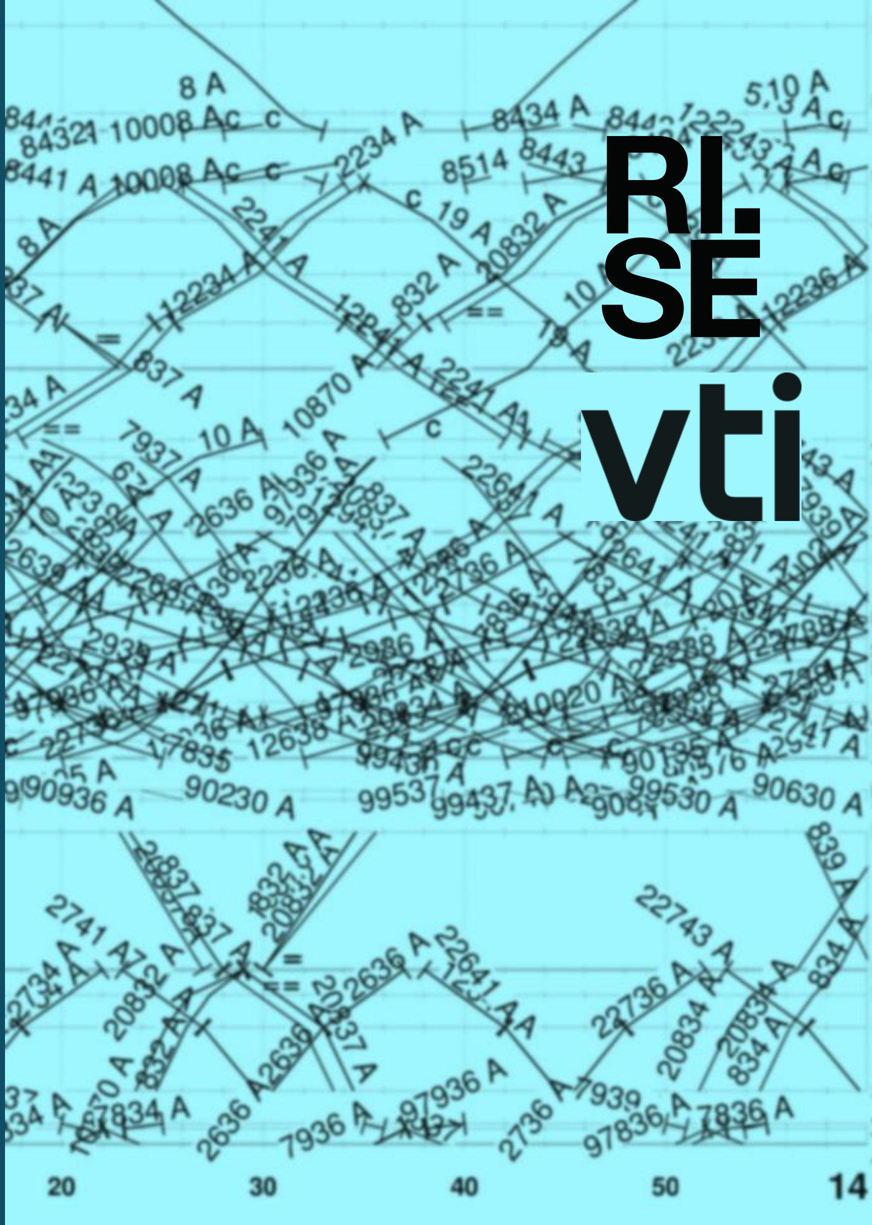
PRESENTATION AND DISCUSSION

Final report



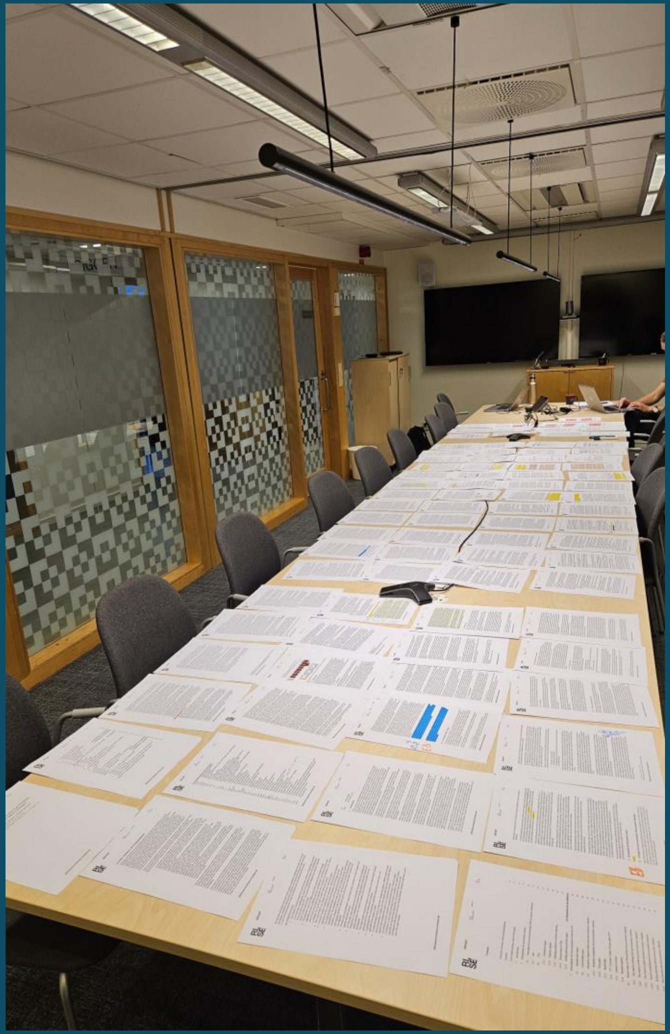
Socio-economic valuation and railway capacity allocation

2024-11-05

Agenda

- Welcome (Daniel Haltner)
- Introduction and background
  - Recommendations (10 min)
  - Three types of allocations methods (10 min)
- Briefly about the TTR process (10 min)
- Coffee break (10 min)
- Development of a socio-economic model for TTR:
  - Standard unit values (incl. association costs) (12 min)
  - Cross-border issues (13 min)
  - Exclusions (12 min)
  - Previously proposed components (13 min)
- Using the model (25 min)
- Conclusions and recommendations (15 min)
- Discussion (35 min)

- Work in progress ...



Recommendations
(briefly for now)

- National IMs do not need to synchronize their use of data
  - Use high-quality country-specific parameter values when available, otherwise use European average values
  - Use comparable values within countries
  - Parameter values can change at the border for international traffic
  - Train classifications do not need to be synchronised between countries. There can be different train classes and different boundaries between classes, depending on national considerations. It is also possible to value each requested train-path directly without the use of train classes.
- Adaptations
- Development needs

Recommendations
(briefly for now)

- National IMs do not need to synchronize their use of data
- Adaptations
  - Make associations part of the valuation
  - Rolling planning segments should have prioritization classifications
  - In advance planning, budget for adjustments needed when moving to ATT
  - Exclusions can be handled using template freight values and a classification system for the proportion of value being lost
    (A more refined system is proposed as a development need.)
- Development needs

Recommendations
(briefly for now)

- National IMs do not need to synchronize their use of data
- Adaptations
- Development needs
  - European operational cost parameter values for passenger traffic
  - A generalized form of association between flows in the capacity model
  - Exclusions can be valued either by freight value or by alternative cost of second-best option.
    IT support is needed for the second option.
    (A temporary solution is proposed as an adaptation.)

Background

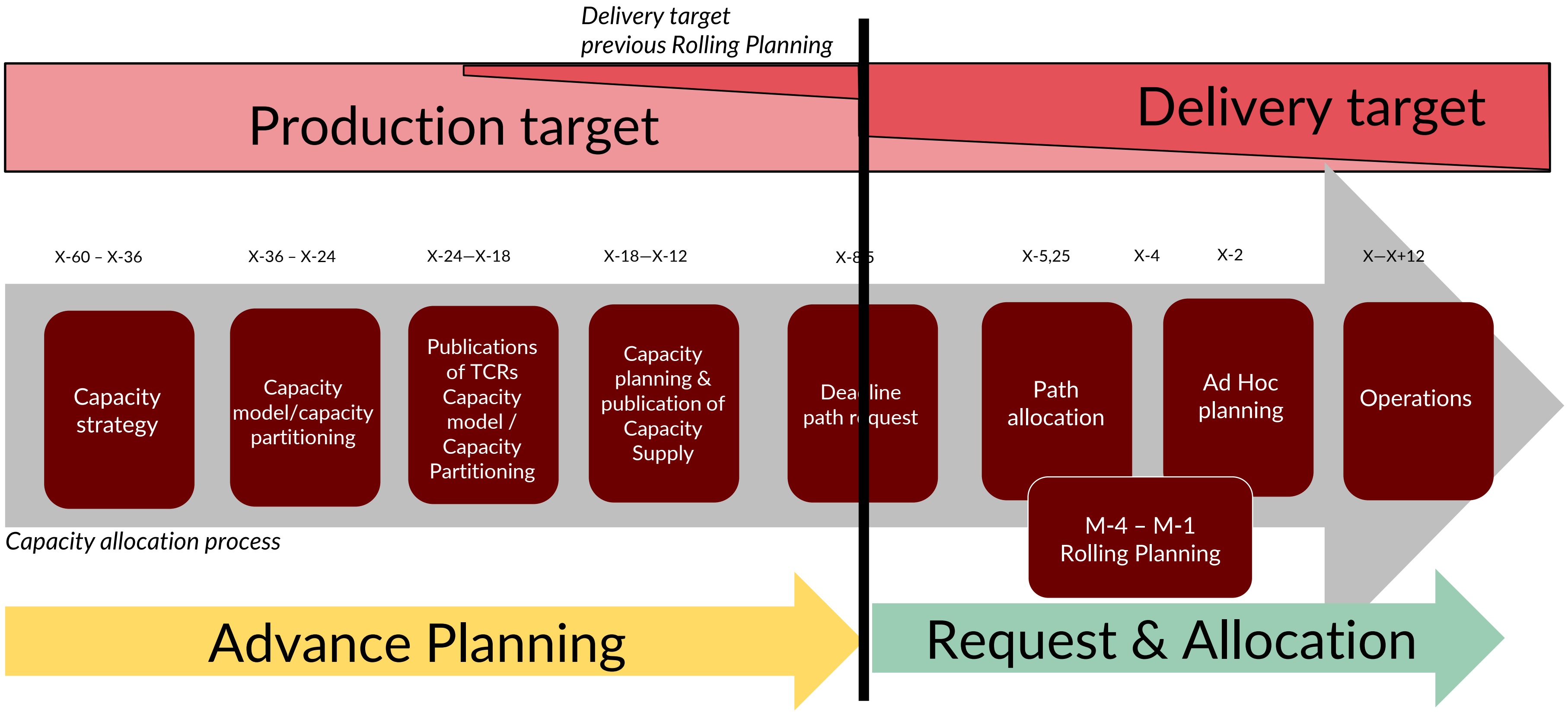
Three broad types of railway capacity allocation methods on vertically separated markets

- Administrative methods
  - Comparatively simple rules, e.g. “passenger trains before freight trains”
  - Either one traffic type is planned at the time, or conflicts are resolved according to train-path type
  - Used in most European countries
- Willingness-to-pay (WTP) based methods
  - Can either resolve specific conflicts through e.g. a train-path auction…
  - …or balance supply and demand by adjusting track access charges
  - Assumes that WTP good measure of value (well-functioning competition, no price-regulation)
- Socio-economic calculations
  - Common for cost-benefit analysis of infrastructure projects
  - Uses e.g. the value of travel-time savings (VTTS), as measured by stated preference and reviled preference studies
  - Expresses generalised costs for train operators, passengers, shippers of goods and the surrounding society in monetary terms
  - Prioritization criteria are a proxy for socio-economic calculations. The rules are calibrated according to socio-economic principles, but explicit calculations are not needed for each decision.

Background

- Efficiency
  - The net benefits to society of the railway system should be as large as possible
  - Prioritize right in each case
  - Minimize costs, including non-monetary costs such as travel-time, environmental damage etc.
  - Incentives for train operators to be efficient, e.g. frugal use of scarce capacity
- Manageability
  - The process must be understandable for IMs and RUs
  - Takes reasonable calendar-time
  - Not too administratively costly
  - Reliably results in feasible timetable
- Transparency
  - Predictable outcome
  - Rules applied equally for every RU
  - Important for lowering barriers-to-entry and ensuring competition

The TTR-process



Coffee break

Development of a socio-economic model for TTR

- Standard unit values (incl. association costs)
- Cross-border issues
- Exclusions
- Previously proposed components

Standard unit values

- Using a model for socio-economic priority criteria on a **European scale** requires standardised input data for the various countries the model will be applied to.
- The required information comprises
  - what is being transported (number and type of passengers, cargo),
  - value of travel time savings (VTTS), and
  - operating costs for both time and distance to consider vehicle (capital) and personnel costs, as well as traction costs.
- The proposed main source of information for a European solution is the Commission's Vademecum (2021) on economic appraisal.
  - Presents guidance for years 2021–2027 based on results gathered by the Commission and JASPERS*.

* Joint Assistance to Support Projects in European Regions, funded by the Commission and European Investment Bank.

Standard unit values: Value of Travel Time Savings (VTTS)

- The European Commission (2021) and European Investment Bank (2023) recommend that VTTS **should be set at the national level** based on stated and/or revealed preference surveys.
- "For countries without VTTS or that are lacking the segmentation by travel purpose, the values from the meta-analysis can be used as provisional values whilst waiting for proper national studies" (p. 322, Shires and de Jong, 2009)
- **Meta-analysis** – a statistical analysis of analyses – can be used for predicting values for countries where VTTS studies are lacking
  - Passenger traffic: Wardman et al. (2012)

Standard unit values: Value of Travel Time Savings (VTTS)

- In addition to ‘in-vehicle time’, the **wait-time** is an important time-element, especially when considering **associations** for
  - connecting passenger trains, and
  - connecting freight trains.

Standard unit values: Associations

- **Cost for connecting passenger trains**
  - **value of waiting at interchange** for passengers is multiplied by the passengers' **expected interchange time**.
- **Cost for connecting freight trains**
  - VTTS for freight is multiplied by the waiting time for the expected number of net tons for the interchange.
  - An operating cost (per net ton) is included in the cost for the association and is calculated with respect to the train's waiting time that the association implies – in other words, a cargo association implies a vehicle association.

Note: An operating cost is not included in the calculation of passenger trains' costs for associations since there is **no extra operating cost when passengers disembark and wait for the connecting train**.

Standard unit values: Broken associations

- Broken associations: **connecting passenger and freight trains**
  - An association is broken if the (proposed) timetable implies a waiting time **below a minimum value** implying that the interchange cannot be carried out for practical reasons.
  - An association is also broken if the waiting time **exceeds a maximum value**, given that the train operator considers the cost to be too high.
  - In both cases, the association cost is based on the frequency of trains and the waiting time this implies.

Standard unit values: Broken associations

- Broken associations: **vehicle circulations**
  - Influences a train operator's use of its vehicles.
  - To calculate the train operator's cost per day for the vehicle during its lifetime (=cost for a broken vehicle circulation)*, we need
    - vehicle investment cost (including one renewal cost), depreciation period, rent, and
    - utilisation rate (number of days per year).

*Calculations made in the spreadsheet model submitted with the Final report. Based on the Swedish Priority Criteria.

Cross-border issues

- Ideally, cross-border traffic is treated in the same manner as domestic traffic, in line with the aim of creating a single European railway area (SERA) and the aims of the Trans-European Transport Network (TEN-T)
  - the train path with the highest socio-economic value is given priority.

    ➡ Give way to cross-border traffic when that train path implies a higher socio-economic value than the domestic train path.
- **Risk that this is not followed.**

Cross-border issues

- Incentives for an IM to not allow/hinder cross-border traffic if this implies its ”own” trains needs to be cancelled/moved.
- A suggestion to consider **actual compensation**.
- Simple example of the compensation scheme, with a **conflict between train paths A and B**

Country	Train type	Train path	Net Present Value
Y	Domestic train	A	15
		a	10
X	Cross-border train	B	11
		b	5

A + B (15 + 11 = 26): Not possible due to conflicting train paths
A + b (15 + 5 = 20): Possible
a + B (10 + 11 = 21): Possible
a + b (10 + 5 = 15): Possible

Solution (a+B)
Country *Y* gets 10 instead of 15 (i.e., loses 5) and
Country *X* gets 11 instead of 5 (it gains 6).
With train path B, country *X* can compensate country *Y* with 5 and still be better off than with train path b.

Cross-border issues

- **The main point** and basic idea behind the compensation scheme is to **create stronger incentives for an efficient use of the European railway network**, getting rid of incentives for a country to hinder, complicate or not allow cross-border traffic that should be prioritized according to the socio-economic priority criteria.

Cross-border issues

- The mechanism to counter disincentives to allow-cross border traffic needs to consider all marginal external costs with traffic.
- There is especially reason to consider reliability costs.
  – The distance covered, which is usually longer for cross-border trains, is an important influencing factor for train punctuality (see e.g., Harris, 1992, Olsson and Haugland, 2004, and Palmqvist et al., 2017).
- The calculations for the compensation scheme should take these costs into account.

Country	Train type	Train path	Net Present Value
Y	Domestic train	A	15
		a	10
X	Cross-border train	B	11
		b	5

Consider solution a+B:
includes reliability costs of cross-border train path B.

Cross-border issues: which parameter values should be used?

- Which parameter values should be used for cross-border traffic?
- Our recommendation:
  - Proper national parameter values change at the border.
  - If national values are not available: use European-wide averages.

- Most exact: Individual VTTS for every person
- Stepwise simplification
  - Simplification #1: Every individual resides in a certain country. Use the (average) VTTS of that country.
  - Simplification #2: Most international passenger train services have a number of passengers from a certain country roughly proportional to the proportion of the trip taking place in that country
- **Solution:** Treat the journey as starting/ending at the national border, in terms of valuation.

National cost factors v.s. European common values

Case 1	Cat A	Cat B	Cat C
Country X	1	2	4
Country Y	2	4	8

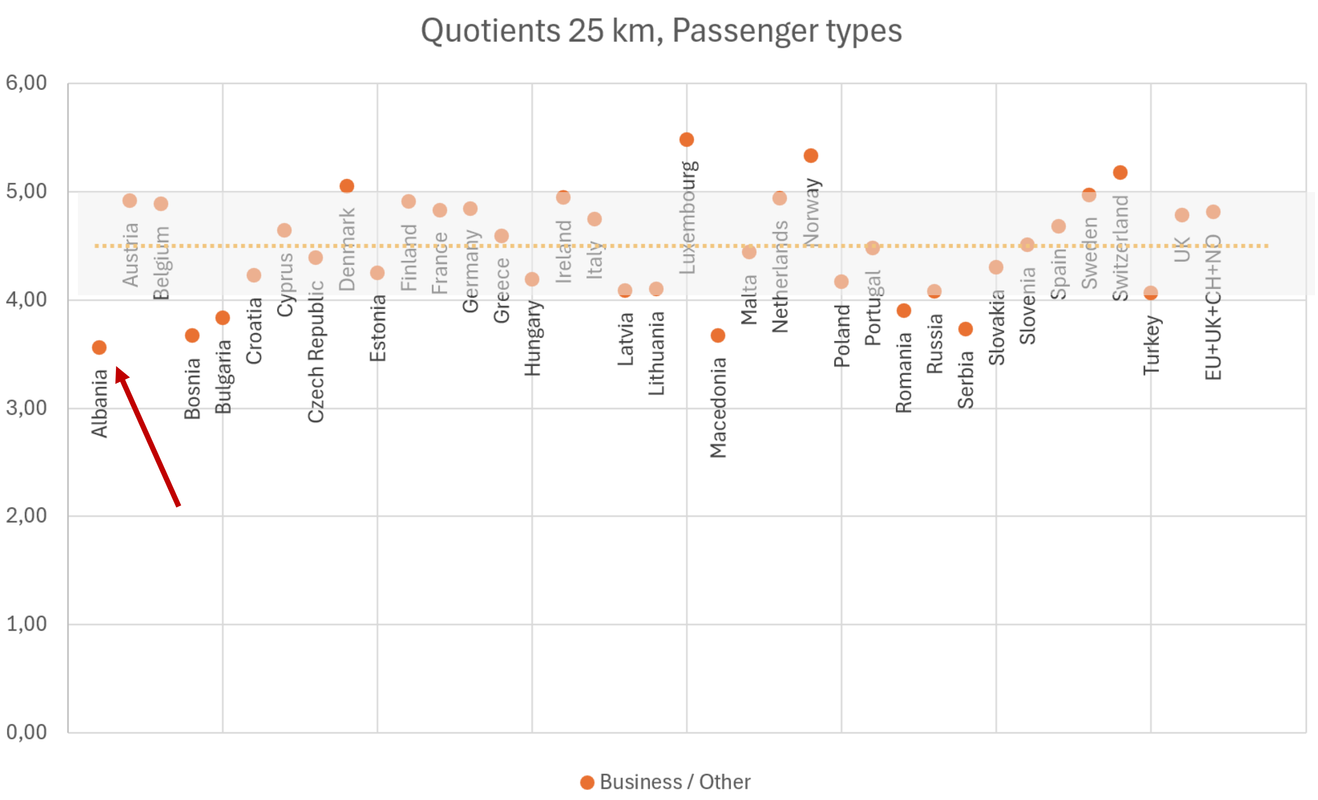
	Cat A	Cat B	Cat C
Country X	1.5	3	6
Country Y	1.5	3	6

Case 2	Cat A	Cat B	Cat C
Country X	1	2	4
Country Z	3	4	5

- Case 1
  - Will give same national results regarding conflict resolution prioritization
  - Will be cheaper to take some meetings/overtake ”on other side of border”
  - Hence some differences in schedules compared to using European common cost factors
- Case 2
  - Different schedules since different quotient between categories
  - Additionally differences over border
  - Hence larger differences compared to using EU common cost factors
- The quotient between categories seems to be fairly the same in neighbouring countries

VTTS Quotients passenger types

Commuter, business, other

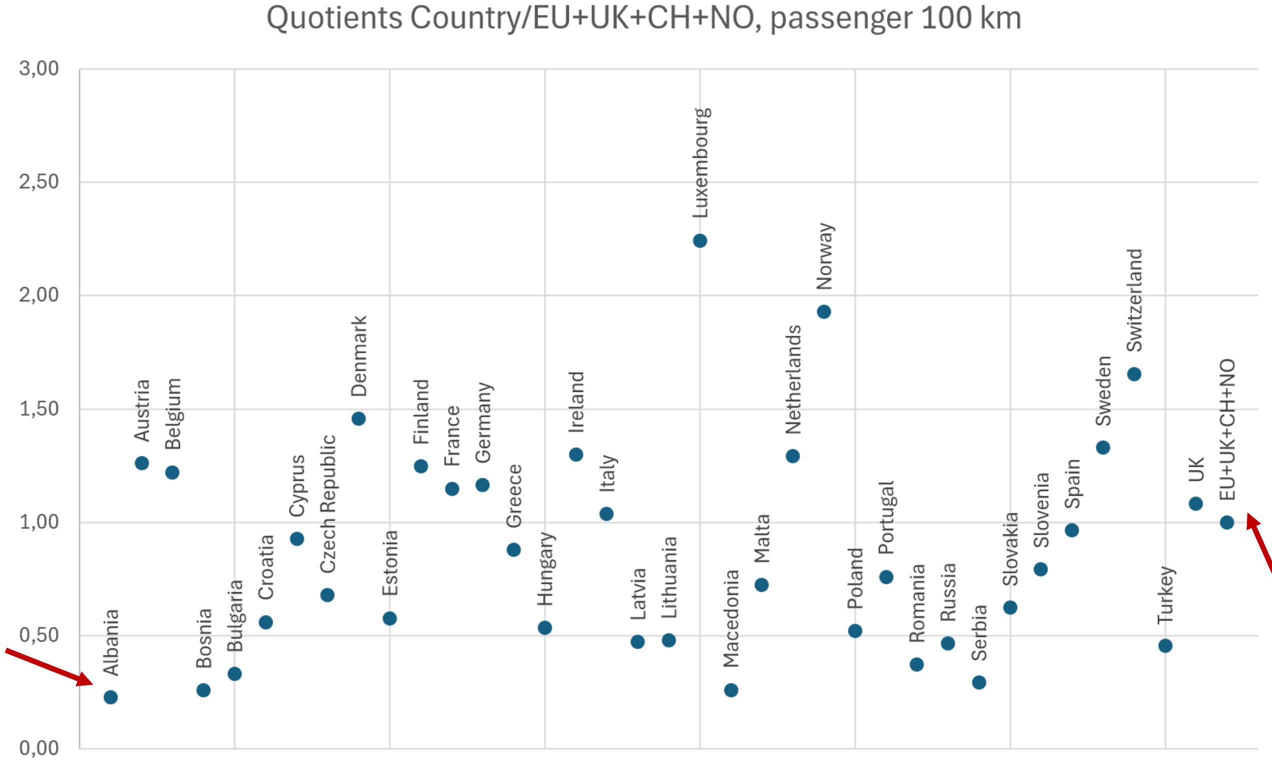


- 25 km journey

	Com	Bus	Other
	Distance, km		
Country	25	25	25
Albania	1,22	3,74	1,05
Austria	6,71	28,4	5,78
Belgium	6,5	27,4	5,6
Bosnia	1,38	4,33	1,18
Bulgaria	1,76	5,79	1,51
Croatia	2,99	10,9	2,57
Cyprus	4,94	19,7	4,25
Czech Repub	3,62	13,7	3,11
Denmark	7,76	33,8	6,68
Estonia	3,07	11,2	2,64
Finland	6,64	28,1	5,72
France	6,12	25,5	5,27
Germany	6,19	25,8	5,33
Greece	4,68	18,5	4,03
Hungary	2,85	10,3	2,45
Ireland	6,91	29,4	5,95
Italy	5,52	22,5	4,75
Latvia	2,52	8,87	2,17
Lithuania	2,55	9,02	2,2
Luxembourg	12	56,4	10,3
Macedonia	1,39	4,37	1,19
Malta	3,85	14,7	3,31
Netherlands	6,88	29,3	5,93
Norway	10,3	47,2	8,85
Poland	2,77	9,92	2,38
Portugal	4,05	15,6	3,48
Romania	1,98	6,68	1,71
Russia	2,47	8,69	2,13
Serbia	1,55	5	1,34
Slovakia	3,32	12,3	2,86
Slovenia	4,22	16,4	3,63
Spain	5,14	20,7	4,42
Sweden	7,08	30,3	6,1
Switzerland	8,82	39,3	7,59
Turkey	2,42	8,45	2,08
UK	5,76	23,7	4,96
EU+UK+CH+	5,33	22,1	4,58

VTTS Quotient between countries

using EU+UK+CH+NO as reference

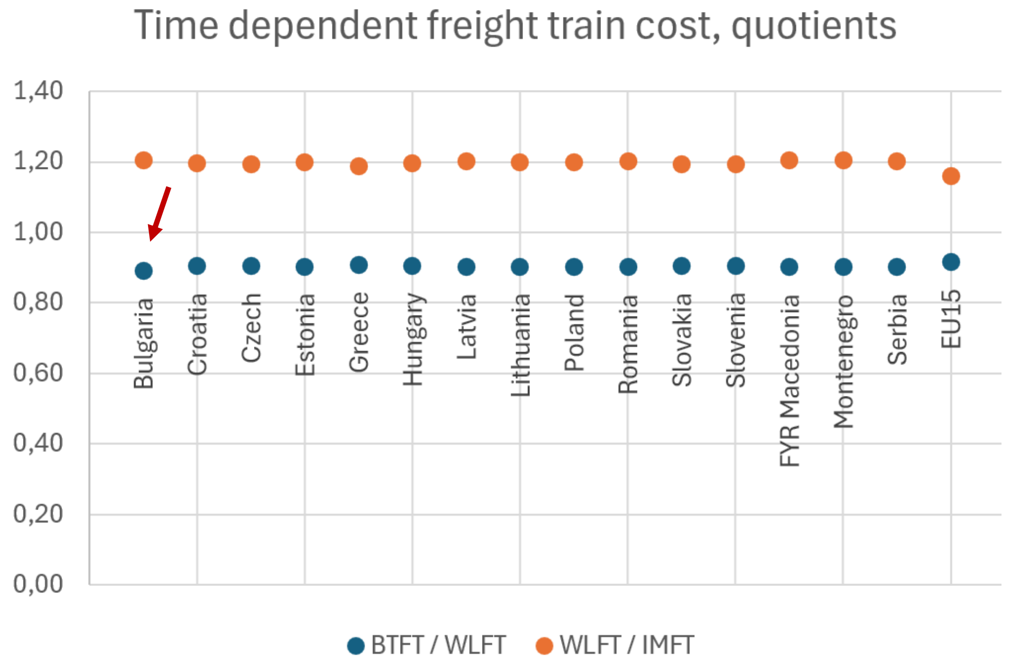


- To estimate border effects
  - E.g. ”cheaper” to take overtakes in one country than another

Country	Quotients 25 km Business / Commuter	25 km Business / Other	100 km Business / Commuter	100 km Business / Other
Albania	3,07	3,56	3,07	3,57
Austria	4,24	4,92	4,24	4,92
Belgium	4,21	4,89	4,21	4,89
Bosnia	3,14	3,67	3,13	3,64
Bulgaria	3,29	3,83	3,30	3,84
Croatia	3,63	4,23	3,64	4,23
Cyprus	3,99	4,64	4,00	4,65
Czech Republic	3,77	4,39	3,77	4,38
Denmark	4,35	5,05	4,35	5,06
Estonia	3,66	4,25	3,65	4,25
Finland	4,23	4,91	4,23	4,91
France	4,16	4,83	4,16	4,84
Germany	4,17	4,85	4,17	4,85
Greece	3,96	4,60	3,96	4,60
Hungary	3,61	4,20	3,61	4,19
Ireland	4,26	4,95	4,26	4,95
Italy	4,08	4,75	4,09	4,74
Latvia	3,52	4,09	3,52	4,10
Lithuania	3,54	4,10	3,53	4,11
Luxembourg	4,72	5,48	4,72	5,48
Macedonia	3,14	3,67	3,15	3,66
Malta	3,82	4,44	3,81	4,43
Netherlands	4,26	4,94	4,26	4,95
Norway	4,59	5,33	4,59	5,33
Poland	3,58	4,17	3,58	4,17
Portugal	3,85	4,48	3,85	4,48
Romania	3,37	3,91	3,37	3,92
Russia	3,52	4,08	3,51	4,09
Serbia	3,23	3,73	3,21	3,75
Slovakia	3,71	4,30	3,71	4,31
Slovenia	3,88	4,51	3,88	4,51
Spain	4,03	4,69	4,03	4,68
Sweden	4,28	4,97	4,28	4,97
Switzerland	4,46	5,18	4,46	5,18
Turkey	3,49	4,06	3,49	4,06
UK	4,12	4,78	4,12	4,78
EU+UK+CH+NO	4,15	4,82	4,15	4,82

Operational costs quotients

Freight train types



- BTFT = Block Trains
- WLFT = Wagon Load
- IMFT = Inter Modal

Country	Block train	Wagon load	Inter-modal
Bulgaria	339,37	380,88	317,54
Croatia	356,34	394,37	337,39
Czech	361,61	399,72	339,77
Estonia	354,31	392,32	332,91
Greece	379,10	417,46	373,64
Hungary	355,87	393,90	333,44
Latvia	348,76	386,69	326,87
Lithuania	355,02	393,04	332,13
Poland	354,39	392,39	332,34
Romania	345,72	383,60	321,53
Slovakia	363,26	401,39	336,28
Slovenia	364,33	402,47	359,34
FYR Macedonia	343,94	381,80	318,53
Montenegro	342,90	380,74	318,07
Serbia	347,69	385,60	322,64
EU15	416,56	455,09	435,47

Exclusions
– why they matter, adaptation and development need

- Exclusion: A capacity-request is denied or scheduled outside of the time-window specified for that train-type
- The socio-economic framework measures changes in generalized cost, not the value of trips
- The economic loss of an exclusion is context-dependent and relies on the alternative cost
- Exclusions are uncommon compared to minor adjustments of capacity requests
- It is especially important that international traffic does not get a superficially low exclusion cost

Exclusions
– why they matter, adaptation and development need

Adaptation

- The IM decides an exclusion cost factor per service category
  - How easy is it to use an alternative mode?
- Freight values are measured according to e.g. JASPERS (2017)
- Passenger services are measured using VTTS and operational costs
- The freight value (or passenger service value) multiplied by the exclusion cost factor is the used value

Exclusions
– why they matter, adaptation and development need

Development need

- All excluded services are valued at the full freight value (or passenger service value) unless the IM can show that there exists an alternative means of transport
- The full freight value is measured according to templates, e.g. JASPERS (2017). Passenger service value according to VTTS and operational cost.
- Alternative costs are measured according to a national freight transport model or passenger transport model, similar to the Swedish *Samgods* and *Sampers*

Previously proposed components

- Exceeding maximum running time
  - The generalized cost increases linearly with running time according to VTTS (etc.)
  - Beyond the maximum running time the service caters to a different demand. The service should be valued against this new demand, possibly with a different train classification.
  - The generalized cost is therefore typically *lower* beyond the MRT, compared to if linear
- Priority bonus for international traffic
  - Purpose: To compensate for additional administrative costs (including “hassle”)
  - Possible but not recommended
  - The purpose of socio-economic allocation is to maximise net-benefits of traffic. A costlier service should therefore have lower priority.
  - The focus should be to remove additional administrative costs for international traffic

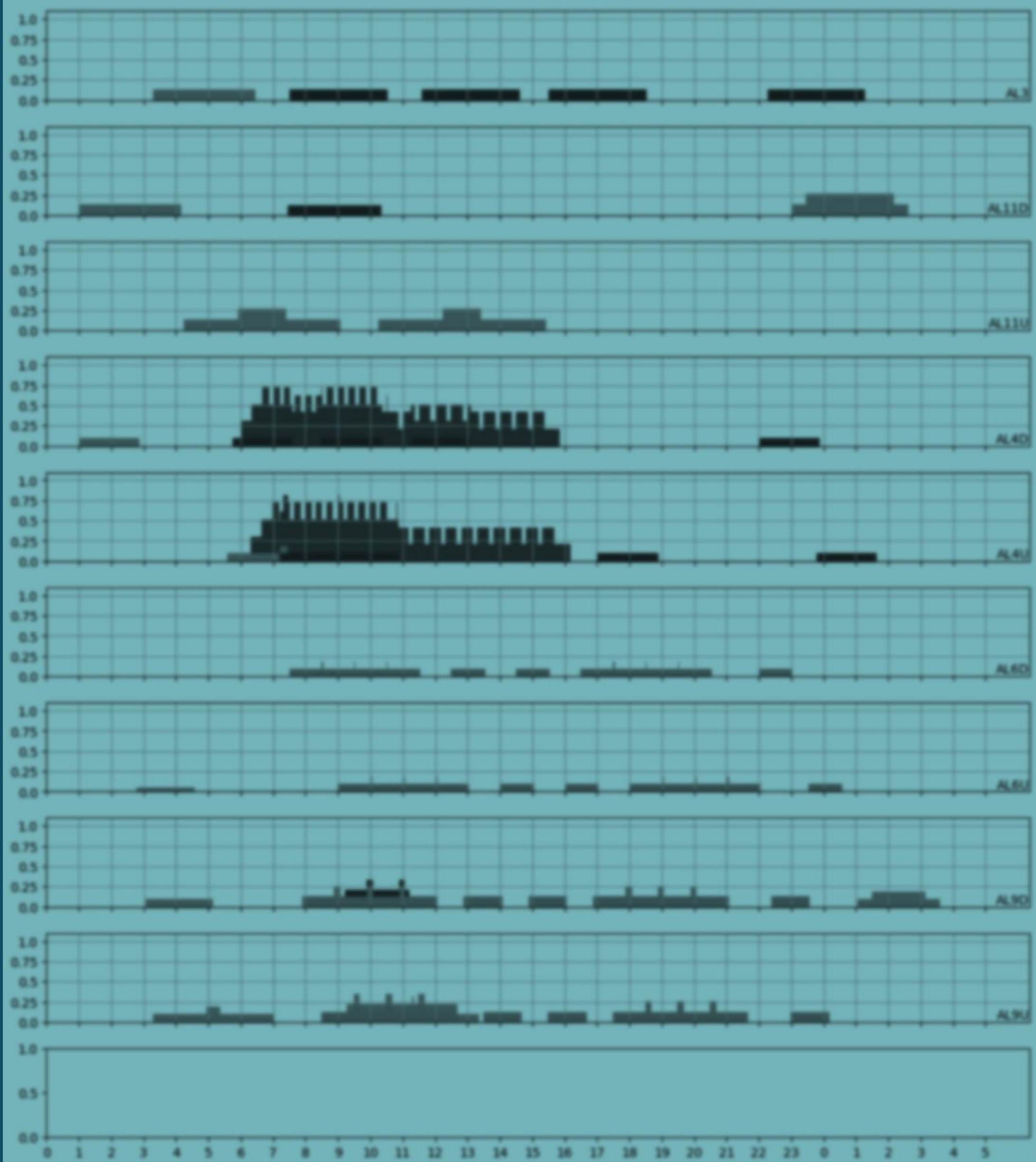
Previously proposed components

- Priority bonus for traffic type in a specific time period
  - Purpose: to reserve capacity for e.g. commuter traffic in rush hour
  - The model already has an implicit penalty for breaking a traffic pattern. (A freight train would displace several commuter trains on a line operating near full capacity.)
- Line coefficient – multiplication of traffic type weight per specific line
  - Purpose: reserving a line for a certain segment, e.g. freight corridor
  - It is possible in principle to define a type train per line, which would “automatically” raise costs for non-conforming services (similarly to discussion above on bonus for specific time periods)
  - Requires some development work

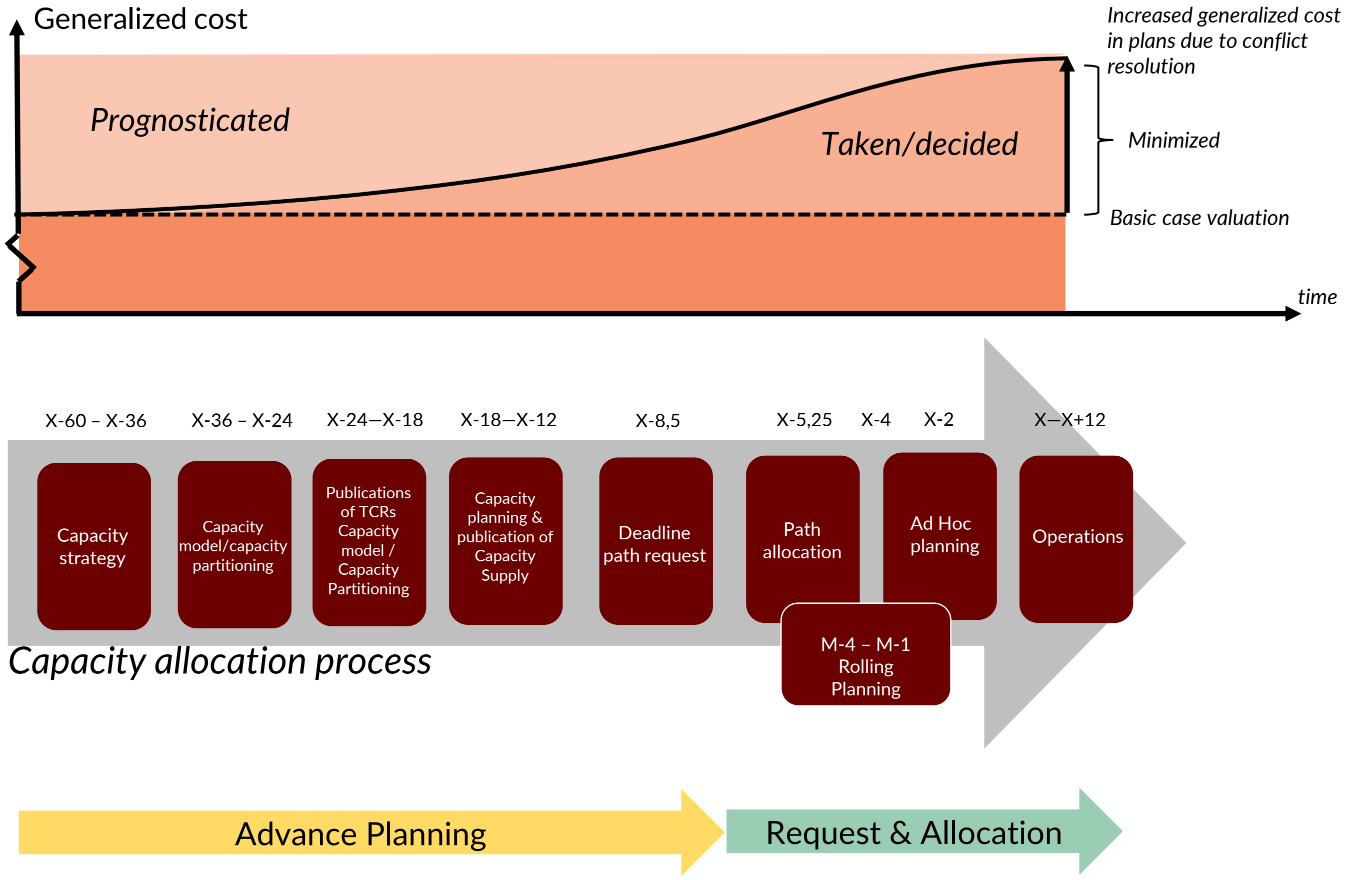
Previously proposed components

- Breaking regular traffic patterns
  - Easy to measure: longer average waiting times
  - Difficult to measure: timetable is harder to remember; more work for traffic planners; consequences for connecting traffic; complicates rolling-stock circulation and staff schedules

Using the model



The TTR process



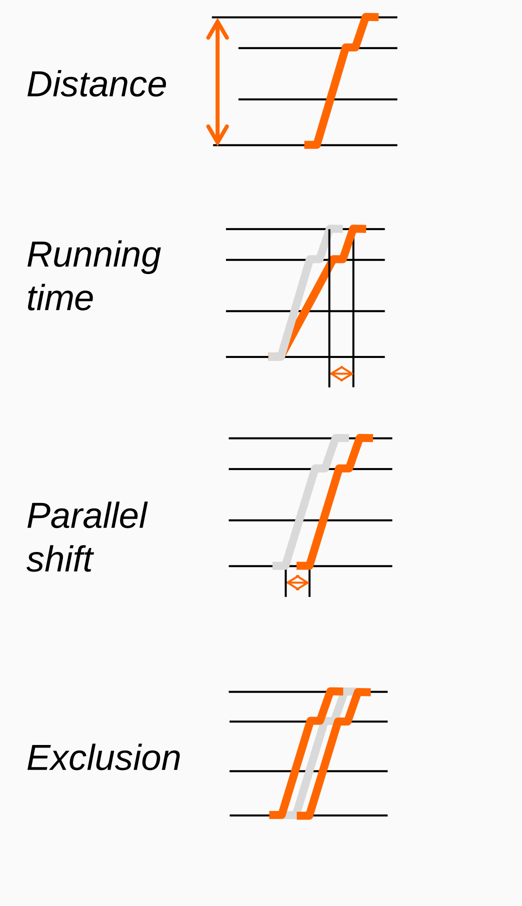
Where may socio-economic valuation help (examples)

- Capacity Strategy
  - TCR strategies, large re-routing of volumes
- Capacity model
  - TCRs & re-routing of volumes / train paths
  - Segmentation / partitioning, including international prioritizations
- Capacity Supply
  - Preplanned paths & residual capacity
  - Safe-guard Rolling planning and other reservations

Design principles

- The plan with the minimal sum of marginal costs is the one to prefer
  - Using the generalized cost as a proxy for utility
- All components of the generalized cost should be linear equations
  - Enables mathematical optimization & efficient decision support systems
- Value trains and associations, not passenger/cargo flows
  - Available data; less amount of data needed
- Categories (classification) should be easy to configure
  - Depending on country specific situation
    - Train types
    - Mix of passengers / goods
    - Use defaults, but also possible to individually configure transports

Main properties to valuate



Passenger traffic VOT Calculation steps

EU+UK+CH+NO	5	25	100	250
Commuter	4,33	5,86	7,60	9,03
Business	17,95	24,30	31,53	37,46
Other	3,73	5,04	6,54	7,77

Share of passengers, type

HSPT	LDPT	RCPT	RSPT	NIPT	Free
10%	*10%*	*70%*	*65%*	*0%*	*10%*
60%	*50%*	*20%*	*15%*	*10%*	*10%*
30%	*40%*	*10%*	*20%*	*90%*	*80%*

Product sum(4,33 / 17,95 / 3,73 ; *10%* / *60%* / *30%*)

Normalized average passenger per distance classes. €

band, km	HSPT	LDPT	RCPT	RSPT	NIPT	Free
5	12,32	10,90	6,99	6,25	5,15	5,21
25	16,68	14,75	9,46	8,46	6,97	7,05
100	21,64	19,14	12,28	10,98	9,04	9,15
250	25,71	20,67	13,26	11,86	9,77	10,87

Share of passenger, travelled distance

band, km	HSPT	LDPT	RCPT	RSPT	NIPT	Free
5	*0%*	*0%*	*30%*	*10%*	*0%*	*0%*
25	*0%*	*0%*	*40%*	*30%*	*0%*	*0%*
100	*30%*	*20%*	*30%*	*50%*	*0%*	*0%*
250	*70%*	*80%*	*0%*	*10%*	*100%*	*100%*

Product sum(12,32 / 16,68 / 21,64 / 25,71 ; *0%* / *0%* / *30%* / *70%*)

Normalized average passenger and distance classes, €

	HSPT	LDPT	RCPT	RSPT	NIPT	Free
VOT, €/h & person	24,49	20,37	9,57	8,10	9,88	9,88
Rel cost shifting	*75%*	*75%*	*75%*	*75%*	*75%*	*75%*
Shifting cost	18,37	15,28	7,18	6,08	7,41	7,41

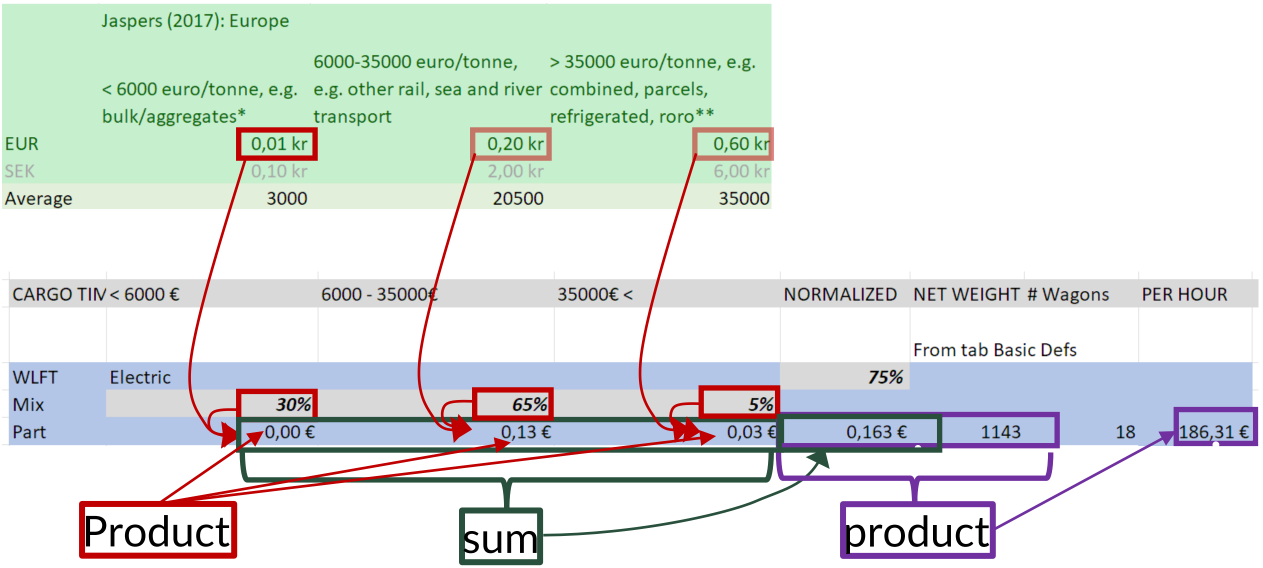
Occupancy rate

Train type	HSPT	LDPT	RCPT	RSPT	NIPT	Free
VOT, €/h						
10%	2,45	2,04	0,96	0,81	0,99	0,99
25%	6,12	5,09	2,39	2,03	2,47	2,47
50%	12,24	10,18	4,78	4,05	4,94	4,94
75%	18,37	15,28	7,18	6,08	7,41	7,41
100%	24,49	20,37	9,57	8,10	9,88	9,88
125%	30,61	25,46	11,96	10,13	12,35	12,35

Steps for passenger traffic

1) Choose region
2) Give mix of passengers
3) For each distance class, determine value for normalized average person
4) Give mix of passenger distance travelled
5) For normalized person in distance classes, determine VOT value per hour per normalized passenger
6) Occupancy rate of train used

Freight traffic VOT
Calculation step



Steps for freight traffic

1) Cargo value classes
2) Give mix of Cargo value classes
3) Multiply value of each value with mix value
4) Sum to get VOT for 1 tonne → normalized (average) tonne
5) Multiply by train weight to get VOT for train

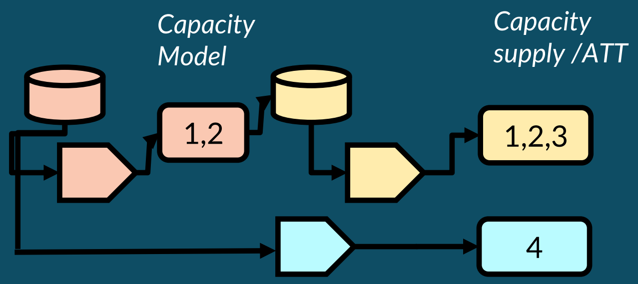
Examples

Examples

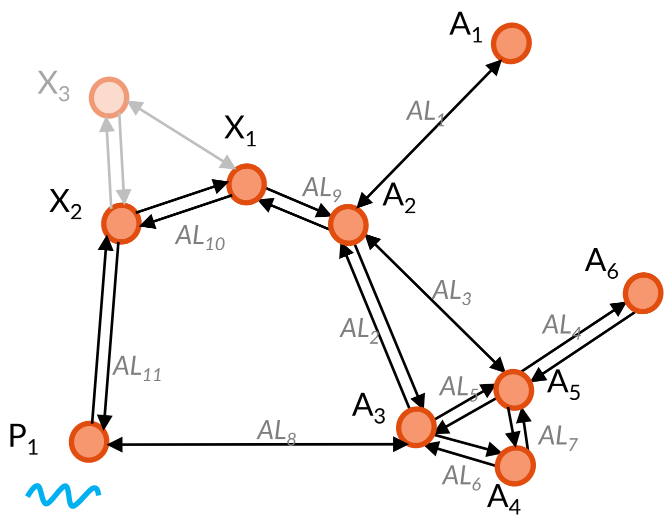
1. Using same valuation in Capacity model and Supply/ATT
   – Using valuation to determine reroutes in CM process step
   – Schedule traffic according to CM (restrict to Time windows used in CM)
2. TCR on one track on a double track line
   – Possible rerouting in Capacity model
   – Scheduling in Supply/ATT model (delays)
3. Socio-economic prioritization vs fixed prioritization on traffic type or train path type
   – Effect of global plan optimization vs fixed priority based on train path service type
4. National cost factors vs European common cost factors
   – It is the global scheduling effects that is the result, not the total generalized cost values in the plan

- All examples are run in software using optimization models
  – Planning model using "the Area method" for capacity measure
  – Scheduling model, simplified conflict resolution (see report)

- Test setup



Small network



- A3, A4, A5 densely populated
  - Regional traffic
  - Maybe there are A3p and A3m
    p = passenger, m = marshalling
- X1, X2, X3 less densely but still an urban area
  - Make the route A2-X1-X2-P1 ”crowded”
- A1 large industral zone
- A6 freight ”terminal”
- P1 could be a town near harbour

Features

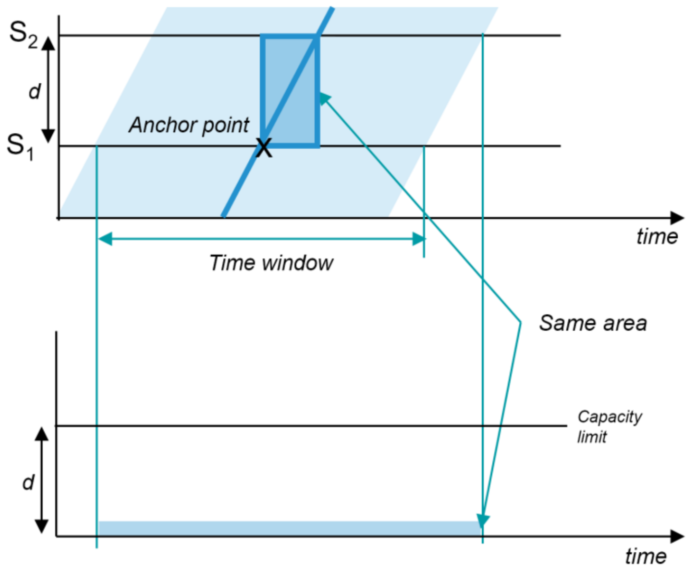
- Intermediate stations & meeting points between shown nodes
- Detour A2-A5-A4 when e.g. A2-A3 is single line traffic
  - Due to e.g. TCRs
- Freight
  A1 to P1, A1 to A6, A6 to P1
- Regional traffic
  X1-X2 , A3-A6
- Passenger traffic
  A4-X2

Network data

ID	Node	Node	Distance	Track speed Average over distance
AL1	A1	A2	250	160
AL2	A2	A3	140	200
AL3	A2	A5	150	100
AL4	A5	A6	25	70
AL5	A3	A5	25	80
AL6	A3	A4	23	80
AL7	A4	A5	15	70
AL8	A3	P1	115	140
AL9	A2	X1	52	120
AL10	X1	X2	35	90
AL11	X2	P1	150	200

- 130 regional trains
  distance: 5240 duration: 63.47
- 22 passenger trains
  distance: 5500 duration: 39.81
- 18 freight trains
  distance: 8137 duration: 84.93

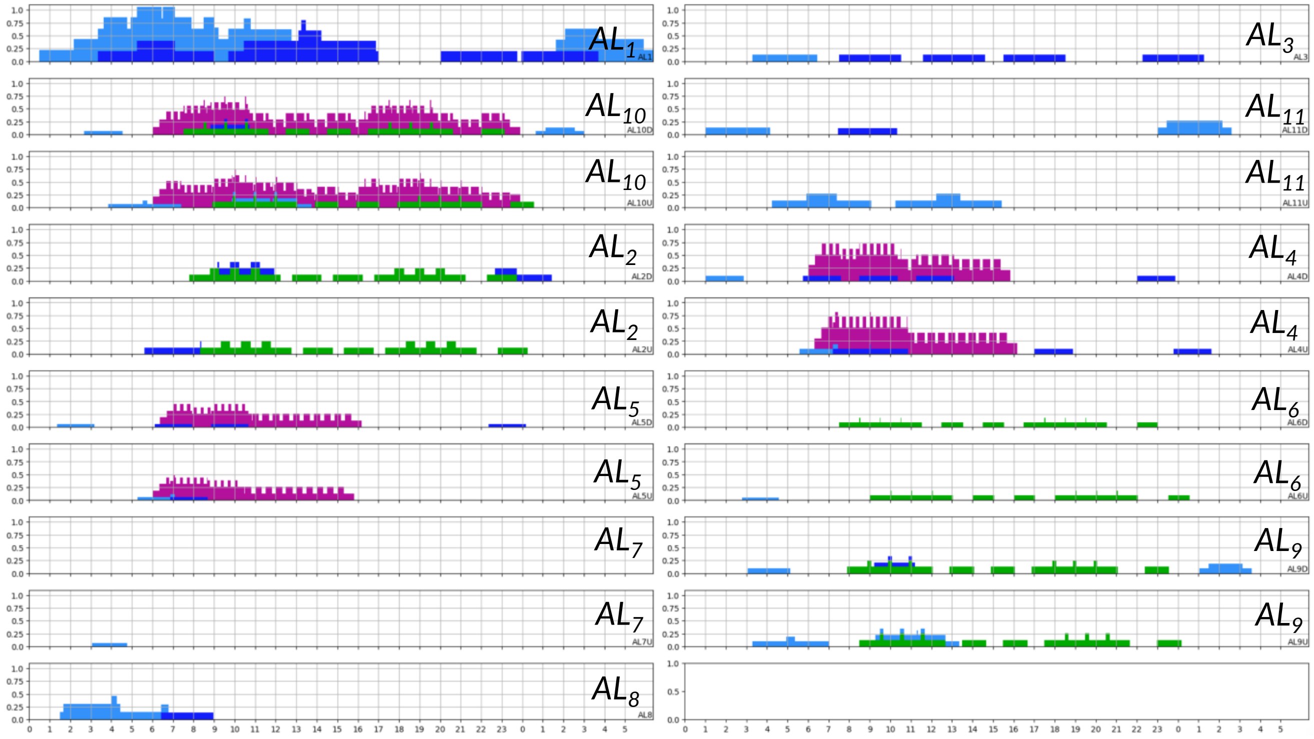
Allocation area as measure of capacity

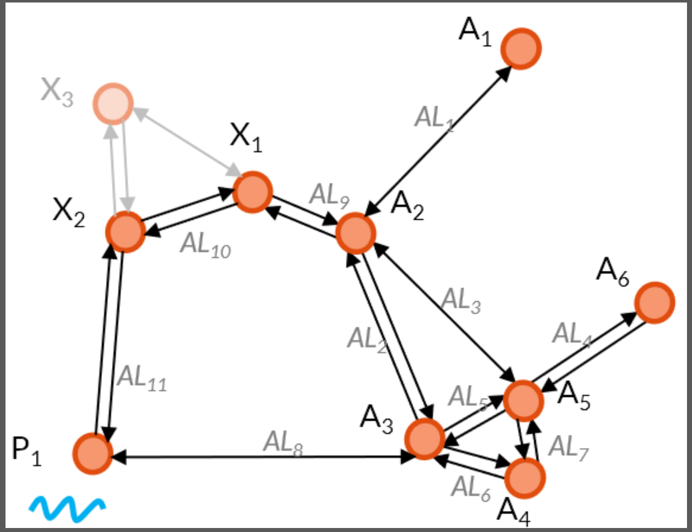


- This model is used to create Capacity models
- Computations are performed with an optimization model (algorithm)
  - A “proxy” for “real” planning in this feasibility study

- The area in the time-space-diagram is consumed capacity
- The time window (TW) includes future
  - Displacement (shift)
  - Wait times
    for the prognosticated train path
  - Necessary buffer times
- As the service product is valid within the TW, the capacity consumption (area) is distributed along the TW
  - The result is a resource consumption object under uncertainty
- With time uncertainties decreases and with that the TW shrinks
  leading to increased
  height of the object

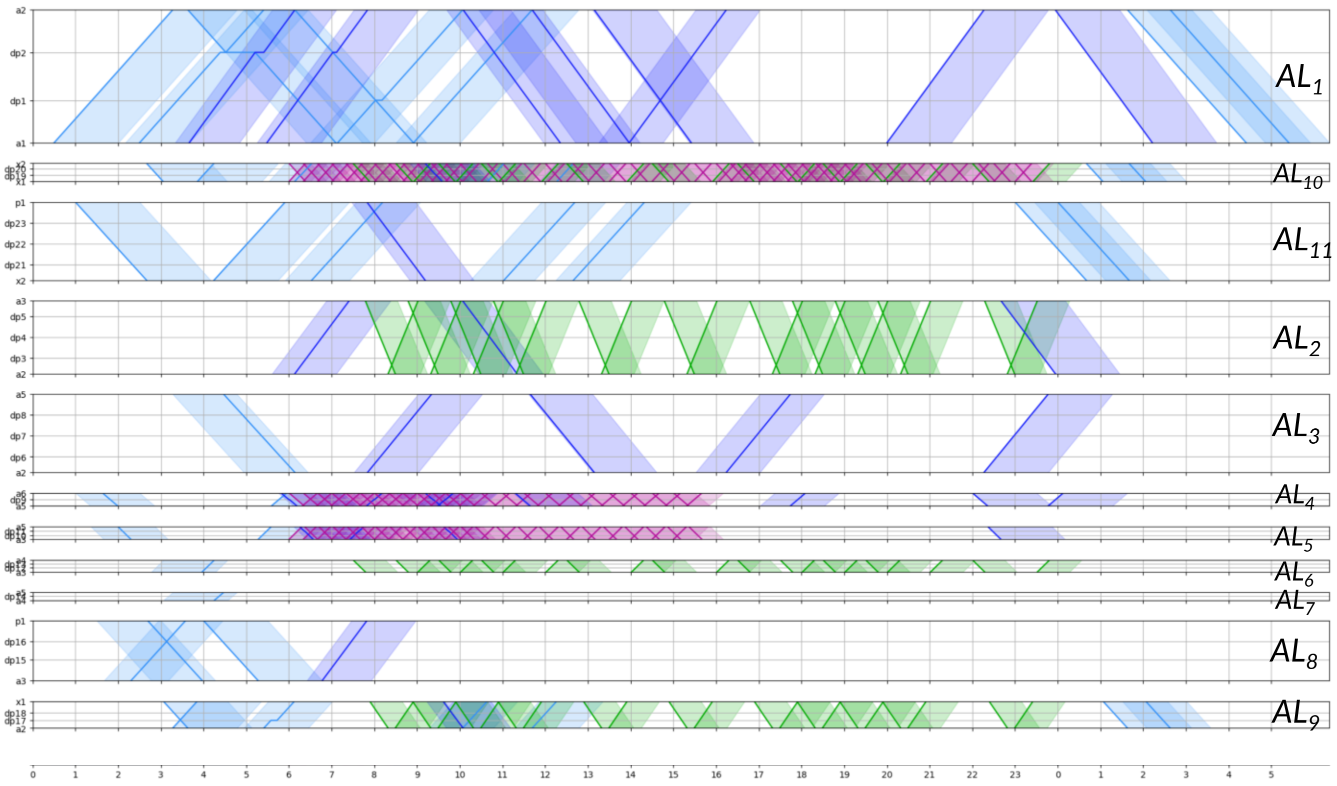
Explanation of the diagrams



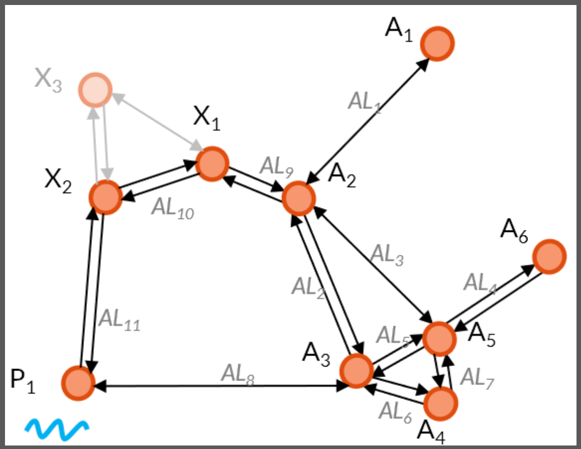


- All Capacity model diagrams are given in one page
- Double track lines have two diagrams, one track “up” and one “down”

Explanation of the timetable graphs

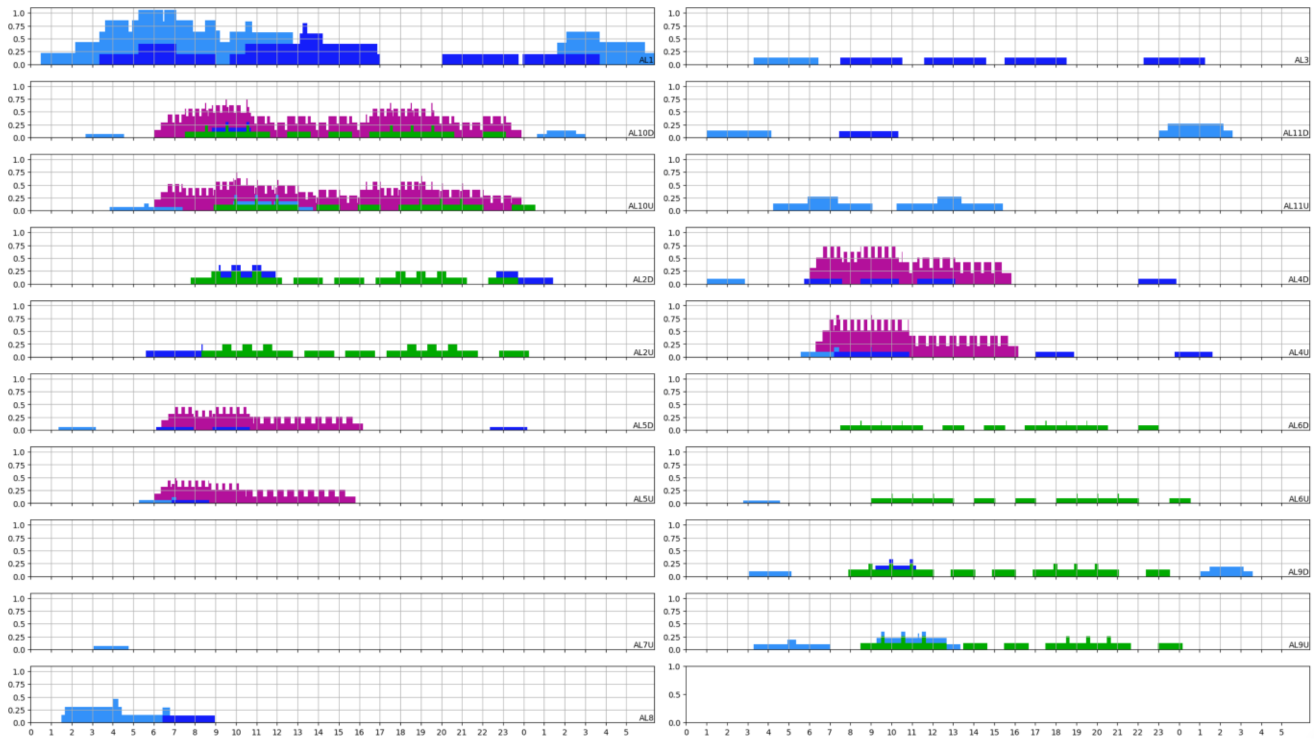


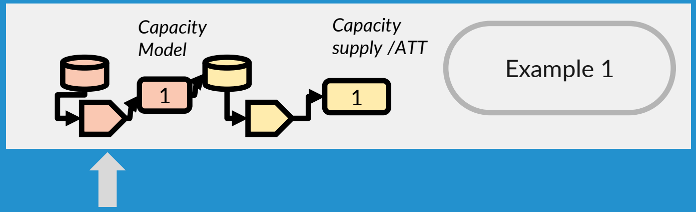
- Time on the X-axis, line section on the Y axis
  - – Operational points and stations along the Y-axis
- Light coloured areas: time window where the product is valid
  - – Inherited from the Capacity model
- All (11) timetable graphs are given in the same page



- Additional operational points between the branching nodes (called "dp_x" in graph)
  - – Single resource assumption between operational points
  - – No block signals between operational points
- Simplified conflict resolution rules
  - – Running time based on distance and speed
    - No acceleration/deceleration
  - – No detailed station layouts
    - No time for crossing train paths
- This does not affect the applicability of the priority categories
  - – Only the scheduling possibilities

1. Capacity model

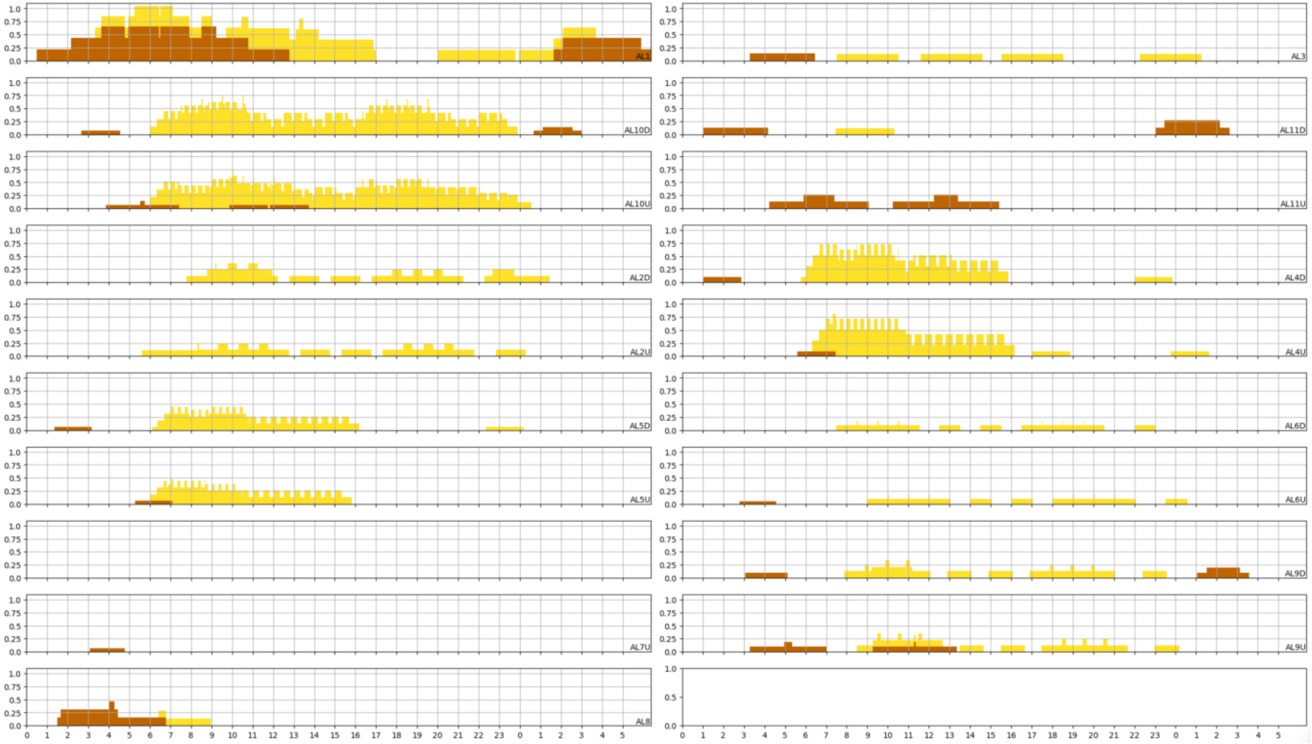




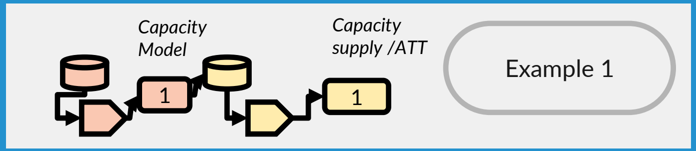
- Wagon load — Light blue
- Intermodal traffic — Dark blue
- Regional traffic — Purple
- Commercial passenger — Green

- Optimized with priority categories in spreadsheet model
- Capacity model computation found some other routes giving less generalized cost compared to original prognosticated traffic

1. Capacity model

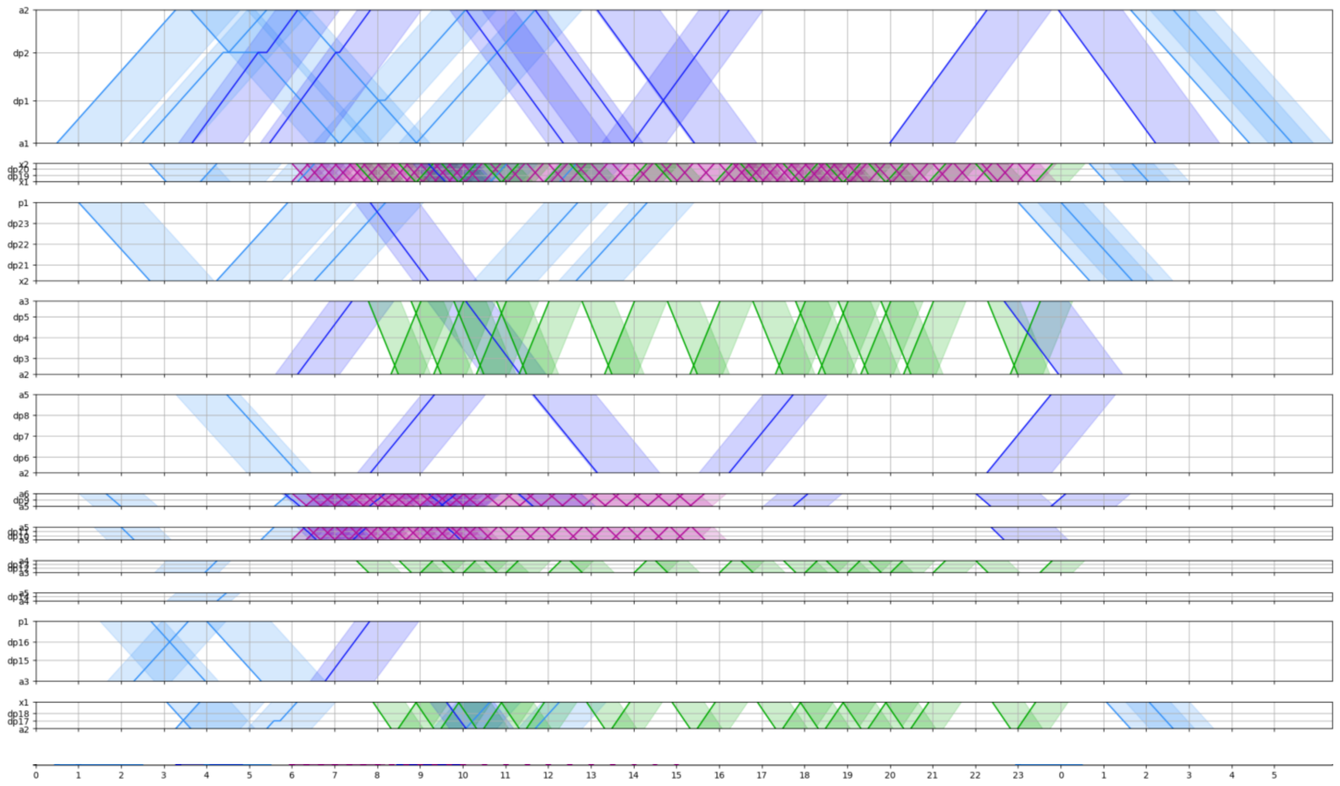


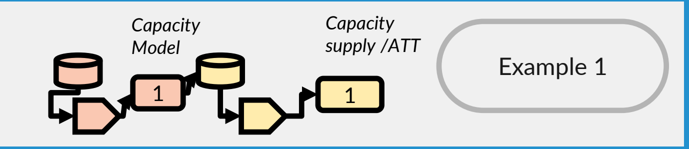
- Annual timetable and Rolling Planning



- Rolling Planning Brown
- Annual Timetable Yellow

1. Detailed schedule

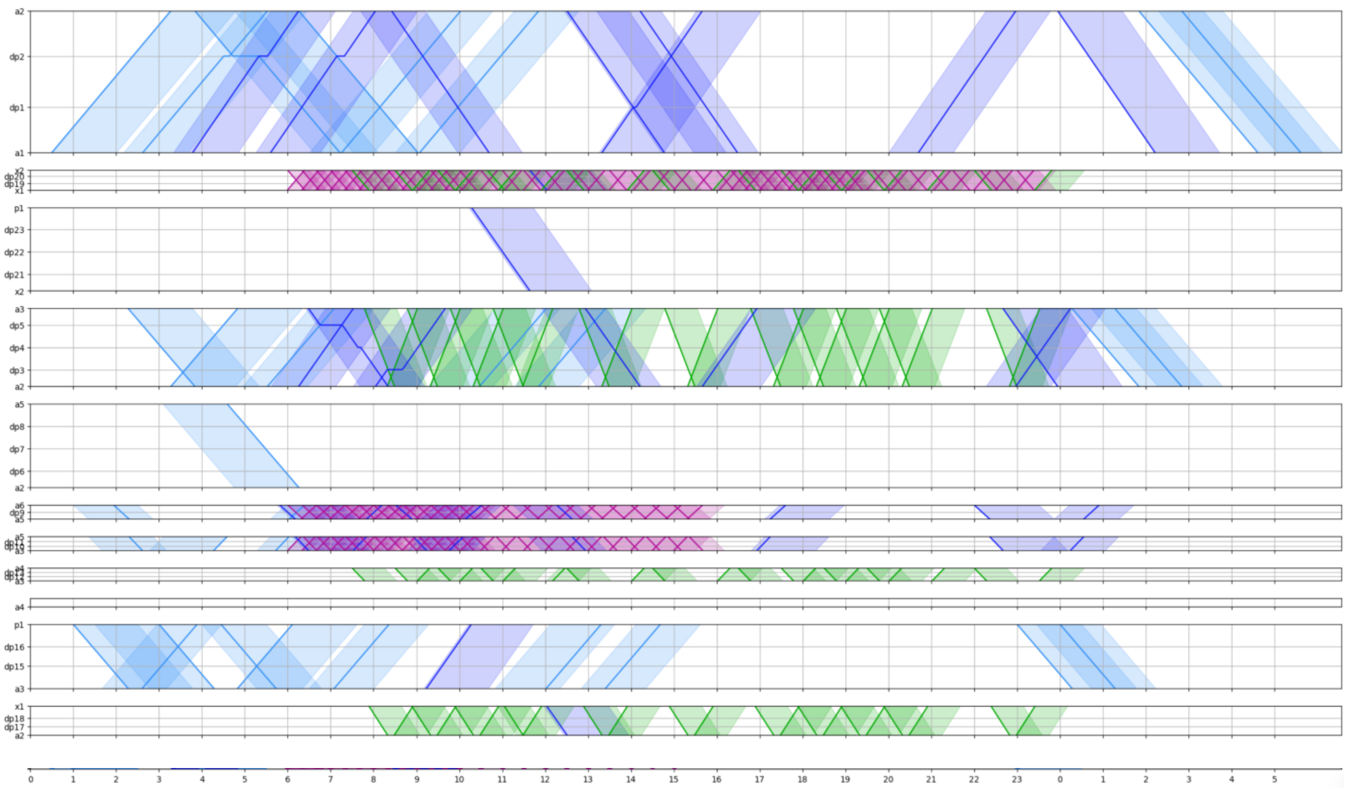




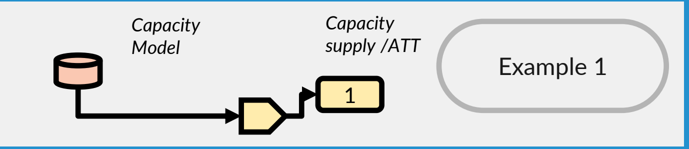
- Computed from results in Capacity model
- Optimized according to priority categories modelled in software

1. Compare with schedule based on original data

without resource optimization performed in Capacity model

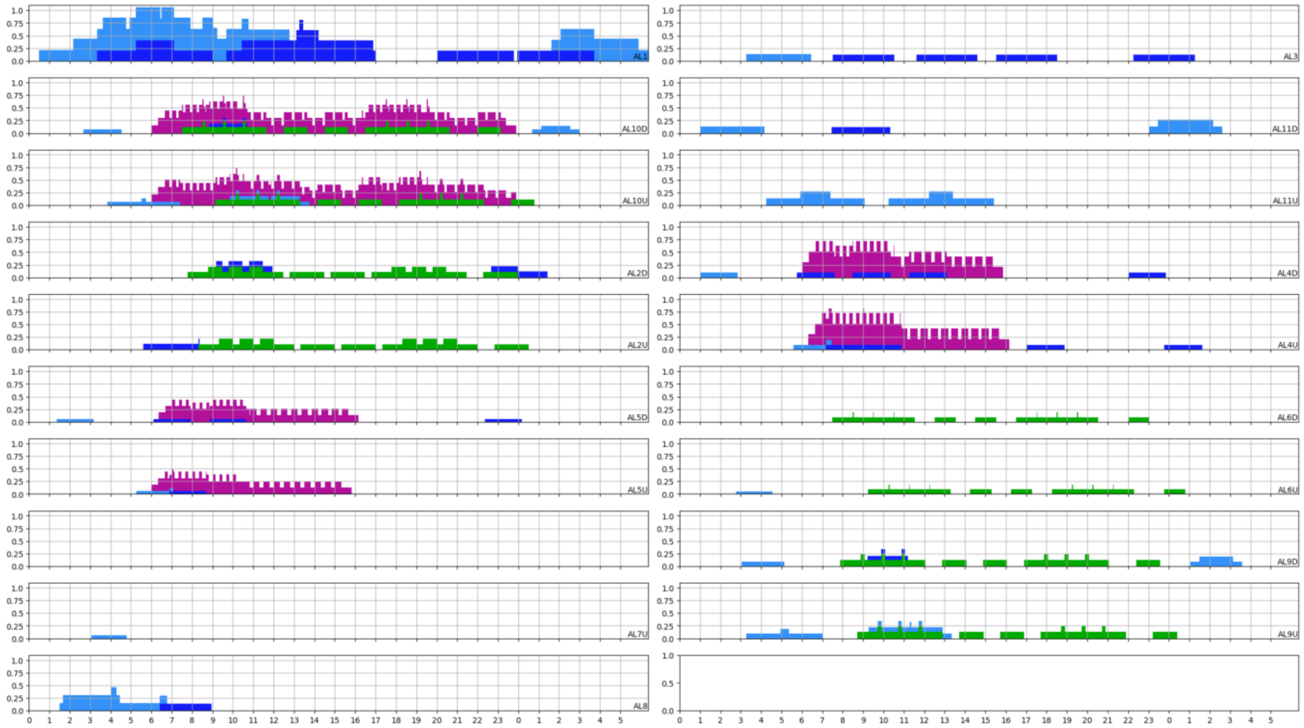


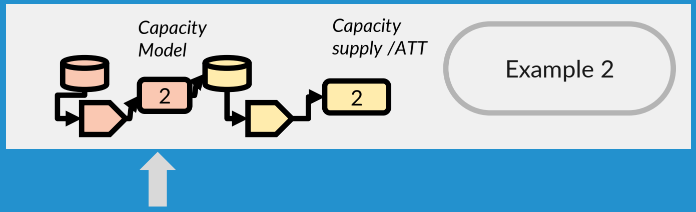
- Computed from original Production target & routes
- Optimized according to priority categories modelled in software



- Original train data
  - i.e. data to Capacity model
  - Same delivery to railway customers
    - i.e. commercial activities
- More expensive (higher generalized cost) than previous schedule

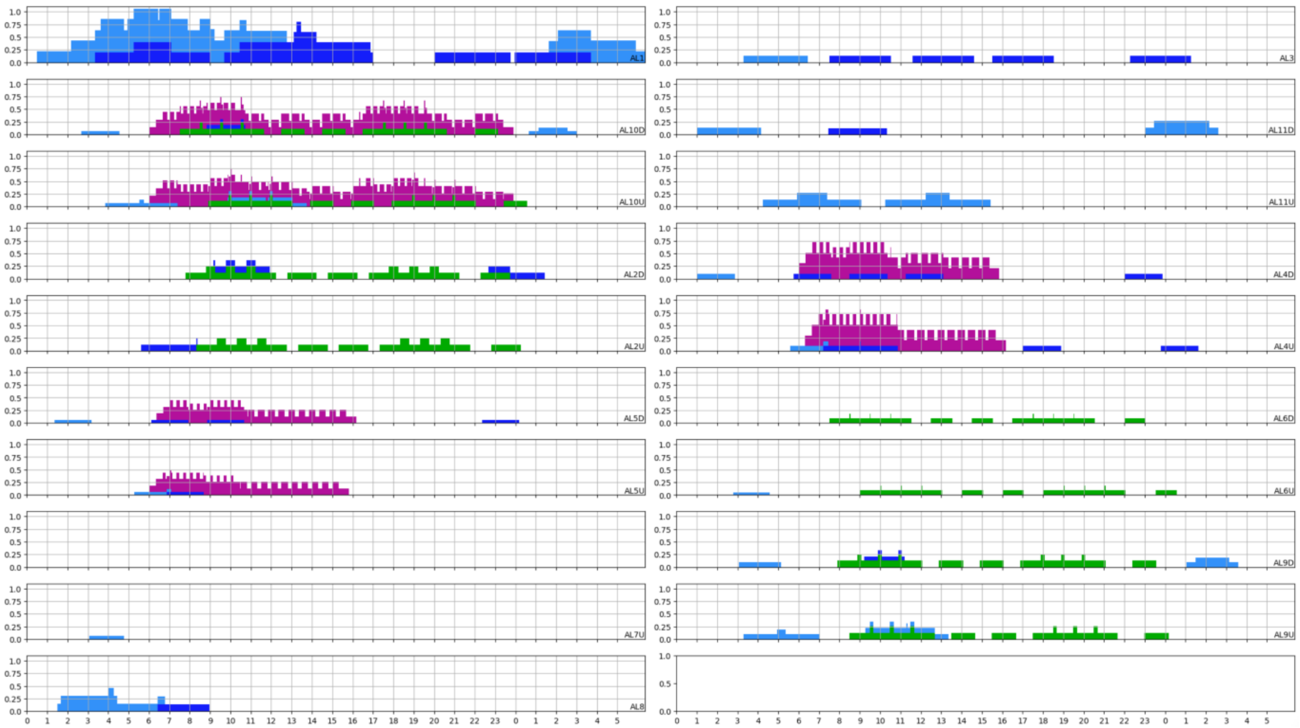
2. TCR rerouting, Capacity model



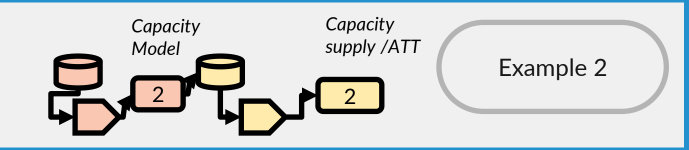


- Capacity model
  - Checking resource consumption
    - Try rerouting
    - Goal: global utility

2. Compare no TCR, Capacity model

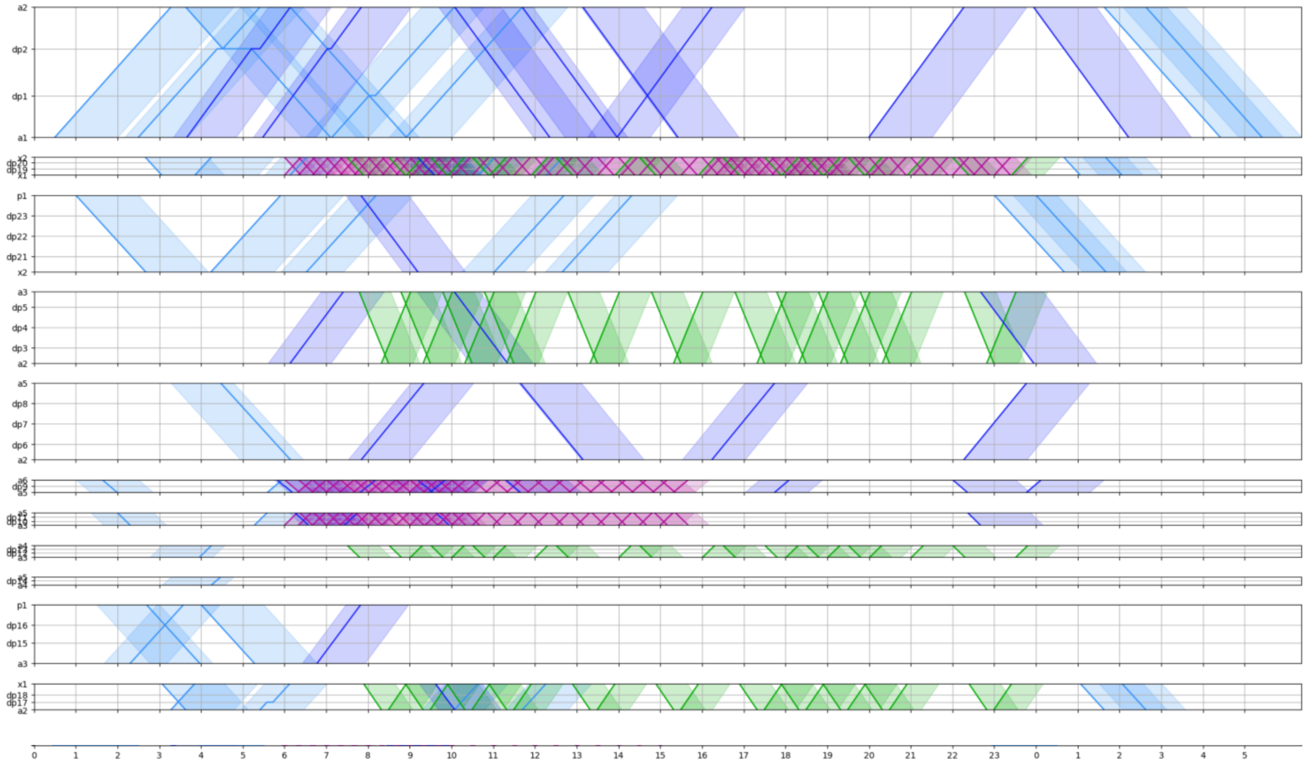


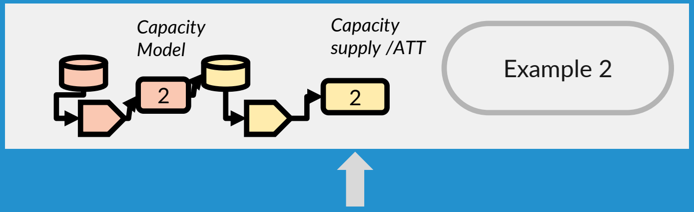
- Optimized with priority categories in spreadsheet model



- Same as previously shown
  - Capacity model with no TCRs

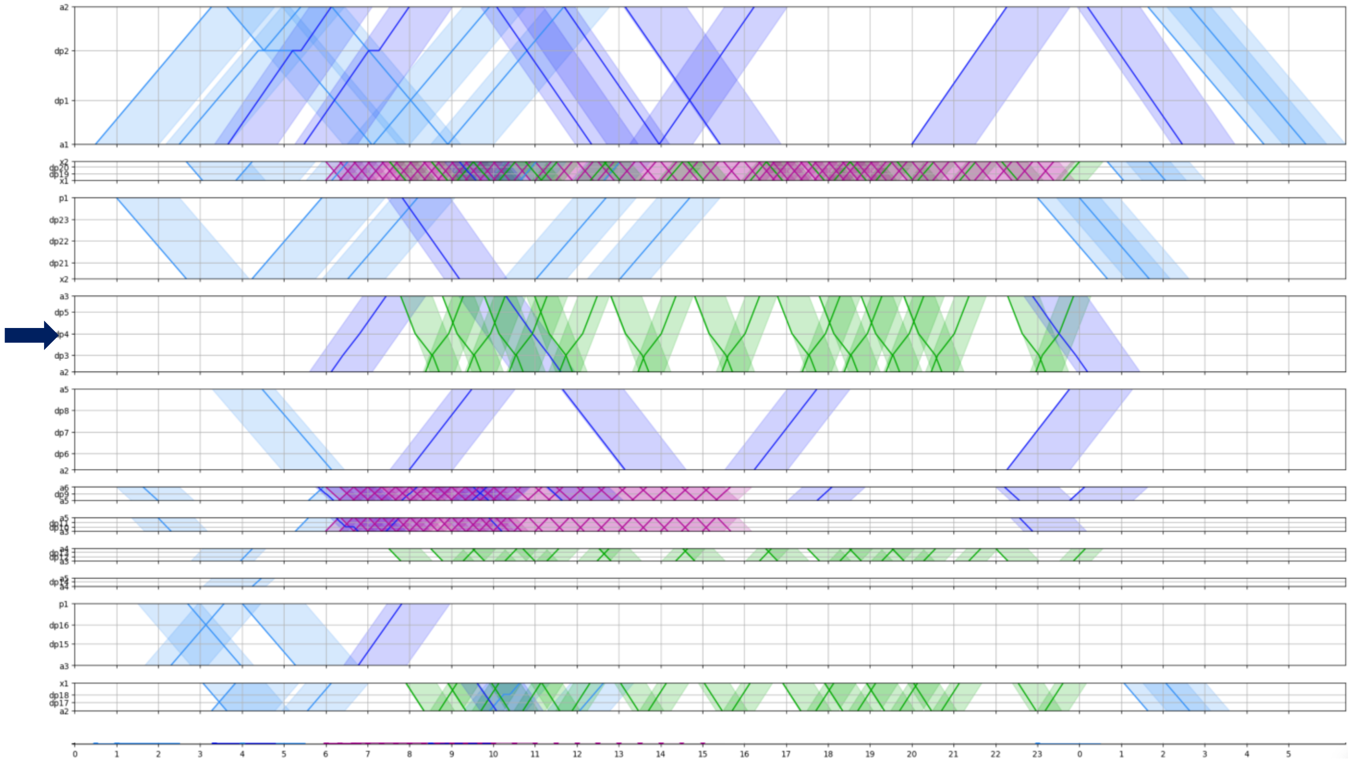
2. No TCR, detailed schedule

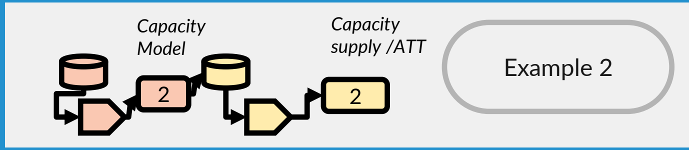




- Same detailed schedule as previously shown in Example 1

2. TCR rerouting, detailed schedule





- Note the slower speed on TCR link
- Regional traffic gains
  - Not part of TCR link
    Would keep original times, if possible
  - Passenger trains do not have another route
    due to topping behaviour
  - Still cheaper for freight trains to take route over dp3-dp4
- Result, scheduled additional times

No TCR	Added time	Shift time
Regional	0	1.36
Long pass.	0	0.16
Freight	2.86	7.90

TCR	Added time	Shift time
Regional	0	0.13
Long pass.	4.97	1.54
Freight	4.29	7.82

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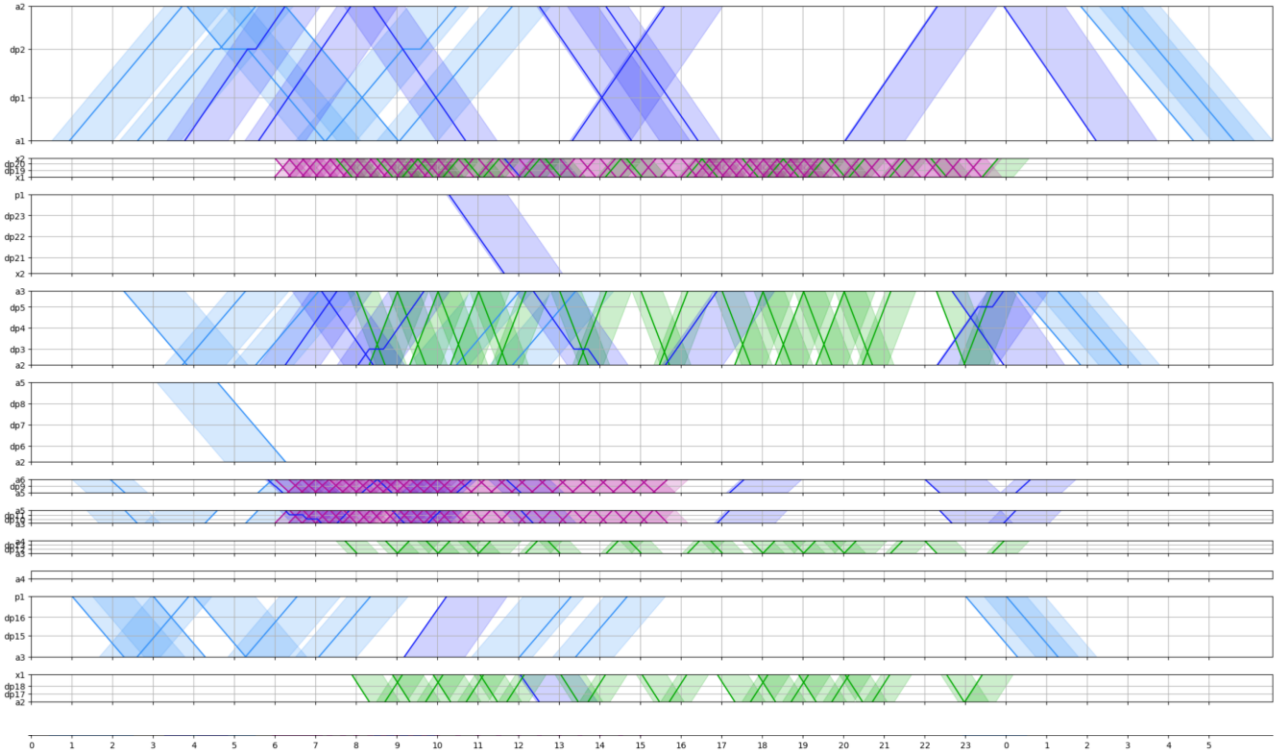
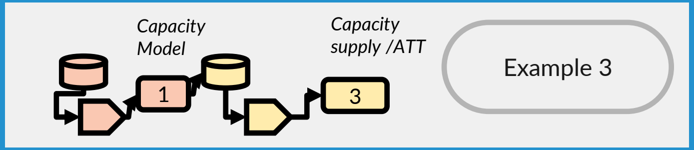
RISE

3. Time tabling based on priority order

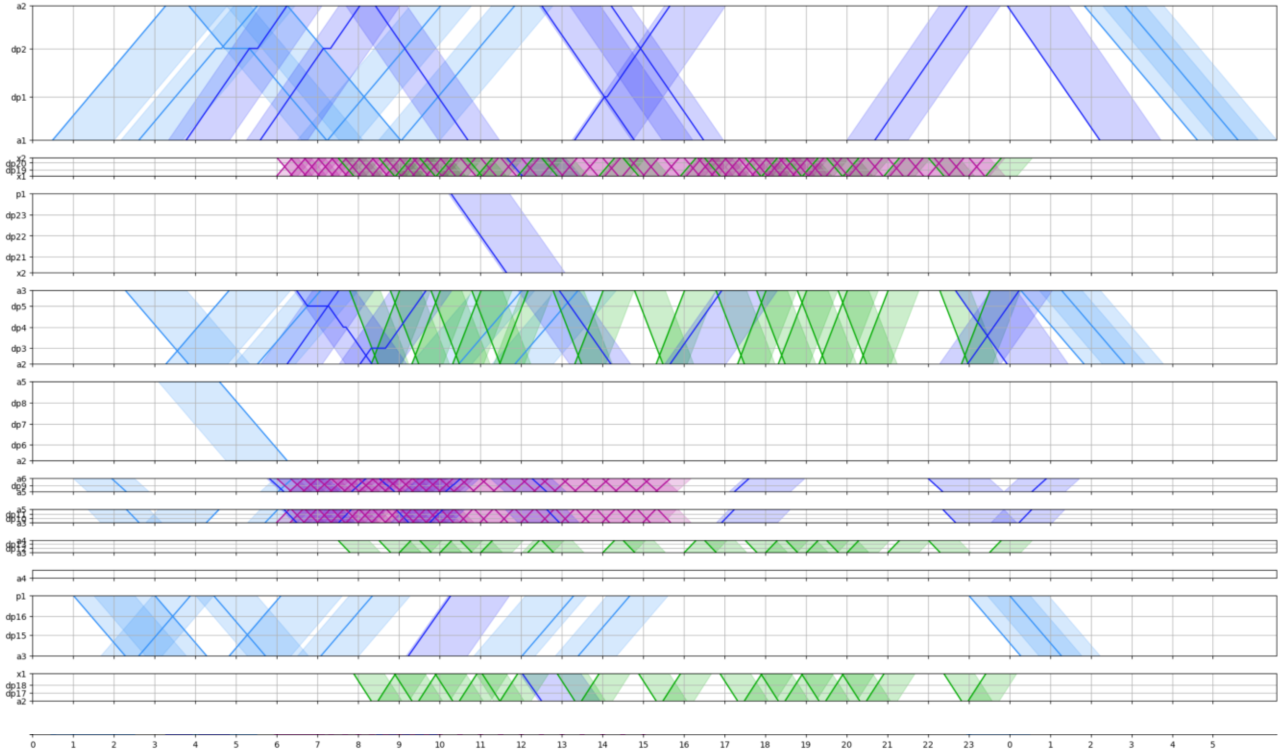
traffic type or train path type

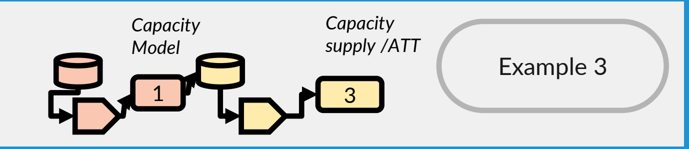




- Basic cost: 1 536 468 €
- Scheduled cost: 1 573 593 €
- Increased generalized cost due to capacity scarcity (conflict resolution): 37 125 €

3. Time tabling based on socio-economic valuation



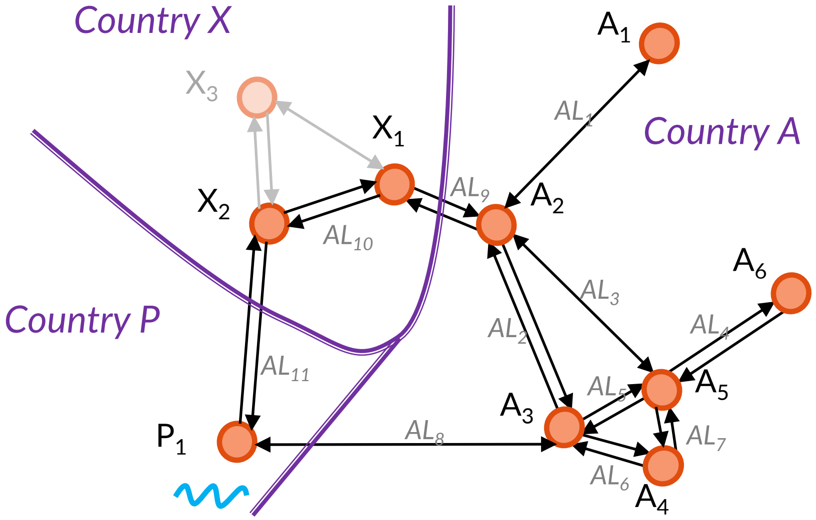


- Basic cost: 1 536 468 €
- Scheduled cost: 1 555 845 €
- Increased generalized cost due to capacity scarcity: 17 748 €
- Lost utility
  - 37 125 – 17 748 = 19 377 €
  - i.e. schedule according to fixed service type order is 109 % worse than the socio-economic solution (in €)

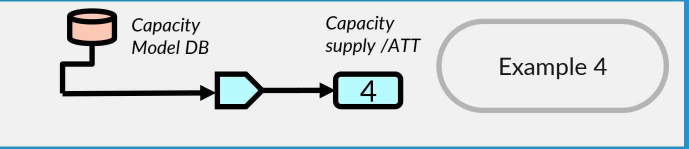
Service type prio	Added time	Shift time
Regional	0	0
Long pass.	0	2.97
Freight	4.32	6.65

Socio-economy	Added time	Shift time
Regional	0	1.36
Long pass.	0	0.16
Freight	2.86	7.90

4. Network with national values



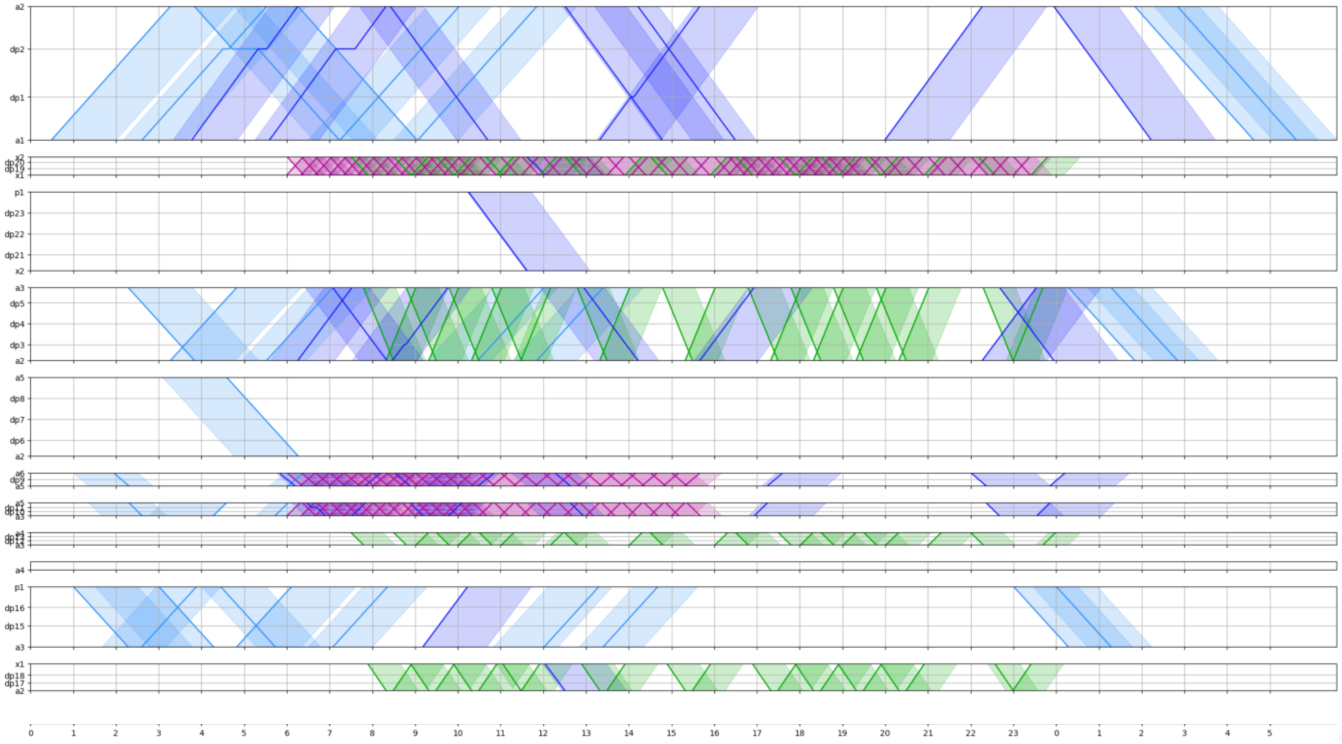
- Same basic data as previously
  - Network and its performance
  - Trains and their performance

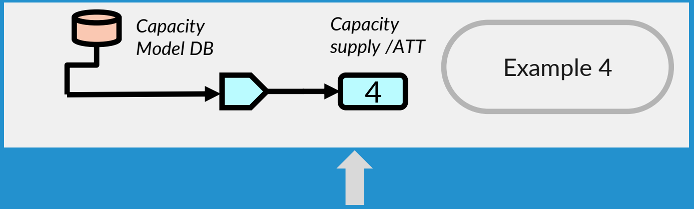


Setup

- Two expensive national cost factors
  - Country A and P
- One country with less expensive cost factors
  - Country X
- Test transit traffic A_1 – P_1
- Border A – X, P – X
- Commuter traffic X_1 – X_2

4. Country-specific cost factors

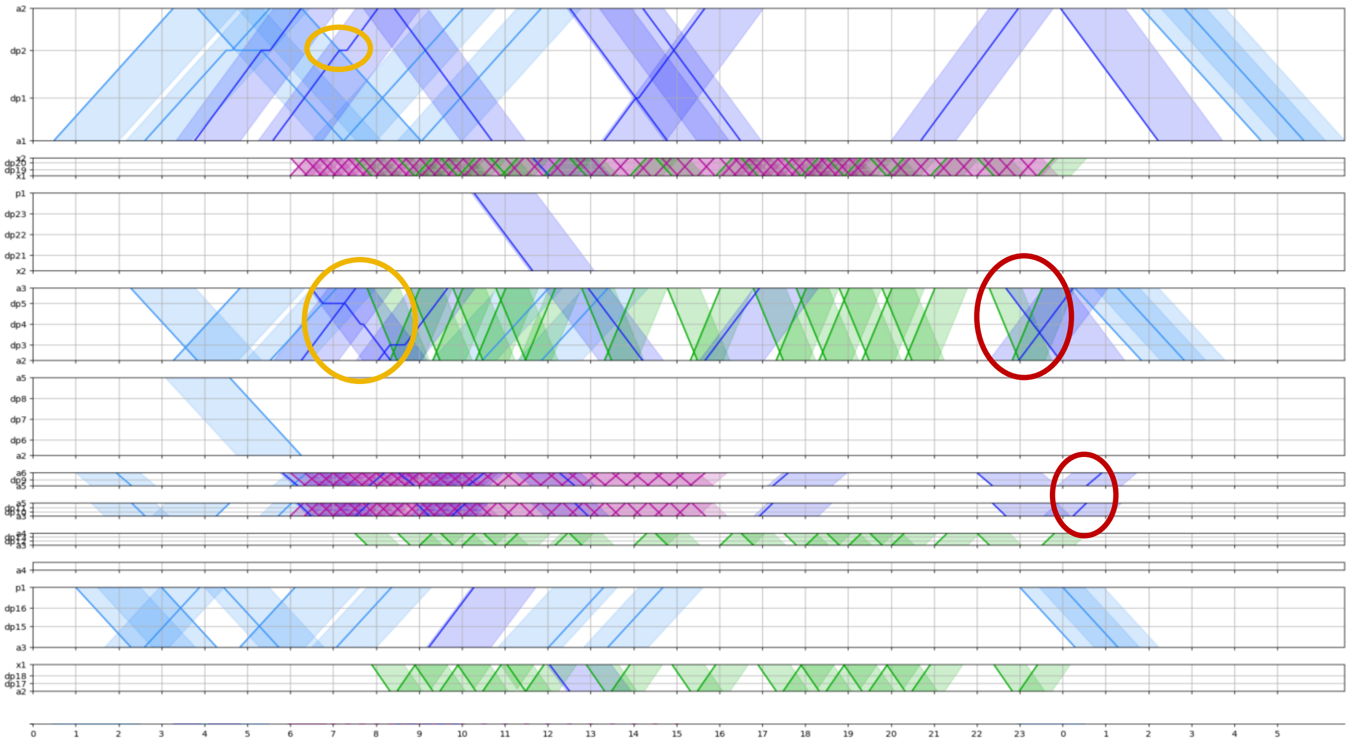


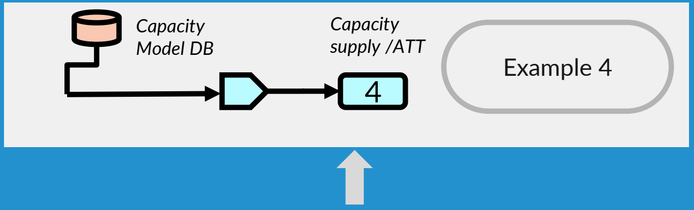


- Test effects of
  - European common cost factors
  - Country-specific cost factors

- Note that
  - Very few timetable points in our examples, compared to a real situation

4. European common cost factors





- Different order on trains
- Knock on effect
- Push of wait times
  - To where it is ”cheaper”
- Repair heuristics may be used to undo some border effects

Conclusion

- Model valuates train and associations
- Also Rolling planning volumes need to be classified and valuated
- Associations in Capacity Model (also) between systems of trains
- Two models proposed for exclusion of train paths and bandwidths
  - Long term: cost is difference to second best alternative
    - Needs further research and investigation
  - Short term: percentage of transported value or transport service's value
- Countries may use national or European common value
  As long as the quotient between the values are fairly equal
  - Consequence: if values are available on a European level, no reason not to use them nationally if values are lacking on a national level
- Lack of European level operational costs for passenger services
  - Development needed


REPORT

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Final report – Feasibility study on using Socio-Economic Cost Criteria in Case of Capacity Shortages

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Discussion

Thank you

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