3 99.0 Rive Droite du Rhône TOURNON 602.6 with freight traffic 63.0 LE TEIL 665.6 Most often (but not on this date) TCR during day on Rive Droite 78.9 (trains by Rive Gauche) VILLENEUVE-LES-AVIGNON 744.6 11 12 13 14 15 16 17 18 19 20 21 22 230 (+1) 0 2 3 5 6 8 9 10

Significant findings about freight trains

Only section without alternative route : Toul - Dijon

On this section TCRs during day are significant

High density of freight traffic on this route North <> South

15.09.2022



Culmont

Bourg-en-

Bresse

Rive

gauche

Rhône

Diion

Mâcon

Lyon

Rive

droite

Rhône

Avignon



Calais – Woippy (by the chosen itinerary, not the most frequent)

Significant findings about freight trains

TCRs during day on Artère Nord-Est No so much freight traffic despite a lot of possible routes





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Anvers – Paris (by the chosen itinerary, not the most frequent)

Significant findings about freight trains

High density passenger traffic on the Belgian part of this route Not so much freight on this route



AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)

15.09.2022







AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)



Namur

Aubange

Thionville

Lux.





Lille

Aulnoye

Longuyon

Douai

Beuvrage

15.09.2022 Synoptic plan of the alternative routes Thionville – Basel with frontiers Thionville by the IM working group) Metz Nancy Reding Bale



[1] General structure

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AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)



15.09.2022







15.09.2022

Synoptic plan of the alternative Calais routes Calais - Woippy with frontiers ---- and preferred itinerary selected Hazebrouck by the IM working group) l er Arras Ostricourt l ille Namur Beuvrages Aubange Busigny Luxembourg Longuyon Thionville Woippy

[1] General structure



AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)



15.09.2022





AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)

15.09.2022

Anvers

Leuven

Ottignies

Chatelet

Aulnoye

Longueil

Paris

Busigny

Aarschot





Synoptic plan of the alternative

preferred itinerary selected by the IM working group)

Halle

Mons

Douai

routes Anvers – Paris with frontiers === and

Gent

Lille

Len

Arras

Longueau

[1] General structure



15.09.2022







15.09.2022



[1] General structure





15.09.2022

[1] General structure





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15.09.2022

Synoptic plan of the alternative Calais routes Calais - Woippy with frontiers ---- and preferred itinerary selected Hazebrouck by the IM working group) l en Arras Ostricourt Lille Namur Beuvrages Aubange Busigny Luxembourg Longuyon Thionville Woippy

[1] General structure


AVAILABLE CAPACITY AT A **GIVEN MOMENT** (2022)

16 17 18 19 20 21 22 230 (+1) 14 15.09.2022 13 15 8 9 10 11 12 km Bettembourg-D 1.2 THIONVILLE 188.0 23 WOIPPY 160.2 29.2 **ONVILLE 332.8** 42.8 LEROUVILLE SUD (BIF) 1.0 65.3 NEUFCHATEAU 70.9 XXXX//// 75.7 T-CHALINDREY RELAIS 389.1 70.3 PERRIGNY-TRIAGE IS 318.8 66.6 Synoptic plan of the alternative routes Bettembourg - Lyon Bettembourg VXVVII 1//// CHALON-SUR-SAONE 382.2 AWH Thionville N 111 1111 57.6 Onville 11 MININ Frouard Toul **MACON 439.7** 111 11 1111 H11 NA AVA 66.7 Culmont Diion 17/11 LYON-VAISE 506.4 Bourg-en-Mâcon 20.0 Bresse SIBELIN BS Bif Sud 526.1 Lvon 19 20 21 22 230 (+1) 0 11 12 13 15 16 17 18 1 2 3 5 6 8 9 10 14

[1] General structure

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Longuyon

Conflans

Lérouville

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AVAILABLE CAPACITY AT A GIVEN MOMENT (2022)

15.09.2022



preferred itinerary selected by the IM working group) Leuven Gent Halle Ottignies Mons Chatelet Lille Douai Lens Aulnoye Arras Busigny Longueil Longueau Paris Crei

[1] General structure





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[Real train data] Average daily volume of trains in 2022 v 2024-03-21





























[1] TCRs stat. typology in 2022 - zoom v2024-03-27







[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21











[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21









[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21















[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21



[5] Median daily volume of trains in 2022 v 2024-03-21



[5] Median daily volume of trains in 2022 v 2024-03-21



2022 Tuesdays (Holidays excluded) Daily volume of trains per section 20



[5] Median daily volume of trains in 2022 v 2024-03-21












[5] Median daily volume of trains in 2022 v 2024-03-21



[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21













[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21



[5] Median number of trains per section on tuesdays in 2022 and variations v2024-03-21



[5] Median planned paths speed in 2022 v2024-03-21



[5] Median planned paths speed in 2022 v2024-03-21



[5] Median planned paths speed in 2022 v2024-03-21











[5] Median planned paths speed in 2022 v2024-03-21



[5] Median planned paths speed in 2022 v2024-03-21



[5] Yearly number of trains per section in 2022 and shares of freight v 2024-03-21



[5] Yearly number of trains per section in 2022 and shares of freight v 2024-03-21



num	ber of trains	5
	3650	
	73000	
Shar	es of freight	train [%]
0		100



[5] Yearly number of trains per section in 2022 and shares of freight v 2024-03-21









[5] Yearly number of trains per section in 2022 and shares of freight v 2024-03-21





[5] Yearly number of trains per section in 2022 and shares of freight v 2024-03-21



















[5] Volume of freight trains per section in 2022 - Zoom Rhone v. 2024-03-21



[5] Volume of Freight trains per section in 2022 v 2024-03-21













[5] Volume of high speed trains per section in 2022 - Zoom Paris v 2024-03-21


[5] Volume of high speed trains per section in 2022 - Zoom Rhone v 2024-03-21

35 70 km 0 High speed trains Width proportional to number of trains per section per year 3650 73000

sma



[5] Volume of High-speed trains per section in 2022 v 2024-03-21













[5] Volume of regional trains per section in 2022 - Zoom Paris v 2024-03-21

sma



[5] Volume of regional trains per section in 2022 - Zoom Rhone v 2024-03-21

sma – 35 70 km 0 **Regional trains** Width proportional to number of trains per section per year 3650 73000



[5] Volume of Regional trains per section in 2022 v 2024-03-21



[5] Hourly distribution : day vs night v2024-03-21



[5] Hourly distribution : morning peak period v2024-03-21



[5] Hourly distribution : peak period (morning+evening) v2024-03-21

sma





sma



[6] Capacity consumption rates in junction v 2024-03-21





[6] Capacity consumption rates in junction v 2024-03-21





[6] Capacity consumption rates in junction v 2024-03-21

35 70 km 0 Y.Noord Berchem Y.Drabstraat Y.Melle-West Y.Melle Y.Nazareth bif de Rivière Neuve 17.03.2022 Y. Abeelstraat Y. Diegem Anderlecht-Gril Est Y.Holsbeek Y.Leuven-Bundel M Y.Zandberg bif de la Haute Loge bif de Hazebrouck Y. Ruisbroek Y.Noord Halle Y.Noord Ha Lille-Flandres J1 Bif de la Voie A TGV Y.Louvain-la-Neuve Baulers-Gril D Y.Saint-Vaast Bif de Beuvrages Sud 50 % 85 % 40 % 70 % bif de Longueau Sud bif de Mohon Luxembourg-St Bettembourg-Ouest 9 ~ 4 Bettembourg-D Bif 2 racc Mondelange 5 bif de Vémars Nord front. St-Fons bifurcation Lyon-Part-Dieu (bif) Lyon-Guillotière Poste 1 (bifurcation) Givors bifurcation Peyraud Lyon-Guillotière*

sma













































[6] Capacity consumption rates in station - automatic method (switches zones excluded) v 2024-03-21




















[6] Capacity consumption rates in sections v 2024-03-21

sma























sma





















[5] Runtimes dispersion per section in 2022 v2024-03-21



[5] Runtimes dispersion per section in 2022 v2024-03-21



[5] Runtimes dispersion per section in 2022 v2024-03-21







[5] Runtimes dispersion per section in 2022 v2024-03-21

sma



[5] Runtimes dispersion per section in 2022 v2024-03-21





























sma -





sma – J 35 70 km Delta in % of freight trains 2023 - 2022 More trains in 2022 -100% More trains in 2023 100% 5



[5] Difference in percentage of trains per section between 2023 and 2022 v 2024-03-21



[5] Difference in percentage of trains per section between 2023 and 2022 v 2024-03-21




35

0

6

70 km

sma Delta in % of high-speed trains 2023 - 2022 More trains in 2022 -100% More trains in 2023 100%

Sh







70 km Delta in % of high-speed trains 2023 - 2022 More trains in 2022 -100% More trains in 2023 100% 5





[5] Difference in percentage of trains per section between 2023 and 2022 v 2024-03-21















sma

















[5] Difference in percentage of trains per section between 2023 and 2022 v 2024-03-21



[9] Itinerary variation for Antwerp - Paris (Total freight trains x days : 562) v 2024-03-21



[12] Itinerary variation for Antwerp - Paris (Total freight trains x days : 562) v 2024-03-21



[9] Itinerary variation for Antwerp - Thionville (Total freight trains x days : 740) v 2024-03-21

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16 32 km Antwerp <-> Antwerpen-Luchtbal Antwerpen-Dam Antwerpen-Berchem Antwerpen-Oost Thionville Number of freight x days 1 Hove Kontich-Lint 2162 Duffel Sint-Katelijne-Waver Mechelen-Nekkerspoe Muizen Rank of the alternative O Eppegem Vilvoorde Schaerbeek-Groupe R Most seen (left), Less seen (right) OLeuven Schaerbeek Halle Ottignies Soignies Jemeppe-sur-Sambre-Marchandise Jemeppe-sur-Sambre Quévy-Frontière 252 194 Houyet Aulnoye-Aymeries 48 237 Hirson Sh 5 Tournes STRAIMONT Liart



[12] Itinerary variation for Antwerp - Thionville (Total freight trains x days : 740) v 2024-03-21





Sh

48 237 294

5

[9] Itinerary variation for Basel - Thionville (Total freight trains x days : 2162) v 2024-03-21

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13 27 km Thionville Basel <-> Thionville UckangeRichemont Number of freight x days Hagondange 1 Maizières-lès-Metz 2162 Woippy Rank of the alternative Metz-Sablon-PA Ars-sur-Moselle Ancy-sur-Moselle Most seen (left), Less seen (right) Rémilly Novéant Pagny-sur-Moselle Raccordement TGV de Baudrecourt Vandières Bénestrof Dieulouard 9 48 51 191 1440 Mommenheim 341 Sarraltrof Pompey Frouard Bif de Frouard (ancien emplacement) Sarrebour Rédir 64 Vendenheim Champigneulles Nancy-Ville Jarville-la-Malgrange Mundolsheim Hausbergen Hausbergen Jonction Strasbourg-Ville OLunéville Blainville-Damelevières Séle Colmar





[9] Itinerary variation for Bettembourg-frontière - Lyon (Total freight trains x days : 2407) v 2024-03-21



[12] Itinerary variation for Bettembourg-frontière - Lyon (Total freight trains x days : 2407) v 2024-03-21

sma

85 km Bettembourg-frontière <-> Lyon 5 Number of freight x days 200 -45 1630 8 2 Rank of the section 5 4 10 Most seen (left), 8¹ 14 10 3 13 Less seen (right) 1630 51 131 20 312 85 71 13 16 26 654 40 77 23 37 8 6 431 13 1199 14 8 2 1 7 64



[9] Itinerary variation for Calais-Fretun - Longuyon (Total freight trains x days : 1620) v 2024-03-21



[12] Itinerary variation for Calais-Fretun - Longuyon (Total freight trains x days : 1620) v 2024-03-21





[12] Itinerary variation for Woippy - Avignon (Total freight trains x days : 4326) v 2024-03-21



[9] Origine - terminus of freight trains in 2022 v 2024-03-21



[9] Sum of distorted TCRs planned for 2022 v2024-03-21



[9] Sum of generic TCRs planned for 2022 v2024-03-21



[7] Level of optimization : sections v2024-03-21



[7] Level of optimization : junctions v2024-03-27



[PCA Assumptions] Capacity consumption rate with forced edges slicing v2024-03-21



[PCA Assumptions] Capacity consumption rate with unforced edges slicing v2024-03-21



[7] Capacity sharing between freight and passenger trains v2024-03-21



[7] Capacity sharing between trains and TCRs v2024-03-21


[7] Capacity sharing between trains and TCRs v2024-03-21



Selected day : 01-06-2022

Capacity consumption rate [Pax + Freight + TCRs]



[7] Capacity sharing between trains and TCRs v2024-03-21









[7] Capacity sharing between trains and TCRs v2024-03-21



[Real train data] Delay evolution analysis in 2022 v 2024-03-21

















[Real train data] Difference in percentage of trains per section between planned and counted data v2024-03-21



[8] Residual capacity

1 day in 2022

Here is an example of Anvers – Valenton, where usable residual capacity is 14 paths.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

No freight trains.





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[8] Residual capacity

1 day in 2022

Here is an example of Anvers – Valenton, where usable residual capacity is 4 paths.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

With freight trains.





[8] Residual capacity



11 - 11

01-14 15-27 27-37 27-37 27-45 45-45 45-65



____ ≥ 10 paths and < 20 paths

── ≥ 20 paths

night....

23h

24-



sma-

[8] Residual capacity

1 day in 2022

Woippy – Calais through Arras, where usable residual capacity is 31 paths towards Calais and 21 towards Woippy.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

With freight trains.





[8] Residual capacity

1 day in 2022

Woippy – Calais through Lille, where usable residual capacity is 9 paths towards Calais and 8 towards Woippy.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

With freight trains.





[8] Residual capacity



[8] Residual capacity

1 day in 2022

Thionville – Basel, North itinerary (Remilly), where usable residual capacity is 12 paths towards Basel and 6 towards Thionville.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

With freight trains.





[8] Residual capacity



Thionville – Basel, South itinerary (Nancy), where usable residual capacity is 4 paths towards Basel and 6 towards Thionville.

Main assumptions : potential increase of runtime = 50% (/ model path which is a real path).

With freight trains.





[8] Residual capacity











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