kombi verkehr

Capacity Management System

Presentation at DIOMIS Workshop

Prozessmanagement · Frankfurt am Main · Februar 2006

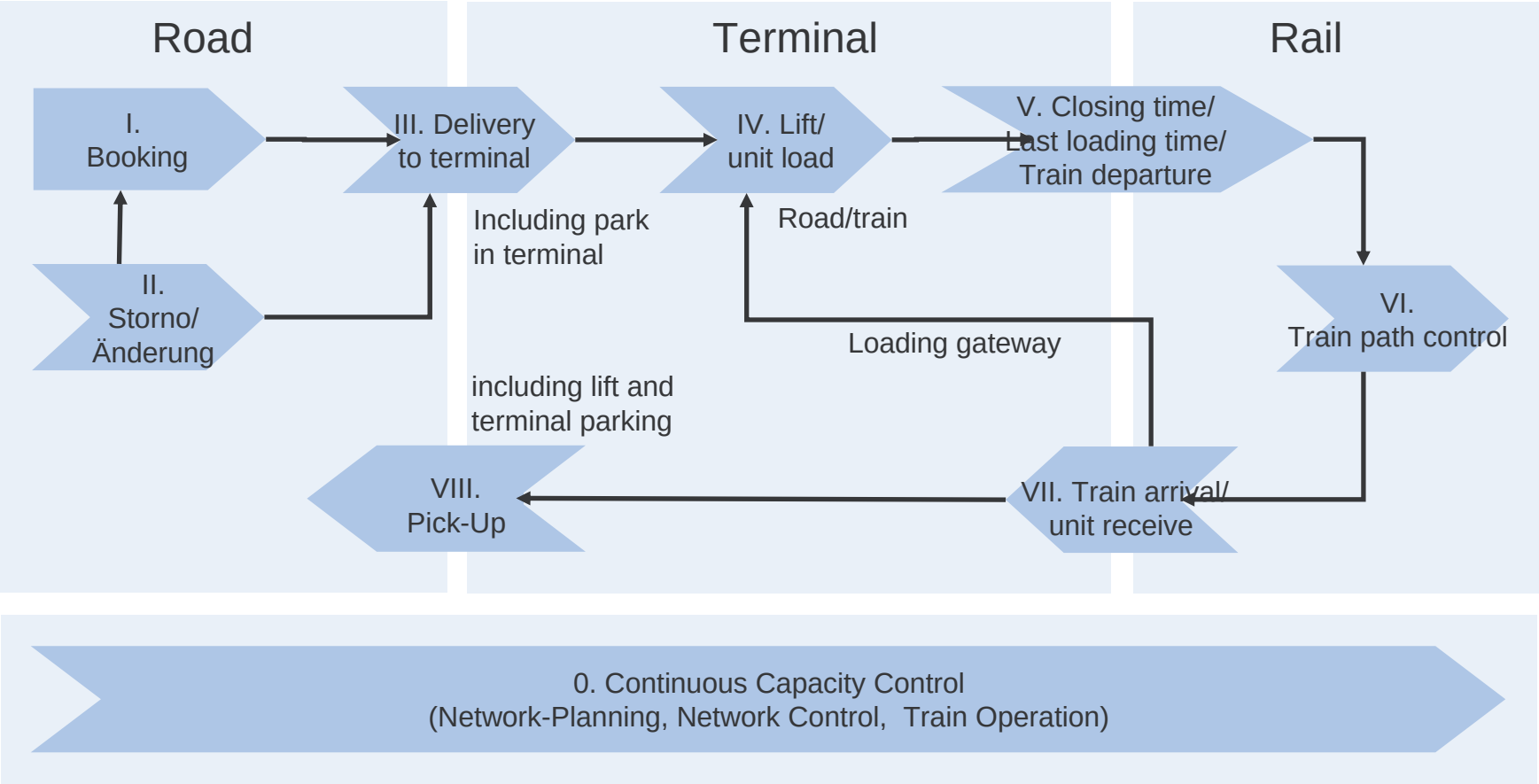
The Easy Way

- Concentrate on specific markets
- Concentrate on specific production concepts
- Reduce variety of loading units (e.g. just ISO-containers)
- Local-View on single train

Reality of Kombiverkehr (General Framework)

- Network of 120 national und international Block-Trains with daily schedule
- Every Train is defined by Parameters Lengths and Weight
- Over 402 Terminals with nearly 6.000 connections in regular european-wide program
- Transport routing over 11.600 single production legs
- Potential of production network is more than 68.000 connections

Business Processes Overview



Overall Targets (in respect to capacity aspects)

- Optimization of Network Utilization

  Active Flow Control of each single unit within network

  Every Unit receives a „capacity corridor“ (a distinctive route) within network at time of booking

- **Optimization of Rolling-Stock-Use:**

  Providing optimal waggon-compositions for block-trains

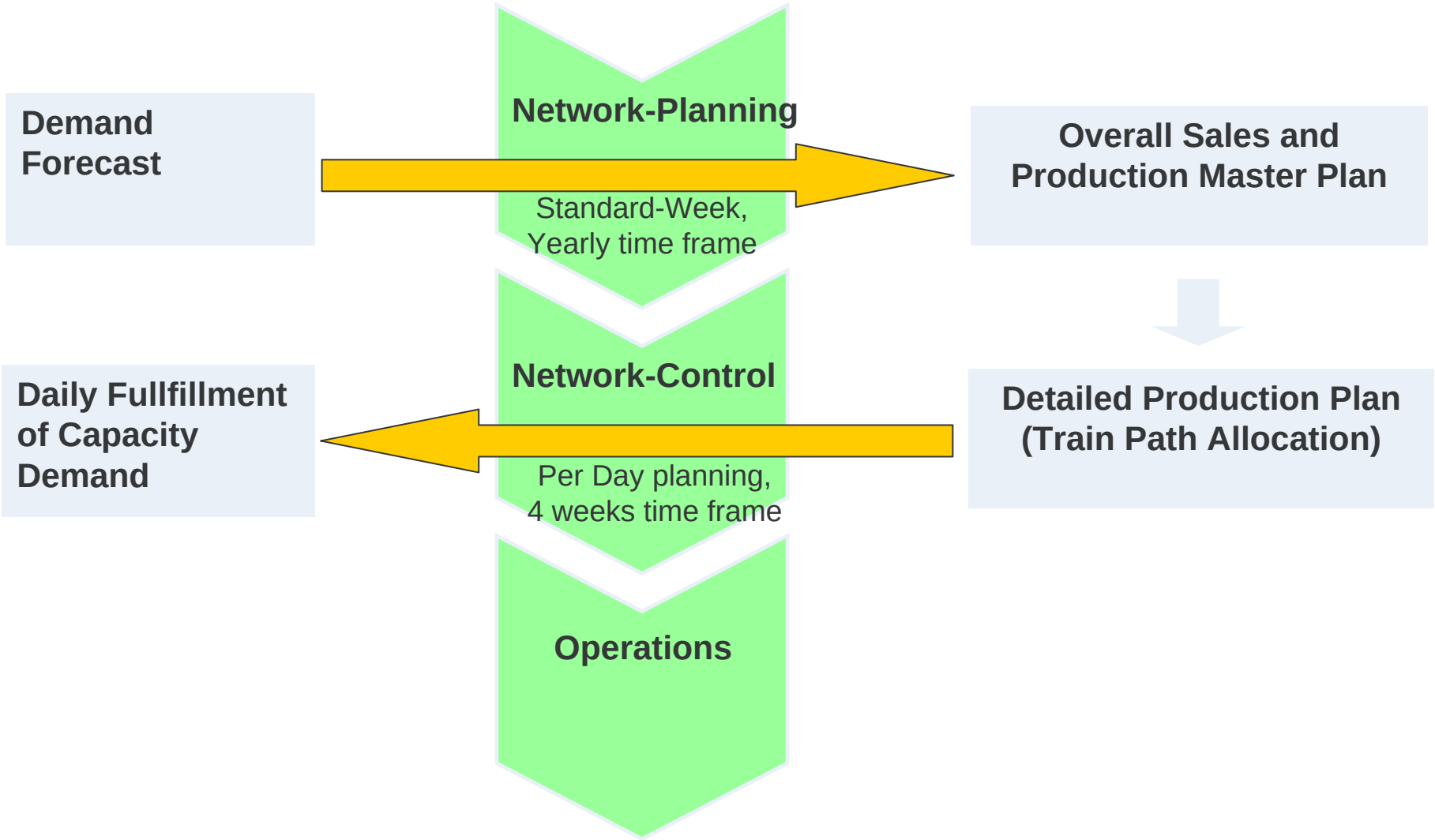
  Taking into account tranport routes and mix of loading-units on these routes

- **Optimization of Train-Loading:**

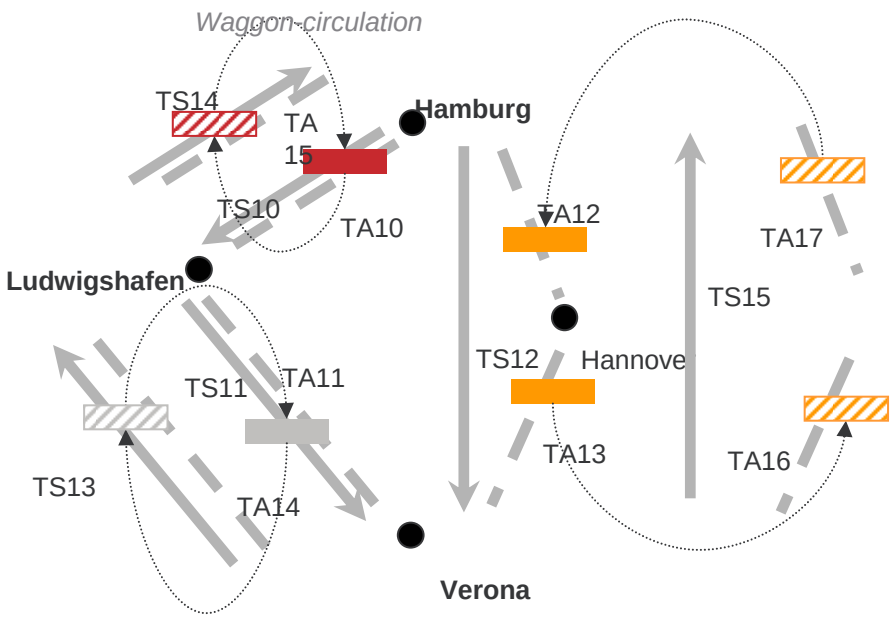
  Automated loading optimization for waggons

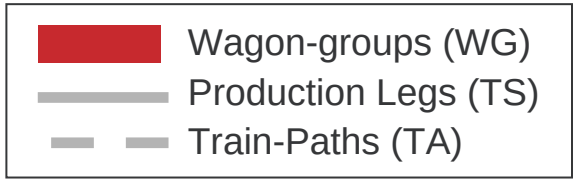
  Taking into account specific waggon-loading-schemes

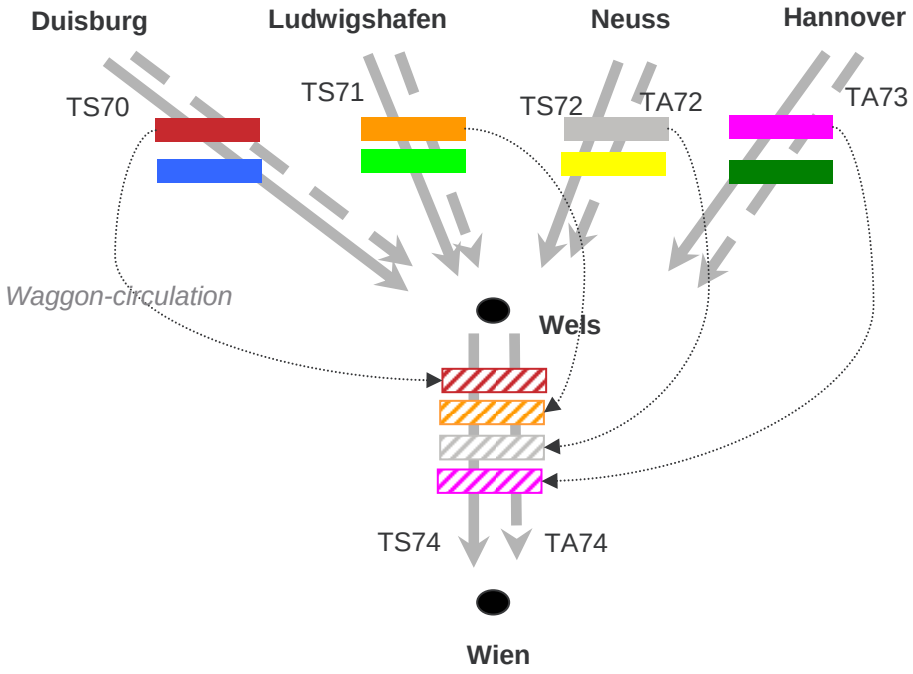
Optimization Levels



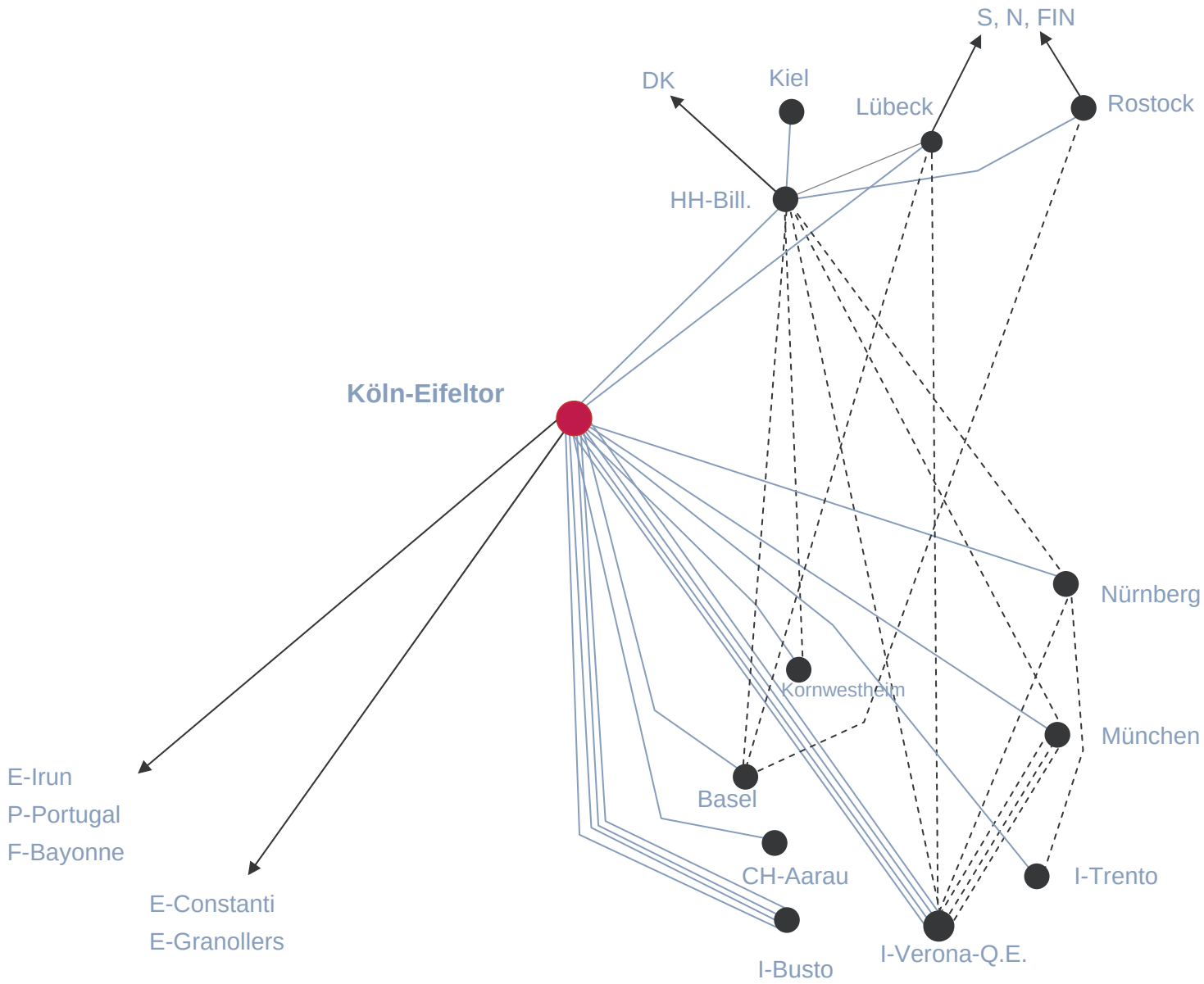
Production system View (Examples)



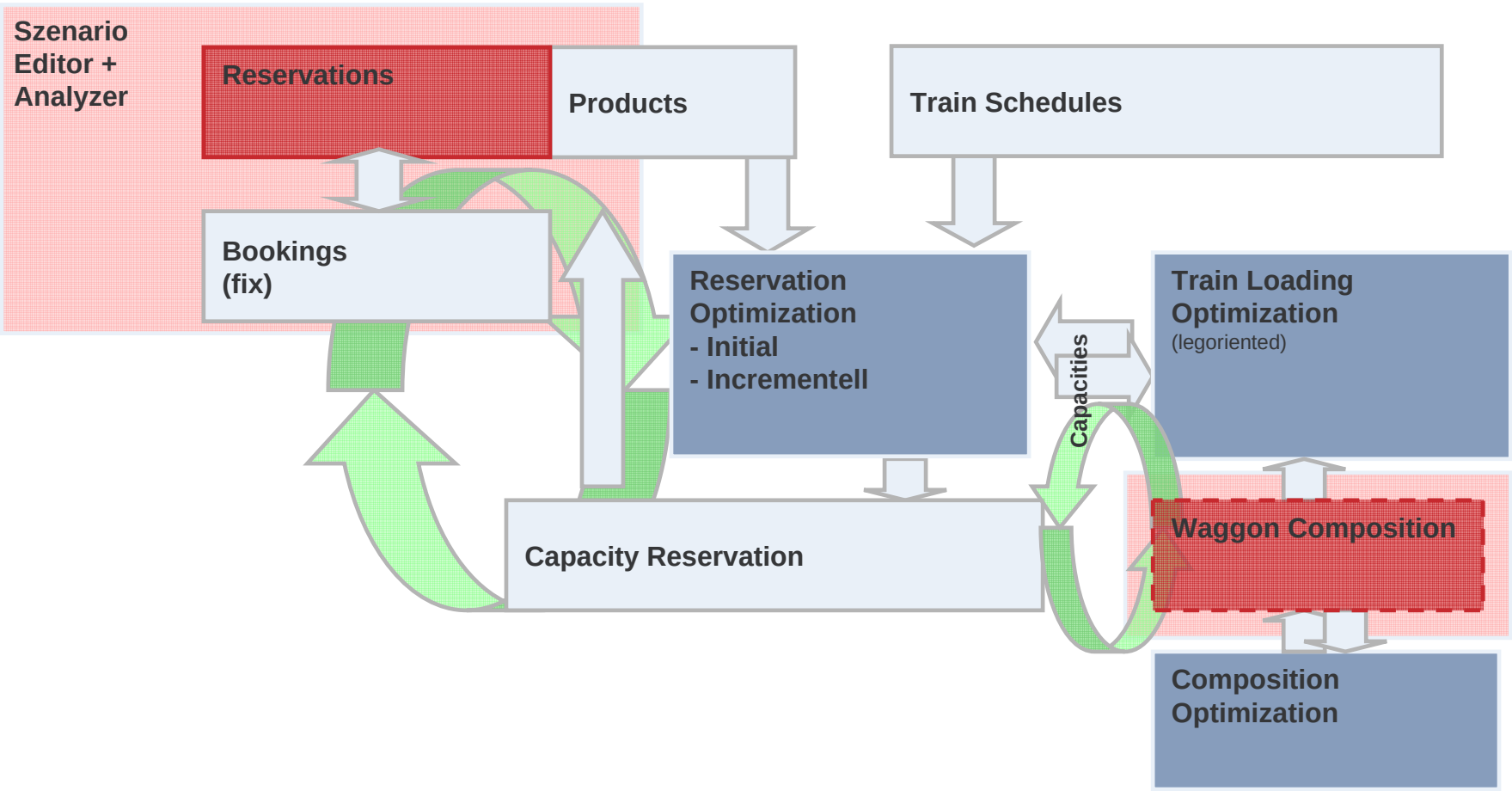




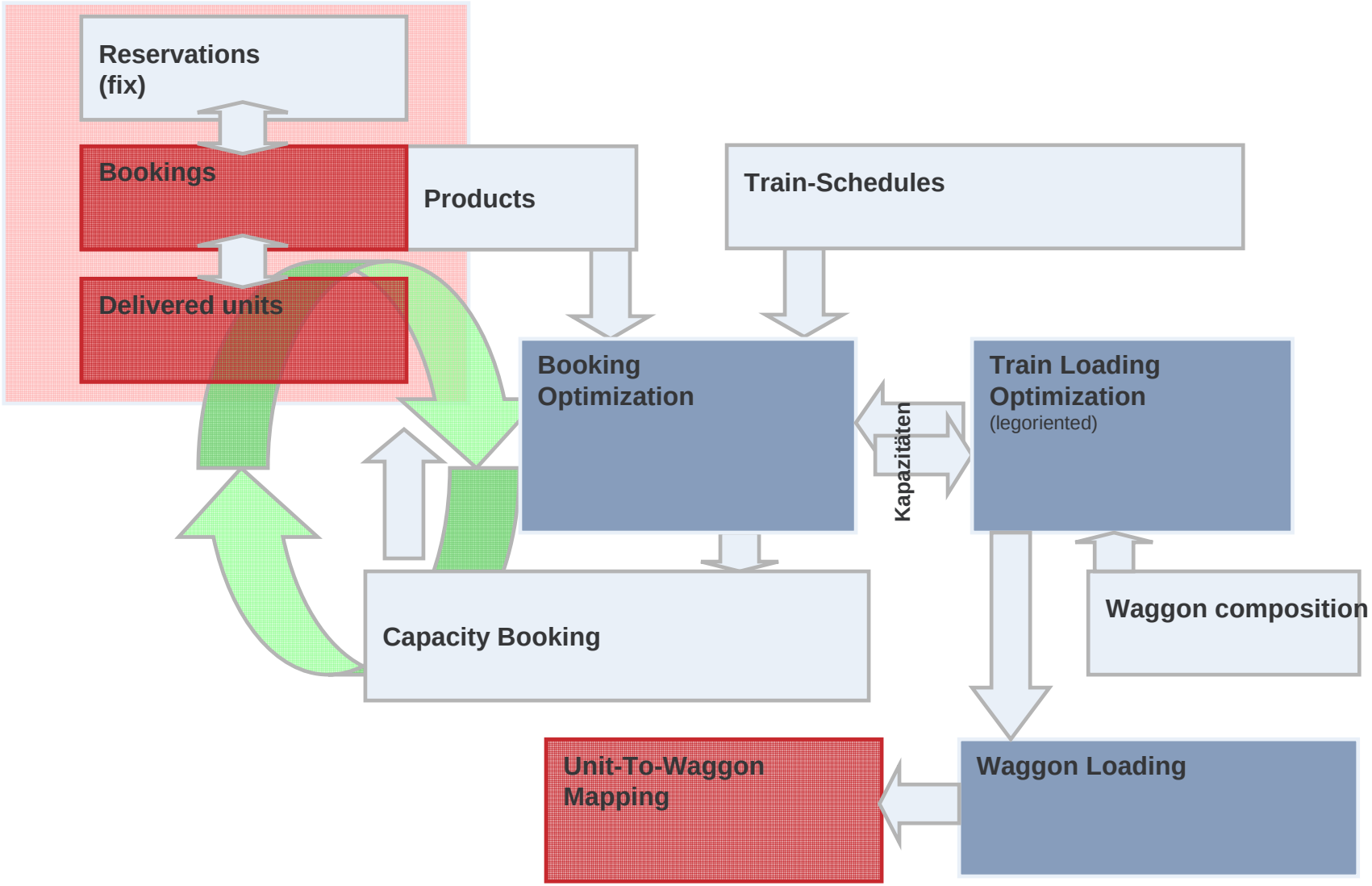
Network view (example)



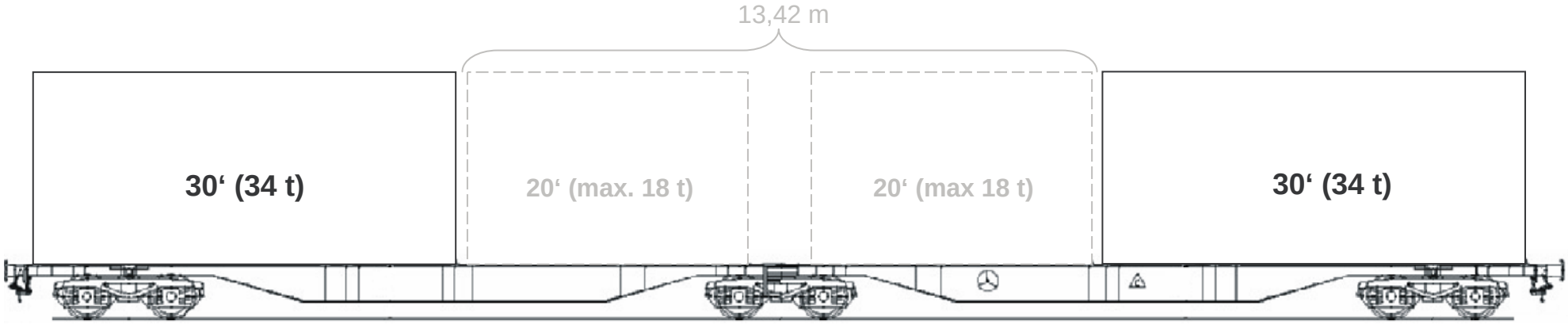
Optimization functions Network Control



Optimization functions Train Control

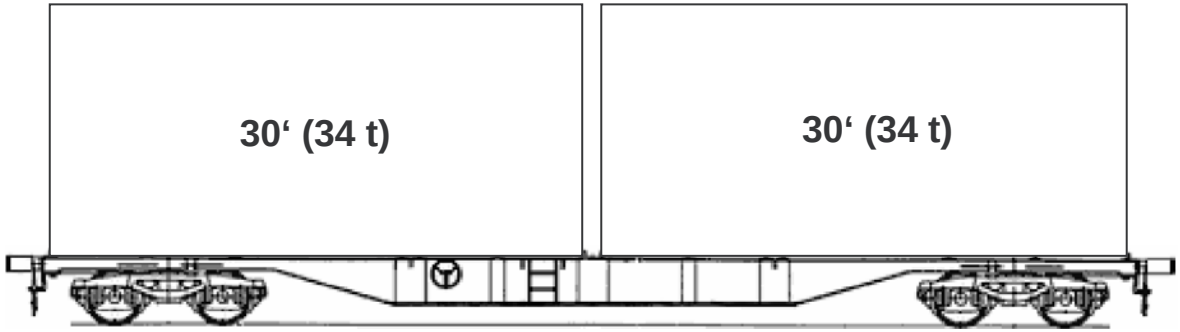


Optimization functions Waggon Loading



Sggmrs 714/715

Waggon-Weight: 30 t Load-Limit: 104 t Load-Length: 32,2 m Waggon-length: 33,5 m



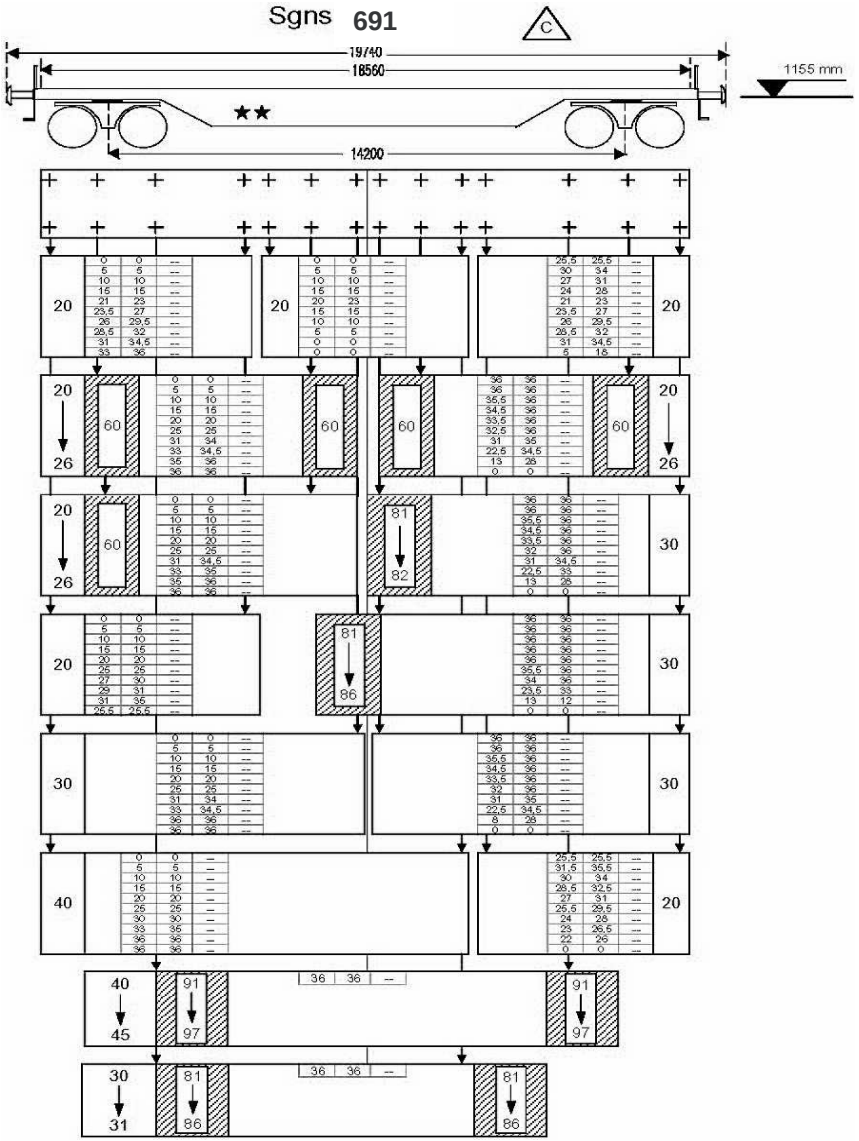
Sgns 691

Waggon-Weight : 20 t Laod-Limit: 70 t

Load-Length: 18,4 m Waggon-Length: 19,6 m

Optimization functions Waggon Loading

Example Loading Scheme



Optimization functions Waggon Loading

Optimization Model (Example):

Maximiere DB (**Beladung**, **Waggons**) := $\sum_{t=1}^{T} \sum_{b=1}^{B_t} \text{Beladung}_{t,b} \cdot \text{leerlös}_{t,b} - \sum_{w=1}^{W} \text{Waggons}_w \cdot \text{wagkost} \cdot T$ (5.1)

Nebenbedingungen:

$$\sum_{w=1}^{W} \text{Waggons}_w \cdot \text{waglänge}_w \leq \text{maxlänge} \quad (5.2)$$

$$\sum_{b=1}^{B_t} \text{Beladung}_{t,b} \cdot \text{legewicht}_{t,b} + \sum_{w=1}^{W} \text{Waggons}_w \cdot \text{waggewicht}_w \leq \text{max gewicht} \quad \text{für alle } t = 1,...,T \quad (5.3)$$

$$\sum_{m=\text{modiwag}_{t,w,1}}^{\text{modiwag}_{t,w,2}} \text{Modi}_{t,m} \leq \text{Waggons}_w \quad \text{für alle } t = 1,...,T;\ w = 1,...,W \quad (5.4)$$

$$\sum_{b=1}^{B_t} \text{Beladung}_{t,b} \Big|_{(\text{lelänge}_{t,b}=l,\ \text{legewicht}_{t,b} \geq \text{lkg}_{t,l,g})} \leq \sum_{m=1}^{M_t} \sum_{p=1}^{P} \text{Modi}_{t,m} \Big|_{(\text{bs}_{t,m,p,1}=l,\ \text{bs}_{t,m,p,2} \geq \text{lkg}_{t,l,g})} \quad \text{für alle } t = 1,..,T;\ l = 1,...,L;\ g = 1,...,G_{t,l} \quad (5.5)$$

$\text{Beladung}_{t,b} \in \{0; 1\}$ für alle $t = 1,..,T$; $b = 1,...,B_t$ (5.6)

$\text{Modi}_{t,m} \in \mathbb{N}_0$ für alle $m = 1,\ldots,M_t$; $t = 1,..,T$ (5.7)

$\text{Waggons}_w \in \mathbb{N}_0$ für alle $w = 1,...,W$ (5.8)

$\text{Waggons}_w \in \{0; 2; 4; 6; ...\}$ für alle $w \in$ doppelwag (5.9)

Conclusions

- Capacity Management in intermodal business is complex acitivity
- Adaptions of best practices and procedures in other business-areas (e.g. airline-network-management, ship-loading, traffic-flow-control) are possible
- For a network carrier the mid-term optimization of network configuration sets the framework for the (daily) optimization of train capacity utilization
- Utilization of Operations Research and Mathematical Programming is key success-factor

kombi verkehr

Thank you for your attention!