



6th Railway Working Group Meeting

17-18 October 2022 • Almaty, Kazakhstan

6-е заседание Рабочей группы по железнодорожному транспорту

17-18 октября 2022 г. • Алматы, Казахстан

People's Republic of China
Poverty Reduction and
Regional Cooperation Fund




Track capacity and timetabling software (TCTS)


Mr. Udo Sauerbrey, Railway Commercialization and Reform Specialist



Agenda



General Information



Functions and Requirements



Procurement Process

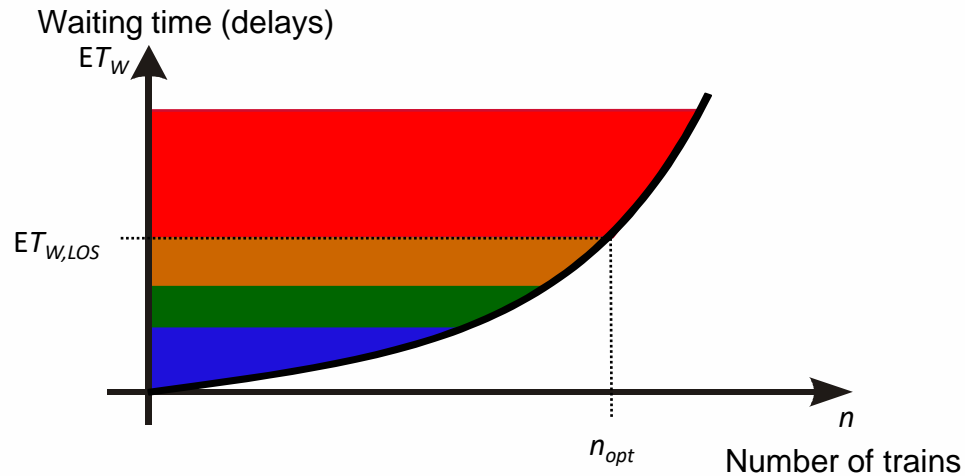


Market Overview and Solutions

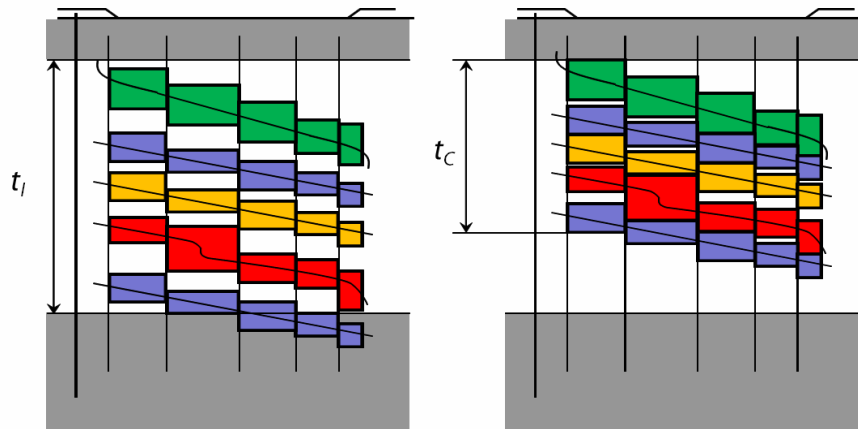


What is track capacity and how can it be measured?

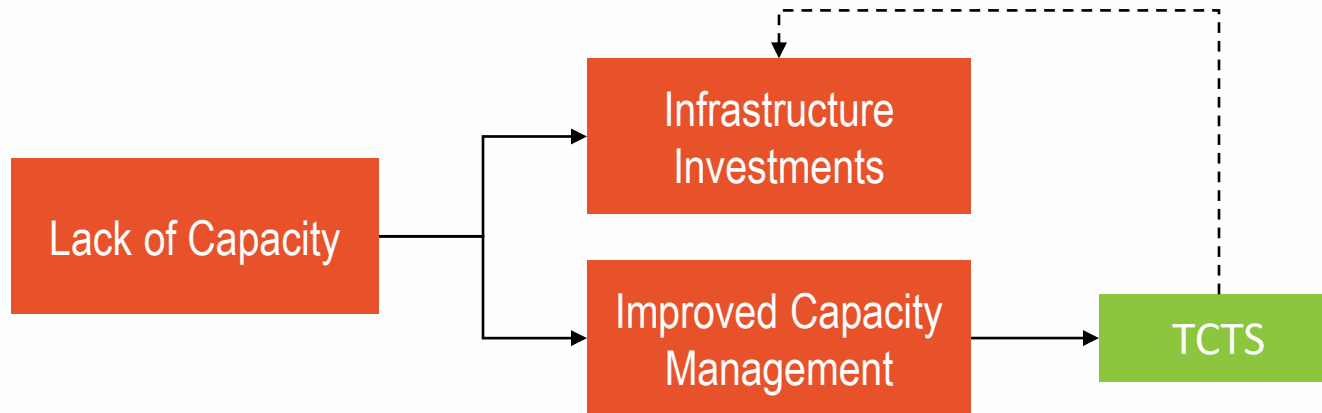
- **Capacity:** The level of traffic that a rail line can accept without exceeding a specified limit of queuing time



- **Measuring Capacity:** a method is given in UIC leaflet 406

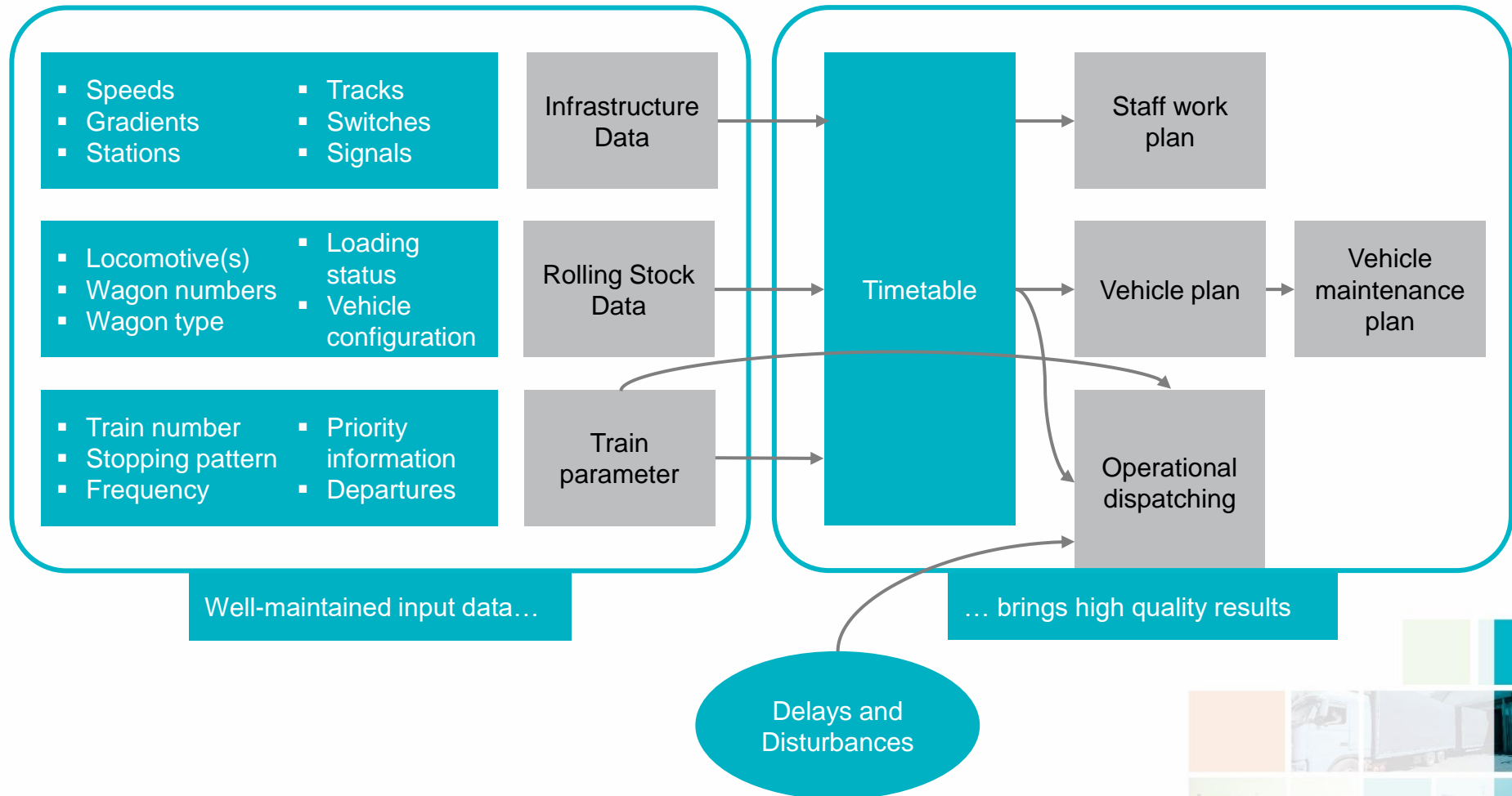


Why Track Capacity and Timetable Software?

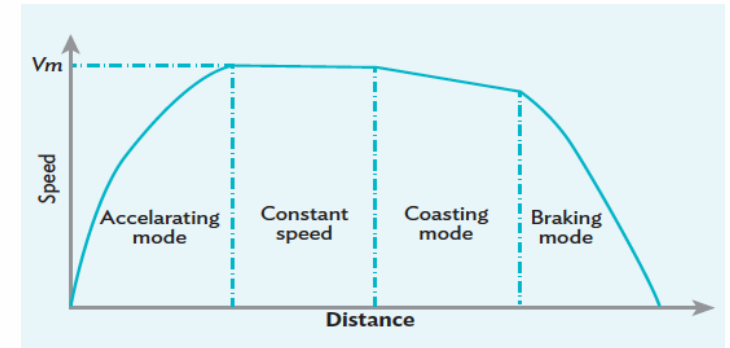
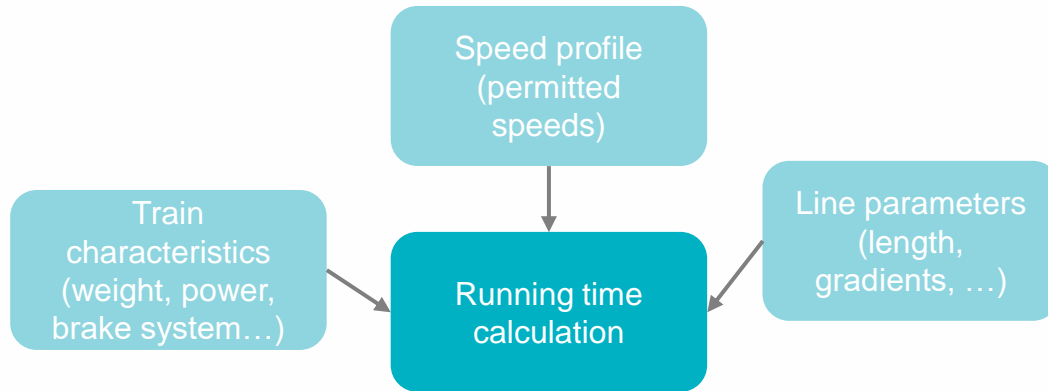


- Track Capacity and Timetable Systems (TCTS) are tools to...
 - ... organise and manage railway traffic and infrastructure
 - ... construct timetables of various kinds
 - ... evaluate railway operation data
- Input data is used to accurately model trains paths in the whole network which allow to...
 - ... detect conflicting train paths
 - ... speed up the timetable process which allows to compare different timetable options
 - ... optimize track utilization by detecting unused capacity
 - ... identify necessary infrastructure measures and compare infrastructure options
 - ... increase asset utilization and use of resources
 - ...many more features

Functions of TCTS – Basic Principle

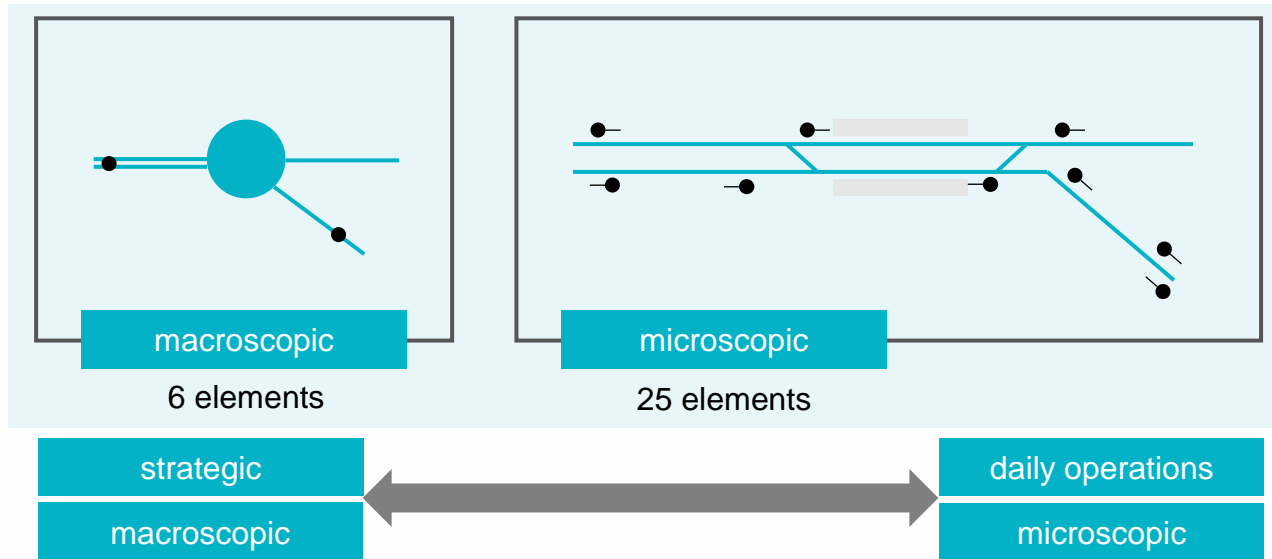


Functions of TCTS – Running time calculation



- Running time calculation is the most important part of all TCTS
- A minimum running time is calculated for each train
- The minimum running times can be used to create a conflict-free timetable by...
 - ... slowing down the trains on certain sections
 - ... adapting stopping times at stations
- When the train characteristics are known the calculation is accurate for all types of rolling stock in all countries

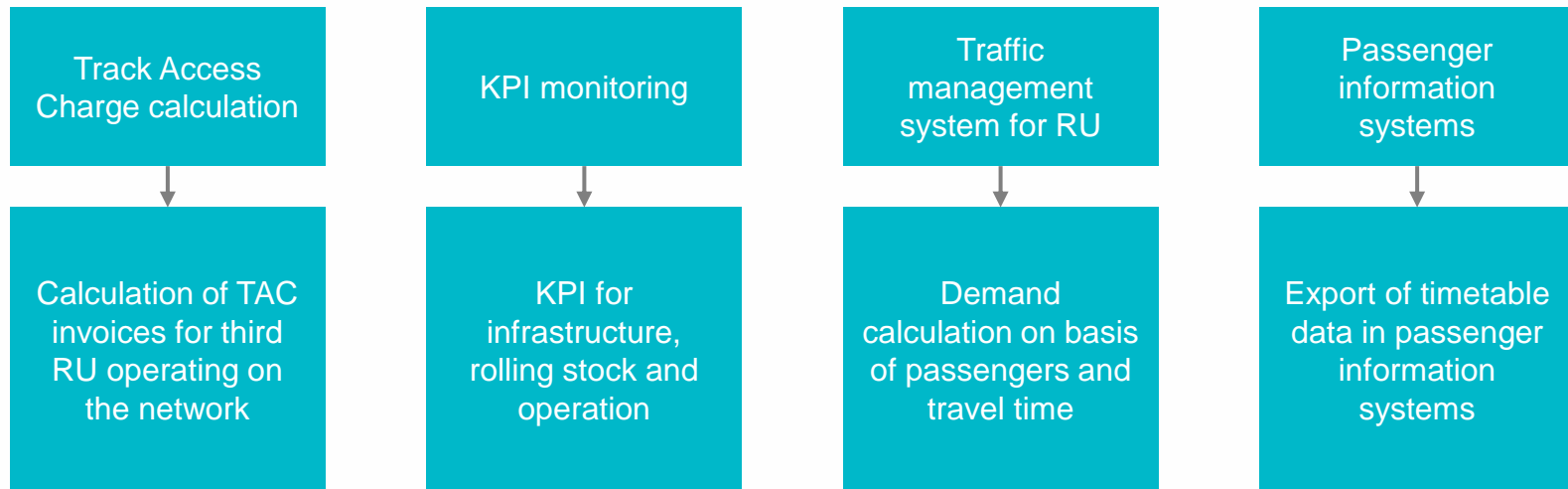
Functions of TCTS – Macroscopic or Microscopic?



- While in the **macroscopic** model only uses nodes and lines as infrastructural basis...
- ... the **microscopic** infrastructure model includes every switch, every signal and every station track for the simulation
- The microscopic approach needs more effort to generate and implement infrastructural data, but is much more powerful to analyse the effects of timetable changes
- The macroscopic approach can be used for strategic timetable planning (years in advance)
- The microscopic approach is closer to daily operations and can be used for more detailed analyses
- Most TCTS are based on the microscopic modelling approach

Functions of TCTS – Add-ons

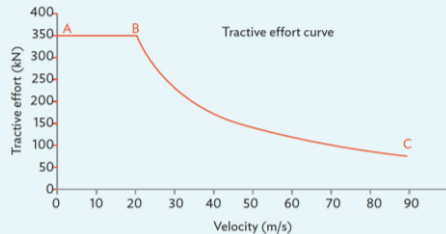
- TCTS generate a lot of valuable information that can be processed in other applications. Some examples include:



Functions of TCTS – Databases

Rolling Stock

- Various train types are included in TCTS
- Custom train types can be added (data required, esp. the tractive effort chart)



Infrastructure

- Infrastructure database can include multiple networks:
 - Status quo
 - Short term changes (speed reductions, line closures, ...)
 - Strategic network extensions
 - ...

Calendar

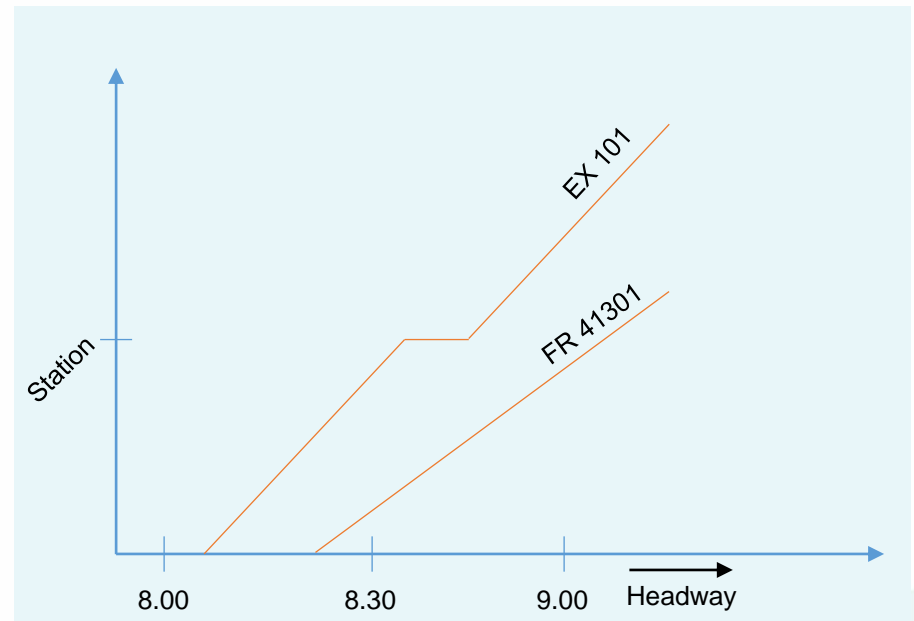
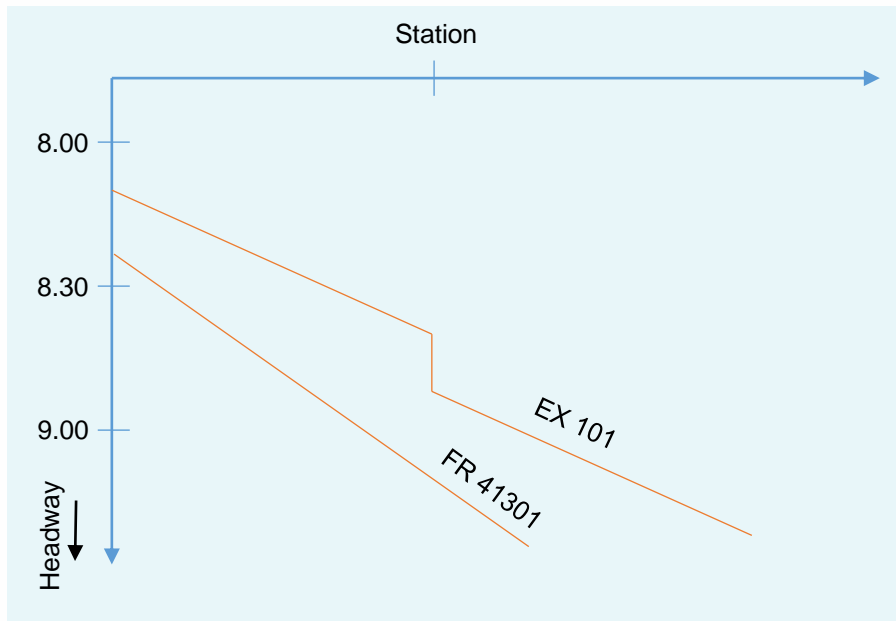
- Different calendars can be used to conveniently define the days on which a train runs:
 - All weekdays
 - Only weekends
 - All days except public holidays
 - Custom days

Route information

- Within stations there are often multiple routes which can be used by trains
- Different priorities can be assigned to tracks and routes
- These might be different for passenger trains and freight trains (e.g. use of tracks with platforms)

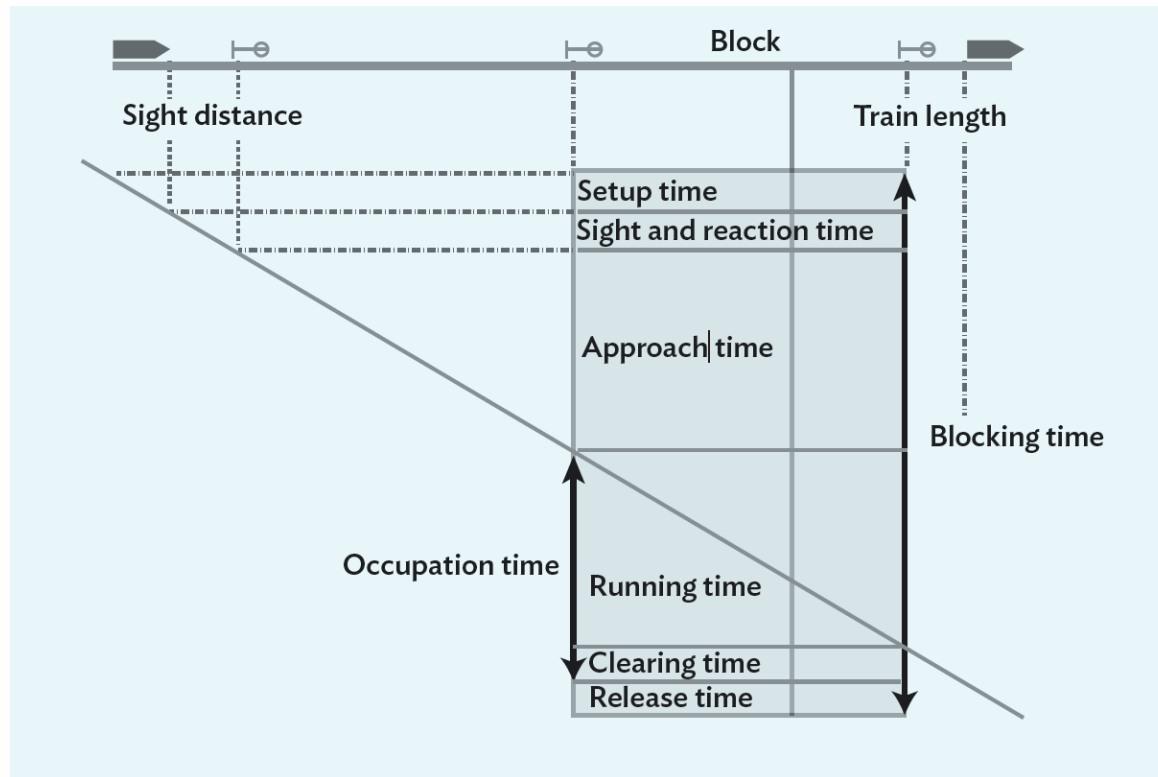
Functions of TCTS – Timetable planning

- Timetable planning is the core feature of TCTS



Functions of TCTS – Timetable planning

- The timetables are based on blocking time stairways, which are calculated from train movement models





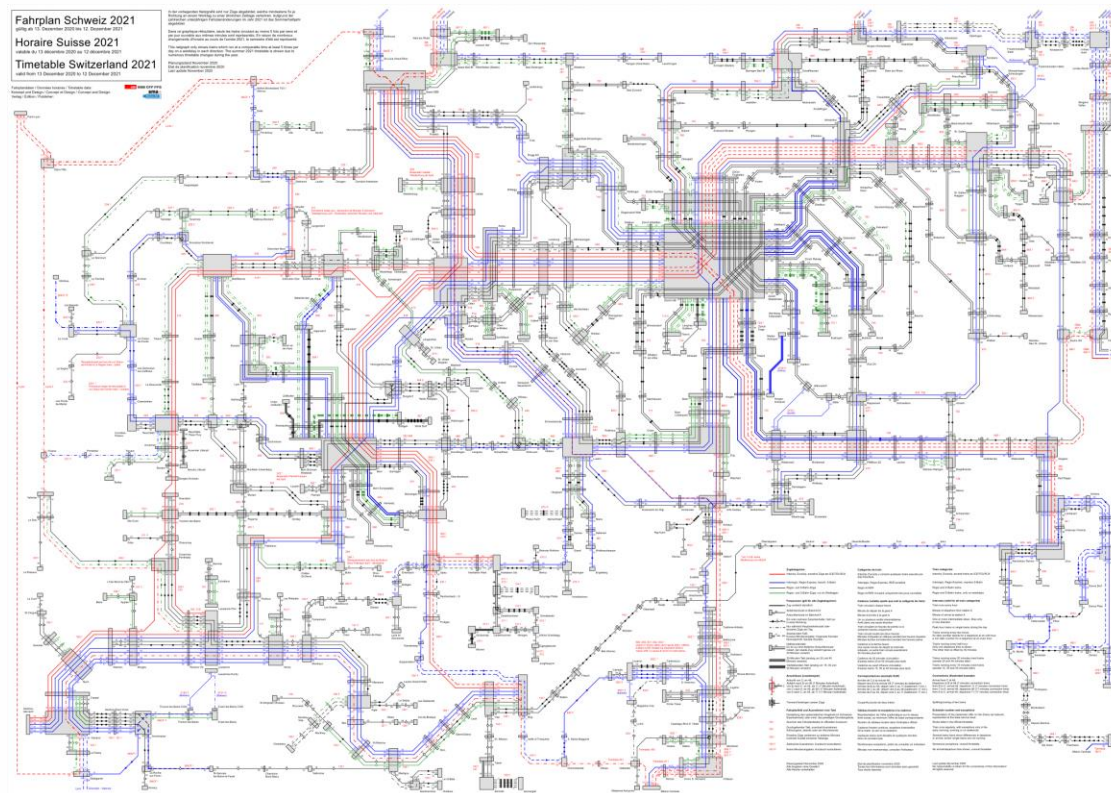
Functions of TCTS – Timetable planning

- Conflicting train paths are detected automatically
- As rail timetables are highly overdetermined systems, conflicts need to be solved by experts weighing various factors such as train priority, entailing conflicts, etc.
- In rail networks with high density traffic the construction of a stable and market-oriented timetable is a permanent task for a highly skilled group of people
- The introduction of clockfaced scheduling in passenger rail is supported by TCTS and reduces the effort for timetable construction
- A high-quality TCTS will allow users to edit train paths in various ways (bend them, change stopping times, define connections, etc.)



Functions of TCTS – Timetable output

- Timetables can be generated for different use cases:



Functions of TCTS – Timetable output

- Timetables can be generated for different use cases:



Mo	FBS-Beispiel-Umlaufplan Netz Ostsachsen Cottbus / Görlitz / Zittau	Umlaufplan Tfz 650	Stand: 31.07.2018 Fahrzeugbedarf: 10 Tfz. Laufleistung aller Fzg. pro Woche: 53.427,8 km mittl. Laufleistung pro Fzg. und Tag: 774,3 km
1			
So 8 DG			
1.142,6 km			
2			
So 1 DG			
652,4 km			
3			
So 2 DZ			
877,7 km			
4			
So 3 DG			
1.082,1 km			
5			
So 4 DEB			
237,0 km			
6			
So 5 XTVD			
547,5 km			
7			
So 6 XTVD			
1.048,8 km			
8			
So 7 DEB			
607,7 km			
1			
Di 1 XTVD			
1.142,6 km			
2			
Di 2 BHW			
652,4 km			
3			
Di 3 DEB			
877,7 km			
4			
Di 4 DG			
1.082,1 km			
5			
Di 5 DEB			
237,0 km			
6			
Di 6 DG			
547,5 km			
7			
Di 7 BCS			
1.048,8 km			
8			
Di 8 DZ			
607,7 km			

Functions of TCTS – Timetable output

- Timetables can be generated for different use cases:

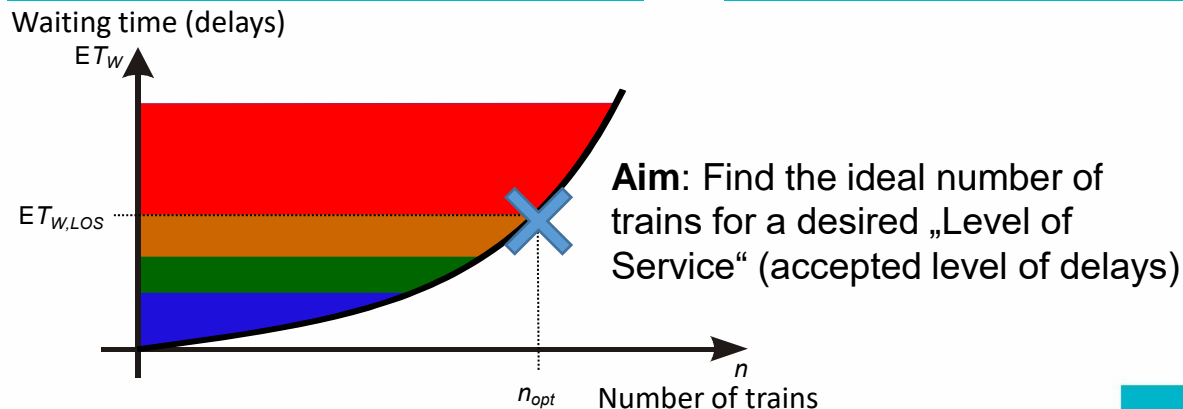
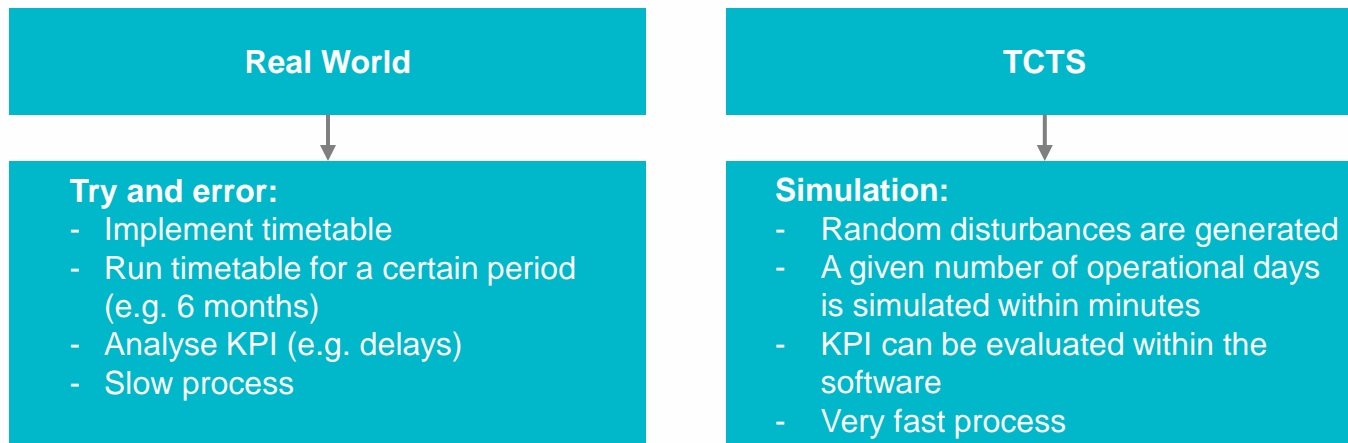


Zug	RE 79 57416 Mo-Fr	RE 75 3981 Mo-Fr	RE 76 7884 Sa,So	RE 76 7886 Sa,So	RE 70 3884 Mo-Do, Sa,So	RB 74 57378 Mo-Do, Sa,So	RB 74 57380 Fr	RB77 62742 Sa	IC 2085 Sa	IC 2083 Sa	RE 79 57418 Mo-Fr	RE 75 3983 Mo-Fr	RE 96 78939 Mo-Fr	RE 72 78941 Mo-Fr	RE 17 3394 Sa	RE 7 3294 Sa	RB68 62704 Sa
von	Ulm																
München Hbf	00 00		13 20	13 20	13 20	13 40	13 40		Hannover	Hannover							14 40
München-Pasing			13 27	13 27	13 27	13 47	13 47						13 54	14 20			14 47
Fürstenfeldbruck						13 56											
Geltendorf	985 80	o	13 47	13 47	13 47	14 07	14 07							14 47			15 06
Geltendorf			13 48	13 48	13 48	14 07	14 07							14 48			15 07
Kaufbeuren	986	o	13 56	13 56	13 56	14 15	14 15							14 55			15 14
Kaufbeuren			13 57	13 57	13 57	14 15	14 15							14 56			15 15
Buchloe	971, 972, 974 81	o	14 05	14 05	14 05	14 22	14 22						14 32	15 03			15 22
Augsburg Hbf			13 41	13 41	13 41			13 48	13 57	13 57	14 14				14 44	14 44	14 48
Bobingen	986							14 11			14 22						15 03
Schwabmünchen								14 19			14 29						15 10
Buchloe								14 30	14 23	14 23	14 39				15 05	15 05	15 20
Buchloe	81	o	14 04	14 04	14 04			14 30	14 23	14 23	14 39				15 05	15 05	15 20
Buchloe		13 39	14 07	14 07	14 07	14 31	14 31	14 43	14 24	14 24	14 40		14 33		15 07	15 07	15 29
Kaufbeuren	81	o	14 19	14 19	14 19	14 43	14 43	14 45	14 38	14 38	14 51			15 19	15 19	15 41	
Kaufbeuren		13 51	14 20	14 20	14 20	14 45	14 45	14 49	14 39	14 39	14 52			15 20	15 20	15 45	
Biesenhofen	974 81	o	13 55					14 49	14 39	14 39	14 56						15 50
Biesenhofen			13 56								14 56						15 51
Günzach			14 09								15 09						15 52
Kempten (Allgäu) Hbf	973, 975	o	14 22	14 42	14 42	14 42			15 09	15 09	15 22				15 41	15 41	
Kempten (Allgäu) Hbf			14 29	14 43	14 43	14 43			15 10	15 10	15 29			15 43	15 43		
Martinszell (Allgäu)			14 37								15 37						15 55
Immenstadt			14 45	14 55	14 55	14 55			15 27	15 27	15 45			15 55	15 55		
Immenstadt						14 57					15 45						15 57
Oberstaufen						15 07					15 51						16 07
Röthenbach (Allgäu)						15 17					16 05						16 17
Heimenkirch	81					15 21					16 10						16 21
Hergatz	82					15 29					16 16		15 59				16 29
Lindau-Insel	82	o									16 16		16 16				
Lindau-Insel	86										16 37		16 41				
Lindau-Reutin	88	o				15 45					16 37		16 41				16 45
Immenstadt	81		14 51	15 12	15 12				15 42	15 42	15 51				16 12		
Blaichach (Allgäu)			14 55	15 16	15 16				15 50	15 50	15 55				16 16		
Sonnhofen			15 00	15 20	15 21				15 50	15 50	16 00				16 20		
Sonnhofen			15 00	15 23	15 23				15 52	15 52	16 01				16 21		
Altstädten (Allgäu)			15 04		15 26						16 05						
Fischen			15 09	15 31	15 36				16 03	16 03	16 10				16 32		
Langenwang (Schwab)			15 13		15 40				16 11	16 11	16 14						
Oberstdorf	81	o	15 19	15 39	15 45				16 11	16 11	16 19				16 40		
nach								Füssen						Memmingen			Füssen



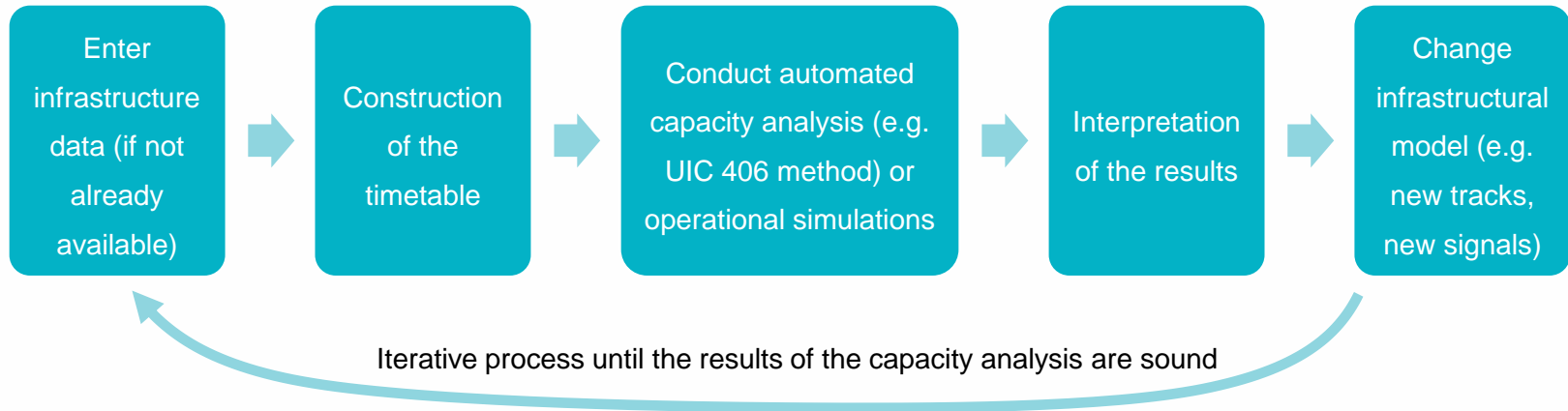
Functions of TCTS – Operational simulation

- A TCTS constructed timetable is not necessarily of good quality, just because it is free of conflicts
- **Timetable Quality** can be assessed in two ways...



Functions of TCTS – Operational simulation

- Developing the ideal timetable is an iterative process



Functions of TCTS – KPI monitoring

Infrastructure utilization

Occupation rate for lines and station tracks

Capacity consumption acc. UIC 406

Available capacity for lines and stations

Change of capacity with new infrastructure elements (e.g. signals)

Locations on network building up most delay

And many more ...

Rolling stock

Mileage for vehicles

Utilization rate (operating time/dwell time)

Difference between actual and minimal number of vehicles to operate

Energy consumption

Journey time reduction with more powerful traction

And many more ...

Functions of TCTS – KPI monitoring

Railway operation data

Running time quotient for trains (real running time/minimal running time)

Number of trains

Punctuality

Number of trains cancelled/delayed

Most delayed trains

And many more ...

Transport related KPI

Train-km

Share and performance of freight and passenger transport

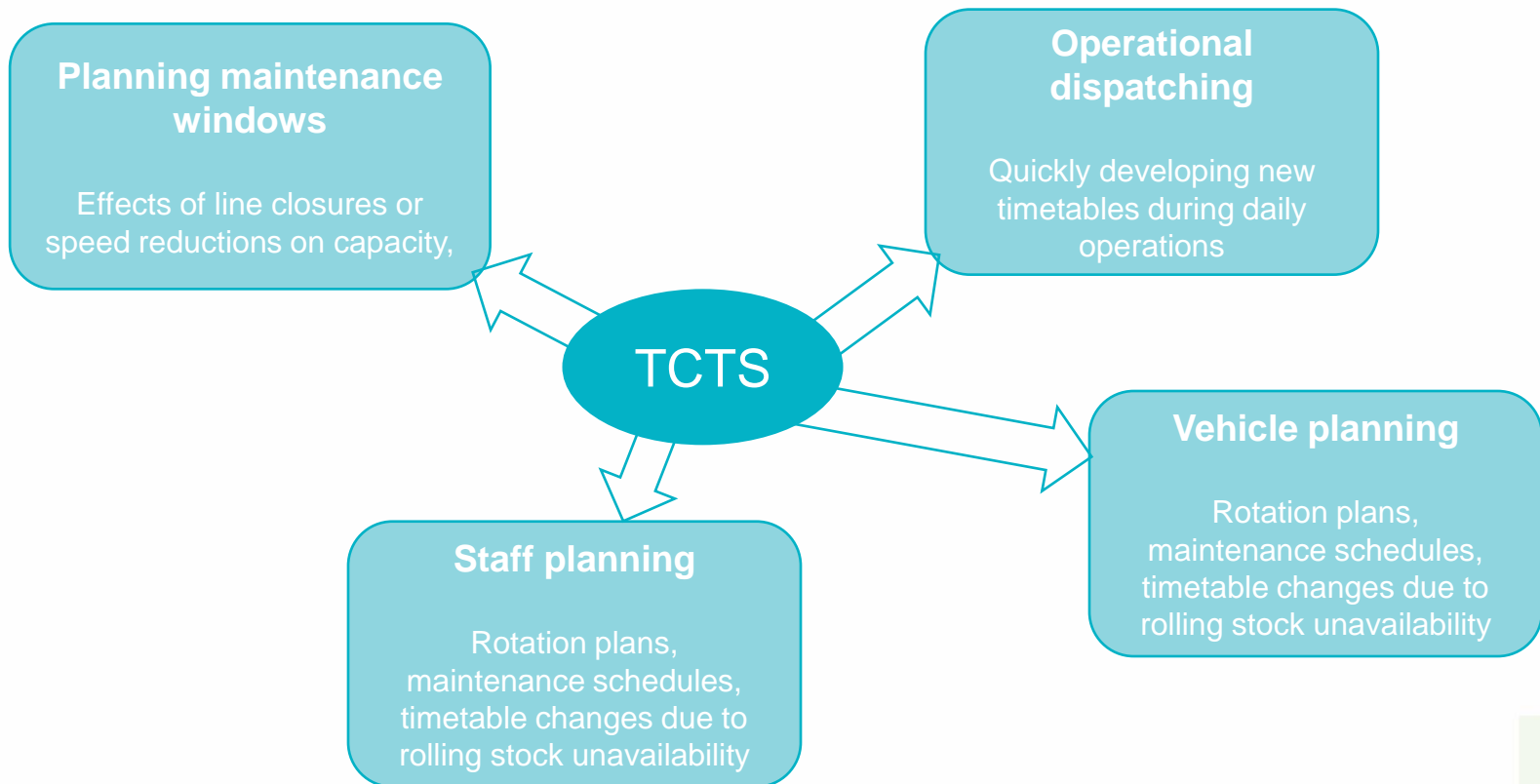
Running time quotient for trains (real running time/minimal running time)

Passenger journey times

Number of available seats / connections / direct trains on routes

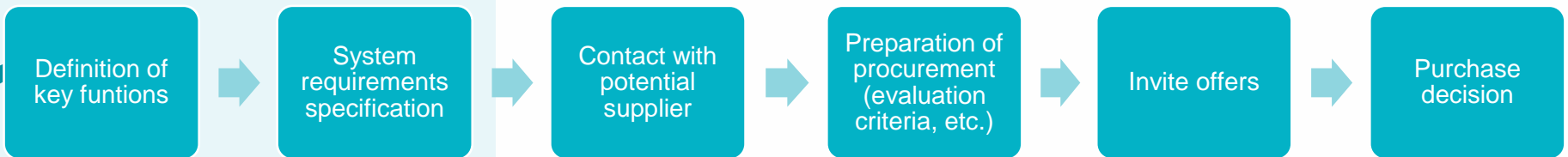
And many more ...

Functions of TCTS – Other functions



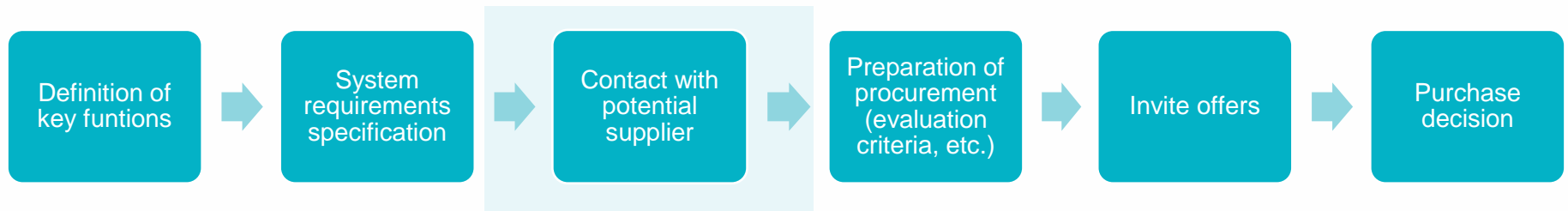
- **Note:** not all functions can be directly achieved within the TCTS, additional software with pre-defined interfaces might be necessary

Procurement Procedure for TCTS



1. What are the required functions the software should fulfil? Do we need dispatching functions?
2. Can we provide a sufficient database? Or what is the time requirement or the cost of creating/updating the database (track videos etc.)?
3. Can the national train protection system (if existent) be modelled in the software?
4. Do we have or do we plan to have interfaces with other systems?
5. Should the system focus on freight transport (less complexity needed), on passenger transport (higher complexity) or mixed traffic (higher complexity)?
6. What is our budget frame? Did we calculate enough for the system maintenance?
7. Do we have a team of experts with sufficient understanding to properly use the system? Or do we additionally need external qualification and training? How many hours of training are necessary before the productive use of the TCTS can start?
8. Do we want to execute all tasks inhouse or do we rely on additional timetable consulting services by specialists (e.g. for timetable feasibility studies)?

Procurement Procedure for TCTS



Supplier	SMA	Hacon	VIA-Con	iRFP	RMCon	Oliver Wyman	Trenolab
Product name	Viriato	TPS	LUKS	FBS	RailSys	MultiRail Planning Suite	Treno
Link	https://www.sma-partner.com/en/software/viriato	https://www.hacon.de/en/solutions/train-capacity-planning/	https://www.via-con.de/en/development/luks/	http://www.en.irfp.de/functions.html	https://www.rmcon-int.de/railsys-en/railsys-suite	https://www.oliverwyman.com/our-expertise/insights/2012/mar/multirail-planning-suite.html	https://www.trenolab.com/tools/

This list is not exhaustive, nor does it imply an endorsement of any of the applications.