

Innovation in Rail Freight

an important contribution to more competitiveness of rail transport



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1. Introduction: Acting now is necessary to preserve competitiveness of rail freight

In the German Masterplan for Rail Freight Transport (Masterplan Schienengüterverkehr) ¹ economic problems for rail freight operators are described. While the average price for diesel has decreased in the last years in Germany, the price for traction electric energy for trains increased. Also the fees for using the rail infrastructure climbed up in Germany.

A further problem for rail freight is, that road transport will be more efficient, based on a degree of automatization, which can be expected based on a fast technological development already in few years Therefore competitiveness of rail is be confronted with a big challenge.

On the other hand, rail freight is clean transport, e.g. in Austria from the electric traction-energy for trains comes to 90,2 % from hydro-power and 2,3 % from other renewable sources, only 7,5 % are produced with natural gas. ² The average CO₂ emission of all trucks in Austria is 71,1 g / ton-kilometer but only 5,3 g /ton-kilometer for freight trains. ³

Truck platooning to increase efficiency of road transport

6 European truck producers (Daimler, MAN, Scania, Volvo, DAF and Iveco) work intensively on the development of technologies for truck platooning. In the actual phase the lead truck and the trailing truck still have a driver, in the next phase the drivers of trailing trucks can rest and do administrative works. The next phase will be driverless trailing trucks and finally autonomous convoys.

Figure 1:

The European Automobile Manufacturers Association (ACEA) road-map for truck platooning



Source: https://www.acea.be/uploads/publications/Platooning_roadmap.pdf

It is expected that after 2025 it will already be possible that drivers from the trailing cars can rest and the next step will be full autonomous trucks.

¹ Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017, elaborated together by BMVI, Allianz pro Schiene, BDI, DB AG, DSLV, DVF, kombiverkehr, NEE, SGKV, Wirtschaftsvereinigung Stahl, VDB, VDV and VPI and representatives of science

² Source: <https://blog.oebb.at/gruener-strom-fuer-die-bahn/>

³ Source :

http://www.umweltbundesamt.at/fileadmin/site/umwelthemen/verkehr/1_verkehrsmittel/EKZ_Pkm_Tkm_Verkehrsmittel_01.pdf

Truck platooning means the following advantages⁴:

- It lowers fuel consumption and CO2 emissions. Trucks can drive closer together (on motorways in a distance of only 15 meters instead of 50 meters with individual drivers) , therefore the air-drag friction is reduced significantly.
- Platooning can reduce CO2 emissions by up to 16% from the trailing vehicles and by up to 8% from the lead vehicle (according to the ITS4CV study by Ertico).
- Truck platooning helps to improve safety. Braking is automatic and immediate; the trucks following the lead vehicle only need one-fifth of the time a human would need to react.
- Platooning optimizes transport by using roads more effectively (less space demand).
- The driving range of trucks can also be extended in certain situations. Up from phase 3 it allows drivers to undertake other tasks, such as administrative work or making calls.

The electricity concern Siemens and the truck producer Scania work together to develop electric powered trucks, which get their propulsion energy from wires like trolley busses, see <https://www.siemens.com/press/en/feature/2015/mobility/2015-06-ehighway.php>

Photo 1: Trolley trucks (Siemens –Scania project)



Source: [https://www.siemens.com/press/en/presspicture/?press=/en/presspicture/2014/infrastructure-cities/mobility-logistics/soicmol201428/soicmol201428-10.htm&content\[\]=ICMOL&content\[\]=MO](https://www.siemens.com/press/en/presspicture/?press=/en/presspicture/2014/infrastructure-cities/mobility-logistics/soicmol201428/soicmol201428-10.htm&content[]=ICMOL&content[]=MO)

Already this short overview on the development of truck technology shows that also further innovations in rail freight transport are necessary to stay competitive.

Moreover, in the Alps high investments of public finances were made and are still under way or planned to improve the rail infrastructure, especially for base tunnels (Mt. Cenis, Lötschberg, Gotthard, Brenner, Semmering, Koralm..). The capacities of the new and upgraded railway lines should be used efficiently.

⁴ Source : http://www.acea.be/uploads/publications/Platooning_roadmap.pdf

2. Benefits of digitization in rail freight

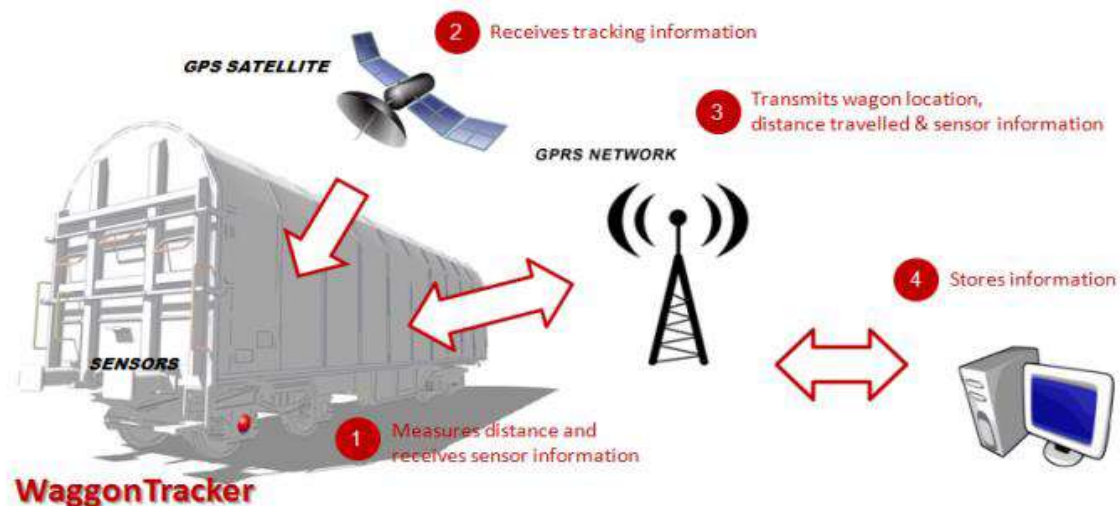
As in almost all branches, also in rail freight digitization is a main field of innovation and contributes to make rail transport more efficient, safe and environmentally sustainable. But for the improvement of competitiveness of rail freight more fields of technological innovation are relevant, like innovative freight wagons, propulsion systems independent from electricity wires, especially for the “last mile”, low-noise brakes for less loud trains. Driverless trains are already reality in metro systems and many tests are under way for other rails. Finally innovations in transshipment for combined transport increase the efficiency for freight transport on rail ⁵

2.1 Digital equipment for the rolling stock

IT- applications can improve efficiency, safety and security of rail freight:

- Location of freight (-wagons) by GPS , periodic messages to sender and the addressees of freight-shipments
- Measurement of temperature and humidity and alarm-message if not suitable,
- Controlling of loading (distribution of weight on axis) and alarm signal if not suitable
- Alarm in case of tried theft of loading units
- Technical control of wagons (e.g. running hot brakes)
- The wagons should have an independent electricity supply for these IT- applications. In the shown case of the Wagon Tracker the independent energy supply is provided by a generator which is integrated in the bearing cap of the bogie.

Figure 2: Example of digital equipment of freight wagon



Source: www.waggontracker.com , (Company JPM; Graz)

⁵ See e.g.: Synthesis document - Analysis of innovative logistics solutions such as rolling highways or solutions for other sustainable modes of long-distance Alpine crossing transport, elaborated by the German colleagues in the working group transport of the Alpine Convention

With the digitization, status data of locomotives and freight wagons are collected during operating time of the vehicles and evaluated in real time. It is possible to locate the vehicles precisely and to recognize technical weaknesses at an early stage, the reliability and safety in the railway operation can be improved. Some complex manual processes of technical control can be replaced or facilitated by digital solutions and cost savings are achieved.

Very helpful is equipment for automatic brake tests. It saves time due to computer-based technology (e.g. RFID-chips). Therefore, the distances which a shunter has to walk will be reduced resulting in a shorter shunting process. Wagons are available more quickly. A permanent control of the brake function is possible even the train is moving. This simplifies also service and maintenance can avoid accidents. On each freight vehicle of the train, an on-board unit needs to be mounted. Sensors are measuring the pressure in the main brake pipe, between the brake cylinder and the control valve. Results of the measurements are displayed on a screen in the locomotive, where the driver can check whether the brakes are well functioning. The automatic brake control was developed in a research project of the German Ministry for Economics and Technology.⁶

2.2 Expected benefits of ETCS (European Train Control System)

The European Train Control System (ETCS) is an example for the benefits of digitization of rail - operation, in the German Masterplan Rail Freight Transport⁷ the following advantages are highlighted:

- An expansion of network-capacity by the reduction of the time between trains on the existing infrastructure,
- a reduction of the maintenance costs for signals on the tracks (after a full change to ETCS),
- increase the productivity of the railway system.

On the other hand the costs for the ETCS equipment of locomotives are between 300.000 and 700.000 €, depending on the number of locomotives to be equipped. The costs are to be paid by the railway operators now, but the benefits will come step by step according the equipment of railway–lines with ETCS equipment. In the German Masterplan Rail Freight Transport (page 18), therefore financial support by public authorities is recommended based on the argument of reduced costs for additional rail infrastructure.

2.3 Digitization of processes in rail freight

In the German Masterplan Rail Freight (pages 19 and 20) some benefits of digitization of business processes are described:

⁶ Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report “Railway Innovations for the Greening of Transport” <https://www.swiftlygreen.eu/en> pages 27 and 28, see also <http://www.dilloc.de/dilloc-brake/>

⁷ Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017

- In general digital exchange of data improves the transparency of transport processes and contributes to the optimization of rail-bound logistics.
- Locomotive drivers and other operating personnel can react based on digital transmission of timetables and regulatory documents in an early stage to deviations.
- Digital interfaces between infrastructure operators and train operators the preparation of train journeys and the calculation of the infrastructure using fee - can be facilitated considerably.
- For rail freight transport, short-term and flexible allocation of railway capacity – to get suitable slots for freight trains - is becoming increasingly important. The flexible demand of freight customers can be often not represented in annual timetables. The use of digital technology facilitates the flexible and demand-oriented allocation of slots for freight trains.
- Through digital provision of train- and customer data for operating staff (e.g. electronic wagon list for train drivers, digitized data acquisition and forwarding in the car inspection) can the subsequent processes for planning, scheduling and maintenance systematically connected and accelerated.
- The development and use of a continuous digital process chain in the maintenance of rail vehicles contribute to increased efficiency and availability in railway operations.

In Germany an umbrella project “Simple Railway” (“Einfachbahn”) is under way. The main objective is to facilitate operating with the system rail by the implementation of user-friendly IT-tools.

Figure 3: Already used applications or “Einfachbahn” (“Simple Railway”)

						
strecken.info Kartenbasierte Online-Darstellung von Infrastruktureinschränkungen: <ul style="list-style-type: none"> • Bauschwerpunkte der 12-Wochen-Bauvorschau • kurzfristig auftretende Störungen (BZ-Info) • Streckenschließzeiten www.strecken.info	Trassenfinder Der interaktive Routenplaner für die Schiene: webbasierte Anwendung, mit der individuelle Routen auf dem Schienennetz der Deutschen Bahn schnell und einfach gefunden werden können www.dbnetze.com/trassenfinder	GretA Grenzlast-Anzeiger GretA Webbasierte Anwendung zur Ermittlung von Regelgrenzlasten und Beantragung von Einzelgrenzlastberechnungen Mit GretA können über 7.700 PDF-Seiten des Regelwerks 491 ersetzt werden. www.dbnetze.com/greta	IKAs IKAs - Informations- und Kommunikationssystem Anlagenstörungen Webbasierte Anwendung zur Eingabe, Verarbeitung und Überwachung der Abarbeitung von Mängeln an Serviceeinrichtungen www.dbnetze.com/ikas	AnDi AnDi Das Planungs- und Dispositions-tool für den Anlagen-disponenten In der Kunden-version kann der Kunde Kapazitäten anfragen, bei Bedarf reklamieren sowie seine Abstellungen einsetzen. www.dbnetze.com/andi	railway.tools railway.tools Webanwendung mit interaktiven Karten, die einen transparenten Überblick zu den Zugangsmöglichkeiten im kombinierten und konventionellen Schienengüterverkehr bietet www.railway.tools	Trace iTrace - Infrastructure Traceability Eine Plattform für die markt-orientierte Infrastrukturentwicklung bei der DB Netz AG www.dbnetze.com/trace

Source: http://www1.deutschebahn.com/einfachbahn-de/projekte/projekte_tools/14337350/ueberblick_projekte.html?start=0

www.strecken.info shows based on maps restrictions on the rail network (e.g. construction works, closing times of some lines and short time disturbances).

“Trassenfinder” optimizes the route planning under consideration of several criteria and facilitates also ordering slots for freight trains.

GretA (Grenzlast-Anzeiger) helps to identify weight-limits for rail-freight and to order calculations for specific cases.

IKAs is an information and communication system for information to equipment failures and to support solving these technical problems.

AnDi is a planning and disposition tool for railway-operators including a customer version, which allows them to ask for free capacities and to look for their wagons on the rail-network.

Railway.Tools (<https://railway.tools/>) gives based on interactive maps an overview to the access points for combined and conventional transport on rail, like terminals, railway-sidings. Moreover, railway-diesel filling stations are shown.

I-Trace is a platform for the development of the rail-infrastructure based on the demand on the market. Also suggestions of clients to improve the rail-infrastructure are considered. The platform includes also tools for a first evaluation of the technical feasibility of the proposed infrastructure measure, costs, benefits, duration of implementation and suitable financing instruments.

3. Innovations in rolling stock to improve efficiency and to reduce negative impacts on the environment

3.1 Modular construction of wagons: different loading units on standard chassis

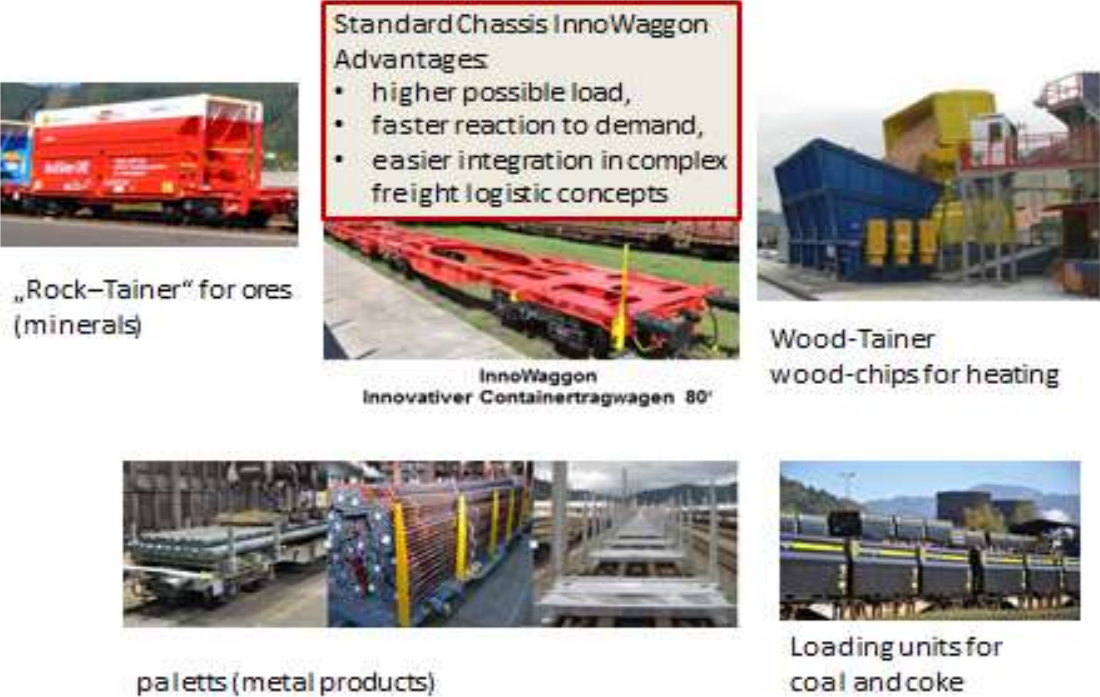
At first a standardized construction of wagon chassis can save production- and maintenance-costs by economics of scale. Moreover, many categories of freight have summits of demand while in the meantime only low transport demand exists. Therefore conventional wagons without the possibility to separate the loading-units (“super-structure elements”) from the chassis have in the low-demand- phases inefficient breaks, their capacity is not used. In the case of modular wagons with an easy possibility to separate the chassis from the loading unit, the chassis with the bogies can be used for other loading units.

Loading units can be removed by crane or reach-stacker, stapled and stored for the next use. Especially interesting are foldable superstructures that can be stapled space-saving.⁸

⁸ Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report “Railway Innovations for the Greening of Transport” <https://www.swiftlygreen.eu/en>

By the construction of the chassis, using innovative bogies with radial steering technology, disc brakes or low-noise brake – pads maintenance cost of wheels and rails can be reduced. In the report of the project “Swiftly Green” 2 German and 1 Slovakian type of innovative bogies are described.⁹

Figure 4: Separation of chassis and loading unit, example Rail Cargo Group Austria



(Source: presentation by Karl Zöchmeister, meeting of the WG Transport, 5.5. 2017)

3.2 Low noise brakes and bogie skirts on wagons to reduce noise

In the report “Railway Noise in Europe”¹⁰, reducing the wheel roughness by replacing cast iron brake blocks – which cause rough wheels – by K- or LL blocks or using disk brakes is regarded as most important option to reduce rail noise

In a “whisper” brake, also called "K-sole", the brake pad (block) is made of composite materials which are more elastic than older, metallic gray cast iron brake pads. In the composite metal fibers, rubber and resin compounds and additional materials are usually processed, therefore these brake blocks are also called "composite brake sole". Compound brake pads can cause a reduction of rolling noise of 8-10 dB (A) on smooth track surfaces, which is perceived by the human ear as a halving of the noise. The disadvantage of the K-blocks is that composite wears

⁹ See note 8 to the report “Railway Innovations for the Greening of Transport”, project “Swiftly Green” p. 55
¹⁰ “Railway Noise in Europe”, published by the UIC (Union International des Chemins de fer) in March 2016, page 28

faster and causes higher maintenance costs for the railway companies. A further development are the so-called LL soles ("low noise, low friction" - low noise, little abrasion).

However, retrofitting a freight car originally equipped with gray cast iron brake blocks is laborious. The entire braking system of the vehicle must be rebuilt for this purpose and re-approved depending on the type of wagon. For example the Deutsche Bahn estimates the costs of converting one freight wagon to low-noise ("whispering") brake between 5.000 and 7.000 €.

Significantly reduced costs result from the conversion to the LL sole, which has been approved since June 2013. Because the coefficient of friction of this quiet sole is comparable to that of the conventional gray cast iron sole, the old gray cast iron soles of standard freight wagons can be replaced 1: 1 with the new composite brake sole without further modification. The costs are about 1.700 euros per car about two-thirds lower than when using the K-sole.¹¹

In addition to the whisper brake with composite brake pads, disc brakes are increasingly being used in rail freight transport - a technique that has always been used to brake lighter passenger trains. With disc brakes, the rolling noise of freight trains can be reduced even more than with whisper brakes.¹² The investment costs for disc brakes per new wagon are about 9.000 € higher compared to a block brake and the lifetime is estimated to 10 years. Disc brakes have an economic advantage in comparison to block brakes by avoiding the wear out of the wheel during the brake operation of the train. Considering a new acquisition of a freight vehicle, the advantage can become apparent with a yearly mileage of 60.000 km. The costs for the modification of existing freight vehicles are high and the process is seen as uneconomical.¹³

Example Germany

In Germany since December 2012 for trains that do not yet have noise-reducing technology (whisper brakes) a higher infrastructure use fee compared to quiet trains is to pay by rail operators. This concerns above all the goods traffic. The aim of the noise depending infrastructure use fee ("lärmabhängiges Trassenpreissystem", short LaTPS) is to accelerate the noise reduction in rail traffic.

A federal funding program worth up to 152 million € was introduced by the German government for converting noisy freight wagons to low-noise braking technology until the 2020/2021 timetable change. From the end of 2020, the operation of noisy freight wagons in Germany will be prohibited by law.¹⁴ Therefor a fleet of more than 60.000 freight wagons of DB Cargo have to be upgraded, also further 60.000 wagons of private wagons owners. Since 2001 new freight wagons of DB-Cargo are equipped with low-noise brakes, at first with K-pads and since

¹¹ Source: <https://www.allianz-pro-schiene.de/glossar/fluesterbremse/>

¹² See number 7 above: Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport)

¹³ Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report "Railway Innovations for the Greening of Transport" <https://www.swiftlygreen.eu/en>, page 30

¹⁴ Source: <https://www.allianz-pro-schiene.de/glossar/trassenpreise/>

2013.with the cheaper LL pads. In January 2019 63 % of the rolling stock for rail transport in Germany was equipped with “whisper brakes”.¹⁵

Photo 2: LL brake pad



Source: DB, Pablo Castagnola, downloaded from <https://www.allianz-pro-schiene.de/glossar/fluesterbremse/>

Example Austria

On the initiative of the Federal Ministry for Transport, Innovation and Technology the conversion to so-called “whisper brakes” is rewarded with a noise bonus for rail tolls. The proposal for the “noise-related railway use fee” has already been approved by the European Commission. The new regulation will be implemented by the Austrian Federal Railways (ÖBB) infrastructure from December 2017. Trains equipped with whisper brakes will be rewarded with a toll credit. The bonus is one cent per wagon axle and kilometer up to a maximum of 1.700 € per wagon. This equates to the cost of retrofitting to new composite brake pads and motivates rail transport companies to transition.¹⁶

At the Austrian Rail Cargo Group, 40 percent of the more than 21.000 freight wagons¹⁷ used in Austria are already quiet. By the end of 2020/2021, more than 90 percent of freight wagons our vehicles, which are mainly used in Austria, will be retrofitted.¹⁸

Critical remarks

Experience in Sweden and Finland shows: In nordic winter weather conditions, trains carrying wagons with composite brake pads - type C810 - could pose serious safety-related problems. Checks shows, that the brakes with the composite soles are blocked by a layer of snow and ice. In trains consisting exclusively of wagons with whisper brakes, in at least one case even “no braking effect” has occurred. Similar incidents were reported from Finland. The Swedish

¹⁵ Source : Information by the German Ministry for Transport and digital Infrastructure (BMVI) department railway research on 29th January 2019

¹⁶ Source: <https://infothek.bmvit.gv.at/gueterverkehr-fluesterbremesen-bremssohlen/>

¹⁷ Source : Karl Zöchmeister, presentation in the WG transport 5.5.2017 in Vienna

¹⁸ Source: http://www.railcargo.com/de/News/News/2017/Q4/Leiser_Gueterverkehr/index.jsp

transport authority "Trafikverket" has reported this problem in a safety alert to the European Railway Agency.¹⁹ In contrast to reports submitted by Sweden, other European railways have already extensive experience with composite brake blocks without any similar incidents. DB Cargo for instance has so far 41,000 wagons retrofitted to the LL blocks. These have now covered by mid-November 2018 a total of more than 1.5 billion wagon kilometers without any incidents reported corresponding to the Swedish incidents.²⁰ , also in Austria no dramatic incidents with low noise brakes are known with low-noise brakes.

Owners of freight wagons complain that "whisper-brakes" causes higher maintenance costs than cast-iron brakes. While investments in new wagons and for up-grading old wagons are supported e.g. by federal funding programs the higher maintenance cost remain for the wagon-owners.²¹

European Solution for low- noise brakes

The European Commission plans a regulation for low-noise brakes after 2024 and is criticized e.g. by the German government that this is very late for countries that have already implemented noise differentiated track access charges.

Bogie skirts on wagons to reduce noise

A further possibility to reduce the noise of rolling trains is to use bogie skirts on wagons. This equipment can reduce the noise up to 10dB (on wagons with cast iron brakes), especially in combination with low noise protection wall on the track near the rails.

On the other hand the maintenance of bogies and wheelsets with noise protection skirts is slightly more difficult than without because the skirts have to be removed during the maintenance. Also the periodical inspection all parts of the bogie by wagon masters at shunting yards can become more difficult. This disadvantage can be solved if sensor technologies (e.g. Cargo CBM) would be used on the freight wagons to simplify the train making process. Further, in winter additional icing hazard of the bogie could occur when using skirts.²²

Photo 3: Bogie skirts for noise protection



Source: The Influence of Surface Impedances on Sound Radiation Properties of a Shroud-Barrier-Combination, Dissertation Kai Johannsen (taken from source 22)

¹⁹ <http://www.taz.de/!5450408/>

²⁰ Information by the German Ministry for Transport and digital Infrastructure (BMVI). Rail research department .

²¹ <https://www.allianz-pro-schiene.de/presse/pressemitteilungen/2014-017-plattform-leise-bahnen-schiennenlaerm/>

²² Project SWIFTLY GREEN (Sweden- Italy Freight Transport and Logistics Green Corridor), TENT-T Programme Activity 4 report "Railway Innovations for the Greening of Transport" <https://www.swiftlygreen.eu/en>, page 33

3.3 Bimodal locomotives with energy accumulator or diesel engines for the “last mile”

For safety reasons (high tension electricity) and to operate without obstacles with cranes the loading rails in combined transport terminals as well in other rail-freight stations are not electrified. Therefore it's often necessary for the full rail transport chain to provide in addition to the electric long-distance locomotive a diesel shunting locomotive. If the capacity of such shunting locomotives is not used in a sufficient size, the cost-structure of the rail-transport becomes inefficient.

A possible solution is to use bimodal locomotives, suitable to pull a freight train over long distance with electric power and also for shunting-services in freight not electrified freight terminals. A research in the internet shows, that locomotives with this performance are already available on the rolling-stock market.

Long distance locomotives with “last mile package” for not electrified tracks

An example for electric locomotive with “a last mile package” is the type 187 (German class number), which is built by Bombardier in Kassel. This locomotive is equipped for 15 kilovolt 16.7 Hertz and 25 kilovolt 50 Hertz alternating voltage. Moreover, a 180 kilowatt diesel auxiliary motor is available to serve sections without overhead wires (“Last Mile”). In diesel mode, all four traction motors are working, the starting tractive force is just as high as during electrical operation. A class 187 locomotive with its diesel engine can reach a top speed of 60 km / h and a train with 2.000 tons can still be accelerated to 40 km / h. The diesel auxiliary engine has a capacity of 7,150 cubic centimeters and complies with the Stage IIIB emission standard. The tank capacity of 400 liters is sufficient for up to 8 hours of diesel-operation, short distances can also be covered only with the built-in battery. The transition from electric traction to diesel traction can be done while driving. A radio remote control is available for shunting operations.²³

Also the newest generation of electric locomotives produced by Siemens – called Vectron – offers as upgrade option an optional shunting module available for the models Vectron AC and DC. It includes an auxiliary diesel engine with a power of 180 kW (exhaust emissions according to EU standard IIIB) with which is possible to drive on not electrified tracks in shunting services.²⁴

²³ Sources: https://de.wikipedia.org/wiki/Bombardier_Traxx#Baureihe_187 and Nahtloser Übergang – die Last Mile Lokomotive. In: Eisenbahntechnische Rundschau 9/2014, S. 174–176.

²⁴ Source: https://de.wikipedia.org/wiki/Siemens_Vectron based on Siemens: Hintergrundpapier Modulerweiterungen

Photos 4, 5 and 6 : Examples of locomotives with last mile diesel motors

Traxx categorie 187



Source : www.railpool.eu

Eurodual from Stadler Spain

Siemens Vectron in Hanko, Finland



Source: <http://junalauta.net>



Source:

<http://www.railwaygazette.com/news/traction-rolling-stock/single-view/view/stadler-seeks-most-powerful-loco-family-as-eurodual-trials-begin.html>

The train producer company Stadler Spain developed heavy 6 axle - dual mode locomotive – called Eurodual - which is capable hauling main line trains at up to 160 km/h in either diesel or electric mode, the prototype is rated at 7 Megawatt (MW) when under 25 kV 50 Hz electrification or 4 MW from a 1.5 kV DC supply. Its Stage IIIB-compliant Caterpillar C175-16 diesel engine is rated at 3 MW.²⁵ The first customer is the Havelländische Eisenbahn Aktiengesellschaft (HVLE), which ordered 10 Eurodual-locomotives. Compared with last mile conceptions these dual mode locomotives (electric or diesel electric traction) provide more flexibility in a network with some not-electrified lines. A disadvantage might be the weight of the strong diesel engine and the big diesel tank.

The ÖBB (Austrian Federal Railways) start in 2019 test with a 3 –piece railcar (type City Jet, from the Desiro main line family with 4 accumulators²⁶ . The range without catenary should be appr. 80 kilometers, the performance appr. 1.300 KW (half of service under catenary) and the maximum speed 140 km/h

Bimodal shunting locomotives

Fuel cells and lithium-ion batteries or super capacitors in Austrian electric shunting locomotives as solution for the last mile:

²⁵ Source: <http://www.stadlerail.com/de/produkte/detail/eurodual/>

²⁶ Source: <https://futurezone.at/b2b/14-tonnen-akku-statt-diesel-oebb-testen-oeko-zug-ab-2019/400114013>

The project was started by ÖBB (Austrian Federal Railways) and is part of a research contract of the Austrian Research Promotion Agency (FFG) and the Federal Ministry for Transport, Innovation and Technology (bmvit).

One experimental vehicle is based on the use of batteries and supercapacitors, while the second experimental vehicle relies on the use of four 600 V lithium-ion batteries and one fuel cell. Two battery packs supply the traction motors with 1,200 V voltage. The supply of the battery packs takes place either directly from the AC overhead line or self-sufficient from the fuel cell, which is powered by hydrogen. The test vehicle is initially equipped with a fuel cell with 30 kW power, which will soon be changed to a more powerful fuel-cell. A positive feature of this technology is that it provides a much longer range or service life than a conventional battery solution. Test services are under way.²⁷

Photo 7: Fuel cell shunting test locomotive

Photo 8: Battery pack on the roof of City Jet Eco



Photo: SN/ HET/Inderst,



Photo: Harald ÖBB²⁸

Fuel cell locomotives and trains

For the regional passenger traffic since March 2017 in Lower Saxony (Niedersachsen) a completely by fuel-cell powered low-floor train unit is on rail in the test phase:

“Alstom has successfully completed its first test drive on the company's own test track in Salzgitter (Lower Saxony) with the world's only fuel-cell-operated passenger train Coradia iLint at 80 km / h. In the coming months, an extensive test campaign will follow in Germany and the Czech Republic, before the Coradia iLint will go into trial operation with passengers at the beginning of 2018 on the Buxtehude-Bremervörde-Bremerhaven-Cuxhaven route.

This completely emission-free train is quiet and only emits water vapor and condensation. The Coradia iLint features a number of different innovations: clean energy conversion, flexible energy storage in batteries, and smart management of power and available energy.

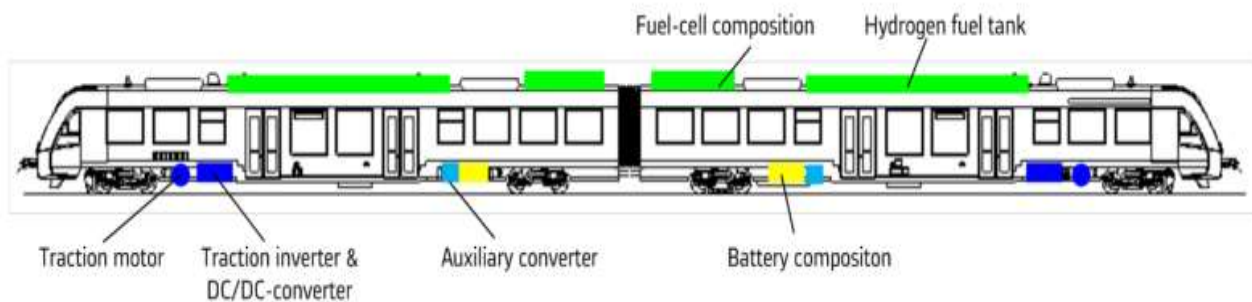
²⁷ Source: <https://www.eb-info.eu/aktuell/forschung-und-entwicklung/11-10-2017-oebb-hybridlok-mit-brennstoffzelle-versuchslokomotive-mit-alternativem-antriebskonzept-getestet/>

²⁸ Downloaded from <http://forum-mobil.at/innotrans2018/>

The hydrogen used for the test drives is the by-product of an industrial process and is usefully recycled. In the long term, the producer Alstom supports the generation of hydrogen from wind power.

This project of a fuel cell driven train benefits from the support of the Federal Ministry for Transport and Digital Infrastructure. Alstom has already signed declarations of intent for 60 trains with the federal states of Lower Saxony, North Rhine-Westphalia, Baden-Württemberg and the Hessian Rhein-Main-Verkehrsverbund”²⁹.

Figure 5: Construction of the fuel-cell powered iLint



Source: <http://www.greencarcongress.com/2017/11/20171109-alstom.html>

It can be expected that success of fuel cells for passenger trains –powered by hydrogen soon will lead to the construction of more powerful fuel cells also for rail-freight.

Alternative freight train conceptions

Successful ways to low-emission traction also on not electrified lines can contribute to the success of alternative freight train conceptions, like the Aron RCS rail cargo system³⁰

Such systems, also the cargo-sprinter of the Deutsche Bahn³¹ have the advantage to be more suitable for smaller freight-shipments and for spontaneous and fast transports as locomotives and wagons which must be often shunted. But recently such innovative rail freight conceptions had the disadvantage of diesel traction, also on electrified lines. The vehicles were equipped with diesel engines – emitting greenhouse gases and NOx - to be flexible for the use not electrified lines and railway sidings.

Dual low emission traction (e.g. electric energy from overhead wires or from fuel cells or batteries) makes such vehicles more attractive from the environment impacts point of view. In the Hungarian Aron RCS rail cargo system the following ways for energy supply are considered:

²⁹ Source: <http://www.alstom.com/de/press-centre/2017/03/erfolgreiche-erste-testfahrt-von-alstoms-wasserstoffzug-coradia-ilint-bei-80-kmh/>

³⁰ <http://www.aron-rcs.com/solutions>

³¹ <https://en.wikipedia.org/wiki/CargoSprinter>

- Electric traction with overhead collection – for electrified networks, with an optional "last mile" function to extend reach to non-electrified sidings and decrease exposure to infrastructure disturbances;
- Battery powered electric traction for operation without local emissions on non-electrified network sections and sidings.
- Electric traction from diesel power pack for non-electrified networks: A diesel power section incorporates several motors in view of efficient operation with low breakdown susceptibility.

The Aron RCS is developed for containers but it could be used also for standardized changing loading units as described above. The twin loading device “riding” the train is an essential part of the ARON-RCS system. Presently no such mobile device operates that loads and unloads standard containers, swaps bodies, and even non-cranable road semitrailers. The required device must speedily crane swap containers on-site as well as being carried on-board, descend from the train and remount, without requiring any particular infrastructure elements. The loading devices can be powered diesel-hydraulic or electric.

Figure 6: Aron RCS twin loading devices



Source: http://www.aron-rcs.com/downloads/ARON-RCS_prospect_En.pdf

4. Automatic coupling systems

Automatic coupling is regarded by many experts as key to improve the efficiency of rail freight. Conventional screw coupling is a heavy and often dangerous work. Moreover, it needs a lot of staff. In the U.S.A. or in Russia automatic coupling is usual, advantages are higher safety for the railway staff, the possibility to pull heavier and longer trains, with some systems also a remote decoupling is possible (e.g. Scharfenberg-coupler, often used for passenger train units in shuttle service). Automatic coupling is a condition to automate shunting procedures.

Conceptions to replace conventional coupling by automatic coupling in one step (e.g. during a long weekend) failed, therefore automatic coupling systems should be compatible with conventional screw coupling (“Schraubenkupplung” in German, sometimes also called chain coupler). Exceptions could be special trains, e.g. block-trains, which need no compatibility with conventional coupled wagons.

The C-AKv coupler (Compact - Automatische Kupplung vereinfacht) as possible solution

The C-AKv coupler was developed by SAB WABCO, now Faiveley Transport Witten GmbH. Unlike the former UIC automatic coupler, it is compatible with the existing chain coupler, which would allow for a longer transition period.³² Since the year 2002, the C-AKv has been on tests on the German railway network.

It is used on heavy coal block trains between the opencast mines at Profen and the Schkopau power plant.

The advantages of the C-AKv coupler are:

- The C-AKv coupler automates the wagon coupling and decoupling procedures and therefore speeds up the entire transport process. This results in a significantly higher system speed and a shorter wagon turnaround time.
- The automatic coupler enables greater drawing and buffing forces to be used for heavier and therefore longer freight trains, making a doubling of current train lengths possible.
- The C-AKv coupler also enables the automatic coupling of the brake pipe and the electrical lines (including data transmission cables).
- The C-AKv coupler is compatible with existing screw coupling systems and the Russian SA-3 coupler and thus guarantees a transition period during which all freight wagons can undergo conversion.
- Once the transition period is over and all side buffers have been removed, the C-AKv coupler will also offer greater derailing protection at higher running speeds.

Large volume production of the automatic central buffer coupler should mean that the cost of retrofitting an older freight wagon is substantially less than €8000, while the cost of equipping a new wagon is estimated to be less than € 5000.³³

The C-AKv coupler enables the double load compared to screw couplers (tensile load 1.000 kN of C-AKv). This makes possible to pull heavy and long trains (up to 1.400 meter length). An example are 6.000 ton iron ore trains from Rotterdam to the steel works at Dillingen in the Saarland. For this purpose 18 DB class 189 electric locomotives were equipped C-AKv coupler and pull the iron trains in double traction.³⁴

³² Source : https://en.wikipedia.org/wiki/C-AKv_coupler

³³ Source: Bernhard Sünderhauf: The Automatic Centre Buffer Coupler (ACBC) - Cost-Benefit Analysis, Köln; Altaplan Leasing GmbH, 2009; downloaded from http://www.automatische-mittelpufferkupplung.de/dl-counter/download/automatische_mittelpufferkupplung.pdf

³⁴ https://en.wikipedia.org/wiki/C-AKv_coupler

Figure 7: Main components of the C-AKv (automatic central buffer coupler system)

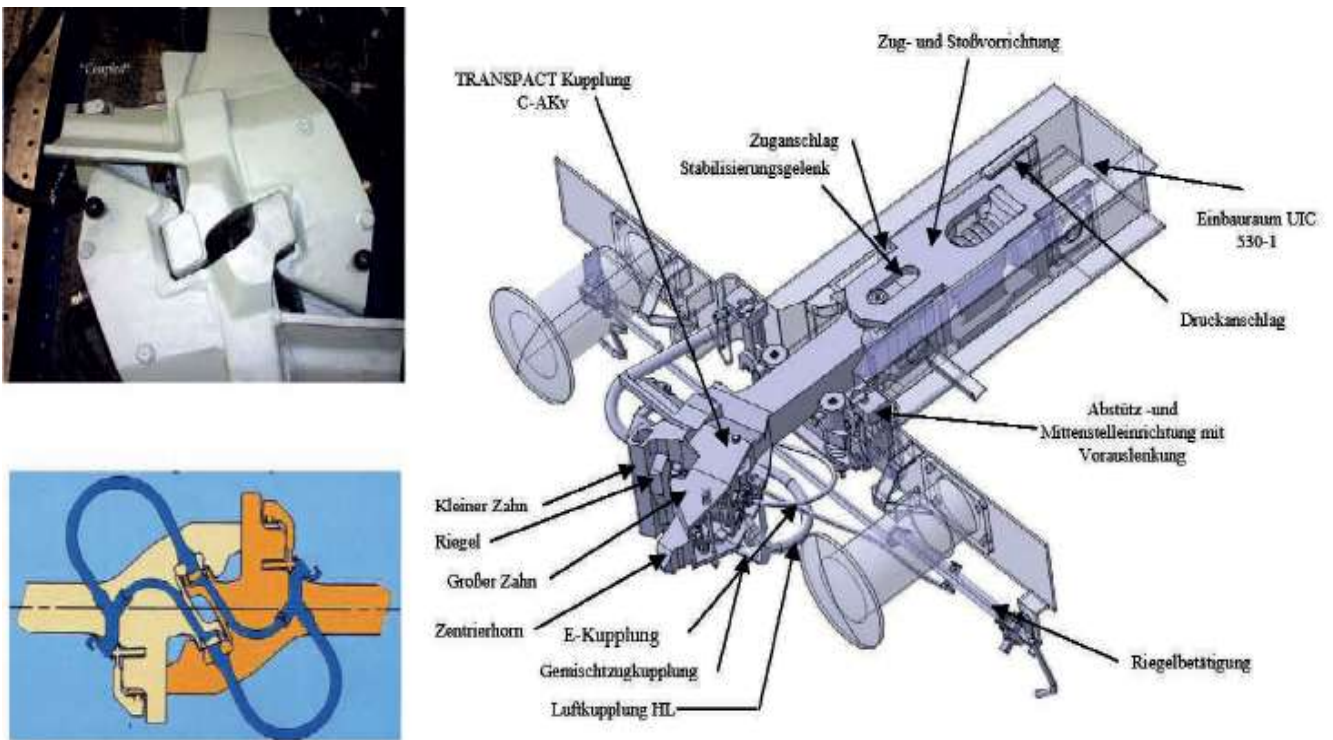
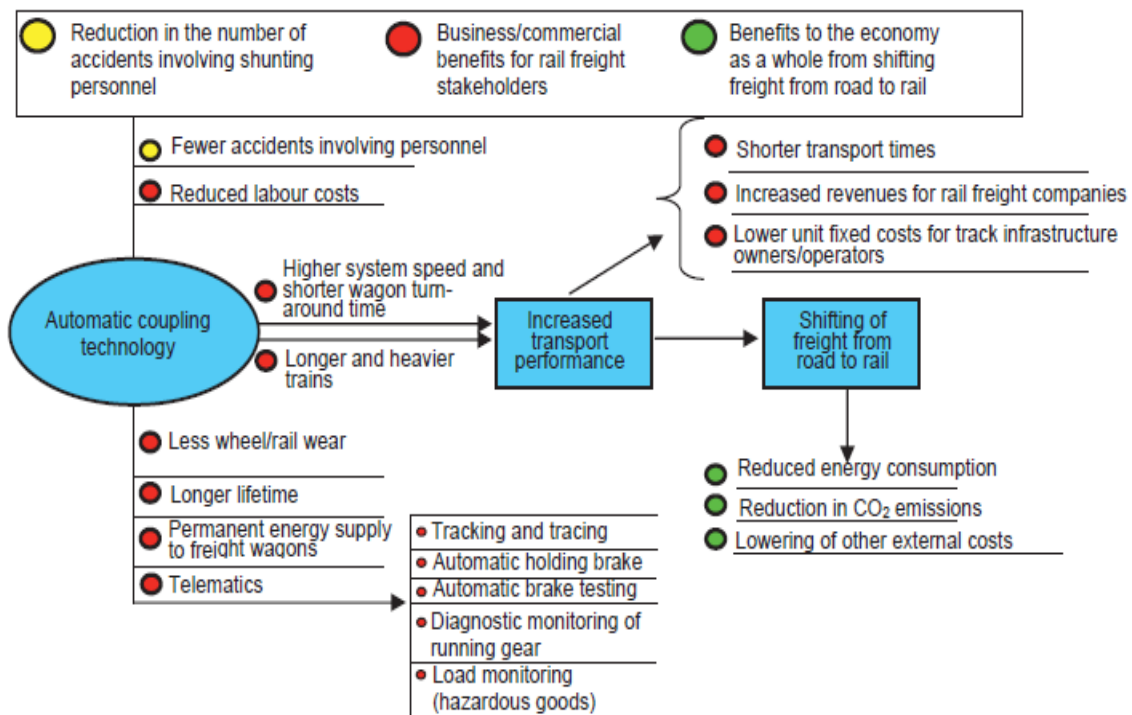


Figure 8: Overview of the most important business/commercial benefits and broader economic benefits



Sources of figure 7 and 8 see next page

Source of figures 7 and 8: Bernhard Sünderhauf: The Automatic Centre Buffer Coupler (ACBC) - Cost-Benefit Analysis, Köln 2009, downloaded from www.automatische-mittelpufferkupplung.de/dl-counter/download/automatische_mittelpufferkupplung.pdf , source of the pictures in figure Source of the pictures: Faiveley Transport

Summed up, automatic coupling can be regarded as condition for automatization an improved competitiveness of rail-freight.³⁵

Regarding to the German Masterplan for Rail Freight Transport a blueprint for the Federal Government programme entitled “The Future of Rail Freight” was developed in September 2018. It shows the need for a digital automatic coupling (DAC). In the same direction the Technical Innovation Circle for Rail Freight Transport (TIS) published a position paper in October 2018.³⁶ The industry wants to develop a DAC type 4 in 2019.

Photo 9 Locomotive with C-AKv coupler



Photo 10: Coupling with conventional screw-coupler



Source photo left: www.fotocommunity.de/photo/189-031-8-martin-morkowsky/20557477

Source photo right: Bernhard Sünderhauf , Faiveley Transport

³⁵ An excellent overview to more rail coupler systems in German language is provided at <http://www.innovative-freight-wagon.de/wp-content/uploads/TIS-uebersicht-Kupplungssysteme.pdf> , written by Stefan Hagenlocher, hwh Gesellschaft für Transport-und Unternehmensberatung mbH, Karlsruhe 2015 (client SBB-Cargo)

³⁶ http://www.innovative-freight-wagon.de/wp-content/uploads/EN_TIS-position-paper.pdf

5. Partly and fully automatic shunting

Shunting, especially coupling with conventional screw couplers needs many employees and is a dangerous work. Automatic couplers, which are described above facilitate shunting and avoid the most dangerous works. For the improvement of the competitiveness of rail-freight compared with road transport, a further step is to automate the traction processes for shunting.³⁷

In the German Masterplan for Rail Freight Transport³⁸ the following measures to automate shunting are mentioned:

- Automation of train formation towards real-time control entire marshaling yard
- development and use of automation options (e.g. decoupling robot) to support and discharge the operating personnel and to increase work-safety,
- fully automatic shunting locomotive,
- automatic check of the wagon-sequence,
- (semi-) automatic coupling and decoupling,
- automated wagon examinations with video analytics,
- automated brake tests,
- real-time monitoring of all shunting processes and the infrastructure
- software for optimal real-time control,
- support of research projects for future work in digitized and automated systems.

Automatic coupling systems are regarded as key-technology for further measures to improve efficiency of rail freight transport.

A pilot project was implemented in the wagon repair and maintenance shop in Paderborn³⁹. The working processes there need many shunting procedures. With the pilot project, DB - Systel wants to prove that the systems and technologies already in use make it possible to implement quickly innovative ideas such as automated shunting. Many current rail vehicles are already prepared for automated driving. The pilot project in Paderborn shows that innovations can build up on an existing base.

The two-way shunting -vehicles in Paderborn use technology such as radio receivers and sensors, which are already for other applications elsewhere. A key step was the development of the interface to the two-way vehicle. These powered vehicles can now interact with the DB technology, addressed via radio from a central control system installed on a notebook - whereas it was previously controlled manually by remote control.

The aim is that the dispatcher enters into an IT system, which vehicles should be provided on which working position, so that the automatic two-way vehicle then can provide the wagons

³⁷ Considerations to the impacts on the labor-market see chapter 8 Conclusions

³⁸ Masterplan Schienengüterverkehr (Masterplan for Rail Freight Transport) published by the German Federal Ministry for Transport and Digital Infrastructure (BMVI) in June 2017, page 22.

³⁹ Source: <http://digitalspirit.dbsystel.de/die-zukunft-des-rangierens>

on the right place controlled by the IT- system. The test in Paderborn, which was finished at the end of 2016 was successful, further steps of implementation are planned.

Photo 11: Small automatic two-way shunting robot in the wagon repair shop in Paderborn



Source: DB Systel GmbH (David Just)

Magna factory in Albersdorf (Styria)

It's almost surprising that an example for automatic shunting is operating since the year 2001 in a plant for automobile technics (e.g. gears) Albersdorf (approximately 30 km in the East of Graz).

The fully autonomous operating shunting-locomotives (robots) were constructed by the regional rail-company „Steiermärkische- Landesbahnen“ (since 2018 called Steiermarkbahn) together with soft-ware partners. The robots are used in a factory area of Magna in Albersdorf (Styria) to provide wagons for loading scrap metal and to shunt them (at first to weigh the loaded wagons).

For steering the shunting robots are used induction loops, photo-cells (light- barriers), also conventional radio remote control is possible. The robots receive electricity from loading wires and from batteries in wireless sections. Also all relevant data to wagons and loads are transferred automatically. Railway -switches and conveyor belts are controlled automatically. In the factory site the automatic shunting-coupler RK 900 is used, before rolling on the network the coupler are fixed by shunting staff. ⁴⁰

⁴⁰ Information by Stefan Greiner, technical leader of Steiermarkbahn, Graz (e-mail 2. November 2016)

Photo 12: Shunting robots work in the Magna factory



Source: <http://www.steiermarkbahn.at/leistungspalette/verladung>

6. Freight trains without driver

Metros are already operating without drivers. Examples are Paris, the Dockland Railway in London, or the metro in Nürnberg. In Wien the new metro-line 5 is under construction and it is planned that the trains will operate without driver. Also the shown examples for shunting in chapter 5 prove, that the technology for automatic driving are available, but experts underline that automatic trains on lines with mixed train categories (fast trains, regional trains with many stops, freight trains and railway crossings with streets on the same level) need a more complex technology than limited systems like metros or shunting services in the local area of a shunting yard. Nevertheless tests are under way in many countries.

For example, the DB (German Railway) in 2016 started a test on a disused 30-kilometer long railway in the Erzgebirge. The test railcar is equipped with state-of-the-art camera and sensor technology. In the project technologies for detecting obstacles from a longer distance, automatically coupling trains and also for digital communication with road users should be tested and improved.⁴¹

Also in Austria a test environment for automatically operating trains on the open track is developed. In the "Open.Rail.Lab", companies and research institutes are testing new railway technology, such as locomotives, which automatically detect railroad crossings or obstacles on the rails. The test track between Friedberg in Styria and Oberwart in Burgenland is over 25 kilometers long. In the "Open.Rail.Lab" the entire development of the technology for automatically operating trains can be performed - from the first simulations on the computer to tests in normal railway operations.

The Federal Ministry for Transport, Innovation and Technology invests together with the state of Burgenland and the industry 11 million € in the upgrading of the track. In addition, the ministry will provide around five million euros annually for research projects related to automated rail operating. The test line will be opened in June 2018. It is expected that the

⁴¹ Source: Deutschlandfunk 18.8.2016, Eisenbahn 4.0

settlement of research institutes and branches of railway equipment producers leads to positive impacts on the regional economic development.⁴²

Smaller tests for sensors on railcars and locomotives to avoid collisions were already performed successfully in the year 2013 on the Traunsee Railway in Upper Austria (cooperation of the Austrian Institute of Technology, Siemens and the regional train company Stern&Hafferl). In fog, heavy snowfall or at night, the sensors achieve a better detection performance than the human eye, which promises to increase the safety of rail traffic ⁴³

The digital association Bitkom has checked the German trust in the autonomous rail traffic. After that, every second person aged 14 or over in this country can imagine using a train that is not controlled by one person and is self-driving. This is the result of the representative survey.⁴⁴ This is maybe an argument to introduce at first automatically operating freight trains.

Photo 13: Old test train for new sensors on the Traunseebahn



Source: 38, Science Apa, dossier.

7. Efficient and environmentally sustainable strategies to collect and distribute rail freight on the “last mile”

The automatization of coupling and shunting can reduce the costs for the distribution and collection of smaller loading-units to/from decentral destinations. Moreover, clean technologies for the “last mile” on rail, especially locomotives with electric energy storage for operation without catenary facilitate services on rail sidings. These facts support measures to come with freight trains into the cities and shorten the transport on trucks. Therefore the delivery and collection of goods is obvious.

⁴² Source: <https://infothek.bmvit.gv.at/europas-1-teststrecke-fuer-selbstfahrende-zuege/>

⁴³ Source:

https://science.apa.at/dossier/Automatischer_Zug_macht_Regionalbahnen_attraktiver/SCI_20130322_SCI457_91818612021142

⁴⁴ Source: <https://www.bitkom.org/Presse/Presseinformation/Jeder-Zweite-wuerde-selbstfahrende-Zuege-nutzen.html>

An Austrian consultant, who is specialized on transport logistics and spatial development, has precisely analyzed the current situation of urban logistics. Based on his studies he shows 2 projects of urban logistics in Paris, which could be a sustainable solution for the future of urban logistics based on new technologies⁴⁵:

A strong trend of city and location development is to be seen, relocating the transshipment points between long-distance and distribution traffic to the hinterland of the core cities, but abandoning the inner-city rail freight facilities so that they can be used for the lucrative real estate exploitation. The price of this spatial development is increasingly the "city of long freight routes", because the performance and payload capacities in distribution traffic within the core city and in the city region, as shown by CEP (courier, express and parcel services), are increasing. The previously decentralized freight handling seemed to have finally disappeared. But there are tentative signs of a trend reversal where space is still available. Projects that mark this paradigm shift are currently being realized in Paris in co-operation of state railway, logistics terminal operators and the city administration.

Intelligent logistics, vehicle and transport technologies are opening new opportunities to transport goods into the cities in an environmentally friendly way and to integrate space-saving transfer facilities into urban development projects, if the relevant players are willing to accept these solutions.

The deconsolidation in the course of cross-docking (steps to arrange the consignments for the delivery to the receiver) can certainly take place in the central logistic centers, which are located in the wider surrounding area of the cities. The transport into the cities can be bundled - with already final-consigned and destination-loaded consignments to the individual reception locations - in rail shuttle traffic to city-center transfer points (PoUT). From there the shipments in standardized containers are handled largely automated in city-compatible emission-free distribution vehicles. The integration of city-center transfer points (PoUT) into a multifunctional urban development project is the second special feature to emphasize, underscoring the importance of multi-agency space management.

Examples of city center transfer points in Paris

ZAC Clichy-Batignolles:

This urban development as a zone d'aménagement concertée (ZAC) takes place on former railway facilities and is part of the urban restructuring program for the northern districts of the core city of Paris, which are among the densely populated and highly polluted areas. Measures are for example, the creation of a green motor vehicle-free axis, the expansion of public transport (fully automated metro line 14, construction of tram line 3b) and consideration of rail-bound supply and disposal logistics were key subprojects. The city-center transfer point (PoUT) can be approached by trains from a main line. It provides 4.8 ha

⁴⁵ Heinz Dörr, Viktoria Marsch, Yvonne Toifl: Smart City Supply – Verkehrstechnologien, Güterversorgung und Stadtentwicklung auf dem Weg ins 4.0-Zeitalter (Smart City Supply – Transporttechnologien, goods-supply and urban development on the way into the 4.0-age), contribution to the conference REAL-CORP 2017 in Vienna, downloaded from http://programm.corp.at/cdrom2017/papers2017/CORP2017_111.pdf

(48.000 square meters) of total floor space on 4 floors for the handling of 60,000 t of goods per year. ⁴⁶

Chapelle International:

The residential quarter as the core use of the new urban development area on a former freight yard will accommodate 900 flats including civic amenities and open spaces, as well as a freight delivery station (city-center transfer point), which will be operated in a multimodal transport chain. Chapelle International will work together with a logistic center in the suburbs, situated on the river Oise (so inland waterway transport is considered). Shuttle trains transport the goods to Chapelle International. Electric utility vehicles distribute the goods in the arrondissements of Paris). Chapelle International is the first logistic station of a new type (Hôtel de Logistique) on the Parisian metropolitan area since the closing of the last freight yard at the end of the 1990s. It provides 4 ha with 390 m track length for indoor cargo handling on 4 levels. In autumn 2017 it starts operation and should save 2.6 million truck kilometers per year. The landowner SNCF, the city of Paris and the logistics terminal operator SOGARIS have jointly developed the project. ⁴⁷

Figure 9 : Hotel de Logistique , Paris, La Chapelle (model)



Source: Girus Eng. <http://girus.fr/2012/10/17/hotel-logistique-chapelle-international-paris-18eme/>

Cargo Cap: an innovative underground solution for the last mile in cities

Goods are transported in tunnels with a diameter of only 2.80 meters. The transport vehicles, called caps, are loaded with 2 to 3 pallets or small containers in standard dimensions. The caps operate autonomously, electrically and fully automatic. Innovative switches make possible short distances between the caps. The cargo is immediately made available to the receiver at Cargo Cap stations or distributed via a connection logistics facility in the vicinity of the station which is also electrically powered. The Cargo Cap only at these stations is there a connection to the surface. Cargo Cap stations can be set up in the middle of city centers as

⁴⁶ Heinz Dörr et al from Mairie de Paris 2015, see also <https://www.paris.fr/services-et-infos-pratiques/urbanisme-et-architecture/projets-urbains-et-architecturaux/clichy-batignolles-17e-2379>

⁴⁷ Heinz Dörr et al, see also <http://www.chapelleinternational.sncf.com/>

well as on the assembly line of a factory. The advantage of Cargo Cap is an efficient operation, an obstacle could be high investment costs for the tunnels.⁴⁸

Figure 10: Principle of Cargo Cap



Figure 11: Cargo Cap loading station



8. Developments in rail freight since 2017 and dissemination of the working group transport report on “ Innovation in Rail Freight “

8.1 Logistic dialog on 17th October 2018 in Altdorf

The logistics dialogue in Altdorf, Switzerland on 17 October 2018 started with a rather political discussion. The share of rail freight on transalpine transport is 67% in Switzerland and only 33% in Austria.

Two contributions were also interesting for innovation in rail freight:

Logistic solutions of the Coop company

The logistic concept of the Swiss super market company Coop, was presented by Georg Weinhofer, the head of the Coop logistic unit. The Coop company is a pioneer in using green trucks. From the year 2008 until 2017 the greenhouse gas emissions of Coop trucks could be reduce by approx. 25 %. From 2010 the share of biodiesel (e.g. gained from biogenic waste) increased from 5 % in 2010 to 40% in the year 2017. Coop is also using hydrogen powered fuel cell trucks and battery electric duty vehicles. The innovation according rail is that Coop has founded a daughter- company , called Rail Care for transports. 3 trains with together 90 container waggons transport goods from , see also https://www.taten-statt-worte.ch/content/dam/act/TatenstattWorte_Relaunch/Cross-Teaser/cross-teaser-links/coop-si-green-railcare_de.pdf

⁴⁸ Source: <http://www.cargocap.de/content/das-cargocap-system>



Photos 14 and 15: Battery driven and hydrogen truck of Coop (source contribution of Georg Weinhofer, Logistik Dialog 2018, 17. October in Altdorf Switzerland)

Verein Netzwerk Logistik (VNL, association network logistics)

Prof. Herbert Ruile presented the Swiss network logistics, see also . <http://www.vnl.ch/de-de/der-verein/mitglieder> . He underlined that logistics innovation will heavily contribute to improve competitiveness and sustainability of economies. VNL supports knowledge transfer between research and industry in the field of logistics. The network also facilitates collaborative projects to innovate in logistics in industry, trade and service sectors. Moreover, the Swiss Logistics Faculty, a cooperation of 14 universities with multiple disciplines, more than 100 researchers and a R&D budget of 100 Mio. CHF works on innovation in logistics, see also <http://www.vnl.ch/de-de/logistics-faculty> . In the Kanton Uri “Detranz” is an innovation center for a transport-efficient economy, also for solutions to decouple transport demand from economic growth, see <http://www.detranz-uri.ch/index.php/ueber-uns>

Finally Dr. Ivan Beltramba , a railway expert who joined the Logistic Dialog in Altdorf sent me some interesting information to automatic coupling of trains. He underlines the advantages of automatic train coupling compared with screw coupling for the safety of railway-workers and to increase the weight of freight trains (more than 2 times higher, e.g. on the Brenner railway from 1.600 tons up to 3.500 tons). He mentioned that beside the C-AKv coupler (Compact - Automatische Kupplung vereinfacht) which was developed by Bernhard Sünderhauf, see page 17 ff. other proven technologies are available. He showed as example the Janney Coupler which is used in Great Britain and in a other version also in Belgium.



Photo 16: Janney Automatic Coupling in Great Britain in a swiveling version which can be compatible with the screw coupler. (Source: Ivan Beltramba)

The SA-3 AK coupler (also called Willison) is used in the former USSR and also in Norway and Sweden for the Kiruna- Narvik iron-ore trains.

In the working group i-Monitraf the reduction of long distance traffic in the Alps by regional consumption and general by changing consumer - behaviour were discussed. Some participants suggested to consider also future transport systems like Cargo Sous-terrain <http://www.cargosousterrain.ch/de/> and the Pipe Net automatic transport system in tubes, developed in the technical university of Perugia. Moreover, the impacts of automatic diving and platooning of trucks on the Alpine freight transport should be analysed. Many participants of the working group agreed that innovation in rail freight needs more support than on roads, with a bigger market for the industry.

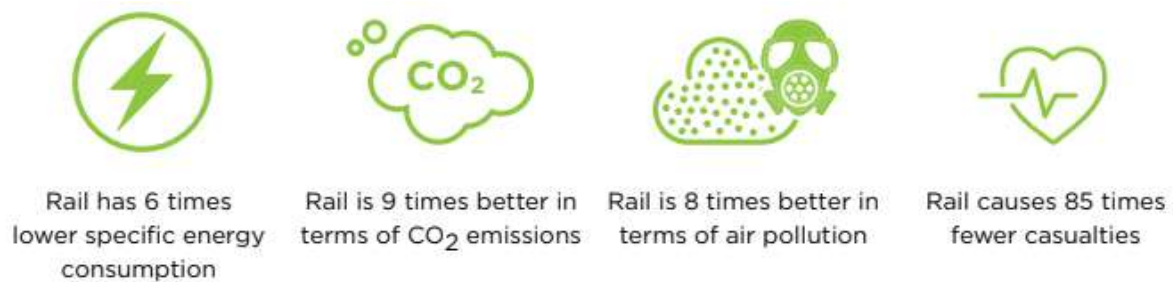
8.2 Rail Freight Day on 6th December 2018 in Vienna

The conference on rail freight with appr.300 participants offered the possibility to distribute the document „Innovation in Rail Freight“ which was elaborated in our working group. The interest for this document was big and I promised to send the updated version to colleagues who did not get a hand-out during the conference.

Main topics of the conference were the development of the European rail-infrastructure to win capacities for rail freight .e.g. by 740 m long freight trains and the improvement of the cooperation of rail companies with other partner on the logistic market and their clients.

Environmental advantages of rail freight were underlined, based on studies of the Rail Freight Forward Coalition:

Figure 12: Environmental advantages of rail freight compared with road transport



Rail transport causes 12 times less external costs to the society than road transport.

Source: <https://railfreightforward.eu/> , brochure 30 BY 2030: TOWARDS A BETTER TRANSPORT MIX FOR EUROPE'S FUTURE

All figures in this brochure are taken from various European studies: CEBR analysis, CE Delft 2012, EEA, eRRac, EU Commission, Eurostat, Fraunhofer IIS, INFRas, INRIX, OANDA, OECD, and UNFCCC

Based on these facts the Rail Freight Forward Coalition recommends to increase the market share of rail transport in Europe from today 18 % to 30 % until the year 2030. (Austria has still a rail-share of appr. 30 % on freight transport in ton-kilometers.)

Therefore railway undertakings have to offer superior innovative products for the benefit of the customer. They can achieve this by:

- continuing restructuring and modernisation to achieve a competitive cost base;
- intensifying their work on quality, flexibility and ease of use by offering integrated multimodal solutions;
- driving automation, continuing to develop telematics and building more user-friendly interfaces;
- implementing their contingency management.

Infrastructure managers have to provide and manage interoperable and sufficient infrastructure which is "as easy to use as European roads" by:

- offering standardised, highly available and high-capacity infrastructure for freight without bottlenecks;
- providing easy access to the entire European rail network;
- ensuring easy, reliable and fast planning of train paths throughout Europe;
- running easy train operations with real-time ETA and dynamic traffic management in the case of congestion.

Policymakers and authorities have to ensure a stable regulatory framework and a level playing field for rail and all other modalities to nudge customers towards rail. They can do so by:

- ensuring a higher level of internalisation of external costs through road charges or carbon taxation, which in turn can be used to stimulate the use of transport modes with the lowest external cost.
- reducing the Track Access Charges;
- avoiding additional administrative costs;
- sharing the burden on safety costs between authorities, infrastructure managers and railway undertakings;
- taking into account all societal benefits when planning infrastructure investments;
- stimulating and maintaining best last-mile infrastructure;
- supporting innovation.

Source: Brochure : 30 BY 2030: TOWARDS A BETTER TRANSPORT MIX FOR EUROPE'S FUTURE at <https://railfreightforward.eu>

Although the focus of the rail freight day was transport policy and also the improvement of processes to increase efficiency of rail freight and services for customers some technical innovation were discussed:

Thomas Spiegel from the Austrian Transport ministry (BMVIT) mentioned the Austrian program to support railway sidings for clients with a higher amount of freight. New technologies can improve the efficiency of the operation with single waggons from railway sidings.

Carlo Borghini (representative of the research programme Shift2 Rail underlined the importance of automatization, digitation, automatic coupling and on-time information (e.g. where the transported goods are and when they will arrive). He underlined that rail operations can learn something from air-traffic, e.g. IT-translation tools with high reliability facilitate the communication between operating persons with different mother-languages.

Many delegates regard a fast implementation of the European Rail Traffic Management System (ERTMS) on the TEN-T network as important to facilitate cross-border rail service.

Also transparency of processes and a reliable exchange of data are considered as important step to improve rail freight services. Ad Toet presented the project ELETA:

ELETA is a co-financed project under Connecting Europe Facility (CEF), launched in September 2017, which aims to demonstrate the advantages of exchanging the Estimated Time of Arrival (ETA) data within the whole rail supply chain management.

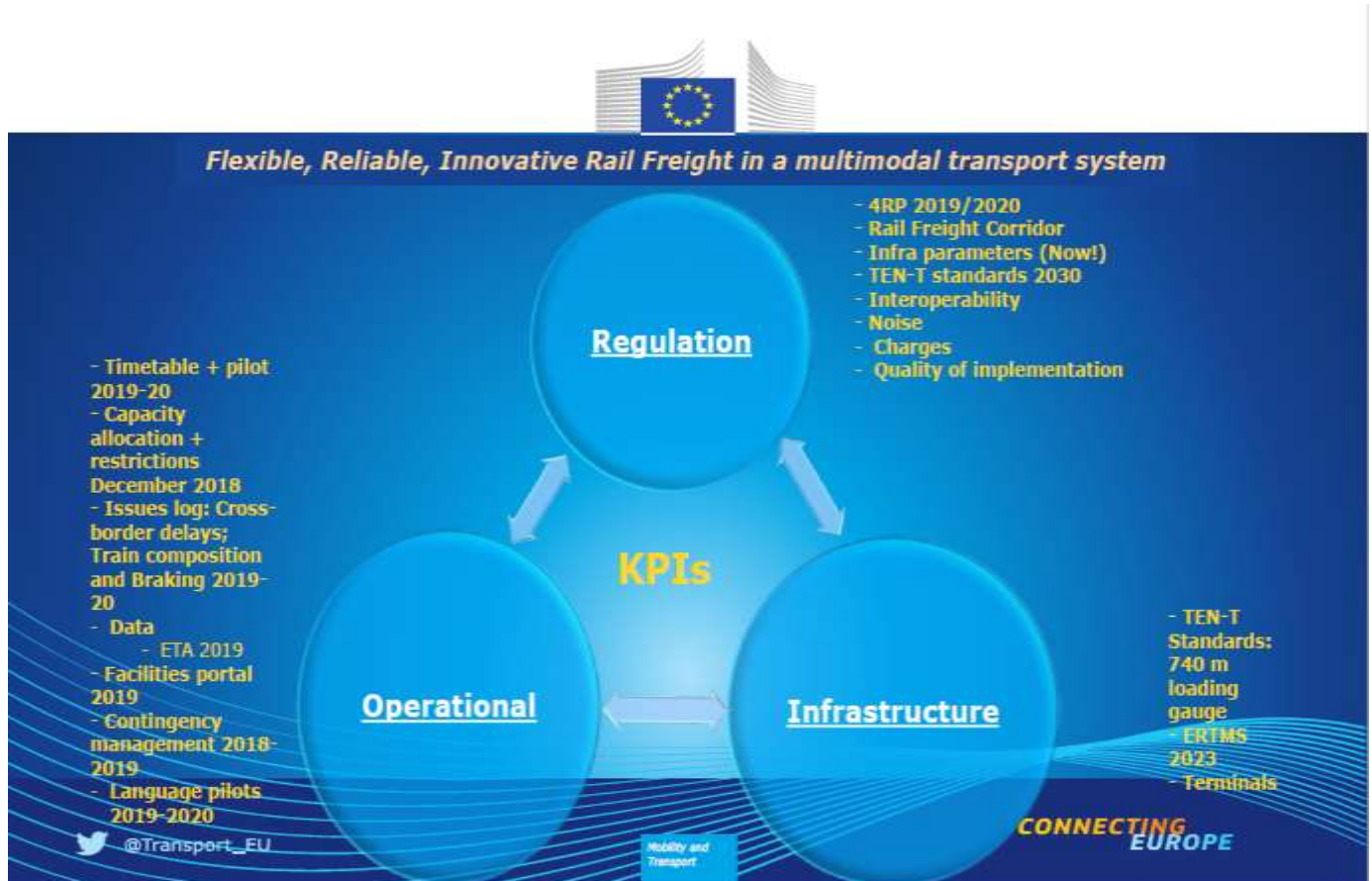
ELETA, which is the acronym for "Electronic Exchange of ETA information" scopes 12 selected intermodal transport relations, which are operated by the Combined Transport operators CEMAT (Italy), Hupac (Netherlands), Inter Ferry Boat (Belgium), Kombiverkehr (Germany) and Rail Cargo Operator (Austria).

The project is the result of an agreement of the rail sector to provide information on Estimated Time of Arrival (ETA) to their contract partners, including terminals and intermodal operators under the protection of confidentiality clauses.

Further information at: <http://www.uirr.com/projects/ongoing/item/21-electronic-exchange-of-eta-information/34-ongoing.html>

The final slide gives an overview to the complex framework of rail freight in Europe:

Figure 13: “Environment” for innovative rail freight



Source: Contribution of Elisabeth Werner, DG Move, director for land transport on Rail Freight Day 6th December 2018 in Vienna

As summary of the Rail Freight Day 2018 also a Vienna Declaration – Progress on boosting rail freight was agreed, this attached declaration is a follow up of the Rotterdam Ministerial Declaration - Rail Freight Corridors to boost international rail freight , see http://www.cer.be/sites/default/files/publication/160621_Ministerial_Declaration_RFC.pdf

8.3 AlpinnoCT

Many thanks to Zlatko Podgorski from Slovenia, he sent for the update of our report “Innovation in Rail Freight” the “Analysis report of projects, policies, strategies and support measures in the field of CT relevant for the Alpine Space”. This report was elaborated in 2017 by EURAC Research in Bolzano/Bozen in the framework of the project “AlpinnoCT” in the Alpine Space Program. Although AlpinnoCT is focussed on combined transport, in the report also some information on innovation is available.

At first the **Appendix 3- Intermodal terminals** - Transport supply, starting at page 101 of the report is a very precise overview to the combined transport (CT) –terminals in the Alpine Space. In this overview information to the location, infrastructures, total area (m²), available modes, terminal operators, provides services and main markets of the described terminals is provided.

Also the **Appendix 10: CT Projects** starting at page 155 of the AlplnnoCT –report from EURAC is very helpful. In this appendix the results of many studies to freight transport in the Alps are presented in useful summaries, including studies on technical innovation in rail freight. An example is the study

SWIFTLY Green - Sweden-Italy Freight Transport and Logistics Green Corridor:

The main result of the project was the drafting of about 130 analysed measures that can all be called up in the Green Corridor Portal and filtered according to certain criteria, and the Green Corridor Development Plan. This document is addressed mainly to the Coordinators and decision-making institutions of the other Corridors and includes recommendations as to how the results of the SWIFTLY Green project can be applied to other projects.

The project partners defined greening (goals) as follows: reduction of noise, energy consumption and greenhouse gas emissions, modal shift, improvement of traffic flows, reduction of air pollution and increased efficiency within individual transport modes and the various measures are mainly evaluated on the basis of these criteria. Subsequently, marketability was evaluated, verifying whether a prototype of a certain technology exists, if it is ready for serial production and whether it is relevant for the corridor as such, whether it can be applied only in a certain region or in the entire Corridor. With a search tool queries can be input and some measures are identified. The measures cover many different sectors of infrastructure, logistics, transport technologies and guidelines or directives. The Green Corridor Portal includes all the measures analysed as part of the project but the overall goal is for stakeholders to upload their own measures to create a portal that can be used over the long term.

Moreover, the AlplnnoCT report provides information on statistics to Alpine Transport and to operators of combined transport terminals.

“Heavy Goods Traffic Management Systems in the Alpine Area” Review on combined/multi-modal/rail transport

This report by the Zurich - Working Group, which was also submitted by the Slovenian delegation of the transport group of the Alpine Convention provides also a good overview to combined transport, but the report from the AlplnnoCT project is newer and more detailed.

8.4 Project Smartlogi (Interreg, Italy - Austria)

In the project, which is focused on combined transport, also innovative solutions, which are helpful for rail freight in general are described. Thanks to Federico Cavallaro from the Italian

delegation in the Transport Group for sending to me the deliverable D.3.3.1 “Analysis of the best methods to give incentives and to benefit by implementing ICT instruments”, see also <http://www.smartlogi.eu/> . In this document (published in September 2018 interesting, innovative solutions for rail freight are presented (pages 18 following), for instance

ERTMS (European Rail Transport Management System)

ERTMS is a Pan-European standardized system for message, control and automatic train protection. ERTMS is articulated in two main elements: The Train Control System (ETCS), and a mobile radio system for the spoken communication and the data communication in rail operation.

Improvements by ERTMS are:

- planning of network capacity and the selection of the route before the ride,
 - the disposition of locomotives and staff,
 - reduction of travel times,
 - the disposition in case of unforeseen events,
 - increase of infrastructure capacity,
 - more efficient driving (optimal speed) based on information to situation on the line ahead
- In Switzerland the ADL system (adaptive train steering) should also improve the efficiency of train operation, see. <https://www.sbbrcs.ch/en/family/rcs-adl/>

ERTMS is already implemented or planned on TEN-T corridors. Further information at https://ec.europa.eu/transport/modes/rail/ertms_en

Automatic Train Operation (ATO)

The French train equipment producer Alstom has signed an agreement with the Dutch infrastructure operator Prorail and Rotterdam Rail Feeding (RRF) to carry out automated train operations (ATO) tests in 2018. The ATO system automates the driver's work, allowing him to focus on surveillance tasks.

These tests will be carried out at automation ERTMS level 2 on the Betuwe route equipped, a 150 km long double-track freight line connecting Rotterdam with Germany and belonging to the European freight corridor A between Genova and Rotterdam. The test drive on the Betuwe route will focus on the ATO application in freight transport. The purpose of the tests is to perform a live demonstration with a locomotive in automatic mode from the port of Rotterdam to the container handling center (CUP) Valburg in the eastern part of the Netherlands. The locomotive provided by RRF will travel approximately 100 km without any driver intervention on sections of track equipped with two different ERTMS steps (1 and 2).

Automated shunting is also tested on Valburg Container Handling Terminal. Read more at: <http://www.alstom.com/press-centre/2018/01/alstom-to-perform-automatic-train-operation-test-drive-with-prorail-and-rrf-on-the-betuweroote-in-the-netherlands>

Automatic inspection of freight trains

The system ensures the high-precision automatic inspection and identification of freight trains through video, high-resolution photos and a 2D scanner system. It allows faster inspection of freight cars and saves time and money. It can also capture and archive identification codes of goods as well as images of the freight car and goods. More information at <http://www.kleintech.net/traininspect.html>

Further innovative solutions described in the Smartlogi project

In the mentioned deliverable of the Smartlogi project also some complex IT solutions to facilitate the administration of freight transport are presented, including also a block chain approach.

Interesting – in competition to rail freight - are also 2 projects with electric propulsion for trucks: the project on the Stockholm airport e-road Arlanda with electricity rails to support trucks (like many urban metros use) and a project in Italy on the Motorway A35 Brebemi (Lombardy) where on 6 km long section in a height of 5,5 m a catenary for hybrid trucks (with an additional diesel motor) should be installed. See also: <https://eroadarlanda.com/>, <http://www.brebemi.it/site/?p=8396> and the introduction to this report.

8.5 Mobility of the Future – Research Program of the Austrian Ministry for Transport, Innovation and technology

In the 11th call of this program “System Rail, Vehicle Technologies and Transport Infrastructure” were main topic. The tasks “System Rail” focus on rail, vehicle technologies on all modes and infrastructures in this call more on the road network. Rail research topics are

- Automated train formation and separation
- Automated railway operation on branch lines
- Automatized train control
- Intelligent measuring technology for infrastructure and rolling stock in the railway system
- Condition-based maintenance in the rail system

Further topics to vehicle technologies are

- Fuel cell and hydrogen technologies for road, rail vehicles and ships
- Temperature management for road, rail vehicles and ships
- Car electronics for road, rail vehicles and ships

Project applications had to be delivered until the end of September 2018, the project selection was done in December 2018.

9. Conclusions

The analysis shows that, based on technological innovation, a lot of measures to improve the efficiency of rail freight transport are available to implement. Negative environmental impacts and the energy consumption of rail operation can be reduced and safety and security in rail operation increased.

In addition to the examples in this report the French overview-document “L'innovation dans le transport ferroviaire de fret en France - Rapport d'étape”⁴⁹ shows, innovations in rail freight transport go in the same direction. In addition to the examples shown in the chapters before the French report includes more recommendation to improve the rail-infrastructure to make it fit for very long and heavy trains up to a length of 1.500 meters and to increase capacity. Low noise brakes, digitization and automatically controlled trains are also topics in the French report.

Not only the technology for rail freight transport can be improved and contribute to increase efficiency and reduce negative environmental impacts, also administrative processes and the legal framework can be updated and facilitate the implementation of successful rail freight services. In the French report « L'innovation dans le transport ferroviaire de fret en France » a lot of recommendations is presented.

The Swiss “Regulation on the transport of goods by rail and shipping companies” (Verordnung über den Gütertransport durch Bahn- und Schifffahrtsunternehmen, Gütertransportverordnung, GüTV) provides a basic legal framework for many aspects of rail freight:

- the financial support for the transport of goods and accompanied motor vehicles by rail;
- the provision of financial aid for the construction, extension and renewal of combined transport terminals and sidings;
- the planning, construction, the operation and maintenance of railway-sidings,

In chapter 4 of the regulation the conditions for the support of the implementation of new technologies for rail freight transport are specified.⁵⁰

A main question, which should be discussed from different points of view, concerns societal impacts of innovation in rail freight. New technologies replace manual – often dangerous – works, like shunting and coupling with screw couplers, but also some cases also other jobs like train drivers. Technological Innovation should not lead to unemployment. Therefore policies and strategies must be developed and implemented to solve the problem. In the rail freight sector in some cases more staff to advice existing and potential clients to suitable freight logistic solutions would be helpful.

⁴⁹ MINISTÈRE DE L'ENVIRONNEMENT, DE L'ÉNERGIE ET DE LA MER, L'innovation dans le transport ferroviaire de fret en France - Rapport d'étape (Rapport n° 010477-01) établi par Hervé de TRÉGLODÉ, Septembre 2016

⁵⁰ Source : <https://www.admin.ch/opc/de/classified-compilation/20160958/index.html#id-4> (Web-Portal of the Swiss Government)

But not only in the field of rail freight policy-solutions are necessary, e.g. a step-by-step reduction of the weekly working time, a discharge of work from taxes by environmental taxes and taxes on profits.

In the transport sector a fair competition between the different modes is a main target. The social standards have to be harmonized, e.g. limits for driving times of truck and train drivers and mandatory rest breaks. Of course efficient control is necessary that the regulations are followed. Moreover, it's indispensable to fight against social dumping. Fair and efficient prices in transport are an objective of Transport Protocol of the Alpine Convention (article 14).

Finally, we have to discuss what we as members of the working group transport of the Alpine Convention can do, that rail freight transport remains competitive and the objectives of the Transport Protocol can be successfully achieved

A main contribution of us can be widespread information of decision makers and the public about innovation in rail technologies and their contributions to an efficient, safe and environmentally sustainable transport in the Alps.

The present report should be regarded as a begin, together with the excellent German report on Combined Transport as an overview to available, innovative technology for rail freight transport. A next step could be to collect further information on innovation in rail freight and to elaborate an interesting publication of the Transport Group of the Alpine Convention. In any case, action from all responsible stakeholders is necessary to make rail freight in the near future more efficient and to use the capacities of existing rail-infrastructure and new lines under construction efficiently.