

Railway systems and their transition
Lecture 7 / Lecture 8

Rail freight transport.

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EPFL, Autumn Semester 2025
November 11, 2025



Today's agenda.

1. Intro
2. Pitch «Case Study» from last time
3. Rail freight transport part 2
4. Inputs for spring semester 2026.
5. Planning and Development – Long term
6. Case Study «Planning and Development»



Case Study

Train station Uster

Student pitch

Tasks.



Task 1

Create a SWOT analysis for Uster station.
At least three important points each.

Task 2

Improve the station regarding station concept and spatial quality.

- Ideas that strengthens the station as SBB's calling card: tidy, clear and convenient.
- Prioritize and assess measures according to effort and impact as well as possible pilot areas for rapid implementation.

Agenda.

1. Introductory information
2. Business models incl. excursus belt and road initiative.
3. Market - structure and competition
4. Customers and offers
5. Challenges and general considerations
6. Ways to solve the challenge

«Freight transport is an essential location factor for trade and industry as well as the supply and disposal of urban areas. Railways play an important role in this as an efficient and sustainable mode of transport»

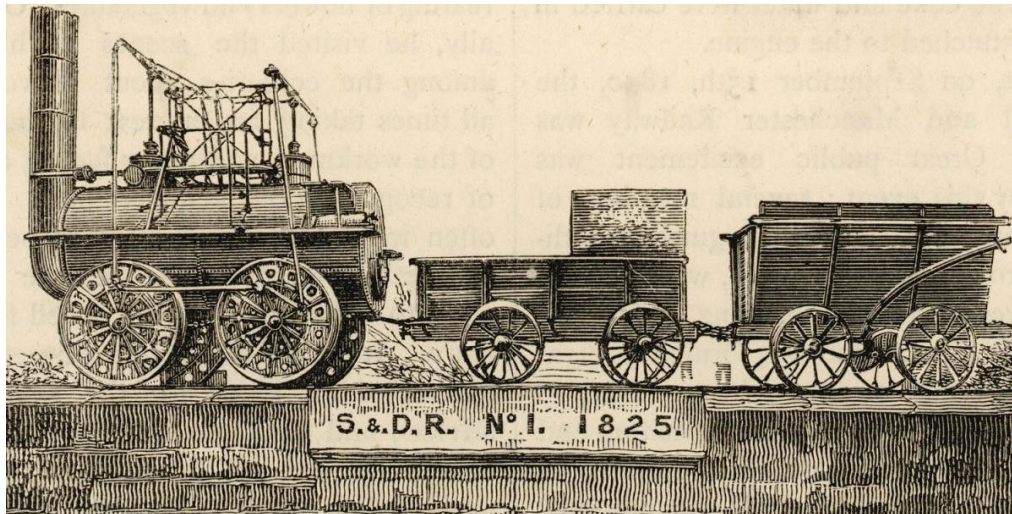




1. Introductory information.

Development of rail freight transport.

A story providing solutions and benefits for the industry and commercial goods market.



- The railway was developed during **industrialization in the 19th century**.
- **In the 1960s, the new concept of containers changed rail freight transport.** In **combined transport**, which uses and connects different modes of freight transport, containers can be efficiently transloaded at terminals.
- Freight railways are still **strongly linked to industry today**. This has led to the development of two offers:
 - **Single wagonload traffic:** Connection of a network of customers and service points bundled in trains.
 - **Block trains:** Transport of large quantities on a certain route from A to B.

Rail freight transport: a solution for sustainable and safe transport.

Less CO₂, energy and space while safer.



- **Sustainability**
Freight transport by **rail emits up to 80 percent less CO2 per tonne-kilometre** compared to the average truck
- **Energy efficiency**
Due to the lower rolling resistance of wheels and rails, the railway is three times more energy-efficient than a car and five times more energy-efficient than trucks.
- **Area-efficiency**
An **average freight train can replace up to 52 trucks**. On a similar transport area (road and rail), railways can carry significantly more at once. Rail freight transport requires approximately **five times less space for the same quantity** than road transport.
- **Safety**
Accident risk of trains is about 42 times lower than that of trucks.

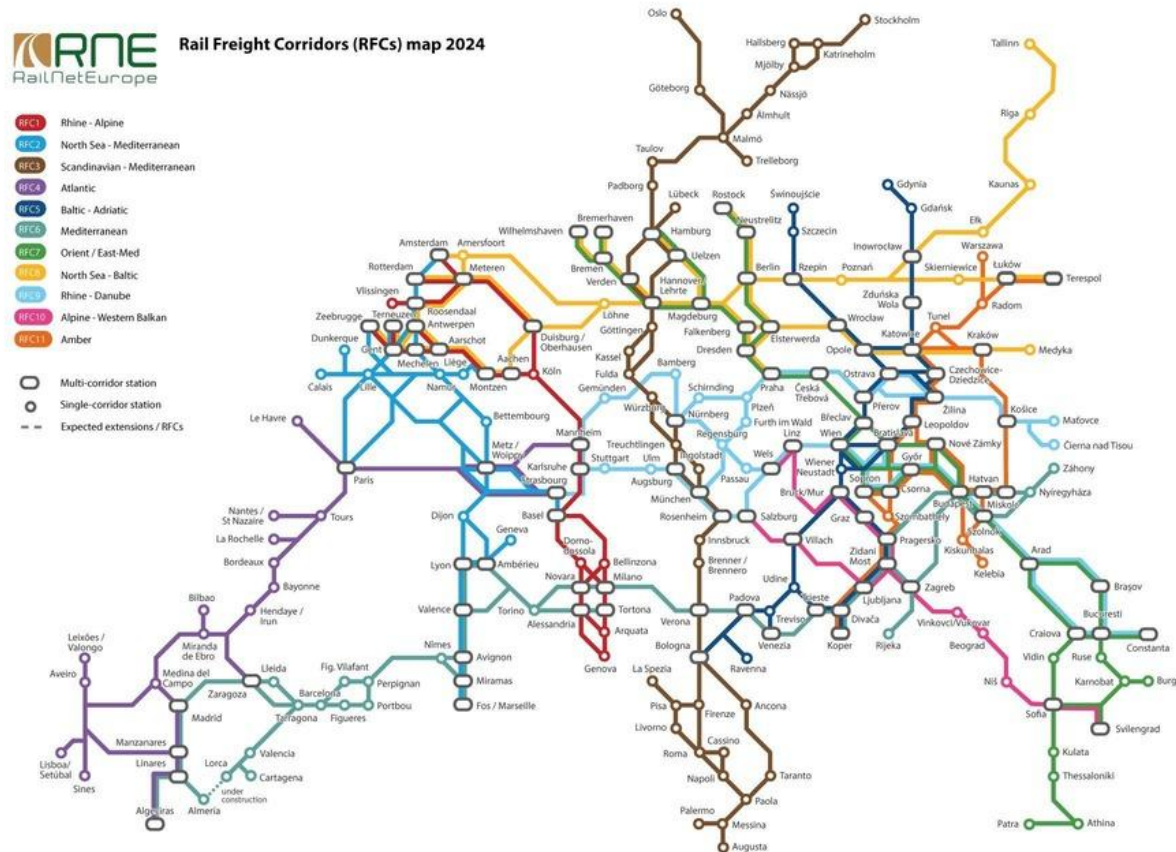
Source: <https://blog.sbbcargo.com/>

Source: ASTRA



Rail freight transport: a solution for intelligent spatial development.

Central role in the freight corridors in Europe.



- The EU promotes **major freight corridors**.
- Rail freight plays a **central role** in these corridors.
- Nevertheless, rail freight transport remains **heavily regulated nationally**, adding complexity, and prevents efficient cross-border solutions.
- **Switzerland** has a target for the transfer of **transalpine freight traffic from road to rail**.

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Source: Rail Net Europe

Rail freight transport: a solution for intelligent spatial development.

A potential role in city logistics for urban areas ?



- The sustainable supply of urban areas is accompanied by an increasing **need for spatial development**.
- Goods such as food, parcels or building materials can be reloaded at **transshipment centers** from rail onto small, also autonomously operated vehicles for distribution in the district. **Waste** can be returned in the **same way back**.
- The **railways can prevent traffic congestion and reduce the space required** for urban logistics.
- For this to be feasible, **regulation is needed**. Currently, it is not economically attractive for logistics providers.



2. Business Models

In Europe, rail freight transport has been liberalised.

State railways had first shaped freight transport.



SBB locomotive with freight train in 1990. Source: www.bahnbilder.de

- In Europe, rail freight transport in the **20th century** was dominated by **state railways**, which had a de facto national monopoly.
- There was **no continuous responsibility for international** transport.
- In addition to the state railways, there were **regional railways and private works railways**.

In Europe, rail freight transport has been liberalised.

Liberalisation: more competition – little private capital.



Source: www.fotocommunity.de



Source: www.railcolornews.com

- **Liberalisation** was **decided** by the European Union in **1991** and **implemented in 2006**.
- The originally planned joint ventures between the **state railways failed to materialise**.
- **Competition** arose primarily with **publicly funded regional railways**.
- **High competitive pressure and low performance** lead to **low returns** and a lack of private capitalization.

In Europe, rail freight transport has been liberalised.

Business models in addition to the core business.

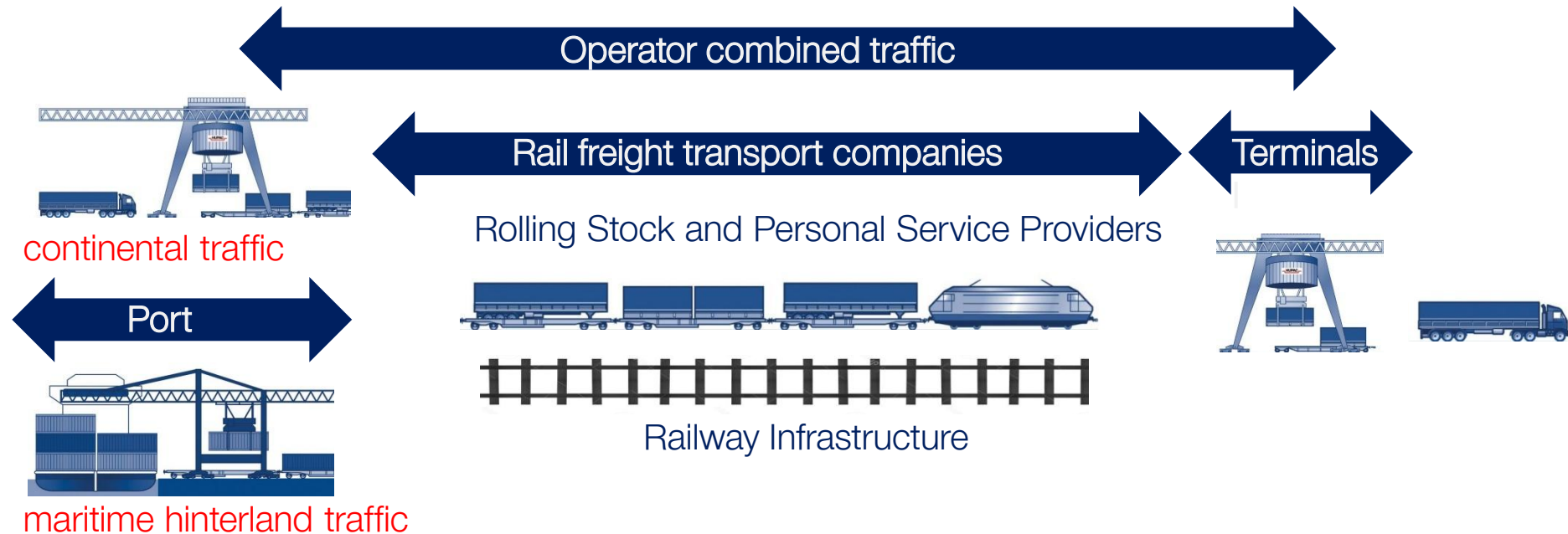


Source: www.bahnbilder.de

- **Specialized business models** have developed in the value chain.
- **Rental and financing of rolling stock** is a profitable business that relieves the railways of long-term capital commitment.
- Services such as the **management of personnel services** and the **provision of licenses, certificates and training** have also been established.

In Europe, rail freight transport has been liberalised.

In combined transport, entrepreneurial success is only possible with an efficient and simple business model.



Operators developed combined traffic

The national railways were unable to develop international transport themselves. Operators have taken on this role. Today, they determine the business. Some of them have their own terminals.

Shipping companies for maritime traffic

With liberalisation, shipping companies are increasingly organising maritime hinterland traffic themselves. They thus control the entire transport chain

In domestic transport a niche product

In most European countries, combined transport has only been able to establish itself as a niche product to date. In Switzerland, there are offers for Swiss Post and large distributors.

Rail freight making money in North America. What are the reasons?





Rail freight making money in North America.

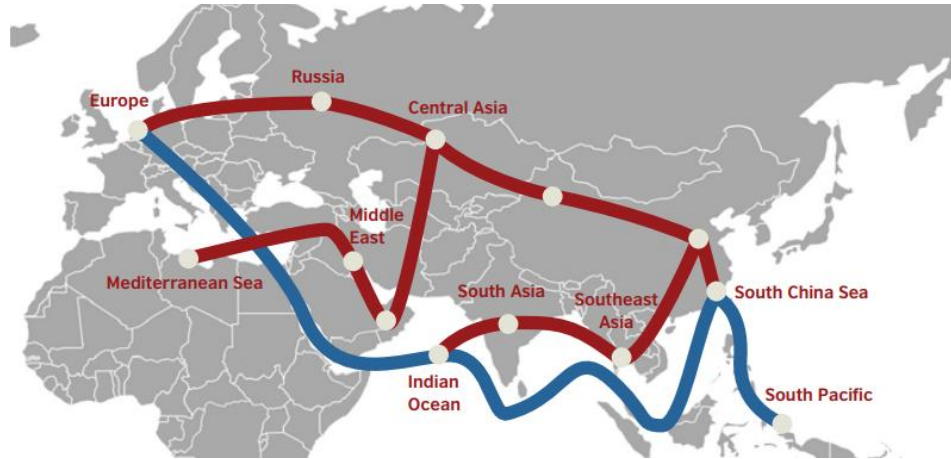
High productivity, simple standards, geographical strengths and a consistent entrepreneurial orientation.



- **Liberalisation** of North American railroads in 1980.
- The railways then focused on
 - **freight** traffic
 - **main transport axes**
 - **lucrative markets** such as bulk, automotives ...
- **'Efficiency revolution'** with long trains of up to 3km and production focused on capacity utilisation.
- Simple **technical standards** and high digital integration.
- High **integration of the value chain** including infrastructure, terminals, truck trailers.
- Thanks to **infrastructure geared towards freight** transport, the assets are used optimally.
- **To consider:**
 - Limited **passenger service** on the network.
 - Focus on **shorter-term planning**.
 - Low system **redundancy**.
 - Rail freight mainly money driven, **investment allocation guided by profitability**.

Excursus: “One Belt One Road” initiative (BRI).

New trading routes.



Blue route is the “21st Century Maritime Silk Road”, and red routes are the “Silk Road Economic Belt”
Source: cbbc.org

- Launched by President Xi Jinping in **2013**
 - **One Road:** The 21st-Century Maritime Silk Road is a **sea route** (reference to the old maritime Silk Road).
 - **One Belt:** The Silk Road Economic Belt enhances and develops **land routes**.

- **New trading routes and business opportunities**
 - Across **60 countries**, through Asia, Europe, the Middle East and Africa.
 - It transported **goods** worth over **\$340 bn.** in a **decade**.

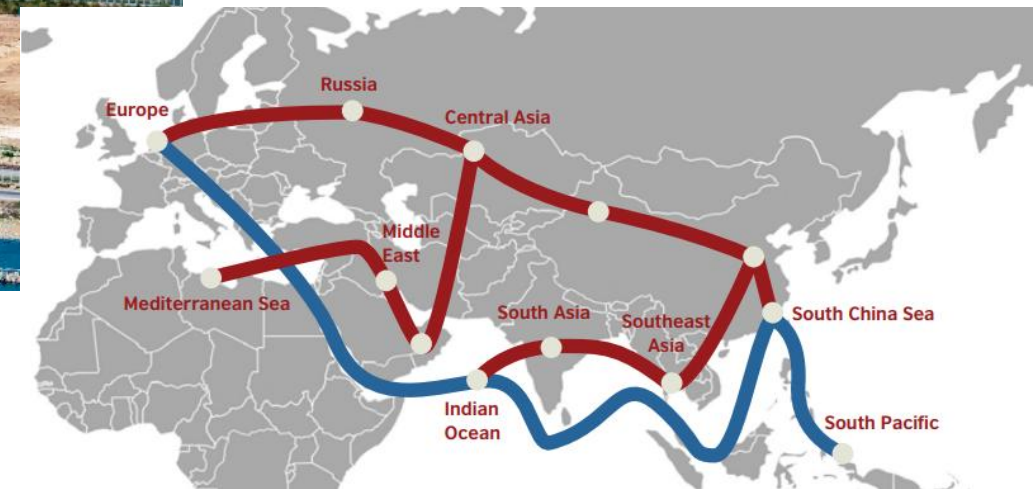
- **Rail** plays an important role
 - **Fast and cheap** deliveries.
 - **Climate-friendly and reliable** goods transport by rail.
 - **Yiwu-Madrid** railway line is the **longest rail link** in the world: 13'000 km.
 - Emerging **logistics hubs**, key **terminals** e.g. in PL, DE.
 - **Land-sea** channel to connect **China's** inland cities with **Southeast Asian** countries.



China Railway Express Routes

Source: news.cgtn.com

Excursus: “One Belt One Road” initiative. Use of rail-sea combined transport.



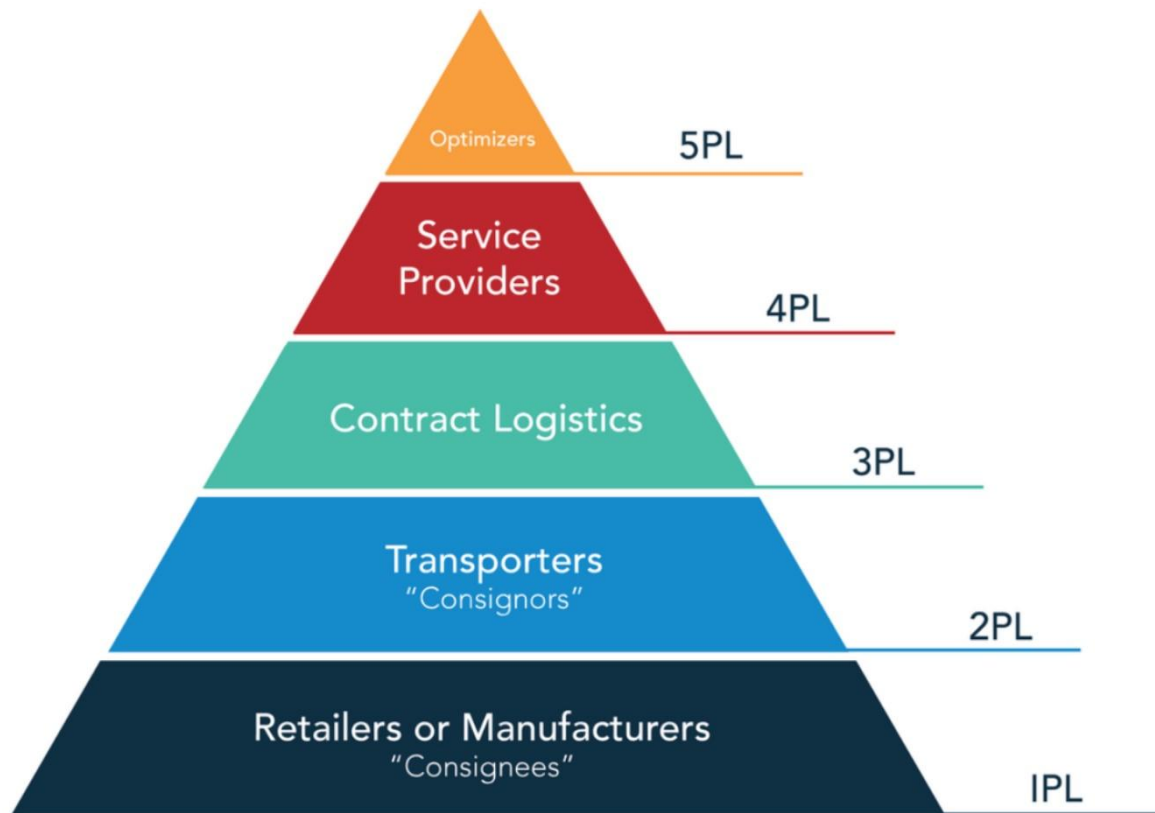
The rail-sea routes of the New International Land-Sea Trade Corridor use ports to offer a faster and cheaper freight transport option between western China and Southeast Asia.

Source: news.cgtn.com



3. Market – structure and competition

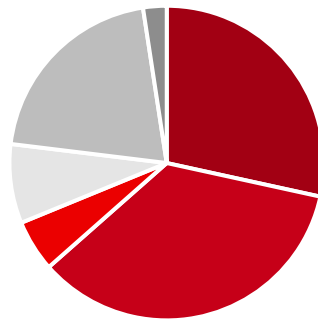
«Rail freight transport companies are weakly positioned in the logistics market as a whole».



- The **1PL-5PL (party logistics) models** represent the different level of outsourcing of logistics activities and the providers that propose the corresponding service:
 - **1PL:** The company manages its own logistics.
 - **2PL:** The transport is outsourced.
 - **3PL:** The supply chain logistics and operations are outsourced (e.g. storing, packing, receiving, shipping ...)
 - **4PL:** The supply chain management is outsourced (e.g. service advice, logistics strategy, 3PL management ...)
 - **5PL:** The orchestration of the whole supply chain network is outsourced. The use of technology, optimisation, digital platform, ... is a key part of this level. (Source: www.flexport.com)
- In the **60s and 70s**, the truck companies pushed the **railways** back **from the 3PL to the 2PL** role.
- In **combined transport**, most of the **railways** have also remained in the **2PL** role.

In Switzerland, due to the disappearance of traditional industry, rail freight transport must focus more on supply and disposal.

Wagons SBB Cargo



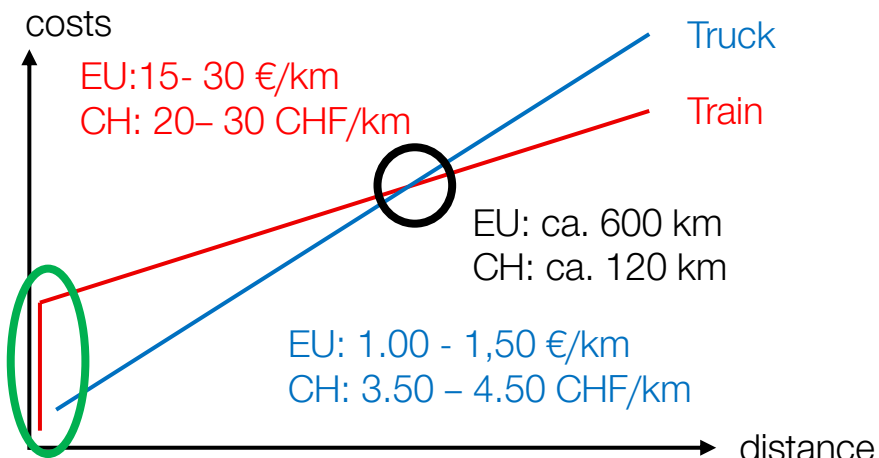
- construction ■ trade & parcel ■ recycling
- industry ■ chemical & oil ■ agriculture

- **In Switzerland, traditionally railway-related industries lost importance** early on. Only 30% of the wagons are still being used for industry and mineral oil. On the other hand, the **construction industry, trade, parcel service and waste and recycling are increasing**.
- The supply and disposal of the densely populated areas is **concentrated on the important traffic axes**.
- The **motorways are full in these areas**. This increases the **competitiveness of the railway**.

Rail is positioned in the freight transport market as a system between vessels and trucks.

| | Load capacity (t) | Volume capacity (TEU) |
|----------------|------------------------|-----------------------|
| Ocean Shipping | Up to 40'000 t | 12'000 – 24'000 TEU |
| Short sea | 2'000 – 4'000 t | 1'000 TEU |
| Barges | 2'000 – 3'000 t | 200 TEU |
| Train | 1'600 - 3'000 t | 80 – 120 TEU |
| Truck | up to 32 t | 1-2 TEU |
| Airplane | 50 -150 t | |

* TEU: Twenty-foot Equivalent Units (standard container size used in shipping)



- Rail freight transport has a **capacity between vessels and trucks.**

- **Compared to trucks:**

- **Trains have higher fixed costs**

See the offset of the curves, green circle

Rail freight transport has efficient loading and unloading. On the other hand, the costs for pick-up, train formation and delivery are very high.

- **Trains have lower variable costs** (per kilometre)

See the slope of the curves

This is because of the higher load capacity of trains that results in significantly lower costs per t/km.

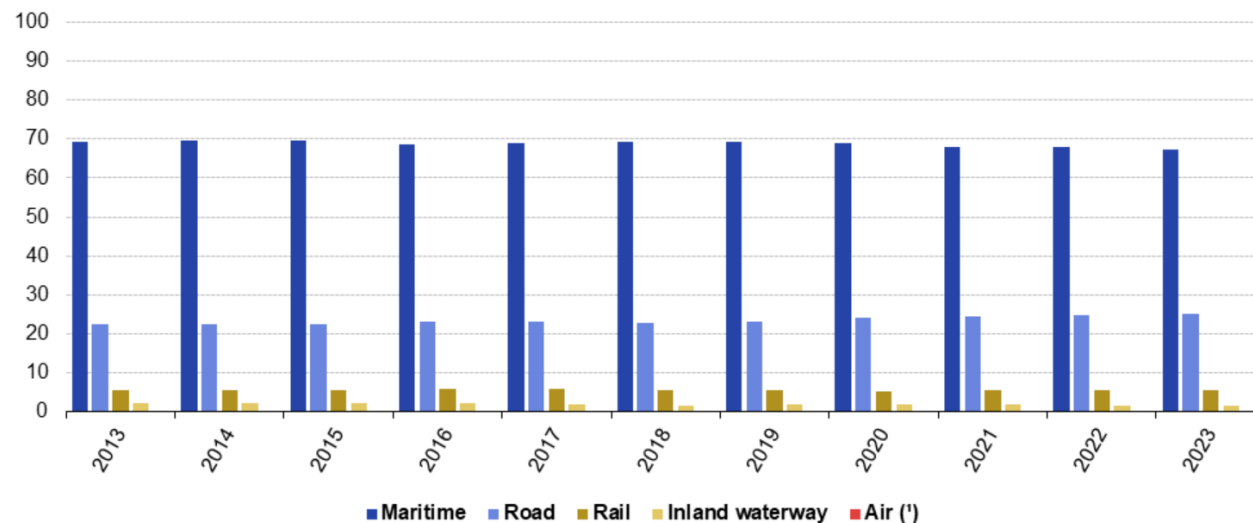
- **Trains are therefore more competitive from ~600km in Europe and ~120km in Switzerland.**

See the intersections of the curves, black circle

In Europe, rail freight transport is not gaining market share.

Shift from road to rail is not happening (EU green deal)

Modal split of freight transport, EU, 2013-2023
(%, based on tonne-kilometres)



Source: Eurostat

- The modal split (market share) of **rail freight transport** in tonne-kilometres (Tkm) **in EU** was **17%** in 2022. Between 2017 and 2022, this value fell by 1.5%. With the **Green Deal**, EU has set the goal of increasing this share to 25% by 2030 and to 35-40% by 2050. (data excluding maritime).
- **In EU, shipping dominates with a share of 67%.**
- **The market is changing**, traditional industries are losing ground, and logistics must become **more flexible**. Combined transport meets this requirement.
- In EU, the **available infrastructure capacity will be decisive**. The intelligent use of existing capacities will be important.

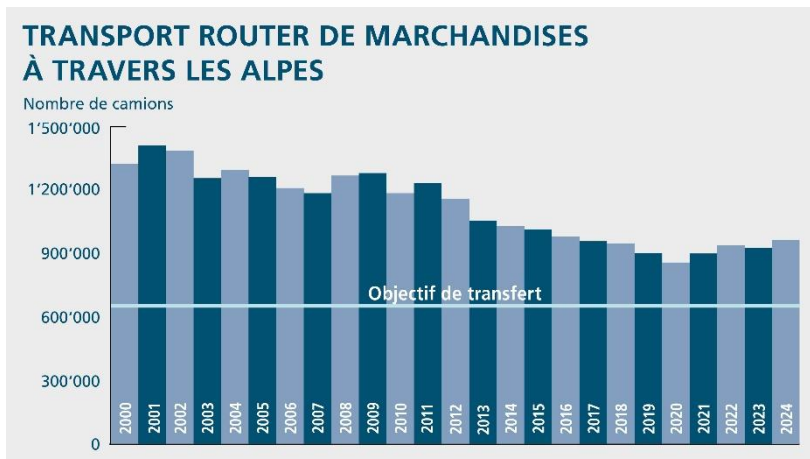
Modal shift policy in Switzerland



Switzerland's modal shift policy relies primarily on the following instruments and measures:

- New rail link through the Alps NRLA and four-metre corridor
- Performance-related heavy vehicle charge (HGV)
- Expansion of terminals

Source: Hupac



Source: BAV



4. Customers and Offers

The offers are defined by the requirements of the customers in combination with the strengths of the railway.

Block Train



- One customer - one good - one relation: simple and efficient offer.
- Main form of rail logistics .
- Train weight up to 2000 t, in exceptional cases 3000 t or 22 wagons with 65 t payload
- High intramodal competition between railways.

Single Wagonload Traffic



- Network between service points available to customers
- Complex and occupancy risk lies with the railway.
- Nationally offered by the former state railways.
- In Western Europe still DE, BE, LU, AT and CH.

Combined Traffic



- A unit is transported by several modes of transport.
- In addition to containers and trailers, smaller units are possible.
- In continental traffic, the railway takes over the long distance, in maritime traffic the feeder service.
- Terminals are decisive.

In Switzerland, the major shippers use rail freight transport and more specifically single wagon load for their logistics.

Block Train

Single Wagon Load

Combined Traffic

Lonza

fenaco **MIGROS**

CAMION TRANSPORT



Swiss Steel
Group



FELDSCHLÖSSCHEN

Part of the Carlsberg Group

coop



HOLCIM

JURA ///
materials

vigier

PLANZER



5. Challenges and general considerations

In the 2024 – 2030 targets, the Federal Council expresses clear expectations of SBB's freight transport.



In the "Cargo Switzerland" business segment, SBB provides profitable services in scheduled services.



In network services it aims for a cost-covering offering for domestic and import/export traffic. In network services deficits are temporarily permissible until the new legal framework comes into force. Any deficits must be minimised.

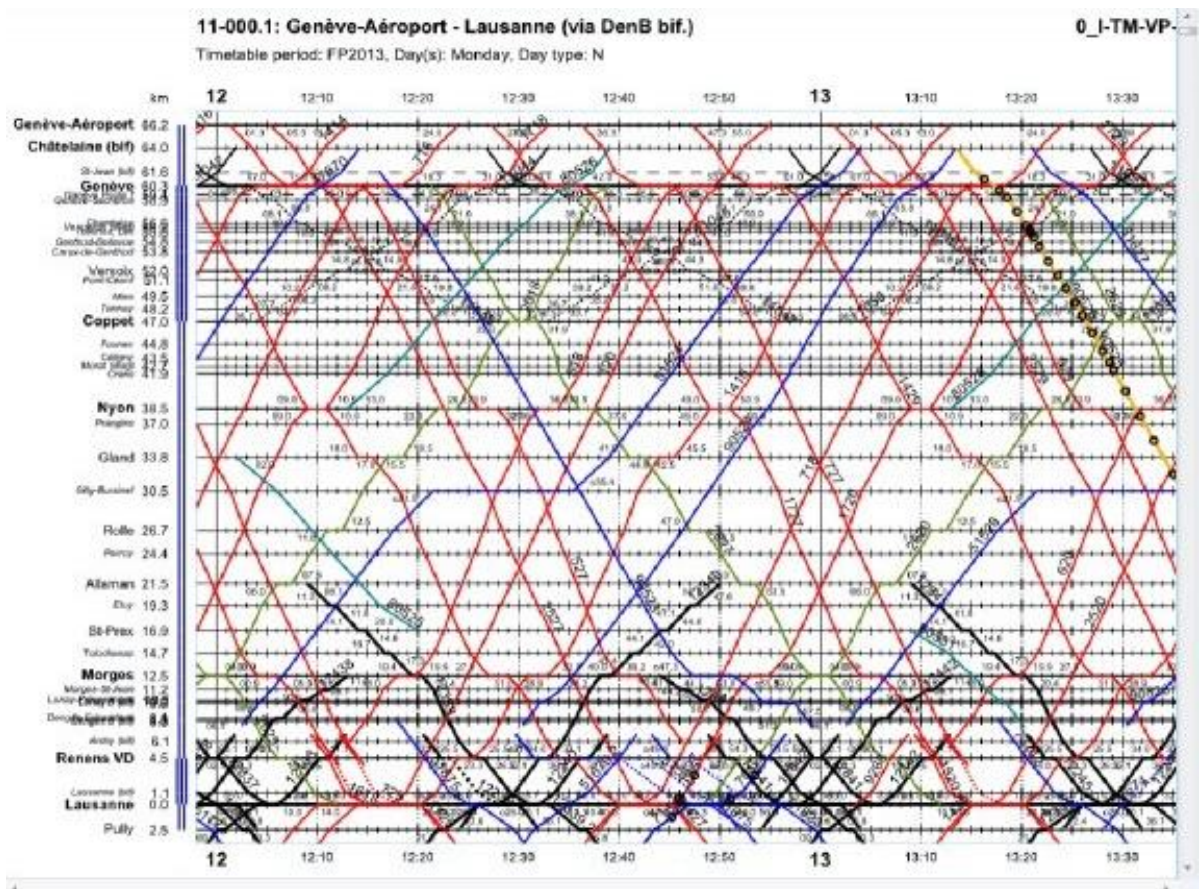


In the "Cargo International" business segment, it provides profitable services on the north-south corridor.

At the group level, a profit is to be generated that will allow investments to be financed in the medium term.

Freight trains are integrated into a fixed timetable.

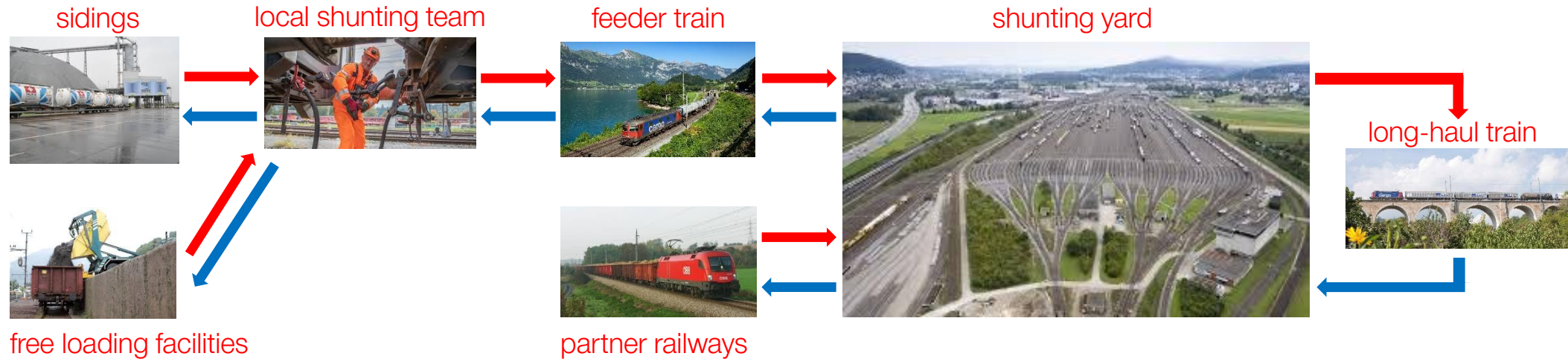
Little room for manoeuvre to optimise freight trains.



- In contrast to North America, **passenger and freight traffic** in Europe is handled on the **same infrastructure**.
- The **gaps** in the regular-interval timetable are **small**. There is little space for increased efficiency.
- Freight trains are planned in the timetable with **low priority**.
- **Maintenance work** on the infrastructure will further deprioritize freight trains.
- The **planning of the personnel deployments** and rotations of the locomotives takes place **after the allocation of the timetable slots**. The most expensive cost factor is therefore not primary optimization.
- In Switzerland and on the EU freight corridors, there exists a **guarantee for allocated train slots**.

The production system for single wagonload traffic (SWT) is focused on the bundling of customers' transport.

Have you ever seen wagons rolling downhill on their own from the top of a hill?



- The advantage of the SWT is the central bundling, which **enables all connections**.
- Due to the rigid production system, it is **supply** and not demand or capacity utilization that **determines performance**.

- The local shunting teams can also take over **decentralized bundling with increasing automation**.
- **In Switzerland**, the SWT is operated and managed by **SBB Cargo** as a system provider.

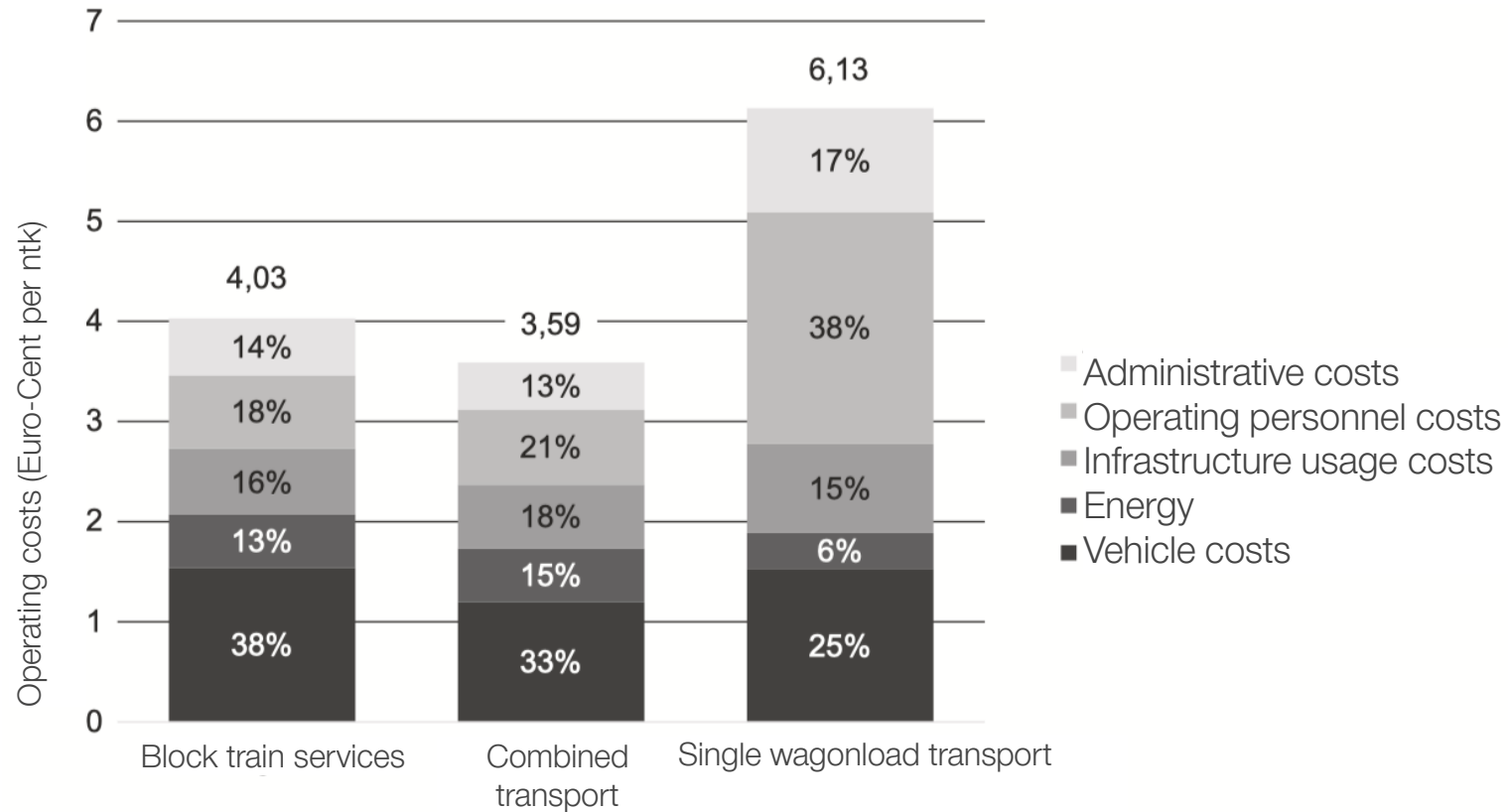
Video on Youtube:

<https://youtu.be/FSX0j89C58g?si=1zNJzG00wTehHKbZ>



Operating costs.

Single wagonload traffic has the operating cost.



Source: Schienengüterverkehr Marktumfeld, Produktion, Technik und Innovation, Stühr Schneider Karch



Despite liberalisation, freight railway companies are largely financed by public money.



Public financing – state and regional railways

- The **state railways and regional railways** that have expanded are **publicly funded** and dominate rail freight transport.
- Most **state railways lose money** and must be supported by the state. The offer in the **SWT** is particularly critical.
- For **international traffic**, most state railways have founded or bought **subsidiaries**.

private financing – new comers and former public railways

- Many **private railways** have been founded in Europe. **Few** managed to **exceed a turnover threshold** of € 50 million.
- Only a **few public** railways are partially or fully **privatized**.
- **Shippers** founded their **own railways**, but these were **not** sufficiently **profitable**.
- **Shipping** companies are increasingly investing in **railways** for maritime **hinterland traffic**.

Private financing for assets

- **Private capital** flows into the financing of **rolling stock or terminals** instead of into the railway companies. The **return** is significantly higher.
- **Railway** companies are increasingly relying on an **asset-light model**.
- In this way, the railways **avoid long-term capital commitment**. This is high with a procurement value of € 4 million per locomotive and € 0.1 - 0.15 million per car.³⁷

Short-term dispatching is becoming more important.

A field for digitalisation.



- **Customer needs, fluctuations in demand or construction sites** are integrated into the planning.
- Operations are managed by a **central dispatch centre**.
- Due to the **overused infrastructure** and the more **flexible transport** industry, **short-term planning** is becoming increasingly important.
- **AI and big data models** can play an important role.
- **The exchange of data** between customers, freight railways and infrastructure is increasing. Database must be improved.



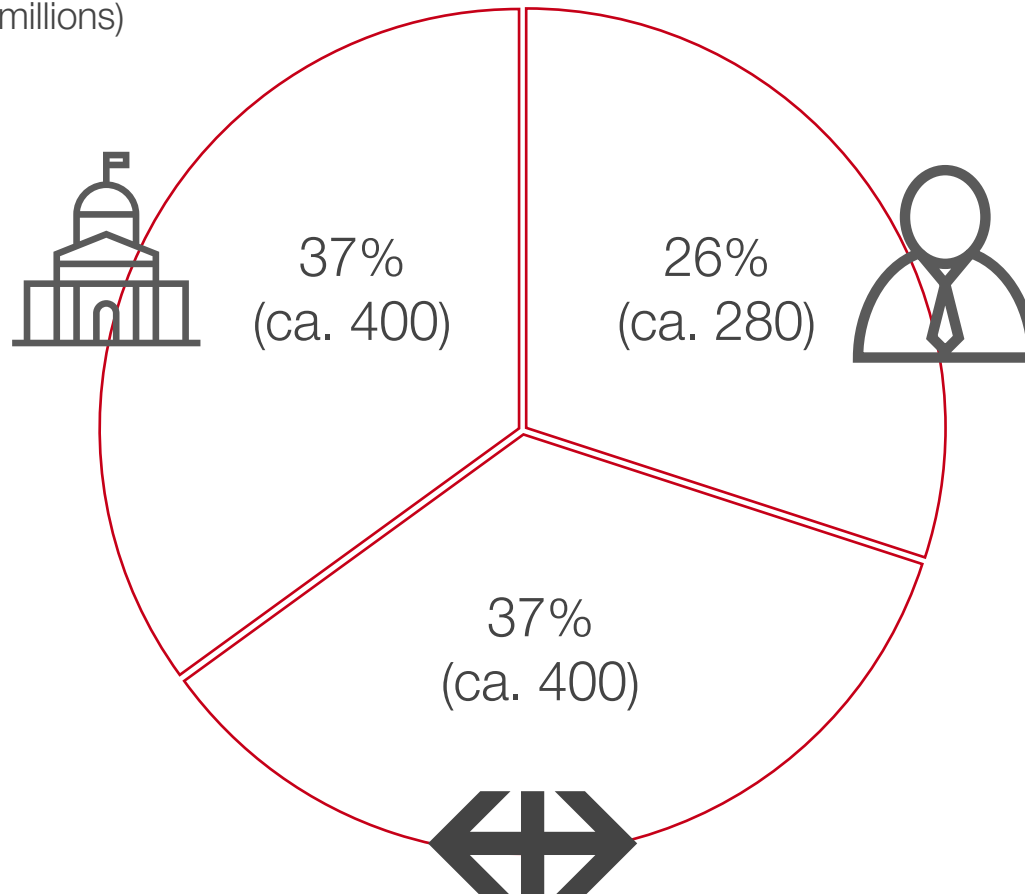
6. Ways to solve the challenge



Single wagonload traffic.

The Confederation, customers and SBB are making a balanced financial contribution to the transformation of SWT in Switzerland.

Contributions to the transformation of SWT 2026–2033:
in % (in CHF millions)



- **Confederation contribution**

- Subsidies
- Investment contributions

- **Customer contribution**

- More flexible production model
- Volume commitments
- Price increases

- **SBB contribution**

- **Cost reduction** through a modified production model: The SWT system will be made **more flexible** in terms of time; optimised locomotive movements will lead to an increase in capacity utilisation and a reduction in network operating costs.
- Investment in **new rolling stock**: it enables SWT to be optimised and further developed away from traditional operations via shunting yards towards optimised transport chain variants enabling wagons to be bundled in formation stations.

Freight transport act.

Planned instruments for the total revision of the freight transport act.

SWT



- Further development and financial support of a network offer

Rail freight transport in general



- Promotion of automation



- Bonus to shippers
- Ordering by cantons
- Investment contributions for transshipment/loading facilities

Long-term and effective development.

Six strategic thrusts proposed to achieve this.



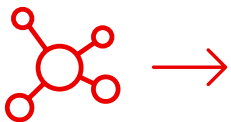
Investment in modern, low-maintenance **rolling stock** with high technical availability



Reduction of the **variety** of **rolling stock** types



Efficiency gains through **automation and digitalisation** steps



Network design: optimal network size **with fewer service points**, larger volumes and regular service

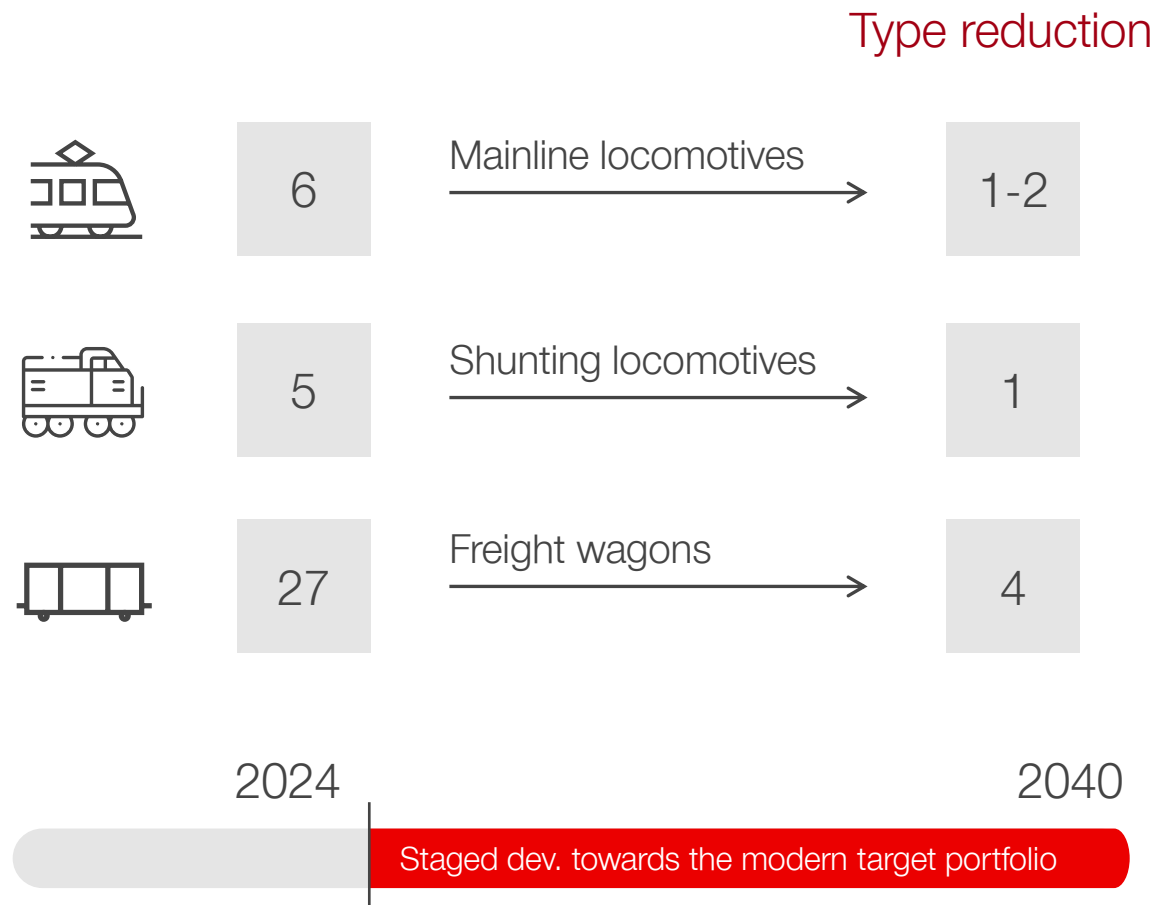


Network optimisation: Optimisation of locomotive cycles and more flexible service windows



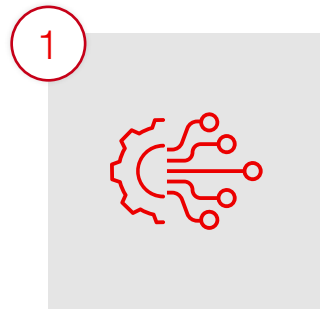
Price adjustments: fair and harmonised prices, staggered price adjustments required until the end of the transformation phase

New rolling stock leads to lower maintenance costs, higher reliability and efficiency gains.

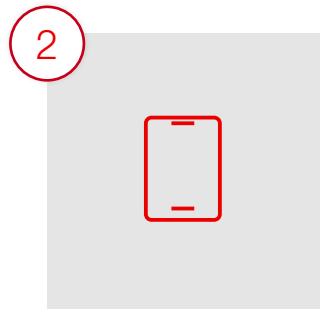


Automation and digitalization.

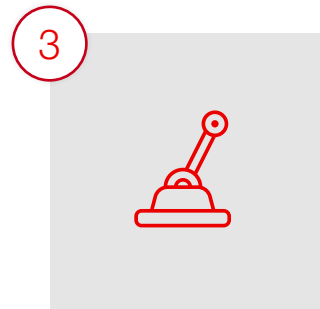
Enablers to achieve greater efficiency and safety.



1
Automatic operational train preparation



2
Digital check logic



3
Automatic brake probe

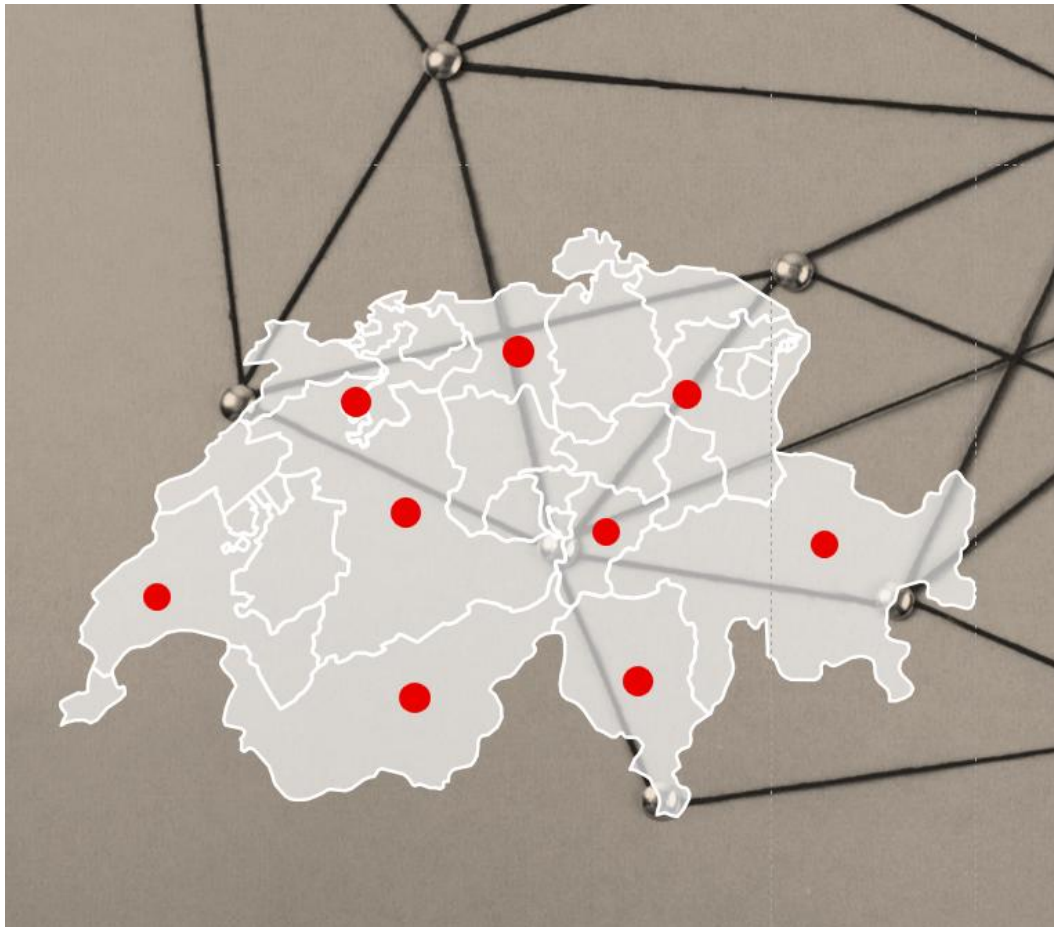


4
Radio remote control



Network design.

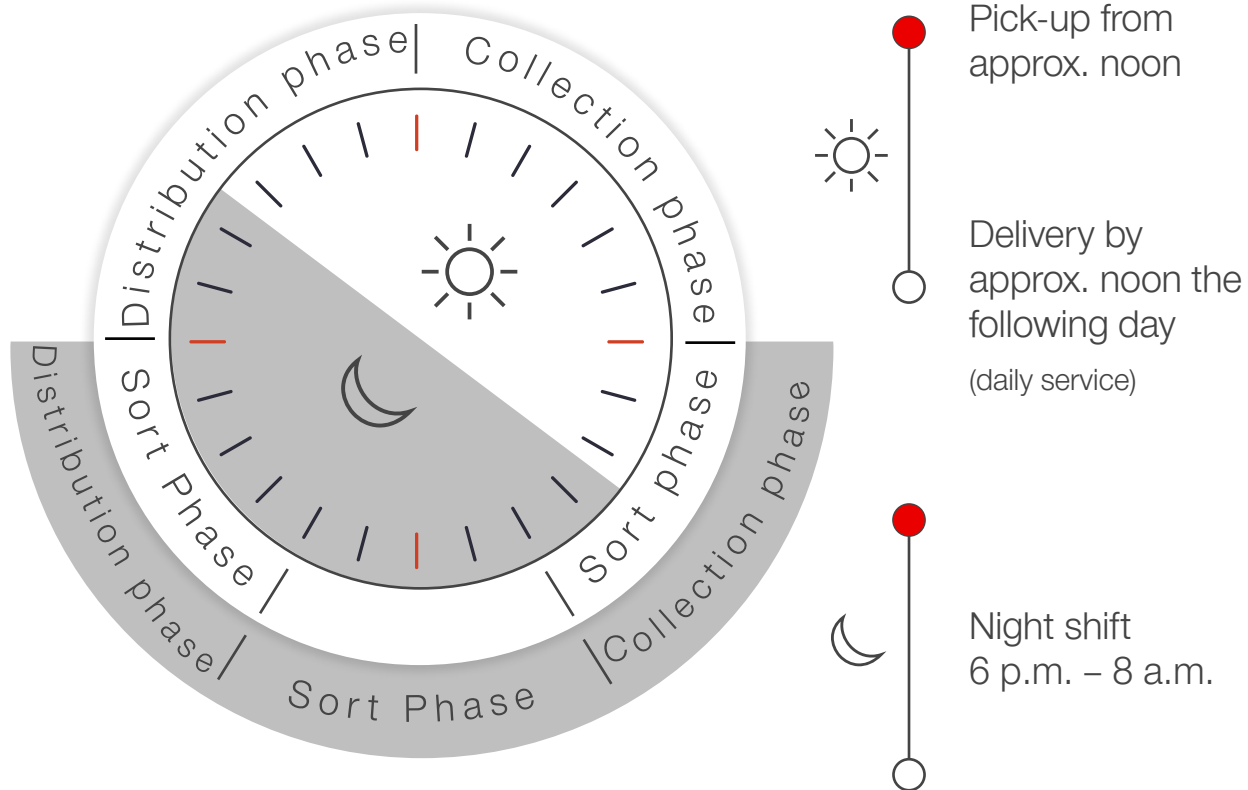
Focusing the operating network on the ideal size.



- The network continues to **cover the whole of Switzerland.**
- It **focuses** on points and relations with **larger transport volumes.**
- **98% of wagons** can **still be transported** thanks to optimisation measures.

Network optimization.

Optimisation of locomotive cycles and more flexible service windows.



- **Optimised service times** in the **daytime** network and a **stable nighttime network** (Express).
- By **smoothing times** in the daytime network, occupancy can be increased, and **resources** can be significantly **reduced**.

Combined traffic.

Unprofitable transports are no longer operated.



- Eight SBB combined traffic terminals that cannot be operated profitably will **no longer be served**: Oensingen, Basel, Gossau, Widnau, Renens, St. Triphon, Cadenazzo and Lugano.
- Goods can still be handled from road to rail at **third-party terminals**.
- In this way, SBB is **financially stabilising** the complex combined traffic system, which is to be operated profitably in accordance with the requirements of the federal government.

Partnerships.

Establish long-term partnerships at a fair price level.



- **Prioritised partnerships**
- **Preferential conditions** based on **fair** prices for anchor customers
- Network **development for anchor customers**
- **Optimised and robust** offering with the necessary flexibility for market fluctuations
- **Transparency** in pricing
- **Digitised** platforms

Conclusion.

Only a transformation that takes multiple aspects into account can be successful.

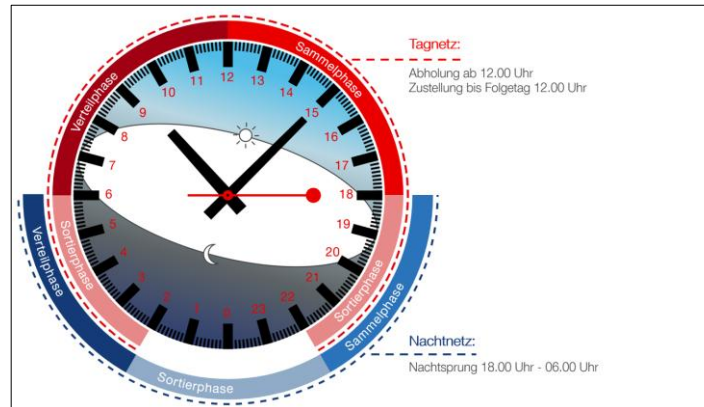
New rolling stock



Unified stance



Optimization of rail operations



Market-driven prices

