SP2 Requirements toward the freight system of 2030-2050
FFE (Madrid Spain) 21 September 2017

Bo-Lennart NELLDAL
Project Leader WP2.1
Content

1. Today’s market
2. Demand for rail and freight flows in Europe towards 2030/2050
3. Customer requirements for different goods segments
4. Technical development
5. Traffic and operational development
6. Conclusions for an efficient rail freight system 2030/2050
Demand for rail freight 2030/2050

Rail market share development

West

Market share for freight modes in EU 15

East

Market share for freight modes in EU 13
Demand for rail freight 2030/2050

The EU target - what does it mean?
For freight transportation by rail and truck in EU

2010 2,300 billion tonne-km
53% of transports in EU is >300 km
Market share for rail is 25% on distances >300 km

2050 total 3,500 billion tonne-km
Increase of approx. 50%
Market share for rail increases from 25% to 60% on distances >300 km

Source: Processing of data from Transtools in TOSCA and at KTH
Future customer requirements

Customer requirements:

- Quality
- Cost
- Environment
Future customer requirements

Longer and heavier trucks

- In some countries: 18m -> 24m
- In Sweden: 60 -> 74ton 25m -> 34m

Cost for inter modal - direct trucking

To compete rail must be even more effective:

- Longer and heavier trains and wagons
- More competitive inter modal
Wagons: Short term: Incremental development Long term: System change

Incremental development:
- Higher axle load 22,5 → 25 ton
- Higher speed 100 → 120 km/h
- Higher gauge
- End of train device (EOT)
- LL-brakes
- Lighter wagons

System change:
- Higher axle load 22,5 → 25-30 ton
- Higher speed 100 → 120-160 km/h
- Higher and wider gauge
- Electro pneumatic (EP) brakes
- Disc brakes
- Automatic couplers
Capacity - traction

Use existing locos better

Locos with higher axle load

Locos with 6 axles

Use Duo-locos
Locomotives: Do we need higher effort or adhesive weight?

- Modern electric locos are developed for passenger service that means 5-6 MW, 200 km/h and 21 tons axle load
- For freight higher axle load is essential to handle heavier trains – normal 22.5 ton or same as the wagons
- 6-axle locomotives is also an option for higher adhesive weight
Long freight trains

Long freight train in EU
- Get as much as possible out of one engine = 1050 m

- An intermodal train weights approx 2 tons/meter
- A modern 4-axle electric loco can haul 2 200 gross tons
- 1000 m wagon rake = 1000x2 = 2 000 tons + marginal = 2 200 tons
- 1000 m wagon rake + loco + marginal = 1050 m
- Optimal length in Europe = 1050 m
- 2 x 750 m = 1500 is an alternative

630 older standard in Scandinavia
740 TSI min and TEN-T, 750 in many countries
835 Hamburg-Copenhagen today 850 in France
1050 TSI max Öresund/Fehmarn Belt and France 2018
**Capacity and cost**

- Longer trains are often possible with limited investments in infrastructure.
- Longer trains mean higher capacity and lower transport cost.
- 630 → 1050 m capacity +76% cost – 21% per tonneskm.
- With one loco more economic operation.
- There is a need of unified braking rules in Europe.
Higher axle load

- Same gross weight approx. 3,200 tonnes train load
- Axle load 20 – 22.5 – 25 – 30 tonnes
- Axle load 25 tonnes with light weight wagon: less tare → more payload
- Higher axle load → fewer wagons for same payload → shorter train
Use of higher and wider loading gauge

- **G2**
  - Maximum total height: 483 cm above top of rail
  - Load width: 210 cm
  - Wagon: 3,15x4,65

- **P/C 450**
  - Load width: 210 cm
  - Wagon: 2,60x4,83

- **C Extended**
  - Load width: 315 cm
  - Wagon: 3,15x4,83

Packaged lumber

Overhead contact wire
Today’s terminals

Inter Modal – terminal handling is crucial

- Terminal costs have a high share of the total transport cost
- Terminals must be built for reach-stackers with big areas with high axle load
- The terminal cannot be electrified – diesel engines are needed to shunt the train
- Tracks has to be built to park the wagons
- Endpoint traffic on long distances – no network

Cost structure intermodal:
- Terminal handling: 37%
- Feeder-transport: 31%
- Long haul: 26%
- Planning: 6%
Paradigm shift in intermodal

Horizontal transfer under catenary

Intermediate terminals

Liner traffic stops at sidings

Shorter feeder transports

End point traffic

Liner traffic
Roll-on roll off for trailers

Inter Modal – roll on roll off of trailers

- Most trailers are not equipped to be lifted
- If the trailers could be rolled off and on all trailers could be handled
- Then the terminals has to be dimensioned only for the trailers axle load
- The terminal can be very compact and cheap
- This means lower logistic costs for customers and society
Traffic and operational development

Possibilities to develop Wagon Load

• Handle group of wagons instead of single wagons
• Production in cooperation with trainload
• Booked network and capacity management
• Higher axle load, meter load and wider gauge
• Concentration of marshalling yards and liner feeder trains
• Automatize of marshalling
• Automatic couplers
Linear operation and Duo-locos

- Linear trains can be more effective than hub and spoke systems
- Sometimes the long distance train also can distribute wagons
- With duo-locos it also possible to shunt wagons at un-electrified tracks
- One duo-loco can replace one electric loco and one diesel loco
- In long term it will also be possible to not electrify yards and sidings
Traffic and operational development

Tracking, tracing and monitoring

- Location through satellites or cellular mobile communication
- RFID and internet in combination for information from trains in real time
- On board or way side monitoring for freight
- Monitoring can also be used for infrastructure health control
- Intelligent rail is technically possible but not at all fully used in the rail system
Demand and rail network 2030/2050

White paper forecast 2050
In tonne-km
Source: D-rail

Rail Freight Corridors 2015
Established 2013-2015

High Speed Network 2025
Existing and planned
Source: UIC
Capacity can be improved in many ways
- Longer and heavier trains
- Higher axle load and higher speed
- Better signaling system
- HSR will free capacity for freight and regional trains on conventional lines
- Dedicated freight lines is an option when RFC is fully utilized

Measures for improving freight rail capacity
Costs for rail freight 2030/2050

Measures to reduce cost for rail freight

- Longer trains 650 to 750m for trainload: -6%
- Longer trains 650 to 750m for WL and IM door to door: -4%
- Higher axle load from 22.5 to 25 tonnes: -10%
- Loading gauge from G2 to GC for volum freight: -23%
- Terminal cost for inter modal 30€ to 10€ door to door: -15%
Executive summary

Conclusions to establish a competitive rail system 2030/2050

• Today’s trend for freight are not in line with EU target – there is a strong need for further technical development as well as market orientation of rail freight


• Wagons, trains and infrastructure: Wider gauge, higher axle load and higher speed. Longer trains with one loco 750-1000 m with two locos 2x750=1500m

• Locomotives: Higher axle load with track-friendly bogies is a possibility to handle heavier and longer trains

• ERTMS L2 must be completed with shorter block lengths to gain capacity – important to develop and implement ERTMS L3 with low cost for freight

• The future network for HSR may free capacity for freight if slots will be reserved on the conventional network – important with high performance on RFC

• Rail can make a real contribution to mobility and to avoid the climate change if EU target will be implemented and rails potential fully utilized
Thank you for your kind attention

Bo-Lennart NELLDAL

Project leader SP2 WP2.1

KTH – Royal Institute of Technology
Stockholm Sweden

bo-lennart.nelldal@abe.kth.se
### Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Common standard 2010</th>
<th>Incremental change* 2030</th>
<th>System change*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wagons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running gear</td>
<td>Different</td>
<td>50% Track-friendly</td>
<td></td>
</tr>
<tr>
<td>Brakes</td>
<td>Cast brakes</td>
<td>LL brakes</td>
<td></td>
</tr>
<tr>
<td>Brake control</td>
<td>Pneumatic</td>
<td>Radio controlled EOT</td>
<td></td>
</tr>
<tr>
<td>Couplers</td>
<td>Screw couplers</td>
<td>Automatic couplers on</td>
<td></td>
</tr>
<tr>
<td>Max Speed</td>
<td>100 km/h</td>
<td>some trains</td>
<td></td>
</tr>
<tr>
<td>Max Axle load</td>
<td>22.5 tonnes</td>
<td>120 km/h</td>
<td></td>
</tr>
<tr>
<td>Floor height lowest</td>
<td>1,200 mm</td>
<td>25 tonnes</td>
<td></td>
</tr>
<tr>
<td>IT-system</td>
<td>Way-side</td>
<td>1,000 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some in wagons</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All track-friendly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disc brakes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fully electronic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic couplers on</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>all trains</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>120-160 km/h</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 tonnes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>800 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Locomotives</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tractive effort kN</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Axle load</td>
<td>20 tonne</td>
<td>22,5 tonne</td>
<td>25 tonne</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Electric</td>
<td>Some duo-locos</td>
<td>All duo-locos</td>
</tr>
<tr>
<td>Fuel</td>
<td>Diesel</td>
<td>LNG/Diesel</td>
<td>LNG/electric</td>
</tr>
<tr>
<td>Drivers</td>
<td>Always drivers</td>
<td>Some driverless</td>
<td>All driverless</td>
</tr>
<tr>
<td><strong>Trains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train lengths in RFC</td>
<td>550-850 m</td>
<td>740-1050 m</td>
<td>1050-2100 m</td>
</tr>
<tr>
<td>Train weight</td>
<td>2,200 tonnes</td>
<td>4,400 tonnes</td>
<td>10,000 tonnes</td>
</tr>
</tbody>
</table>

*) Adapted to market needs in each product and line
Appendix

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Common standard 2010</th>
<th>Incremental change* 2030</th>
<th>System change* 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail Freight Corridors</td>
<td>18,000km</td>
<td>25,000km</td>
<td>50,000km</td>
</tr>
<tr>
<td>Signalling systems</td>
<td>Different</td>
<td>ERTMS L2 in RFC</td>
<td>ERTMS L3 in RFC</td>
</tr>
<tr>
<td>Standard rail weight</td>
<td>UIC 60 kg/m</td>
<td>70 kg/m</td>
<td>70 kg/m</td>
</tr>
<tr>
<td>Speed, ordinary freight</td>
<td>100 km/h</td>
<td>100-120 km/h</td>
<td>120 km/h</td>
</tr>
<tr>
<td>Speed, fast freight</td>
<td>100 km/h</td>
<td>120-160 km/h</td>
<td>120-160 km/h</td>
</tr>
<tr>
<td><strong>Traffic system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wagonload</td>
<td>Marshalling - feeder</td>
<td>Marshalling – feeder</td>
<td>Automatic marshalling</td>
</tr>
<tr>
<td></td>
<td>Some liner trains</td>
<td>Some liner trains</td>
<td>Liner trains – duo-loco</td>
</tr>
<tr>
<td>Trainload</td>
<td>Remote controlled</td>
<td>Remote controlled</td>
<td>All remote controlled</td>
</tr>
<tr>
<td>Intermodal</td>
<td>Endpoint-trains</td>
<td>Endpoint-trains</td>
<td>Endpoint-trains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liner trains with stops at siding</td>
<td>Liner trains fully automated loading</td>
</tr>
<tr>
<td>High Speed Freight</td>
<td>National post trains</td>
<td>International post and parcel trains</td>
<td>International post and parcel train network</td>
</tr>
<tr>
<td><strong>IT /monitoring systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some different</td>
<td>Standardized</td>
<td>Full control of all trains and consignments</td>
</tr>
</tbody>
</table>

*) Adapted to market needs in each product and line