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1 Preface

This study is a contribution to the Efficient Train Systems for Freight project carried out by the Centre for Research and Education in Railway Engineering at the Royal Institute of Technology Stockholm (Railway Group KTH) during 2000-2004. An earlier study "The Railways Prospects on the Future Freight Transport Market", published in 2000 can be seen as a starting point for this project and delivered also first input to the current study. Considerable amount of information has been added and much work has been laid down to exploit additional sources and to carry out own analysis as well as to develop own ideas in order to present a study on state-of the-art in High-Speed Rail Freight with both width and depth and which also includes a vision for future development.

The author would like to thank all persons from railway companies, research institutes as well as individual experts who have contributed to the study with information, comments and material.

As has been mentioned above the project ran over several years and consequently even this study has developed over a longer time. Therefore it has been unavoidable that some of the information collected in the beginning of the project had become obsolete when the project finished. It has been the ambition of the author to keep information updated as much as possible, or at least to add a comment where changes had occurred. The amount of information handled in the project makes however that some of the information given may not present the absolute latest state in each detail. In the authors opinion this however does not impinge on the general validity of the analysis and the conclusions in this study.

Gerhard Troche

2 Summary

High-speed rail freight has to be defined by speed as well as other characteristics, like type of cargo, operating principles and vehicle concepts. However, when looking at speed, 160 km/h can be set as a lower limit for the demarcation of high-speed rail freight. The fastest train operating today, the TGV Postal in France, has a maximum speed of 270 km/h.

The business idea of high speed rail freight can be defined as follows:

High-Speed Rail Freight:

Faster than by truck –
cheaper than by air

High speed rail freight addresses the market segment of mail and express freight. For a long time rail hold a strong position in this market. However, since the middle of 20th century rail lost much traffic to both road and air transport and new traffic was quickly absorbed by the competing modes. Today the situation varies between countries: In some countries new traffic systems were built up (again) and new rolling stock able to run at high speeds was introduced. In other countries traffic declined and finally ceased totally.

Rolling stock for high-speed rail freight show a large variety of different train concepts, from single wagons to freight multiple units. Common for them is the use of passenger train technology. Some vehicles are even directly derived from passenger trains.

The market for high-speed rail freight is certainly small as far as volume is considered. It offers however a high specific revenue-potential and it is also a fast-growing market.

In order to develop high-speed rail freight it is crucial to look at it as a system, comprising not only the rolling stock but also terminals, loading units, transloading techniques and train operations. The development of suitable located and designed terminals is crucial if rail is to take a bigger share of the market. Intermodality has to be improved both towards road and not least air transport.

Another critical aspect is the operational coordination with other train traffic. Conflicts may not only arise with passenger traffic, but – perhaps mostly – with conventional freight traffic.

The emerging pan-European high-speed network offers new opportunities for high-speed rail freight and can contribute to diminish the above-mentioned problem. In Scandinavia the Europa- and Götalands-lines would contribute to improve the chances to establish new high-speed rail freight traffic in Sweden.

3 What is high-speed rail freight?

In the railway context, the term high-speed is by most people associated with passenger traffic, not with freight traffic: High-speed traffic is understood to be *passenger* traffic, high-speed trains to be *passenger* trains.

The reason for this is probably that it were passenger trains which gave the term high-speed a concrete content and which attracted the attention of a broad public: First out were the Shinkansen-trains in Japan launched in the 1960-ies, followed in Europe by the French TGV in the beginning of the 1980-ies. Since then high-speed passenger services have been introduced in several European countries and constitute today an important part of many European railways business.

When it comes to freight, however, high-speed traffic is in best case a small and somewhat exotic niche activity for the railways; or it is seen as a *future* product in rail traffic, something to come, rather than an existing phenomenen. It does normally not fit into the general perception of rail freight.

Consequently there is today no generally established definition of ”high-speed rail freight”, and there is quite little concrete to go on when trying to find a suitable definition.

There are, of course, the French TGV postal trains, running at speeds up to 270 km/h since the 1980-ies. Without having given any definition yet, most people will probably agree, that this service in fact *is* high-speed rail freight; certainly they will also agree, that a heavy iron-ore train or any other slow-running freight train for bulk commodities like coal, oil, etc. is *not*. The question is where to draw the line between these two extremes. Factors to be considered can comprise both technical, operational and market aspects.

In order to try to get some guidance in this question, it lies near at hand to take a look at the definition of *high-speed* in the passenger context and to see if that definition could be applied on freight traffic as well.

High-speed in passenger traffic

However, when looking nearer at passenger services running under the denomination high-speed, it becomes quite immediately obvious that the understanding of the term is somewhat diffuse here as well and that it differs not least between different countries. Often a demarcation is set at a speed of 250 or 200 km/h, in the latter case either including or excluding the speed in question.

Several reasons lie behind the uncertainty in the definition of high-speed:

- One is that the term high-speed is attached with a specific (positive) image and thus by railways, rolling stock suppliers, traffic planners, politicians, etc. gladly used in the field of marketing etc., making its use quite diffuse. Sometimes it is probably used even in contexts where it from a scientific point of view perhaps appears rather doubtful.

- Another reason is that the term *high-speed* often is connected not only to speed alone, but even to other attributes of a train or a train service. Especially the technical train-concept and a trains visual appearance should be mentioned. High-speed (passenger) trains are normally semipermanently coupled trainsets with a uniform outer (and inner) design and aerodynamically shaped fronts. Kottenhoff describes these type of trains as design-trains. Furthermore high-speed trains often operate over a dedicated infrastructure (new-built or heavily upgraded lines), either in combination with conventional lines (as the French TGV or the German ICE) or exclusively (as the Spanish AVE or the Japanese Shinkansen).

- A third reason explaining the somewhat different understanding of high-speed in different countries is, that the term has to be interpreted relatively, not absolutely. There has to be a point of reference, and this point of reference is the speed normally achieved by other trains in a network. This speed can vary between different countries. The speed of a high-speed train is ”high” just in relation to the speed achieved by those other trains. There is no absolute speed which has to be exceeded in order to qualify for the denomination high-speed, the trains simply have to run faster than ”conventional” trains.

This might explain why high-speed in for example France and Germany normally stands for speeds $\geq$ 250 km/h, while in Sweden the ”only” 200 km/h fast X2000 could slink in among the European high-speed train family[1]: France and Germany simply already had trains with a maximum speed of 200 km/h in service since the mid-sixties or seventies, while in Sweden passenger trains’ maximum speed before introduction of the X2000 had been 130 km/h (160 km/h on some shorter sections for some few trains).

Widening this line of reasoning helps to define a demarcation of high-speed rail freight: If we accept that the speed of reference can be different in different countries, it should also be possible to accept that it varies between different kind of train services as well, for example passenger and freight traffic.

The typical maximum speed of (conventional) freight trains in Europe lies today in a speed-interval of about 90 to 120 km/h (the RIV-agreement sets a ”minimal” maximum speed for freight wagons of 100 km/h). Thus the maximum speed of freight trains is considerably lower than that of conventional passenger trains, which usually lies in the 140 to 200 km/h-range. In consequence this would mean that freight trains would not necessarily have to run as fast as passenger high-speed trains to deserve the attribute high-speed, since the reference speed is lower.

It may of course be argued, that it would be preferable to apply one and the same speed demarcation on high-speed passenger and high speed freight traffic in order to avoid misunderstandings and confusion.

When applying a demarcation of high-speed rail freight in analogy to passenger traffic, the demarcation should be somewhere in the range of 200-250 km/h. Wilckens[2] from the UIC suggests ”>200 km/h”. (Furthermore, he says that high-speed freight trains should be able to operate on dedicated high-speed lines with gradients up to 4%).

However, such a demarcation causes a problem: A quite big speed-interval, from about 120 km/h (the maximum speed of conventional freight trains) to 200 km/h, would remain uncovered by it. Wilckens ”solves” this problem by considering trains in that speed interval still as ”classic freight trains”, may be technically further developed. In the opinion of the author of this study,

[1] It should be mentioned that the X2000 in fact only on an international level is regarded as a high-speed train, in Sweden there is indeed made a finer distinction between snabbtåg (=”fast train”), as represented by just the X2000, and höghastighetståg (high-speed train), which consequently does not (yet) exist in Sweden. This aspect will be taken up again further below.

[2] Wilckens, M., ’Frachthochgeschwindigkeit – eine Idee gewinnt Konturen’, Internationales Verkehrswesen, no 9, 1994, p. 506-512

however, both technical, operational and even market reasons talk against doing so:

- Running gears and brake systems of trains in the 120-200 km/h range often differ from that of conventional freight rolling stock (though not necessarily influencing the outer visual appearance of the trains very much).
- Trains in this speed interval often operate over dedicated high-speed lines with steep gradients as well, lines which sometimes are banned for conventional freight trains
- The market which is addressed by these trains coincides partly rather with that of ”real” high-speed freight trains, than that of conventional ones.

Not least should be noted that there are a number of freight trains with a maximum speed just in the >120-200 km/h-speed interval, which actually are denominated as just high-speed freight trains. DB for example marketed its 160 km/h InterCargo-Express as high-speed freight traffic. Another example is the French MGV, which expressively includes the attribute *high-speed* in the product denomination (MGV=Messageries á Grande Vitesse). This is obviously not in line with the demarcation suggested by Wilckens.

So a general exclusion of freight trains running slower than 200 km/h is not in line with the actual usage of the term high-speed rail freight.

Making a finer distinction

If one wants to apply the same speed demarcation on both freight as well as passenger traffic, but without considering all trains <200 km/h as conventional trains, a solution would be to make a finer gradation and not only distinguish between two groups of trains – conventional freight trains and high-speed freight trains – but to define a third group in between, which would cover semi-fast – but not *high-speed* – trains with maximum speeds of ≈120 km/h up to 200 km/h. This would allow to reserve the attribute high-speed to the fastest trains, making it possible to apply the same demarcation of *high-speed* on both passenger and freight (at least in respect to speed), as suggested by Wilckens.

In Sweden such a distinction is indeed made in passenger traffic between *höghastighetståg* (high-speed trains) and *snabbtåg* (”fast” trains). A similar distinction is also made in Spain between *Alta velocidad* and *Velocidad alta*. So it would actually be possible to make an analogous distinction even when it comes to freight, between *snabbgodståg* and *höghastighetsgodståg*, (or in Spanish between *trenes de mercancias de alta velocidad* and *trenes de mercancias de velocidad alta).*

However, to translate this into other languages proves difficult, as for example the German *Schnellzug* – which is the direct translation of Swedish *snabbtåg* – has a different meaning; and the German word *Schnellgüterzug* can for the same reason neither be translated with *snabbgodståg*. And the direct translation of Spanish *Alta Velocidad* and *Velocidad Alta* into English will always be *high speed*.

The table below is an attempt of a classification and demarcation of different rail freight services, taking into account the aspects discussed above. In any case the reader should be aware of that the boundary lines between conventional and high-speed rail freight are fluid, depending on the context – technical, operational or market-related – and that other factors have to be considered as well. Not least may the demarcations also vary over time.

In this study the term high-speed rail freight is understood in a broader sense In the following the term high-speed freight train and high-speed rail freight consequently even comprise semi-fast trains, as long as nothing else is mentioned. Another umbrella term is express rail freight, which sometimes also is used in this report.

Table: Possible demarcation of different rail freight services

Denomination	Maximum speed:	Predominant vehicle concept:
High-speed rail freight	>200 km/h	modified high-speed passenger trains fixed trainsets
Semi-high speed rail freight	140–200 km/h	both vehicles based on passenger train concepts and further developed freight wagons fixed trainsets as well as individual freight wagons
Conventional rail freight	< 120 (140) km/h	conventional freight wagons

4 The market

4.1 Market segments

The freight transport market can be segmented in different ways. The table below contains a rough segmentation taking into account the two aspects time-sensitivity and desired frequency; it shows also which kind of railway service address the different segments. As can be seen the market segment addressed by high-speed rail freight is here called the Service market.

On the following pages this market segment will be described more in detail. It should be noted that the terms used often vary between different sources; they are also partly overlapping.

Figure: Market segments, customer requirements and main railways services addressing each segment (Source: Railway Group KTH)

Market segment	Typical transport time	Typical frequency	Dominating railway service
Bulk market - Raw materials	Less than one day	Continous	Unit-trains
Base market - Raw materials - Semi-finished products	National: Day 0-1 International: Day 1-3	Daily Several times / week	Wagonload traffic
Product market - Semi-finished products - Finished products	Overnight 17:00 – 07:00	Daily	Combined Traffic
Service market - parcel and letter mail, express cargo - couriergoods	Overnight Same day	Daily Several times / day	High-speed rail freight

4.2 Players and services

The express freight market traditionally embraced courier-, parcel and express goods services which could be discerned from other transport services primarily through their short transport times and small shipment sizes. Among themselves the three services can to some degree be discerned by the shipment size as well, with courier services taking the smallest shipments and express freight at the other end of the scale. Same-day delivery is a typical feature of courier services, while the others mainly offer Day B-delivery and even longer transport times. Note that the term express goods (or express freight or similar) often is used as an umbrella term covering courier-, parcel and express goods services as a whole.

A new approach, which has been suggested[3] to demarcate the express market, would be to include other criteria than transport time and shipment size, for example the kind of service offered by the express companies. Indeed, one feature characterizing the services in this field is its all-inclusive character. This means that the service covers all aspects from collection to transportation, customs clearance, delivery and proof of delivery. In to planning and stearing complex logistical systems.

Table: The express market yesterday, today and tomorrow. Source: "Integrativer Ansatz zur Optimierung von Transportketten im Expressgüterverkehr", TU Berlin, 1994-1998 (translated, originally in German)

	Market character	Suppliers	Customers	Service characteristics
Yesterday	supply-oriented	courier-, express- and parcel companies	large-scale enterprises, special businesses	transport time, shipment size
Today	in transition	as above + freight forwarders, airlines	all kind of enterprises	basic + additional service
Tomorrow	demand-oriented	as above + post offices	enterprises and private customers	plug-and-play logistics

3 suggested in for example: Integrativer Ansatz zur Optimierung von Transportketten im Expreßgüterverkehr …, TU Berlin, 1994-1998.

The national Post offices are not always considered being part of the express freight industry, probably due to their special status and historical background (state-owned, monopolies). However, as a) their services address in principle the same market as their private counterparts and b) their "protected" status is eroding more and more, it appears to be justified to count them to the express freight industry. Furthermore, a high-speed rail freight service addressing and meeting the needs of the post offices should to a large extent be interesting to and applicable on the transport needs of private express companies as well.

The mail service offered by the national post offices might be counted nearest among the courier- and parcel services as far as shipment sizes and transport times are concerned. The production system of the post offices differs insofar, as it rests on a fixed network of collection points (letter boxes and post offices) served after a fixed timetable. The private express companies in most cases collect the shipments after demand and directly from the shipper. The mail services offered by the national Post Offices are (at least until now) partly regarded as public service and enjoy or enjoyed as such a far-reaching monopoly. This is also the reason why the Post offices offer(ed) their services only within a country or, when it comes to international mail, in cooperation with each other, not in competition (though this is getting more and more a truth with modifications). In comparison to this, the many private players offer their services internationally and even in competition with each other.

The following table gives an overview over services in the express market.

Table: Services offered in the express market (Source: Doganis/AT&C/York)

Service / Factor	Express (Same-day)	Express (Next-day)	Express (Deferred)	Forwarders & Parcels Operators	Mail Service
Cost	very high	high	medium	medium/low	low
Speed	very fast	fast	medium	medium/low	medium/low
Distance	restricted	unrestricted	unrestricted	limited	unrestricted
Item Size	unrestricted	unrestricted	unrestricted	restricted	restricted
Need for large, regular flows	no	no	no	yes	no
Reliable Delivery Time	same day	next day	2 or more days	2 to 7 days	variable
Standard Global Service	no	yes	no	no	no
Consignor / Consignee	door to door	door to door	door to door	door to doors	variable
Mode of Transport	usually road	road and air	road	road	road, air, rail
Tracking and Tracing	yes	yes	yes	basic	no
Hub and Spoke	no	yes	varies	varies	varies

Revenue varies between different kind of services. The table below gives some average values. As can be seen mail services earn a lower revenue, however item size is probably also smaller.

Table: Specific revenue for express freight companies in the US (Source: SJ Consulting Group, in Traffic World, september 18, 2000, page16)

	UPS	FedEx Express and Ground	USPS Priority Mail and Express Mail
Daily domestic volume (millions)	12.1	4.4	4.1
Revenue / package	$ 7.98	$ 10.02	$ 4.35
On-time service (Reliability)	94.7 %	96.4 %	89.2 %

The four main worldwide participants in the express industry, generally known as ”the integrators” are:

• DHL

• FedEx

• TNT

• UPS

In addition to these there is a large number of small courier and express companies concentrating on regional markets or on selected niches.

Market concentration is high and tends to consolidate any more. The market share held by the integrators in the European express market is estimated at about 47% (1998)[4]. In Germany, United Kindom and France 70 % of the turnover in the express market fall on the 10 biggest companies respectively. The market shares between them are quite stable over time, indicating a high customer loyalty.[5]

From the four integrators all but one (TNT, a Dutch company developed from PTT Post) have their origin in the United States, where the express market developed first. However, the European express market is growing and has strengthened its importance and attractiveness to both global players

4 ’The importance and Impact of the Express Industry in Europe’, AEEC, EEO, 1999, p. 32

5 ’Integrativer Ansatz zur Optimierung von Transportketten im Expreßgüterverkehr …’, TU Berlin, 1994-1998.

and new emerging actors not least thanks to an opening-up of former monopolies of the national Post offices.

The express industry is already to a high degree international, a fact which now even increasingly is true for the national Post Offices. Even these have been or are currently undergoing an restructuring process, often leading to alliances with or takeovers of foreign companies, mainly transport companies in the field of parcel transport and single consignments, rather than other national Post Offices. The table below, showing the members of the Deutsche Post Group, illustrates this trend all to clearly. Today there are even alliances between integrators and national Post offices. So, even the national Post offices are increasing their business geographically and gradually getting there, where many of their private counterparts already are.

When looking at the table it becomes obvious that several of the companies in the list are not only or not even primarily dealing with mail and letter transport, but rather with "classic" cargo, like single consignments or even truckload traffic. This reveals another trend in the express industry: In addition to the internal growth within the express market the express industry increases its market by entering into the "classic cargo-market". This trend is even true for private express companies, including the big integrators.

Table: Members of the Deutsche Post Group (Source: http://www.urgenteonline.es, 14+21 Oct 1999)

Company	Market
ASG	Denmark, Finland, Norway, Sweden
Ducros	France
Guipuzcoana	Spain, Portugal
MIT	Italy
Securicor	Great Britain, Ireland
Servicso	Poland
Quickstep	Austria, Switzerland, Checkia
Orgadis	France
Van Gend & Laos	Netherlands, Benelux

This trend might not only be seen as an attempt from the express companies side to increase their market base, but also as an indication that some of the outstandingly high quality standards (reliability, punctuality), typically demanded by the express customers – and normally met by the express companies! – also are demanded (but not yet met?) in markets outside express market. If this is true, it is highly relevant for the railways as well, since then considerable transport volumes which actually *are* going by rail today might be concerned.

The following figures show the market shares both by shipments and by revenue in Europe.

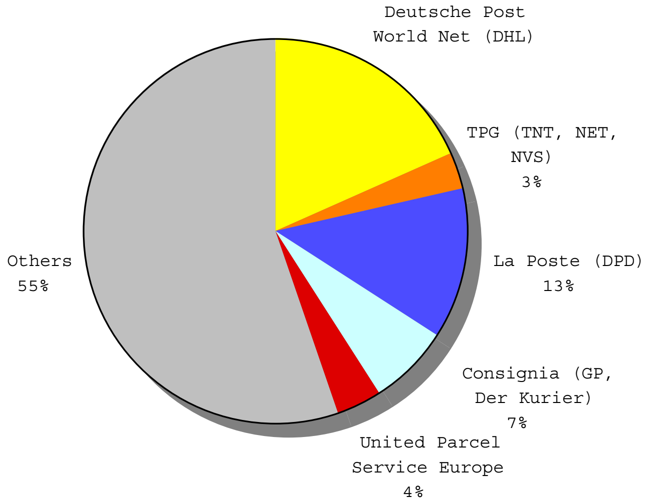

Figure: *The “Big Five” in the European express and postal market – market shares in 2000 <u>by shipments</u> (Data source: MRU GmbH, DVZ 17 Nov. 2001)*

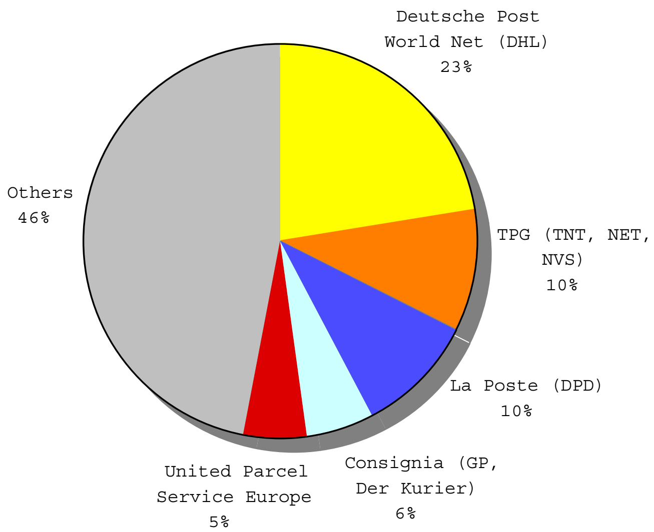

Figure: *The “Big Five” in the European express and postal market – market shares in 2000 <u>by turnover</u> (Data source: MRU GmbH, DVZ 17 Nov. 2001)*

The observed trends in the express freight market can be summarized as follows:

- Deregulation of mail and express services
- Entrance of national Post offices, acting more and more business-oriented, into the competitive market by bi- or multilateral national and international alliances or take-overs.
- In addition to internal growth the express freight industry widens its market by widening its customer base to include even privat persons as well as by entering into selected segments of the ”classic cargo”-market and
- by doing so the demarcation between express freight and ”classic” freight gets more and more diffuse and difficult to define.

4.3 Cargo

The common denominator of the goods handled in the service market is its time-sensitivity. Furthermore the goods has an compared to traditional rail cargo high specific value (value per kilogram or cubic-metre). Compared with conventional carload-freight the value of express freight is about 100 times higher per kilogram, but with large variations.

However, it’s often not the high material value in itself which demands a fast transport, but other characteristics of the cargo. Actually the material value can be quite low. Flowers for example loose in freshness when not delivered in time and fruits and vegetables get unpalatable. Newspapers have a quite low material value, but loose their news value, when delivered too late. These goods retains its high value only for a very limited period of time, after that it’s almost worthless. Another reason responsible for that certain goods must be shipped very fast, is an difficult to foresee and to plan demand, as for example in the case of spare parts or pharmaceutical products.

Another characteristic of express freight is the shipment-size. The average item weight in 1998 of freight handled by the express industry worldwide was around 5-6 kg with an average shipment weight between 6 and 8 kg, both slightly increasing. There are, however, big variations and the size of shipments ranges from the size of a letter to items with a weight of several tonnes. Many airlines restrict individual items to a maximum weight of 30 kg, being that weight, which can still be handled by one individual. But there are virtually no strict upper limits and there have been cases where for example whole locomotives have been taken onbord of aircrafts. In the vast majority of cases, however, the shipment-size is less than carload (LCL).

Internet and e-mail changes the structure of the express freight. Pure infomation (letters) will certainly to a high degree, though within a foreseeable future not totally, be replaced by electronic data-transfer (email, EDI). This is true not only for private communication, but even for official mail and advertisement. On the other side Internet opens up a big new market for internet purchase. The result is that goods (consumer goods) has to be transported often over long distances. Consequently its interesting to see that just the parcel service will probably become an increasing market, while the conventional letter mail business will suffer most from Internet.

5 The prospects for rail

5.1 Strategic decision

For the express freight industry in Europe the choice of transport mode stands at the moment almost exclusively between aircraft and truck. Only as far as mail is concerned rail plays a certain role in several European countries, in many of them however since many years with a negative trend. Several railway companies offer even an courier cargo service utilizing mainly passenger trains. These services can be quite well developed within a national network, but do not cover international routes (with some few exceptions).

There are some examples where rail has succeeded in entering into the express freight market. Yet these are still very isolated phenomena and not all ventures have been a lasting success. Nevertheless they show an increased interest in the use of rail and could indicate a changing trend.

Trying to enter into and meet the challenging demands from the express market, would for the railways not only open up an highly interesting, today by rail largely unpenetrated market, but also facilitate meeting increasing quality demands in some of railways traditional markets, helping to secure these volumes.

The international orientation of the national Post Offices is highly relevant even for the railway companies since mail transportation by rail today almost exclusively is organized in national systems, something which probably do not comply with the future demand (and perhaps not even todays any longer).

The business idea for of high-speed rail freight can be described as follows:

High-Speed Rail Freight:

Faster than by truck –
cheaper than by air

Figure: The Business idea of high-speed rail freight

Loading capacity is cheap on railways, especially in comparison with aircrafts. Of course rail has to be integrated into multimodal transport chains. Rail can be both feeder transport mode or main transport mode, depending on the transport chain.

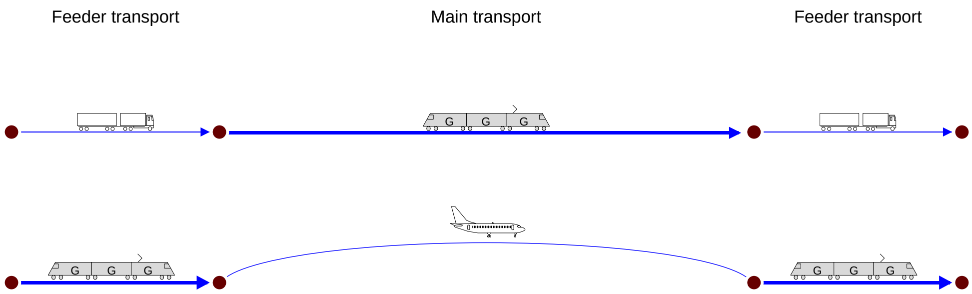

Figure: High-speed freight trains in intermodal transport chains – examples. The train can function both as feeder transport mode (see upper example) or as main transport mode. Further combinations are, of course, possible.

The market for express and high-speed freight trains is small in terms of volume, but it is an expansive market and offers considerable revenue potential. Few concrete data are available on this, but the figure on next page, showing the specific revenue per ton-kilometre by market segments of Spanish National Railways RENFE in the beginning of the 1990-ies gives an indication of the big differences. Though the exact values are certainly not transferable to other companies, the general situation should tend to the same.

It is important to emphasise, however, that it is not the case that the customer does not enquire about rates merely "because the freight value amounts to several million SEK". Just like in other markets, competition is stiff and prices are under pressure in this segment too, even if price levels here are naturally on a totally different scale compared to other areas of rail transport.

So in order to realize not only high (specific) revenues, but also a profit, it is necessary to run the service in an efficient way and to market it actively.

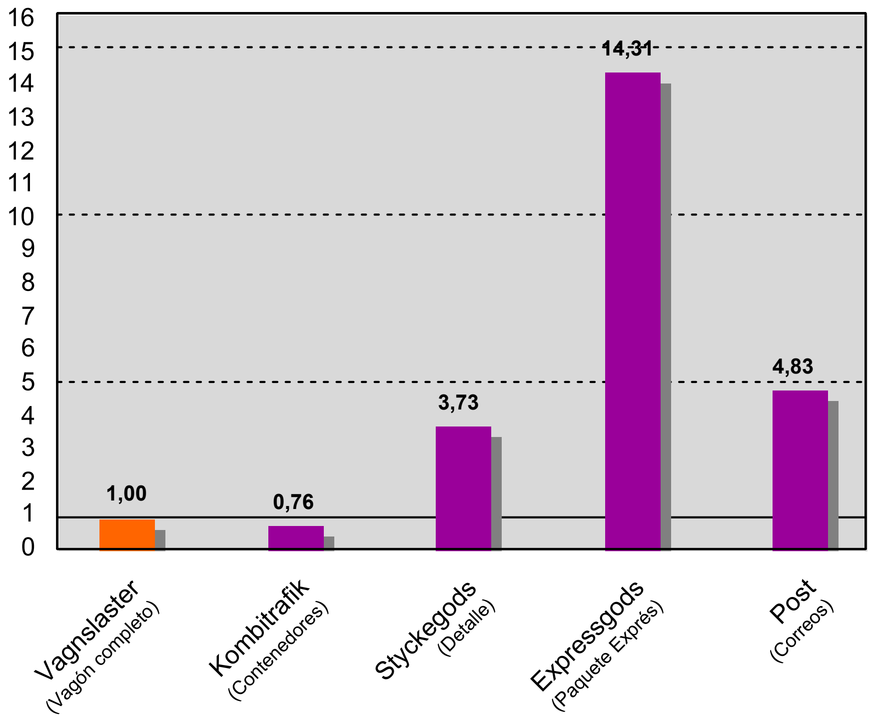

Figure: Specific revenue per ton-kilometre by market segments of Spanish National Railways RENFE in 1990. Wagonload (Vagnslaster) = 1,00

5.2 North America – examples of continent-wide express rail freight services

USA: Amtrak and freight railroads

In the USA, passenger train operator Amtrak offered substantial freight services by using their passenger trains to carry both mail and express cargo. Though operations have ceased it is worth to take a look at the system since it covered a whole continent – in contrast to Europe where practically all services are national. Transportation times were approximately the same as by road or shorter. A coast-to-coast express freight haul took approx. 66 hours by rail compared to 5-6 days by road[6]. The maximum speed in most places is 125 km/h, and 145 km/h on some lines.

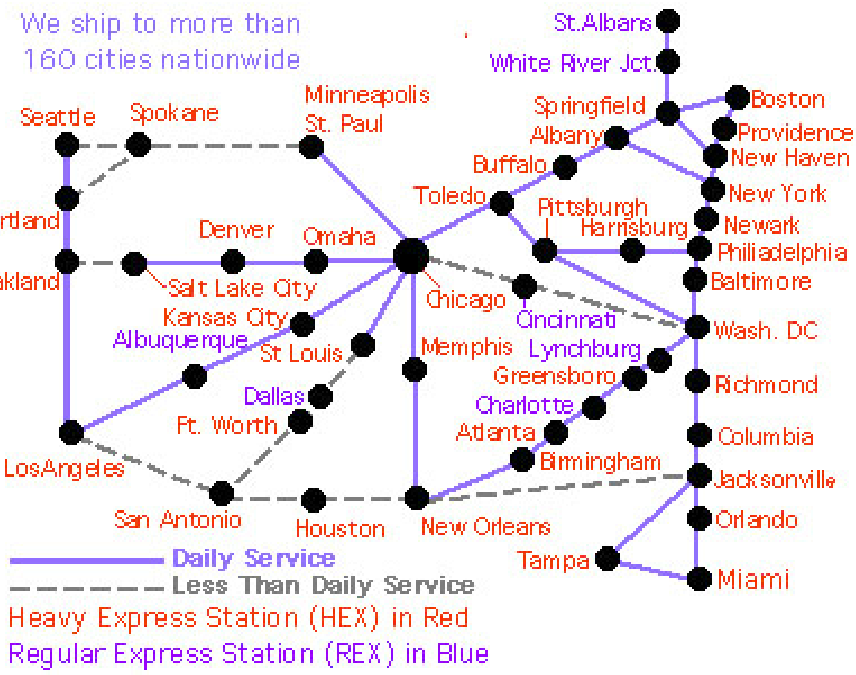

Figure: Amtrak's express freight service network at the beginning of the millennium.

6 "Amtrak builds non-passenger revenue", Railway Gazette International, July 1998, page 450

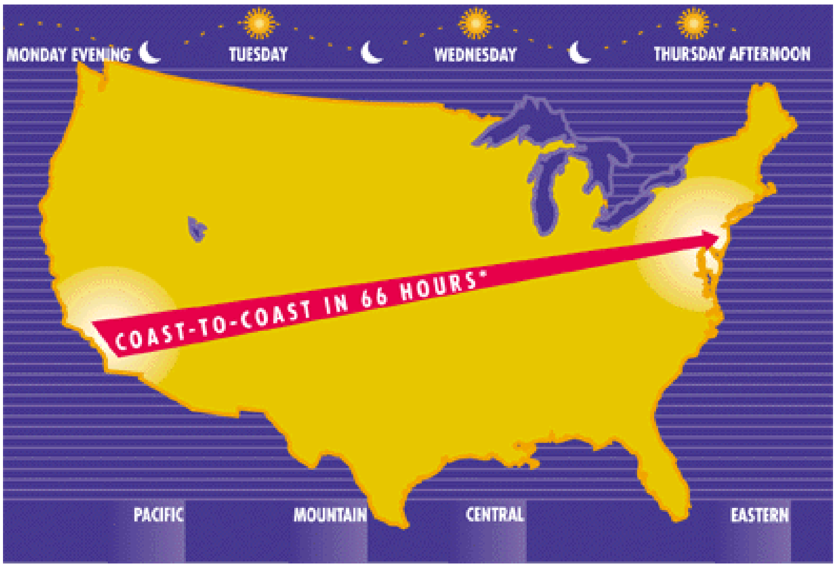

Figure: Amtrak offered express freight transport coast to coast in 66 hours.

Express rail freight price levels were approximately 15-20% above those of intermodal traffic and 10-15% lower than for equivalent road haulage transportation[7]. Air cargo is approx. 10 times more expensive than rail freight[8].

The figure below shows the market shares of mail transportation in the USA in terms of turnover, exclusive of air freight (with which the railways do not as a rule compete)[9]. Air freight's revenue from mail traffic is almost as high as that of road haulage, although the volume is substantially smaller.

Though Amtrak has withdrawn from the market other (freight) railway companies continue to to operate mail and express freight services, mainly using (semi-)trailers and containers in intermodal traffic. Road haulage certainly still holds most of the market and will continue to do so, however freight railroads are rediscovering the potential for time-sensitive express freight and are again making inroads into this markete segment. Not least should be mentioned the successful attempts by Union Pacific to win back perishables traffic, which had been almost entirely lost to road.

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7 "Getting the mix right", Containerisation International, March 1998, page 73

8 Hartley, S.A., "Amtraks's Fast Mail", Trains, December 1996

9 Air cargo generates almost the same revenue as trucks in mail traffic, but volumes are considerably smaller

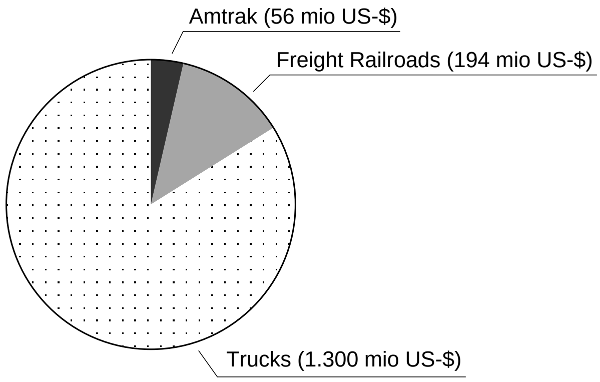

Figure: US mail traffic. Market shares for land transport in 1994, by turnover. (Source: Trains, December 1996).

Express and mail freight can make a significant contribution to a improved economy for passenger rail traffic. On certain Amtrak routes in the USA, revenue from express freight and mail traffic accounted for up to more than 40% of the total revenue[10] and thus sometimes constitute one of the basic prerequisites for operating the route in question at all. Some of Amtrak's long-haul trains convey more express freight wagons than passenger coaches. The record was hold by *Three Rivers* that operated between New York and Chicago and normally consisted of 24 express freight wagons and only 5 to 6 passenger coaches[11].

From 1999 onwards, Amtrak also operated refrigerated transportation in special high-speed refrigerated wagons (reefers) that are coupled to the passenger trains. Trans-continental transportation times with such configurations compared to intermodal traffic and wagonload are shown in the table below. One of the reasons why Amtrak decided to go in for refrigerated wagons instead of an intermodal TOFC (Trailers On Flat Cars) setup is the considerably better utilisation of length and volume. Using reefers, transportation capacity is approximately 3 times greater than if trailers were used[12].

The view on the mail and express business in America is – or at least was - apparently different to that in many European countries. It was not seen as an encumbrance but as a possibility.

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10 Railway Gazette International, May 1997: Amtrak struggles to find secure funding

11 Railway Gazette International, July 1998: Amtrak builds non-passenger revenue

12 http://www.kalmbach.com/news/ (20 February 1999): Amtrak plans four-day transcontinental reefer service

Table: *Approximate transportation times for transcontinental refrigerated transportation in the USA in different production systems. Source: http://www.kalmbach.com/trains/News/, 02/99)*

	Approximate transportation time
Amtrak reefer service	4 days
Intermodal traffic	5 days
Wagonload	11-12 days

Canada: VIAPAQ Courier

The Canadian passenger train operator VIA Rail Canada has in 2000 in partnership with Montreal-based Intelcom Courier for the first time started a mail and express package service, called *VIAPAQ Courier*, in a pilot project on its Montréal–Senneterre *Abitibi* and Montréal–Jonquiere *Saguenay* trains. The service on these two pilot routes is patterned on a similar one offered by Canada´s long distance buses.

The service offers sameday and next-day delivery between Québec City, Montréal, Toronto and Windsor, and will in phases become extended to more than 30 stations, by including smaller towns along the corridor as well as adding new relations to cover other eastern and western Canadian citys by the end of 2001.

The customer may choose between four price and service levels, dependent rather upon quality than distance. Pickups and deliveries are organized by partner Intelcom, which even operates freephone call centres, handles dispatching, provides a computerised tracking system and oversees account administration. In Montréal Central station and Toronto Union station dedicated VIAPAQ service counters have been installed, while at other stations existing ticket offices handle the traffic. [13] [14]

[13] TRAINS, october 2000, p 27

[14] *VIA launches parcels courier*, Railway Gazette International, january 2001, p 24

5.3 The situation in Europe

Thanks to its intense passenger traffic, Europe has a high-class rail network designed for high speeds. The infrastructural prerequisites for express and high-speed freight traffic in Europe are thus comparatively good and the pan-European high-speed network now taking shape will further improve these prerequisites.

The railways in Europe, however, have still not managed to exploit this potential to any great extent for freight traffic. In some countries mail traffic by rail has ceased – and the ancillary infrastructure has been dismantled – while in other countries it has entered a new phase of development. Under these circumstances, no continuous international rail network has been able to be established. In Sweden, too, mail traffic has been decreasing for many years, but the trend has now reversed and considerable amounts of mail are now transported by rail using a new concept.

A very successful rail-borne courier-goods service can be found in Germany where time:matters, a daughter company of airline Lufthansa, buys capacity onboard of Deutsche Bahn's InterCity- and InterCityExpress-trains and markets it to both private and commercial customers. Consignments can be delivered and picked up at all major stations, but door-to-door service is available, too. The system offers frequent services, fast transport times (enabling same-day delivery in most relations) and high geographical coverage.

However, though there are a number of "good examples" in Europe, despite less favourable prerequisites in many respects, the North American railways have generally ymanaged to penetrate the market segment better. Both the United States Postal Services and private mail carriers like UPS are customers of all major American freight railway companies. As an example, a few years ago only 4% of UPS's consignments were transported by rail in Germany; in the US the equivalent figure is 29% [15]. As described earlier, even coast-to-coast consignments – i.e. over distances of almost 4000 km, or one and a half times the distance from Sweden to Spain – are partly transported by train in the USA, either on intermodal trains or until recently even on Amtrak's transcontinental passenger trains.

The railways in Europe have no problems beating the running times of American freight trains by a good margin – with passenger trains. If similar running times could also be achieved for freight traffic, the railways' market share would be even higher in Europe.

[15] Modern Railways, May 1998

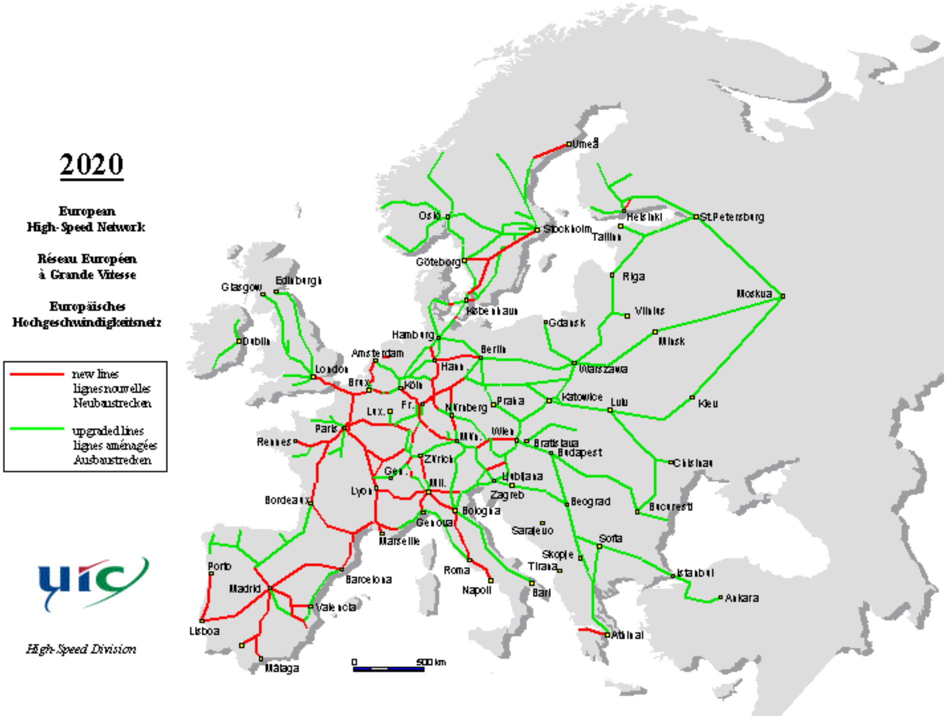


Figure: *The Pan-European high-speed network now taking shape offers new opportunities to develop high-speed rail freight. The potential is however until now – with very few exceptions – not exploited for freight.*

6 Loading units

6.1 Types of loading units

For most of the express cargo some type of loading unit is used in order to simplify terminal handling and transport. An exception can be courier goods which sometimes is handled "item by item" during the whole transport chain. For the rest, which is by far the majority, a large variety of different loading units has been developed over time, from the classic and simple mailbag over pallets to containers. Dimensions and capacity vary from a bag for some kilograms to containers carrying several tons. The size of a loading unit is influenced by several factors:

- the maximum size of individual items
- the ability to consolidate sufficient volume
- the handling equipment (esp. weight restrictions when manual handling)
- the available space in/on rail wagons, aircrafts and trucks

Often even several kinds on loading units are used in combination, for example a mailbag in a rolling bin in a container.

Not all loading units are necessarily intermodal, i.e. designed to be used on different modes of transport. Especially when it comes to air-transport a number of highly specialized loading units have emerged in order to maximize the utilization of available space onboard of aircrafts. These loading units normally do not leave the air-transport system.[16]

[16] During the 1990-ies intermodal operator ICF ran a train carrying air-cargo. On this train air-cargo containers where stowed in conventional ISO-containers, in order to be able

Neither have loading units to be specific for the small market segment of express cargo, or high-speed rail freight in particular. Much of the express cargo is carried in standard ISO-containers or swap-bodies. However, there is a trend towards equipping these loading units with IT, mainly for tracking and tracing purposes, which becomes increasingly important. For certain kind of cargo there's also a need for insulation and/or temperature control.

In the following two kinds of loading units specific to express cargo are presented, rollings bins and air cargo loading units. The latter are certainly not used or usable for rail transport, however since and increased cooperation between rail and air is advocated in this study in order to improve the prospects of rail in this market, it is seen as valuable to include air cargo loading units in this overview. Standard ISO-containers and swap-bodies are not described here, since they are probably well-known to most readers of this study and information on these is easily available.

to be carried by rail. However, this example has to be considered as an unusual exception.

6.2 Rolling bins

Rolling bins are widely used by mail companies all over the world. Designs can slightly vary but most are more or less similar to the design shown in the illustration below (showing a rolling bin of Deutsche Bahn). Dimensions are 1040 x 920 x 1435 mm (W x D x H). Tare weight is 140 kg and the loading capacity 500 kg or 1,4 m^3.

Rolling bins allow manual handling. They are used both for internal terminal handling and transport onboard of trucks and trains. Several bins can be coupled together to be hauled by (often battery-driven) trolleys, making terminal operations more efficient.

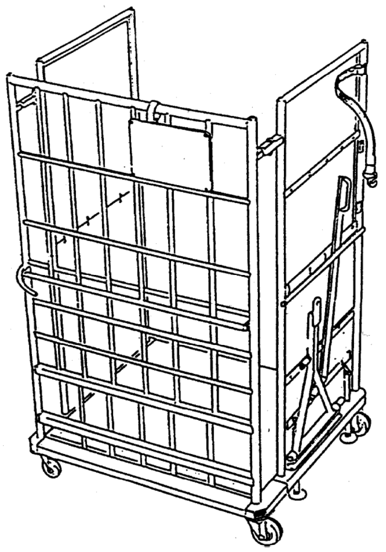


Figure:
Rolling bin of Deutsche Post AG.
Similar designs exist in other countries.

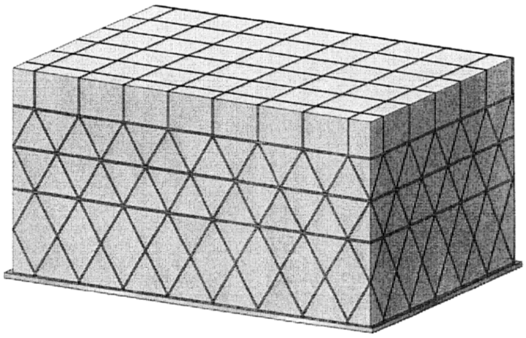
The rolling bin used by British Royal mail is called the York-container. It is used for letter and parcel mail and has been introduced in connection with the start of a new system for the conveyance of mail on rail in 1996. The 'York' is non-towable; it can be nested when empty and has a tare weight of 50 kg and a gross weight up to 250 kg. Every container conveys 28 trays or up to 20 mailbags. A four-car postal EMU class 325 carries 180 York-containers. The use of the 'York' is not limited to rail, it even covers road transport and the handling in sorting offices.

6.3 Air cargo loading units

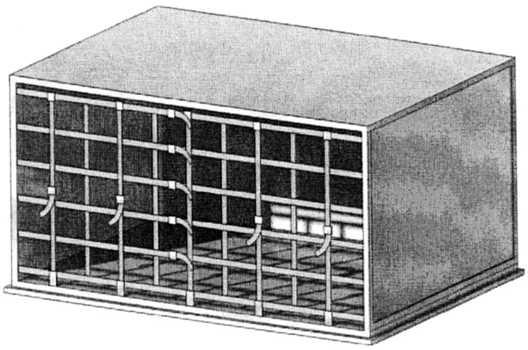
Air Cargo loading units come in a large variety of different forms and dimensions. They are designed to make maximum use of the available space onboard of aircrafts. The most “basic” air cargo loading unit is a pallet, on which the cargo is secured by a and a net. Containers can have different forms in order to adapt to the downto rounded form of the aircraftbody. For temperature-sensitive goods insulated containers exist.

In opposite to wheeled loading units used in land transport air cargo loading units are not equipped with wheels. Instead “rolling floors” are used, both inside the aircrafts and on the loading equipment. This makes it possible to move the units easily.

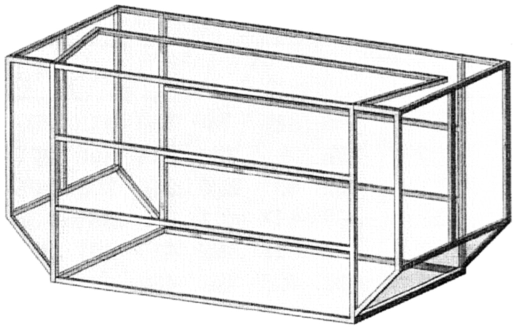
The figures below show different types of air cargo loading units.



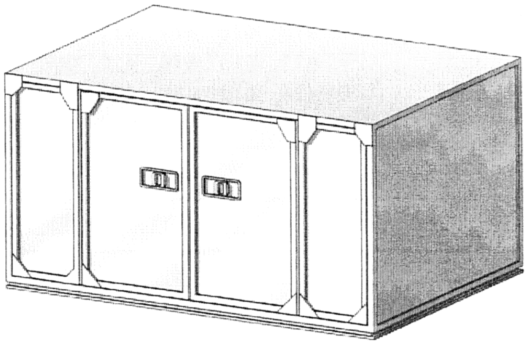
Air Cargo Pallet



Air Cargo Container



Lower Deck Container



Air Cargo Cooltainer

Figure: Different types of air cargo loading units (Source: SAS Cargo)

Table: Typical dimensions of SAS air cargo loading units (selected units, note that further units with other dimensions exist)

	Length	Width	Height
Main Deck Pallet P6P, PMC	318 cm	244 cm	244 cm
Air Cargo Container AA2	318 cm	224 cm	160 cm
Lower Deck Container DQF,LD8	244 cm	153 cm	160 cm
Lower Deck Cooltainer RAP	318 cm	224 cm	160 cm

7 Terminals

7.1 Principal considerations for terminal design

Good accessibility is essential for a competitive high speed rail freight system. This means that there is a need for efficient "interfaces" for transshipment of cargo between different modes of transport – train, truck and aircraft – and in some cases even directly from and to the customer.

Terminals are the places where the cargo enters and leaves the rail transport system. Consequently terminals play a crucial role when designing a high-speed rail freight transport system as a whole. The localization and design of terminals are key factors, which to a high degree determine the performance and efficiency of the system.

When dealing with terminals for high-speed rail freight one has to take into account that there exists close dependencies between a terminals localization in the rail network and its (track layout) design on one side and train operating principles, rolling stock concepts and transloading techniques on the other. A terminal can therefore not be designed without taking a decision on operation principles and types of trains, choices which in their turn are closely related to technique chosen for transloading.

The following table contains some fundamental questions, which have to be answered when designing a terminal. It does not claim to be complete, but gives an impression of the complexity of dependencies. Since a terminal is a long-term investment it determines system options for a long time.

Not all high-speed rail freight systems are based on new-built terminals but rely on inherited ones. In these cases often the terminals determine the operational options and vehicle options rather than vice versa. Due to the high investment costs the terminal structure is very persistent.

Question	**Aspect of terminal design affected**
● Which amount of incoming and outgoing cargo has to be handled and how is this volume distributed over time?	● Total length of loading tracks ● Number of loading tracks
● Will loco-hauled trains or multiple units be used?	● Overhead electrification of terminal tracks (when electric traction)
● Which are the maximum train lengths to be handled?	● Length of loading tracks ● Necessity and length of separate receiving/departure and shunting tracks
● Will it be necessary to be able to spot and pick out individual wagon from/to certain positions in the loading tracks at each time?	● Tracks and track connections for shunting movements ● Platform layout
● Will the cargo be transported in covered wagons or in standard intermodal loading units (containers/swap-bodies)?	● Loading under roof or open sky ● Kind of transloading equipment
● Will there be only starting and terminating trains, or also through-running trains?	● Connection of terminal tracks to mainline ● Platform layout and accessibility ● Localization of terminal on macro-level (at through-routes only or even at dead-end secondary routes)

When planning a terminal even the movements and storage needs within the terminal have to be considered as well as road access both on macro-level and locally. Since this study is on high-speed *rail* freight this chapter however focuses mainly on the rail-specific aspects of terminal localization and design.

7.2 Terminal types and localization

A high-speed rail freight terminal can serve an origin- or destination point directly – for example a mail sorting centre[17] –, or create a connection with other transport modes, primarily road and air.

In order to reduce the number of ”breaks” in the transport chain it is from a transport-logistical standpoint advantegous to build sorting centres with access to several modes of transport. Road access can be seen as ubiquituous, though there may be more or less advantegous localizations in the road network. Thus more limiting in the choice of a suitable localization are the factors access to the rail network and/or access to airports. In some cases both should reached. There are of course other aspects to take into account as well, as for example ground prices.

Different types of terminals can be discerned:

- Customer terminals (for example mail terminals)
- Dedicated (public) high-speed rail freight terminals
- Rail/Air-terminals
- Conventional Combined Traffic-terminals
- Passenger stations with cargo handling facilities

As can be seen from the list above, the rail services offered at the terminals do not necessarily be limited exclusively to high-speed rail freight. The terminals can provide for the needs of for example conventional combined traffic as well. Positive effects of such a combination could be

a) a joint utilization of (parts of) the terminal infrastructure and resources, offering the possibility to share costs

b) synergy effects on the traffic production side through coordination of terminal operations, feeder transport to and from the terminals and possibly even in train production

c) synergy effects on the market side; goods can interchange between different rail services (e.g. high-speed rail freight and conventional

[17] Whether a mail sorting centre can be considered as an origin or destination point depends on the definition and perspective. Here an origin and destination point is understood as a place where more than a pure transloading function is located. Adopting this definition and from a “rail perspective” a mail sorting centre can be considered as an origin or destination point, well aware of that the total transport chain does not start nor end there.

Combined Traffic), presumably increasing the market for each system. (It can reasonably be assumed that the markets for different rail freight services are not strictly separable, i.e. that the needs of express freight for example to a certain degree also can be met by other rail freight services than high-speed rail freight and vice versa.)

One should however be aware of that the degree of integration of different production systems (i.e. in first hand conventional Combined Traffic and high-speed rail freight) depends on the design of the high-speed system and the conventional CT-system, for example in respect to train-concept(s) and types of loading-units. Another factor is terminal capacity and capacity demand, including its variation over time. Finally also the spatial market structure in relation to the localization of the terminals has to be considered. All these factors can limit the possibility to integrate high-speed rail freight services with other rail services and thus the possibility to utilize joint terminals.

Integrated terminals will probably be easier to realize when even the high-speed system utilizes intermodal loading units similar or compatible to those in conventional Combined Traffic. In several of todays existing high-speed rail freight systems this is not the case; here instead enclosed vehicles are used like the French TGV Post, British Royal Mails Postal EMU Class 235 or GreenCargos new B-mail-wagon.

The above mentioned aspects thus have to be carefully considered. Probably there will be a justification for a co-existence of both integrated terminals and dedicated high-speed freight terminals.

Need to develop air-rail terminals

Terminals for high-speed rail freight already exist today, mainly in form of mail-train terminals. However, there is a big and urgent need for further development – both in quantitative and qualitative terms – if the traffic potential of high-speed rail freight is to be widened and if larger volumes are to be brought onto the train.

The integration of airports into the rail freight system is crucial if rail is to take a bigger share in the international express freight market. Even if – as has been pointed out earlier – much of the express freight carried by aircargo-companies in reality is carried by truck, the production system revolves around airport-based freight terminals. This is unlikely to change since air transport cannot be replaced on intercontinental relations and neither for transport of the most time-sensitive shipments on long-distance relations within Europe.

However, the integration of airports in the rail freight system is today almost non-existent – both in Sweden and abroad. This means that the today small amount of air-cargo carried by train often has to be trucked between the airport and a nearby (conventional) CT-terminal, adding a further link to the transport-chain with the result of reduced competitiveness for rail and thereby effectively limiting the prospects for an increased use of rail for this kind of transports.

Under the last 10 to 15 years many airports worldwide certainly have been connected to the rail network – in Scandinavia recently the three big national airports Kastrup (1998), Gardermoen (1999) and Arlanda (1999) –, but the specific requirements for handling of express cargo have seldom – if at all – been taken into account. Railway links to airports are in most cases exclusively designed for passenger traffic – often with sub-surface stations, which are neither suited for cargo handling nor easily adaptable to the needs of handling of larger volumes of freight. To the extent to which there exists separate rail links to airports dedicated to freight these are normally intended for the transport of aviation fuel and can neither straight off be used by express freight trains.

There are some few examples of airport rail links used for the transport of express freight. One is in Frankfurt/Main, where the Air Cargo City Süd is connected by a freight branch to the rail network. The terminal however is a conventional CT-terminal. For some time it has been served by CargoSprinter services feeding express cargo from Northern Germany to Frankfurt and vice versa. For transloading of checked baggage, carried in special compartments on ICE high-speed passenger trains, the passenger platforms of the airport station are used.

More ambitious plans for new Air-Rail-Cargo-terminals exist for Paris Charles-de-Gaulles and other airports, however these have not been realized yet. A pre-study has been carried out even for a freight link to Arlanda airport. By the author of this study it has also been suggested to prepare for an Air-Rail-freight-terminal at Skavsta in connection with construction of the new Ostlänken high-speed-line between Stockholm and Norrköping.

Passenger stations and high-speed rail freight

Passenger stations are already today used for handling of courier goods, which is carried onboard of passenger trains. Formerly – and in a number of countries still today – passenger stations were and are used even for transshipment of letter and parcel mail.

The use of passenger stations has the advantage that they form a very tight network, allowing a high geographical coverage. In the case of courier goods it is also an advantage that they can be used without bigger adaptations, since the volume, which has to be handled is very limited and typical item sizes very small. Especially for courier goods also the central location of passenger stations in the centre of the cities can give a competitive edge.

When it comes to mail the situation gets more complicated. In earlier times passenger stations had been used for mail handling to a large extent. Railways and mail services actually have been developed in a close symbiosis for more than a century. The main mail offices in the cities have often been located adjacent to the railway stations and many long-distance (and as well regional) passenger trains conveyed mail wagons. Consequently the necessary infrastructure to handle mail at passenger stations has been planned in from the beginning. At larger stations for example dedicated tunnels and elevators connected the mail terminals with the platforms. The logistic concepts of mail transport evolved around the use of rail for practically all long-distance mail transport.

Two developments have made that the utilization of passenger stations for mail handling has to be regarded as less suitable – and in many cases probably even impossible – from todays point of view.

Changes in the logistic concepts: For both economical and service reasons trucks took over from rail in most less-than trainload lanes after the war and air took over from rail on distances where rail could not offer competitive transport times any more. The result was that mail handling moved out from the city centers into new (automated) sorting centers in the periphery – with good accessibility to the road network, but seldom rail-connected.

The conversion of passenger stations: The conversion of passenger stations into modern "travel centers" seldom has been done with the demands and needs of cargo-handling in mind. Apart from physical accessibility to platforms, and platform furnituring, which already can present unconquerable obstacles for the usage of passenger stations for cargo handling, conflicts with passengers are likely to arise if loading and unloading has to be done from the same platforms, which are used by the passengers and if larger volumes of cargo have to be handled. It is normally not possible to have any fixed installations on passenger platforms, which might allow an automation of the loading and unloading process. A solution would be to let passengers board and alight on one side of the train and to load and unload cargo on the other. This has been done earlier on big stations in Europe; it requires, however, dedicated freight platforms. Since such normally do not exist (any more) and since it would be virtually impossible to integrate new freight platforms in existing passenger station layouts, this solution must in almost all cases be regarded as unrealistic. Another alternative would be to have separate tracks (and platforms) for cargo handling in immediate proximity to the passenger platform tracks. Even this solution existed (and sometimes still exists) in many places in Europe, however it requires additional track space and shunting, which in its turn may affect the capacity of a station.

Summarizing the above it can be said that a return of mail handling to passenger stations has been made practically impossible in many cases – and is probably not even desirable, since it would be difficult to address todays logistical needs (for example concerning loading/unloading). Where passenger stations still are used for express cargo handling (here: mail) it is likely that it will disappear sooner or later. In order to avoid that this results in a loss of traffic for rail it is however important that alternative solutions are offered, i.e. that new terminals can be created in other places.

The utilization of passenger stations for express cargo handling will therefore in the future most likely be limited to the small – but for that reason not less interesting – market segment of courier goods. The expansion of the InterCity-Kuriergut service in Germany, operated by Lufthansa-daughter time:matters and Deutsche Bahn shows that this market segment offers an – in several European countries unexploited – market potential.

7.3 Terminal layout

The design and internal layout of terminals is, among other things, depending on the choice of the operating principles and vehicle concepts, the type of loading units and the transfer technique.

The figure below shows some principal terminal layouts.

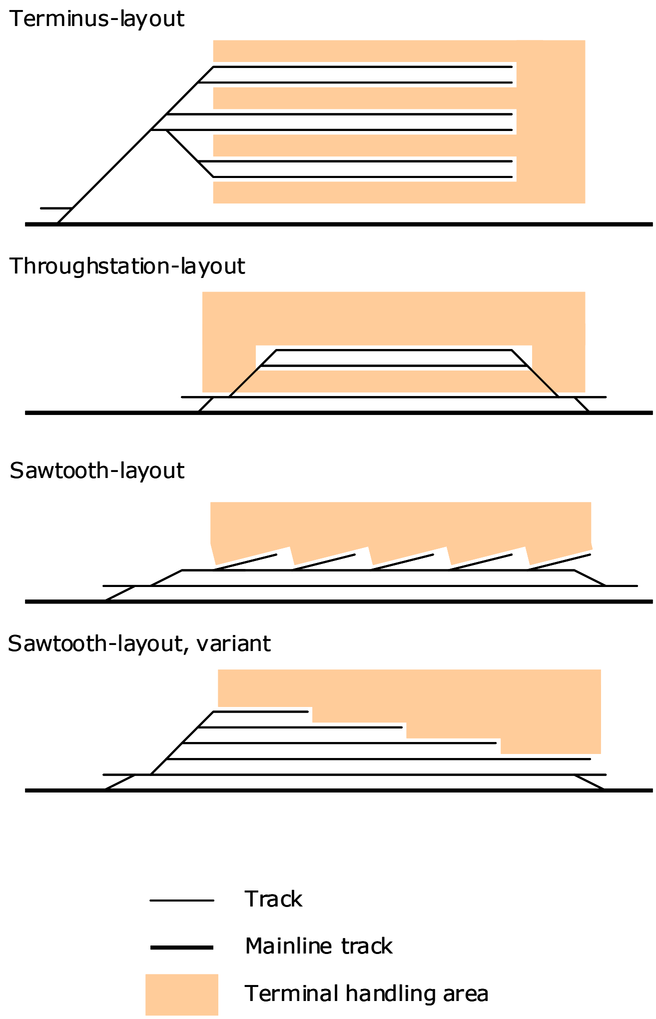


Figure: *Schematic terminal layouts for high-speed rail freight terminals. Not all tracks required for shunting are necessarily shown. (figure: Gerhard Troche)*

The *Terminus-layout* is the most common one applied on many mail rail-terminals. It is most suitable for point-to-point traffic, where trains are either starting or terminating. It is less suitable for through-running trains. In earlier times terminals of this type could be found as mail terminals at many places as "annexes" to larger passenger stations. Often these have disappeared when mail handling moved to more peripheral locations (for example the Klara terminal in Stockholm). One of the most recent mail terminals in Europe where the terminus-layout was applied is the London Distribution Centre (LDC) at Willesden used by Royal Mail, whose track layout is shown in the figure below. It features seven platform tracks of 260 metres each. The LDC started operations in 1996, when it took over all mail train services in the London area.

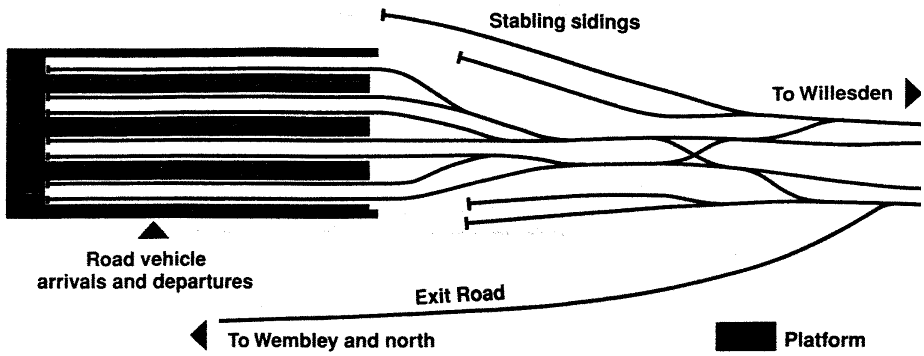


Figure: Track-layout of Royal Mails London Distribution Centre at Willesden, alongside the West Coast Main Line.

The *throughstation*-layout is suitable for liner-train based high-speed rail freight networks, where trains even call at intermediate stations. Here it is desirable – under the condition that loading and unloading takes place during the stopping time of the train – to have the terminal tracks connected to the main line in both ends of the terminal. This layout can sometimes be found in conventional CT-terminals as well, though those are not intended to be used by linertrains. Given electric traction is applied, linertrains put further requirements on the terminals in form of overhead electrification of terminal tracks (hybrid traction could eliminate this requirement). The figure on the next page illustrates the idea of linertrains.

The throughstation-layout has actually been very common in earlier times, due to the fact that at intermediate stops often passenger platforms were used for mail handling. These mail-train systems can therefore be considered as an early application of the liner-train principle.

The *sawtooth-layout* is nowadays seldom been used. Its advantages can only be fully exploited in single wagon (or wagon group) traffic, since it offers the possibility to spot and pick up single wagons (or shorter wagon groups) to/from their loading positions independently from each other. It is however a relatively expensive track layout due to the high number of turnouts (relative to track length). For this type of terminal it may be interesting to develop new low-cost designs of turnouts. However it would in any case be a challenge to keep the total cost of a production system largely based on single wagons at a competitive level.

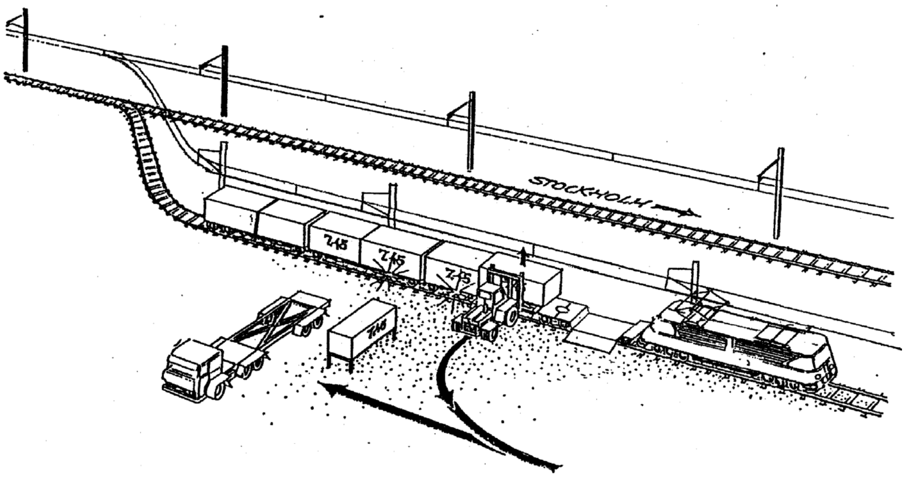


Figure: For liner trains terminals are preferably designed with a throughstation-layout.

7.4 Transshipment techniques

The loading/unloading process represents a critical moment in the transport chain. It is both time-consuming and connected with costs.

The sorting and transshipment of express freight must happen quick, reliable and cost-efficient. The handling equipment has to be flexible in respect to both extreme peak loads and a heterogenous goods structure, the latter concerning both weight, size, form and package of the shipments.

Increasing express freight volumes have already lead to a high automation of the sorting process in mail and express freight terminals. Due to the high costs of the necessary equipment, the result is a concentration on few high-capacity terminals. In order to reduce even loading and unloading times attempts have been made to automate even here. The ambition is in both cases to reduce time consumption and costs.

As a consequence transshipment methods can be divided into three groups, according to their grade of automation:

- manual
- semi-automated
- automated

Figure: Manual loading of mail wagons at a passenger platform in Germany during the 1980-ies. (Photo: Bundesarbeitsgemeinschaft Bahnpost).

Fully automated systems for loading and unloading are to the authors knowledge not in use anywhere.

Considerable efficiency gains can already be reached by relatively simple means. An example is the equipment developed for the loading and unloading and terminal handling of York-containers, rolling bins for letter and parcel mail used by Royal Mail in Great Britain. The range of equipment includes:

- The York Lifter
- The Purpose Built Trolley
- The York Interface Ramp
- The Pedestrian Controlled Tug

Even an earlier planned high-speed freight-ICE traffic in Germany would have – at least initially – mainly relied on manual loading and unloading, partly due to the fact that loading and unloading was expected to happen at passenger platforms. Simple equipment in form of lifts would, like in the British example, speed up the process. An automation of the procedures would require high investments and raises of course also reliability questions; ready solutions are today not available on the market.

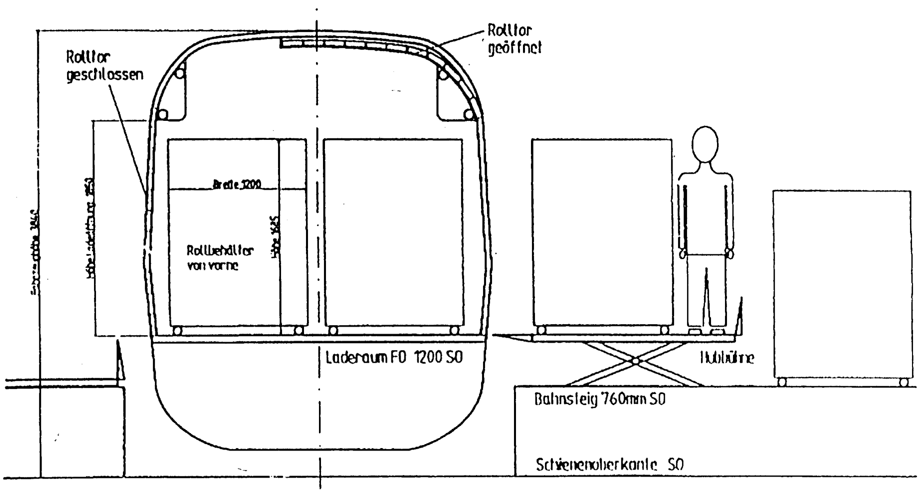


Figure: Loading or rolling bins into a covered high-speed freight train (here an earlier planned freight version of the German ICE)

If standard intermodal loading units like ISO-containers and swap-bodies are used an automated loading and unloading could look like in the figure below.

An advantage is that the solutions in this case would not be specific to express freight, but the techniques could have wider applications in Combined Traffic in general.

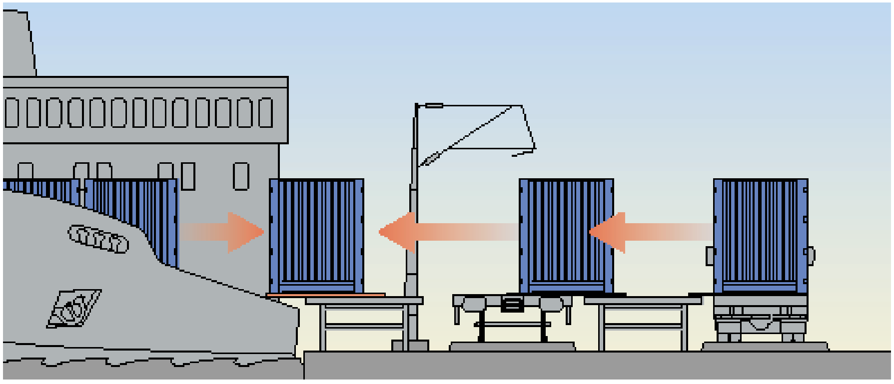


Figure: Automated horizontal transfer-techniques could be used for containers and swap-bodies (here the Swedish CCT-system). However, none of these techniques is in commercial operation today.

8 Rolling stock

8.1 Vehicle types and train concepts

Rail vehicles for high-speed rail freight can appear in very different forms. There are different ways to categorize vehicle and train concepts; some are presented in this chapter.

One common feature of all rolling stock in this market segment is not unexpected a relatively high maximum speed compared to conventional freight wagons. In high-speed rail freight traffic the maximum speed is playing an unlikely bigger role than in conventional freight traffic, where other factors often are more important, for example a high loading capacity. In high-speed rail freight higher maximum speeds can translate into higher average speeds, a crucial competition factor in this market. The production principles in high-speed rail freight traffic normally exclude time-consuming marshalling and long standing times.

For conventional rail freight the benefits of higher maximum speeds would in many cases be rather limited due to the fact that the average speed in a transport-chain is here to a higher degree influenced by factors such as shunting, marshalling and waiting times rather than by the maximum speed of the rolling stock or the permissible line speed. In conventional freight traffic neither the gains in competitiveness nor in productivity – if such can be achieved at all – would probably in many cases be able to counterbalance the higher costs for an increase of the maximum speed. The primary field where higher maximum speeds could come to their right is high-speed rail freight.

The rolling stock for high-speed rail freight can be grouped into two types of vehicles:

- vehicles derived from conventional freight car constructions, as for example the new B-mail wagons of Green Cargo or the container bogie wagons for DBs Parcelnet-system, both with a maximum speed of 160 km/h.

- vehicles derived from passenger rolling stock, adapted to carry freight, as represented by the TGV Postal or the British class 325 mail multiple units.

The figure below is an attempt to categorize the different vehicle concepts:

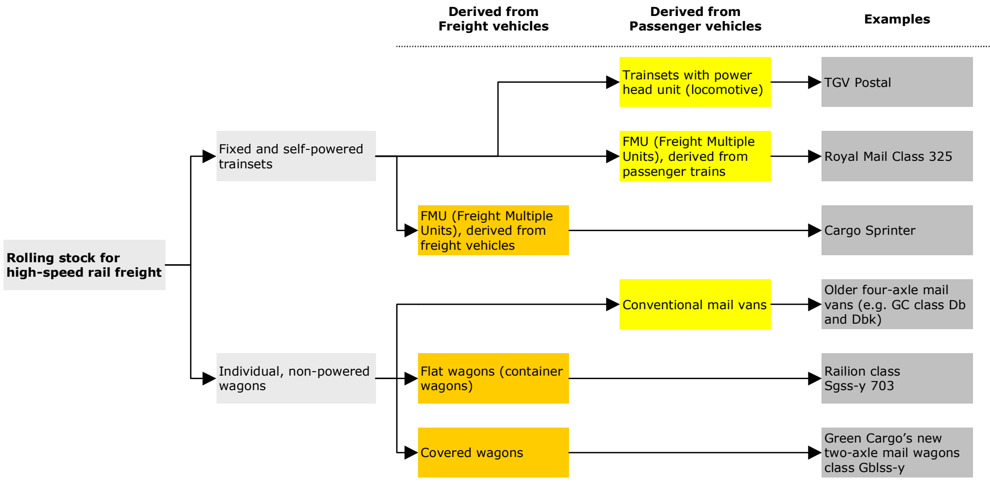


Figure: Categorization of vehicle concepts for high-speed rail freight (Gerhard Troche)

Both in the case of vehicles derived from passenger vehicles and vehicles derived from freight wagons passenger train technology is used, however, in the first case limited to the running gear and braking technology, while in the latter case this even applies to the car body, resulting in a more or less distinct affinity with ”real” passenger rolling stock in their outer visual appearance.

Vehicles belonging to the first group – further developed freight cars – are typical designed for maximum speeds up to 160–200 km/h. The modifications needed to cope with higher speeds concern primarily the braking system and the running gear and possibly load protection equipment. There exist both two- and four-axle covered as well as container wagons in this speed range.

Another way to categorize high-speed freight trains is after the train configuration. High-speed freight has even in this respect seen the entry of concepts from the passenger side. While the loco-hauled train formed of individual wagons is the classical train type in conventional freight traffic, fixed trainsets and multiple units are common in high-speed rail freight.

Three different types of train types can be identified:

- loco-hauled trains of individual wagons (Example: "classical" mail trains)
- fixed trainsets with integrated power units (example: TGV Postal)
- multiple units with distributed power underfloor (example: Royal Mail Class 325)

In the following table train concepts for high-speed rail freight categorized by looking both at the vehicle concept and how the goods is transported, i.e. in covered wagons or in containers.

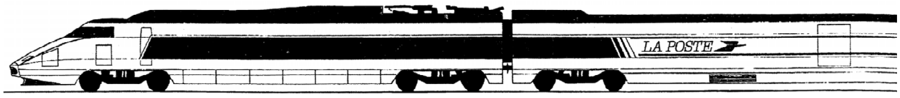
Table: Categorization of trains concepts by vehicle concept and transport method (idea: Gerhard Troche).

Vehicle concept \ Transport	In covered wagons	In containers
Loco-hauled, single wagons	GreenCargo mail trains (S)	Parcel Intercity (D), MGV (F), SBB mail trains (CH)
Fixed, self-powered trainsets	TGV Postal (F), Postal EMU class 325 (GB)	CargoSprinter (D)

On the following pages a number of different rolling stock is presented, illustrating the variety of vehicle concepts for high-speed rail freight.

8.2 Vehicles in Europe and abroad

TGV Postal high-speed train



In France, mail has been carried between Paris and Lyon by the TGV Postal high-speed trains since 1984. A total of 7 half-sets are available to the service. Two half-sets coupled together make up a full train consisting of 2 motor units and 8 freight cars. A full TGV Postal train can thus – unlike the TGV passenger trains – be split in the middle, which makes maintenance easier and reduces the need to hold trains in reserve. Each train can carry a load of 75 tons. If necessary, a half-set can also be put into service as a separate unit. Energy consumption per ton on the Paris-Lyon route with a payload/train of 75 tons is stated to be 0.02 TEP (tonne équivalent pétrole) compared to 0.12 TEP/ton if the mail had been transported by air (Transall with a payload of 14.3 tons)[18].

Loading and unloading is done through doors in the middle of the car. Each car takes 30 load containers in which 40 letter-sorting racks are arranged, with a total maximum weight of 10.8 tons.

Table: Technical data of the TGV Postal high-speed train

Electrical power systems	1.5 kV DC / 25 kV 50 Hz AC
Length	200 m
Configuration	2 motor units + 8 freight cars (full train)
Service weight	345 tons
Output	6.450 kW
Maximum speed	270 km/h
Loading capacity	61 tons

[18] ”Attention! Un TGV peut en cacher un autre”, SCNF information brochure

Freight version of the ICE trains

In connection with the development and introduction of the ICE trains at the beginning of the 1990s, the prerequisites for high-speed freight traffic and the possibility of producing a freight version were also studied.

The Hamburg-Munich route with stops in Hanover and Nuremburg was identified as a possible pilot route. Including the 2 stops of 20 minutes each, the running time from Hamburg to Munich would be approximately 6.5 hours. Mail would be the basic load, and truck freight and air cargo would also be carried.

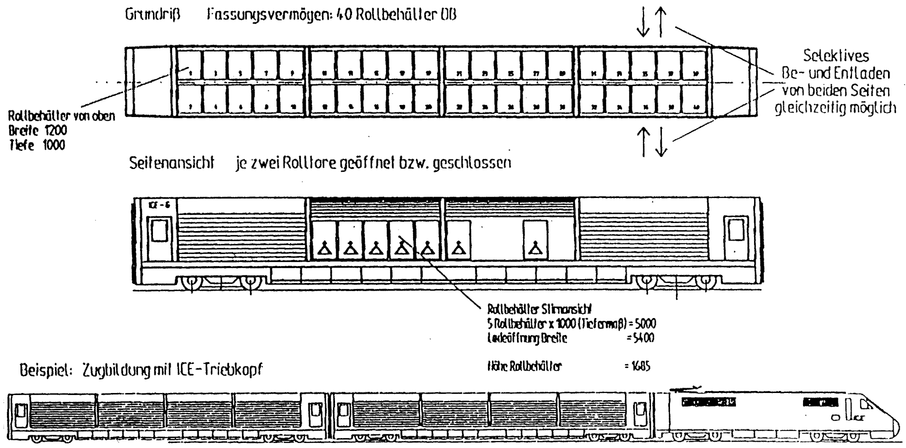


Figure: The freight version of the ICE (Drawing: Waggon Union/Thyssen)

The train would consist of 6-12 freight cars plus motor units. The vehicles are based on the ICE1 passenger trains. Each car would have a loading capacity of between 36 and 40 wheeled bins, giving a load weight of between 12.2 and 13.6 tons and a payload of approximately 8 tons per car. The axle load would then be a non-critical 12-13 tons, and thus lower than for the passenger coaches. The figure above shows a proposed freight car. To allow freight to be loaded and unloaded quickly (this is assumed to be done manually, at least to begin with), the wagons would have roller shutters along the whole length of the load area. Once on the train, the wheeled bins would thus not need to be moved.

The train has never been built, but the high-speed freight train issue is still being pursued within the framework of the FEX (Frachtexpress) project, with France's SNCF among the operators involved.

CargoSprinter

The CargoSprinter is a diesel-powered Freight Multiple Unit for container transport, consisting of two end cars, each powered by two 265 kW diesel-engines, and unpowered intermediate wagons. There exists two versions: The Windhoff-version has three two-axle intermediate wagons, while the Talbot-version counts three (Jacobs-)bogie wagons. The units are equipped with automatic couplers to allow quick coupling and uncoupling. More technical data are presented in the table below.

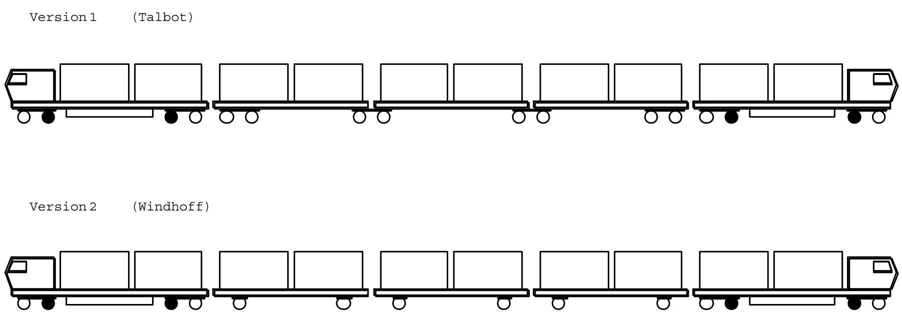


Figure: The German CargoSprinter is a diesel-powered freight multiple unit. It comes in two different versions, one where the intermediate cars rest on (Jacobs-)bogies and one where two-axle cars are used.

The CargoSprinters were developed in close cooperation with DB in the 1990-ies with the ambition to establish a network based on the operation principle of Train-Coupling and –Sharing. Up to seven CargoSprinter-units could run in multiple.

After delivery the trains carried express freight from Northern Germany to Frankfurt airport on behalf of freight forwarder Hellmann. After some years the trains were withdrawn for economic reasons however.

Rolling stock supplier Windhoff succeeded to sell CargoSprinters even to Australia where they run in commercial service.

There were also plans to build an electric version of the Cargo Sprinter. Express Shuttle GmbH, a jointly owned subsidiary of UPS and Deutsche Post AG, was planning to introduce a further developed version of the CargoSprinter trains in the end of the 1990-ies for transport of parcels around the whole of Germany. In a first step twelve hybrid (diesel/electric) 160 km/h 5 or 6-car units with space for 10-12 swap-bodies should be acquired. They were planned to be put into service during autumn 1999 on the Munich-

Stuttgart and Hanover-Hamburg routes. The trains would even use the high-speed lines[19].

If traffic developed as expected, the company had plans to establish a nationwide network and also some international connections. A total of 70 trains were estimated to be needed and the company intended to invest 140 million USD in the full system[20]. However, the infrastructure charges were crucial to whether the services would be able to start or not. Though the company after lengthy negotiations with infrastructure manager DB Netz managed to press track access charges down from 14,00 DM/train-kilometre to 5,80 DM/train-kilometre, the project was never realized.

Table: Technical data of the CargoSprinters

Wheel set arrangement (end cars)	(1A)' (A1)'
Rated output	4 x 265 kW
Engines	Volvo 6-cylinder diesel engine
Regulation	Electronic (EDC)
Transmission	5-gear Automatic Volvo Powertronic PT 15650
Service weight	End-car: 42,5 t Intermediate car: 12,7 t
Width	2.900 mm
Height	2.010 mm (driver cabin)
Brake mechanism	EBAS
Maximum speed	120 km/h
Maximum number of units in multiple	7
Number of units built	18
Contractor	Windhoff AG Rheine / Talbot Aachen
Delivery	1996-97

19 "Hybrid-Gütertriebzüge für den Paketverkehr?", Eisenbahn-Magazin, no. 11/1998

20 "UPS decidirá sobre el transporte nocturno por tren en Alemania", http://www.urgenteonline.ipf.es/ (99-01-28)

Postal railcar class 325 Royal Mail

In 1996 British Royal Mail signed a contract with freight train operator EWS to operate a heavily redesigned network of mail train services. As a part of the modernisation Royal Mail invested into new Freight Electrical Multiple Units, the Class 325.

The Class 325 mail train multiple units are 4-car units with a length of 84 metres. Up to four units can be coupled. The trains can operate on 25 kV alternating current under live catenary and 750 V direct current supplied through a conductor rail with automatic system switching along the way. The trains can also be hauled by locomotives on non-electrified routes. The maximum permitted speed is 160 km/h with a 400-ton load per unit. Each wagon is equipped with two roller shutter doors on both sides. It is not possible to cross between wagons and the doors have security locks. Only Post Office personnel have access to the freight compartment. Generators and batteries provide the power for lighting, the door-opening mechanism and safety equipment since the train has no external power source. Other features are non-slip floors and container retention straps.

The Class 325 is a modular train, the driver cabin is a bolt-on cab, fully fitted out before mounted on the vehicle. The train is designed in such a way that it can be relatively easily rebuilt into a passenger train, if not any longer required for mail services.

Figure: A class 325 Postal Freight Multiple Unit. (Photo: Gerhard Troche)

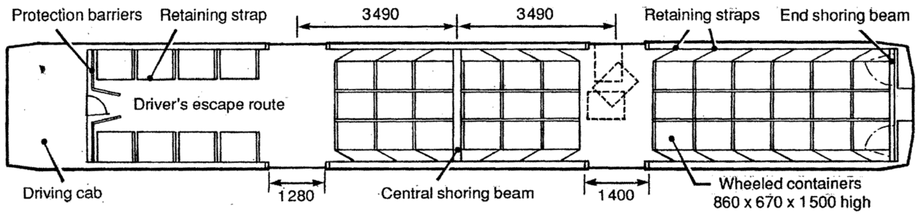


Figure: Layout of British Royal Mails postal railcar class 325 (end car with driver cabine)

Table: Technical data of the CargoSprinters

Formation	DTPMV(A)+MPMV+TPMV+DTPMV(B)
Vehicle length	DTPMV: 19,83 m MPMV/TPMV: 19,92 m
Height	3,78 m
Width	2,82 m
Internal layout	Open
Gangway	No
Toilets	No
Weight	Total: 138,5 t DTPMV(A): 29,2 t MPMV: 49,5 t TPMV: 30,7 t DTPMV(B): 29,1 t
Brake type	Air (EP/auto)
Bogie type	Powered – Adtranz P7-4 Trailer – Adtranz T3-7
Power collection	25 kV AC overhead 750 V DC third rail
Traction motor type	4 x GEC G315BZ
Output	990 kW
Maximum speed	160 km/h (100 mph)
Contractor	Adtranz Derby
Delivery	1995-96

Green Cargo "B-mail" wagon

In order to replace older class DV30 mail vans SJ decided in 1999 to purchase new wagons. As the class DV30 the new wagons of class Gblss-y are based on standard two-axle freight wagons which were modified. The running gear of type TF25SA, developed by Powell Duffryn, allows an increased maximum speed of 160 km/h and the wagons are today the world's fastest two-axle freight wagons in regular service.

70 wagons were built by TGOJ Eskilstuna and put into service under 2000 and 2001. Test runs showed very good running behaviour up to 180 km/h.

The wagons are today mainly deployed on the lines from Stockholm to Gothenburg, Malmö and Sundsvall.

Figure: Green Cargo's mail wagon class Gblss-y is the world's fastest two-axle freight wagon (Photo: F. Tellerup)

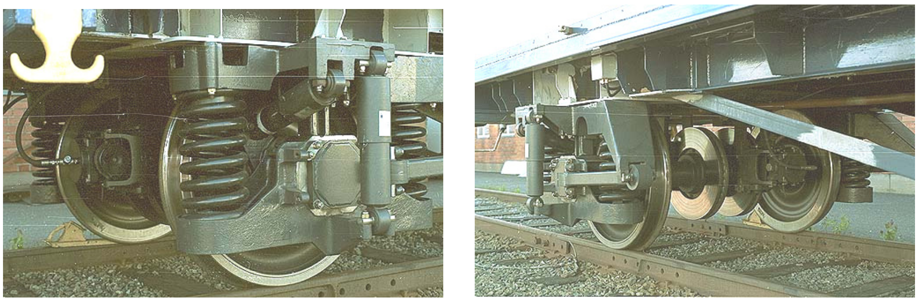


Figure: The TF25 SA running gear allows a maximum speed of 160 km/h. In the picture to the right the disc-brakes. (Photos: B.Dahlberg)

Table: Technical data of the class Gblss-y mail wagon

Length over buffers	12,8 m
Axle base	9,0 m
Brake	KE-P-A
Maximum payload at 160 km/h (on class C- and D-lines)	22,4 t
Loading area	33,9 m²
Builder	TGOJ Eskilstuna
Delivery	2000-2001

DB Inter-Cargo-Express container wagon

For the Inter Cargo Express-system German railway operator DB purchased in 1991 bogie-container wagons with a maximum speed of 160 km/h. The wagons frame is identical to standard wagons, however, in order to secure the loading units the wagons were equipped with automatically vertical-locking container pins of Buffers Inc. (USA). The Talbot-bogies were of type DRRS with disc-brakes; each bogie counted 6 brake-cylinders.

Technical data can be found in the table on next page.

Figure: Container bogie-wagon class Sgss-y 703 of DB from 1991. The wagon has a maximum speed of 160 km/h. (Photo: www.parostroj.net/technika/DRRS/DRRS.htm)

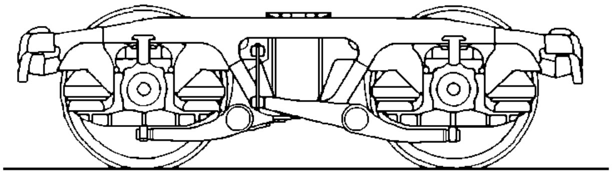


Figure: Bogie of a class Sgss-y container wagon of type DRRS. Note the outer suspension of the brake unit.

Table: Technical data of the class Sgss-y container wagon

Tare weight	22,0 t
Max. payload (at 22,5 t axle-load)	68,0 t
Maximum axle-load at 100 km/h	22,500 t
Maximum axle-load at 120 km/h	18,375 t
Maximum axle-load at 160 km/h	17,875 t
Loading height over rails	1.180 mm
Length over buffers	19.740 mm
Bogie-type	Talbot DRRS
Brake equipment	<R> KE-GPR-A [D], EP
Nr. Of brake cylinders	12
Wheel diameter	920 mm
Loading length	18.400 mm
Min. curve radius	75 m
Loading options	Containers max. 60’ or 2 x 9.125 mm swapbodies
Builder	Talbot / Aachen (D)
First delivery	1991

9 Train operations

9.1 Integrated versus separated production freight-passenger

Express and high-speed freight services can be produced either together with passenger traffic services or in a separate system. There are advantages and disadvantages to both systems, as will be discussed later.

There are two principal technical requirements for co-production of passenger and freight traffic:

- The vehicles must be able to run at the same speed
- The vehicles must be able to be coupled, preferably automatically

A problem which faces the high-speed rail freight is that new passenger rolling stock often are fixed multiple unit trainsets, making it practically impossible to attach existing express parcel or mail vans to them. The new passenger trainsets themselves are normally not intended to carry larger amounts of goods – if any at all –, and subsequently do not provide any space for this or only very small compartments, like on the French TGV. However, there are exceptions: In the United States, Talgo America offers a version of its Talgo XXI tilting train for 300 to 400 passengers with a maximum speed of 200 km/h and with two cars reserved for express parcels.[21]

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[21] US Rail Project Launched. IRJ, october 2000, page 2

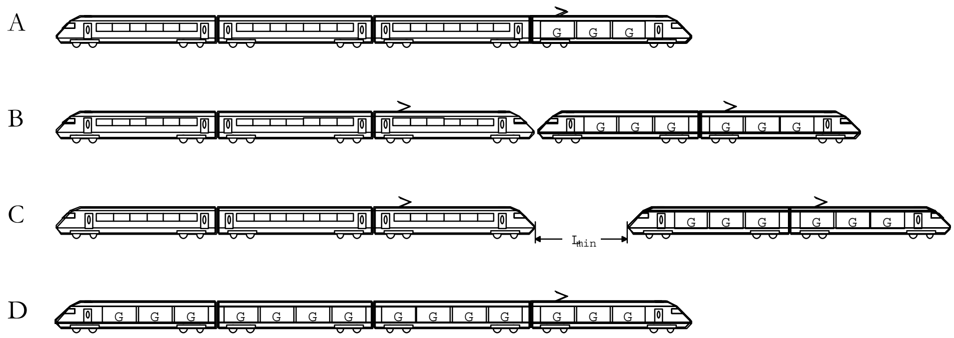
The figure below shows different ways of coordinating high-speed freight and passenger traffic. Three of the alternatives represent production methods that to varying degrees are based on integrating the passenger and freight traffic systems.

Case A represents the highest level of integration: The freight is transported in the same train as the passengers. Freight traffic is as good as fully integrated with passenger traffic as regards timetables, networks, stops, vehicle circulation etc. Loading and unloading along the way is only possible at passenger stations and naturally only at those where the train stops to let passengers on and off. In principle, this production method corresponds to today's express freight traffic using the X2000 train, but with more space for freight.

In *case B*, passengers and freight are transported in separate trains that can be multiple-coupled. This makes express freight traffic more independent of passenger traffic. Passenger and freight trains can for example travel coupled together on shared stretches, yet have different starting points and destinations (Train Coupling and Sharing, TCS). When necessary, the trains can be switched between different passenger trains, which gives greater opportunities for creating direct connections. In the same way, the freight trains can be used together with passenger trains during the day and as pure express freight trains at night, which increases rolling stock utilisation. The ability to multiple-couple the rolling stock can naturally also be exploited to join several freight units together.

In *case C*, passenger and express freight traffic are coordinated only as regards timetables. This is advantageous if the trains for some reason can not or may not be multiple-coupled and the track network suffers from capacity problems. Running the freight trains "in the shadow" of the passenger trains (or vice versa) reduces the capacity needed for the additional trains. Other advantages are that stops for loading and unloading need not be made at the same time as passengers board or leave the trains, and that the trains do not necessarily need to stop at the same stations as the passenger trains (this is important, for example, if goods terminals are called at where passenger trains do not stop). It should, however, be pointed out that stopping times and/or stopping patterns between the passenger and freight trains make it difficult to coordinate the train's positions over greater distances. In contrast to case B, an extra driver for the freight train is also needed in case C.

Case D shows a pure express freight train that operates fully independently of passenger traffic, i.e. the system is completely separate from passenger traffic.



Figur: Different ways of coordinating passenger and high-speed rail freight

When passengers and express freight are carried on the same train the following areas are especially critical:

- Sharing passenger platforms for loading and unloading
- Stopping times at stations
- A train's stopping patterns
- The routing of lines and the network's design/structure.

The critical areas of a combination of passenger and express freight transport do not, however, mean that these are always so serious that passenger and freight transport should not generally be combined on the same train. The fact that express freight transport on passenger trains is reliably practised in many countries in Europe already today, shows that the concept can and does work successfully. Furthermore, express freight transport and passenger transport are commonly combined in both air and road traffic (bus parcels).

The solutions applied, however, need to be reviewed if larger volumes of express freight need to be handled. Experience from the air traffic industry shows that both solutions, transport in dedicated freight aircraft and on board passenger aircraft, can be justified and that they together can form part of an integrated transport concept.

Coproduction with passenger traffic – in the case of daytime transportation – gives a higher frequency of service and relatively high geographical coverage in Europe. At night, the synergies are limited to using the same tractive power and train positions for both passenger and freight traffic. Coproduction also has drawbacks of its own. The fact that the production systems are tied to the passenger train supply's network and its stopping patterns should also be mentioned in this context. This means, among other things, that the freight is loaded/unloaded on the same platform, and also at the same time as passengers are boarding and alighting, and must often be completed during very short stops. Stopping times are almost always dimensioned by the time required for passenger exchange; no extra time just for loading and unloading express freight or mail – with certain exceptions for night trains – is allowed as a rule. It should also be pointed out that the transformation of passenger train stations into modern travel centres does not always take the needs of express freight handling into consideration.

The advantages and disadvantages of coproducing express freight traffic and passenger traffic need thus to be weighed against each other from case to case. What we will probably see – as today – is a mixture of integrated and separate production systems for passenger and express freight traffic.

9.2 Coordination with other train traffic

Express freight has to share the rail network with other users such as conventional freight trains as well as a large range of different passenger services. This can result in timetable and capacity conflicts, which in their turn can negatively affect the quality of the services of one or several users.

Conflicts arising from the mix of different traffics are first and foremost a result of different (average) speed levels. Conflicts did earlier exist mainly between, on the one hand, fast-running long-distance passenger trains and, on the other hand, relatively slow-running conventional freight trains as well as regional and local passenger services with frequent stops. Even freight traffic can interfere with local and regional passenger traffic in spite of an often quite similar average speed level, since local and regional passenger traffic – at least in agglomerations – is often characterized by a high frequency, which can make it difficult to put freight trains between the passenger train paths and which can lead to even small speed differences causing timetable conflicts.

High-speed rail freight is, what concerns timetabling and possible capacity conflicts, in a specific position for two reasons:

1) The characteristics of high-speed rail freight operations are often more similar to those of (long distance) passenger traffic than to those of conventional freight traffic – this applies to both the speed levels as well as the operating principles. It does, however, not necessarily apply to the traffic time; high-speed rail freight will – certainly not completely but to a large extent – have to be carried at night. Together these factors make that high-speed freight trains are more likely to conflict with conventional freight trains rather than with fast passenger traffic.

2) High-speed rail freight is to a high degree based on the joint utilization of infrastructure and production resources with passenger traffic. This ranges from the joint use of dedicated high-speed-lines and the use of passenger stations for terminal functions to the integration of passenger and goods transport on the same train. There are synergy-effects between express freight traffic and passenger traffic. This does, however, not mean that the joint production of passenger and express freight traffic is conflict-free. This will be discussed more in detail further below.

Some trends in railway operations which separately or in combination are of importance for the coordination of different traffics, are concerning *passenger traffic*:

• increased train frequency

• introduction of regular-interval and systematic timetables

• higher average and maximum speeds

• introduction of new local and regional train services

• extension of the traffic time with increasingly early morning and late evening departures

Concerning *(conventional) freight traffic* the following trends can be identified:

• increased demand of high-priority train paths for just-in-time traffic

• increased demand of continuous, cross-boarder train paths for international traffic and – partly as a result of this –

• increased demand of operating long-distance freight trains even at daytime

It should, however, be mentioned that many of the conflicts, which exist *between* passenger and freight traffic, to some extent even can be found *within* passenger and freight traffic respectively. As far as freight traffic is concerned such conflicts may have been few until now, but an increased diversification of the railways freight transport services in order to penetrate new markets and address different customer requirements – and in this context high-speed rail freight should expressly be mentioned – will most probably lead to an increase in conflicts, which have to be solved in a suitable way.

The trends mentioned above affect the possibilities of high-speed rail freight in different ways. Whether these are positive or negative is also depending on how high-speed rail freight is produced.

Two different production methods can be distinguished:

• a integrated production

• a separated production

As far as an integrated production of high-speed rail freight is concerned, i.e. the joint transport of passengers and express freight on the same train, the effects are positive, as high-speed rail freight benefits from the improved offer in passenger traffic. But even here the situation is complicated, as the introduction of regular-interval timetables (Taktfahrplan) often is accompanied by the break-up of individual through-running train connections over long distances in favor for shorter services.

As far as a separated production of express rail freight is concerned the effects are rather negative, as passenger traffic demands a greater part of the limited resource infrastructure-capacity, thereby limiting the capacity available to high-speed freight trains. Strict regular-interval timetables are also less flexible insofar as they do not allow a change of a single passenger-train path without changing all connected train paths similarly. This is can make it difficult to find suitable, high-priority train paths for high-speed freight trains.

9.3 Engineering work

Another problem and source of special concern is engineering work on railway lines. Due to the prioritization of passenger traffic these works are normally carried out during the night, often resulting in temporary speed restrictions or track and sometimes even line closures.

For conventional freight traffic, which runs at more modest speeds and often (not always!) is somewhat less time critical, in such cases normally one of the two following solutions is chosen: (1) Halting back trains for some time or (2) rerouting traffic over other lines, when engineering possessions last more than some hours. Both options are, however, difficult to apply on high speed rail freight.

The first option presents itself as unrealistic in most cases as already short delays make it impossible to meet the narrow time windows in the express freight market. However, high-speed freight cannot even simply be rerouted over other lines either, for several reasons:

• due to the small time-windows allowed for high-speed freight traffic even slightly small detours result in for this kind of traffic unacceptable delays.

• the line speed on alternative routes is often lower, resulting in considerable delays even when distance is not significantly longer.

• alternative routes carry even regular traffic which normally is prioritized before rerouted traffic. For this reason time needed for additional train meetings and take-overs in first hand affect rerouted traffic (this problem could be solved by changed prioritization and early planning)

• the need of calls at intermediate stations (as for example often in mail traffic) is geographically limiting the possibilities to reroute high-speed freight trains over other lines. Conventional freight trains normally do not call at intermediate stations.

Possible solutions could be

- To move possessions to day-time
- To improve long-term planning of engineering possessions so that alternative traffic solutions can be put into the regular timetable.
- To temporarily transfer traffic to other modes (air och road transport)

In order to be able to meet the customer demands on the express freight market it is important to achieve both a high *planning quality* for the trains carrying express freight as well as a high *operational quality* for the train traffic as a whole. High planning quality means that trains carrying express freight has to be given a high priority under the timetable planning process, for example when defining trains paths. A high operational quality means that the trains are running according to the timetable. In case of planned or unplanned traffic disruptions the express freight trains have to be handled with high priority.

10 Examples of transport systems

10.1 Sweden

In Sweden until recently rail was used for two products in the mail and express freight market:

- Dedicated mail trains for the Swedish post office and
- Express parcel service (SJ Expressgods) marketed by SJ itself

For the mail business freight train operator Green Cargo has invested in new rolling stock, in order to meet the demands from the Swedish Post office. Ambitious plans are made up for the future. In contrast to this, the Expressgods business earlier managed by SJ has been sold in end of 2000. The new owner has discontinued all overnight-shipments on bord of night trains and transferred them to road, retains however shipments on bord of InterCity- and X2000-daytrains, where rail is unbeatable in both speed and frequency. However, no separate express freight wagons are attached to the trains any more; the cargo is shipped in dedicated freight compartments on bord of the passenger trains. When SJ operated the Expressgods-service themselves, 90% of SJ Express' consignments were carried by rail[22].

The map on next page shows the mail train network currently operated by Green Cargo. It consists of three lines: Stockholm – Sundsvall, Stockholm – Gothenburg and Stockholm – Malmö, of which the latter even calls at

[22] Expressgods i ny regi, Transport-Journalen, 3/2000, page 11

Norrköping, Nässjö and Alvesta to set out and pick up wagons, while the others are direct trains without intermediate stops. In Stockholm two terminals are served: Tomteboda to the north of the city with four tracks under roof, and Årsta to the South. From the terminal track in Årsta truck transport is arranged to the nearby mail terminal.

The network was introduced in two steps during 2001. After full implementation 3,4 million truck-kilometres could be saved, corresponding to a decreased diesel fuel consumption of 1,36 million litres. This resulted in a reduction of CO2 by 3534 ton annually.

Currently mainly B-mail (delivery day C) is carried, however certain A-mail has been added to the system. There are plans to transfer more A-mail to rail, however this requires train speeds to be increased from the current maximum of 160 km/h. The possibility has been studied to carry additional volumes in containers instead of covered mail vans which are used today.

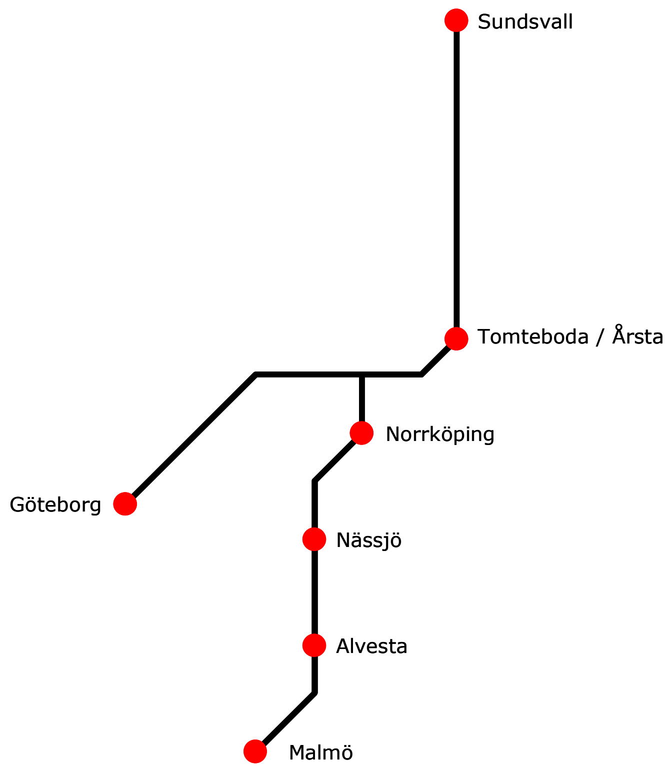


Figure: The Swedish mail train network consists of three lines radiating from Stockholm to Sundsvall, Gothenburg and Malmö. (Map: Gerhard Troche)

10.2 Denmark

The fixed Great Belt link

The opening of the fixed link over the Great Belt in 1997 – connecting the Eastern and Western parts of the until then devided Danish rail network – involved some fundamental changes for Danish rail traffic. The new opportunities created by the Great Belt-link affected even the mail train operations, which started using the new link in April 1997, about two month before passenger traffic.

The restructuring of mail traffic saw the cessation of staffed mail trains, on which mail was sorted manually en route, the replacement of older ”passenger-style” mail vans by new mail freight-cars and the cessation of joint mail and passenger trains. The number of train-kilometres in the new system remained constant but thanks to the new rolling stock the transport capacity increased by about 10%.

However, since some years all mail train operations have been abandoned and transferred to road.

It should be mentioned, that the Danish mail trains with their maximum speed of 140 km/h formally did not meet the speed criterion of >= 160 km/h established in chapter 3 in order to qualify for being considered as high-speed freight. However, as has been discussed there as well, this criterion should be applied with some flexibility, and as the Danish mail trains address the same market as 160+ km/h-trains in other countries they are described here as well.

New rolling stock

The Danish railway company DSB ordered 64 new four axle boggie freight-cars with sliding doors and a maximum speed of 140 km/h (class Habbinss-y). Due to the relatively short distances in Denmark 140 km/h were considered as sufficient to meet the time window for the majority of mail consignments. Every car offered a loading capacity of 32 tonnes or 63 wheeled mail containers, which have the same size as EUR-pallets, i.e. 1200 x 800 mm. The cars are used for first-class mail, day-2-parcels, early posted express mail and other mail.

In addition to these new cars there were a number of older two-axle wagons with a maximum speed of 120 km/h, taking 38 mail containers each. They carried second-class mail, day-3-parcels, advertising matter and other less time-sensitive shipments.

Terminals

The Danish mail train network served seven terminals: Brøndby (Copenhagen), Ringsted, Odense, Frederica, Herning, Århus and Aalborg. All terminals were rail-connected with exception of Fredericia, which required trucking over a distance of about 5km. Passenger platforms were not any longer used for mail handling.

In Copenhagen the mail trains were terminating at the new parcel-sorting centre in Brøndby, about 12 km from the city-centre of Copenhagen. Brøndby was the biggest and busiest of all terminals. It is fitted with four tracks, of which two indoor and two outdoor (but under roof). Letter mail, which is sorted in the sorting and distribution centre in central Copenhagen, was trucked to and from Brøndby

Operations

In total DSB was running 70 mail cars Monday to Friday between the above mentioned terminals. 60 of them were 140 km/h-cars, the remaining ten 120 km/h-cars. The 140 km/h-cars were running in dedicated mail trains, while the 120 km/h-cars are attached to conventional domestic freight trains, but get high priority at arrival. The longest distance, Copenhagen–Aalborg (490 km), was covered in 5:12 h:min on the outbound run and 4:55 h:min on the return run (1999), giving an average speed of about 100 km/h.

On a normal working day four mail trains were leaving Copenhagen (Brøndby) between 8pm and 11pm and the same number of trains arrived between 0am and 3am. Every train consisted normally of 4 to 9 freight cars.

There were no trains running on nights from Saturday to Sunday. On nights from Sunday to Monday 14 of the 140 km/h-cars were running in the relations mentioned above.

Prospects

Post Danmark was DSB Gods' biggest individual customer by revenue. In inter-terminal traffic rail hold a market share of 80% in parcel-transport and 70% in letter-transport. In relations served by the train there was almost no mail going by truck. Between Copenhagen and Jylland there was, however, still some amount of mail carried by aircraft in order to meet the transport time demands for the most time-sensitive shipments.

An increase of the maximum speed of the mail trains from current 140 km/h to 160 km/h had been discussed but proved to be not economically justifiable. The benefit would even be limited as the maximum line speed north of Randers is limited to 120 km/h, which means that a higher maximum speed could not be utilized over the whole distance.

New prospects for mail traffic could have emerged from the opening of the fixed link over the Öresund between Copenhagen and Malmö. This would offer the opportunity to connect the Danish with the Swedish mail train network. Discussions were going on, but the idea was never realized. Today no mail is carried by rail any more in Denmark.

10.3 France

TGV Postal

The figure on next page shows the transport system as it looked when operations began in 1984. As can been seen, the TGV Postal services were complemented by road haulage and conventional mail trains. Some of the conventional mail traffic on the railways is coproduced in the traditional way with passenger traffic by coupling mail coaches to passenger trains. There existe two types of mail vans for this services, PA (“Poste Atelier”, or “Post Ambulant”), which were staffed and where mail was sorted on bord and PE (“Poste Entrepòt”), which only carried mail. In the most important relations dedicated mail trains, TPS (“Train Poste Autonome”) had been introduced during the 1970-ies. Between Paris and Lille postal multiple units entered service towards the end of that decade. These vehicles of class X4750 cand be seen as predecessors of todays TGV Postal. Conventional mail trains, however, have now been completely discontinued and replaced by trucks. The last conventional mail train ran in December 2000 between Besancon and Paris. On the other hand, the TGV mail network has expanded and now also serves terminals located on conventional lines.

Figure> The TGV postal high-speed train – with a top of 270 km/h currently the fastest freight trains in the world. The trains are derived from the TGV passenger version. (Photo: Gerhard Troche)

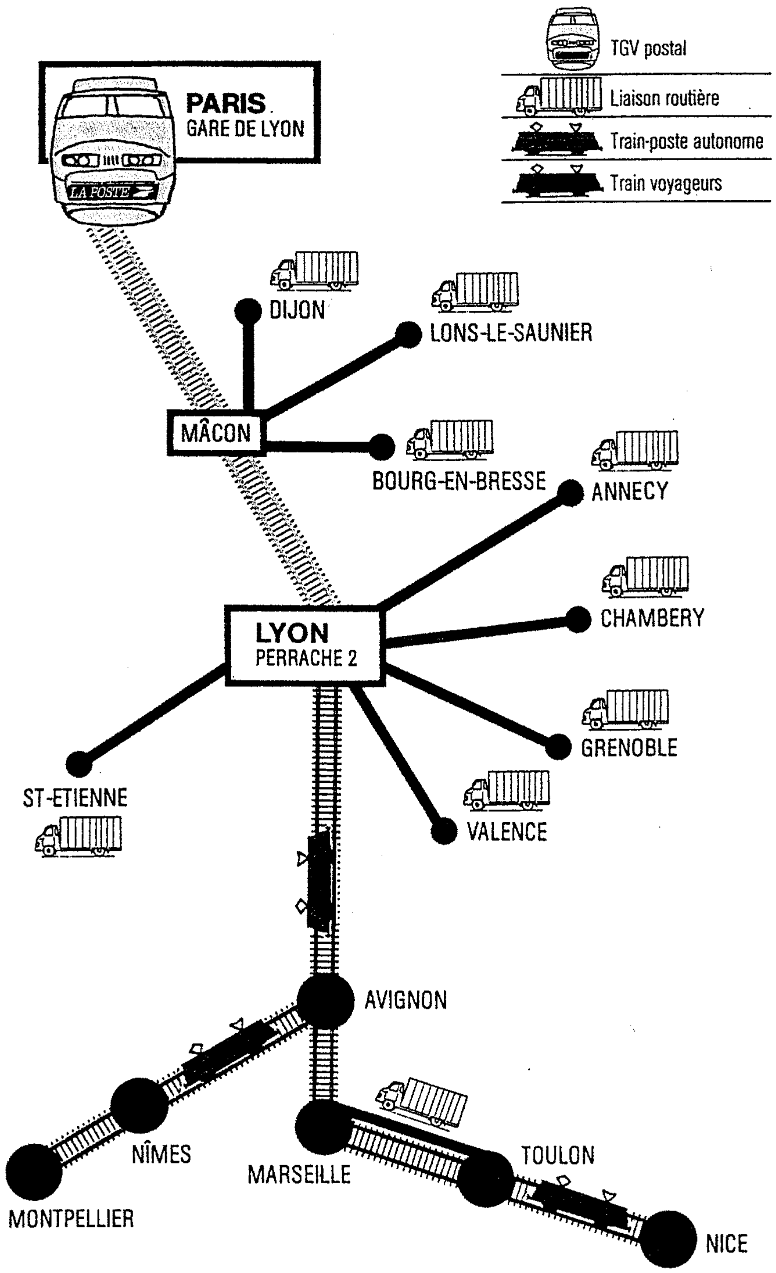


Figure: The transport system of the TGV postal high-speed train when operations started in the 1980-ies. At that time both road and conventional rail completed the system. During the 1990-ies TGV Postal operations were extended to Avignon, while conventional rail was suspended subsequently.

MGV – Messageries à Grande Vitesse

Since 1997, locomotive-hauled freight trains have been allowed to use France's high-speed lines (LGV), previously exclusively used by TGV trains. The services, known as Sernam 2000, began on 13 October 1997, with two pairs of trains on the Paris-Bordeaux and Toulouse-Orange (Avignon) routes. To begin with, the top speed was 160 km/h, but the intention was to increase the maximum speed to 200 km/h and extend the network to also include Marseille in 1998. The services were marketed under the name MGV (Messageries à Grande Vitesse). The trains are primarily focused on the express cargo market. A rail connection to Charles-de-Gaulle airport in Roissy outside Paris together with a new Air-Rail-Cargo terminal at the airport has been discussed[23].

The trains consist of modified conventional BB 22200 locomotives and covered bogie wagons with sliding walls. This solution was judged to be more economically viable than high-speed TGV freight trains. The locomotives are equipped with speed limiters and have special signalling equipment to be able to operate on the LGV lines. Measures to reduce noise have also been taken. An axle load of 18 tons is permitted at 160 km/h; at 200 km/h the axle load is restricted to 11 tons. The braking system is the limiting factor (despite their higher maximum speed, the TGV trains, for example, have an axle load of 17 tons). At the present time, 8 locomotives and 48 wagons are available for this service[24].

TGV Fret

The TGV Postal trains are used exclusively for mail and the traffic system is designed especially for them. SNCF is therefore conducting a project called TGV Fret in order to study the financial, technological, infrastructural, and traffic-related prerequisites and possibilities for introducing high-speed freight trains across a broad front. The figure on next page shows a possible future high-speed freight train based on the TGV Duplex trainset. The trains will combine high speed with high capacity and would be able to carry 10'-minicontainers.

The project is also of interest for the planned high-speed freight traffic between Paris and Frankfurt (FEX). This project will be described later.

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23 "SNCF parcels to run at 200 km/h", Railway Gazette International, July 1998

24 "Freight on the LGVs", Modern Railways, November 1998

Figure: The TGV Fret would be based on the TGV Duplex trainsets and could carry 10'-minicontainers.

10.4 England

Restructuring of mail traffic

In connection with the signing of a new 10 year contract between Royal Mail and Rail Express Systems (RES)*, starting 30 September 1996, the movement of mail on rail in Great Britain saw some fundamental changes. By this contract the partners committed long term to the use and development of rail conveyance for mail.

In collaboration between RES, Royal Mail and the infrastructure holder Railtrack a project was started called Railnet, including:

- a dedicated network and new train plan for mail trains, cessation of mail conveyance on passenger trains
- containerisation, faster loading and unloading, keeping mail in good condition, making passenger stations container compatible
- introduction of 16 new class 325 mail EMUs and modernization of older rolling stock
- transferring of all mail train services to and from London into a new distribution centre at Willesden outside London

* belonging to English, Welsh and Scottish Railways (EWS)

New network and train plan

When the new rail plan came into force on 30 September 1996, it covered a total of 65 mail trains. The network is shown in figure 7.4. 22 trains were operated using the new 325 mail train multiple units, mainly between London and Glasgow on the West Coast Main Line, to Edinburgh on the East Coast Main Line, and to Norwich and Tonbridge. 18 trains were Travelling Post Offices (TPOs), i.e. manned locomotive-hauled mail trains with on-board sorting. It is only on these trains that mail is still handled in mailbags. All mail that is not sorted on board the trains is transported in wheeled bins. All TPOs also carry containerised mail. The remaining trains are unmanned locomotive-hauled mail trains.

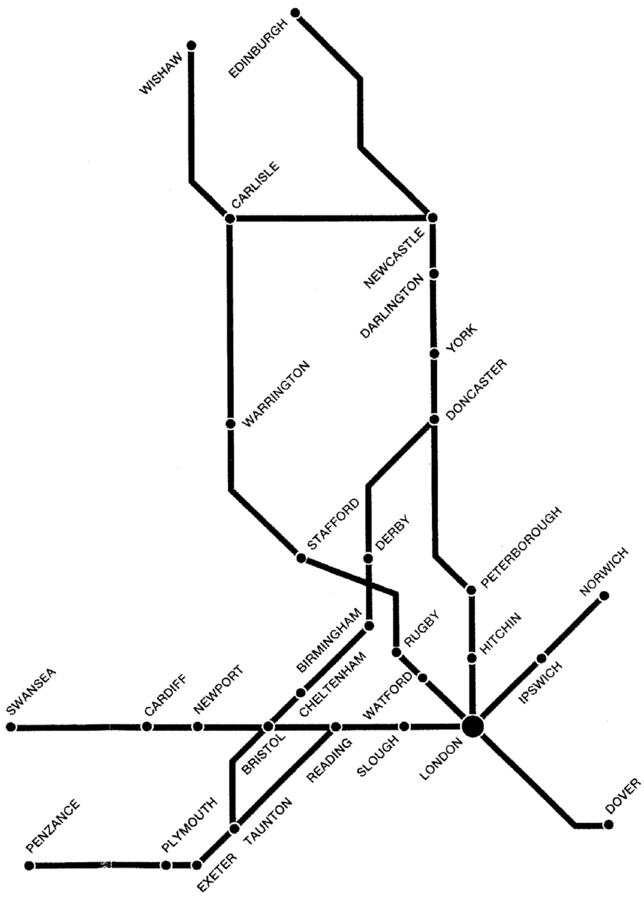

Figure: *Network for mail trains in Great Britain (Source: Modern Railways, december 1998)*

The train plan is arranged in three distinct daily waves:

• Wave 1 – starting in the early afternoon, for the conveyance of second class mail

• Wave 2 – starting in mid evening at around 19.00, for conveyance of first class mail from early afternoon collections

• Wave 3 – the overnight network starting about 22.00 to 23.00, for the conveyance of the majority of first class mail from late afternoon and evening collections.

Trains with TPOs only run in the latter wave.

Most trains operate within one wave, while some long distance trains cover two – a train from, for example, South England to Scotland starting in Plymouth in the afternoon carries Second Class mail on the first part of its journey and begins to pick up First Class mail in Mid England in the evening. In Great Britain mail trains thus also operate at daytime, in oppostion to most other countries mail train services, which normally only operate overnight.

In order to achieve a high geographical coverage many trains connect to each other in certain nodes. Through-connections are achieved both by coupling and sharing of trains and by transferring containers between trains. The latter is done particularly in the London Distrubution Centre in Willesden, which works as a big hub in the whole system. However, there are some through trains through Willesden, too. All trains even connect with Road Services and these connections are, of course, also time critical.

Royal Mail has exacting requirements with regard to punctuality – 95%. A deviation of more than +10 minutes means that the train is considered to be running late. Unlike in passenger traffic, punctuality is measured at all stations and thus not only at a train's destination.

Terminals

The number of stations for Royal Mail operations has been reduced to 45 in the new network. Of these three are dedicated railheads at Willesden (London Distribution Centre), Low Fell (Tyneside Rail Terminal) and in Tonbridge (South Eastern Rail Terminal). All terminals are electrified. As for the rest mainly passenger platforms are utilized for loading and unloading. The stations are equipped with movable ramps, lifters and trolleys. There is no fixed equipment installed on the platforms.

The York-container, a universal rolling bin is used for both road and rail transport and in sorting centres.

Market position and prospects

About 30% of the 75 million letters carried by Royal Mail each day are travelling by rail. Trucks hold 65% and air transport the remaining 5% (figures for 1999). Rails position is specially strong on medium distances, between 240 km (150 miles) and 400 km (250 miles). On shorter distances road transport dominates, while longer distances are normally covered by aircraft. [25]

Railnet has developed very postively, in spite of some problems to fulfil the high quality demands (punctuality). Problems can partly ascribed to the use of old unreliable traction, a problem which was largely eliminated with the introduction of new motive power (Class 67).

In a change of strategy Royal Mail started a few years ago to replace rail transport by road. However, since this caused severe quality problems rail could not be abandoned totally as originally planned and it was later decided to continue using rail on selected relations.

10.5 Germany

ICGE – InterCargoExpress

When the high-speed stretches between Hanover ands Würzburg and Stuttgart and Mannheim were opened, German Rail (DB) introduced the InterCargo Express (ICGE) express freight trains, that were primarily intended for intermodal traffic.

In June 1991, services began on the Bremen–Stuttgart and Hamburg–Munich routes, each with its own pair of trains. The trains operated at 160 km/h on the newly constructed lines and 140 km/h on upgraded lines. The higher speed reduced the running time by 2 hours to about 8 hours between Bremen and Stuttgart and 9 hours between Hamburg and Munich. The trains consisted of 20 four-axle Sgss-y 703 bogie container wagons. 5 Hbillss-y 307 two-axle covered wagons were introduced on the Hamburg-Munich routes for single consignments and part cargo (during trials, these wagons reached speeds of up to 213 km/h.

The trains had a maximum gross weight of 900 tons. The payload was 500 tons and the trains were hauled by type 120 locomotives. The original intention was for the trains to travel coupled together on the shared Hanover–Würzburg stretch (Train Coupling and Sharing, TCS), but this proved to be unfeasible due to technical problems that have yet to be resolved.

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[25] Bill Berridge, EWS, 11 November 1999 (oral)

After a few years, the ICGE trains' maximum speed was again lowered to 120 km/h, according to German Rail a result of poor profitability. In the long term, however, they still feel that the prerequisites exist for higher speeds, especially for intermodal traffic. At present, a speed increase to 140 km/h for certain selected freight trains is being considered. High-speed freight trains between Frankfurt and Paris (see below) are also being planned in cooperation with SNCF and other operators.

The average speed terminal to terminal on the Hamburg-Munich ICGE route was 92 km/h; the average speed on the run was about 130 km/h. The losses occur mainly around the terminals themselves, due to shunting and locomotive switching (from diesel to electric).

Parcel-Intercity

By the end of January 2000 DB Cargo launched a new mail and parcel train service for its customer Deutsche Post, only x years after that conventional mail trains finally had been discontinued in Germany and Deutsche Post had restructured its terminal network, abolishing a comprehensive network of rail-connected mail terminals, which in some cases had been modernised not long time before.

After the abolition of the former rail-based transport system only a small portion of parcel traffic was left on rail, carried in containers. On working days about 220 loading units, corresponding to about 10% of Deutsche Posts' total parcel business in Germany, where carried by rail. At weekends the rail share increased to 50%. In total about 80 000 loading units annually went by rail.

The aim of the Parcel-Intercity project was to increase this volume. In a first step 10 000 more containers per year should be transferred from road to rail, corresponding to a 20% increase in the rail transport volume on working days.

The 31 January 2000 operations started on a North-South pilot route, linking Hamburg and Hanover with Würzburg, Munich, Nuremberg and Stuttgart via the Hanover-Wurzburg high-speed line, connecting 13 of Deutsche Posts 33 freight centres. However, since the new freight centres had been built without rail access, the parcel containers have to be trucked on their first and last leg of the journey. They are transloaded in conventional intermodal terminals.

The maximum speed of the trains is 160 km/h, which necessitates the use of special high-speed container wagons, in this case four-axle bogie wagons of type DB Sgss-y 703, originally developed for the former InterCargoExpress traffic in the beginning of the 1990-ies. Motive power is hired from sister company DB Reise und Touristik in form of two 6 MW-locos of the new class 101.

A crucial aspect in this kind of traffic is a high reliability and punctuality. DB Cargo guarantees a punctuality of 94%. Should it fall under 90% Deutsche Post has the right to cancel the contract immediately. However, punctuality up till now has been constantly between 98% and 100%.

The good performance of the ParcelIntercity has confirmed DB Cargo and Deutsche Post to bring forward the expansion of the network. New routes from East to West and East to South are planned and may create a nationwide network of Parcel-Intercity trains.

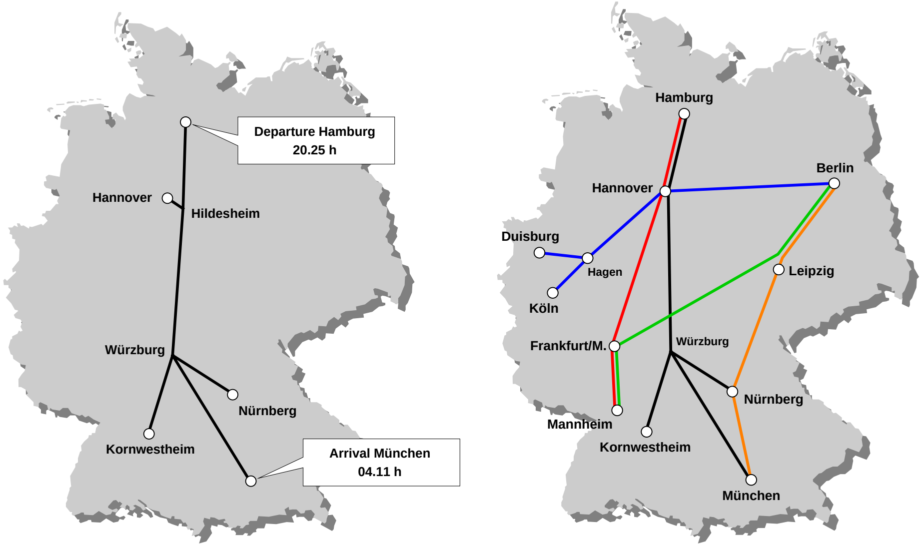

Figure: The planned german Parcel-Intercity network. Above the pilot route due to open in beginning of 2000, to the right an extended scenario by Deutsche Post AG for year 2001/02 (map: G.Troche).

10.6 International

OverNight Express Amsterdam–Milano

The OverNight Express Amsterdam–Milano was an attempt to (re)launch the idea of combined goods- and passenger trains in Europe in a time, when elsewhere in Europe the trend rather goes in the opposite direction. It was launched in May 2000 jointly by railfreight operator Railion Benelux and passenger operator NS International. It is also is one of very few European high-speed rail freight services, which was international, running through no less than four countries – The Netherlands, Germany, Switzerland and Italy.

The train was addressed to time-sensitive premium freight, such as flowers, vegetables, fruits, computer equipment and other lightweight high-value merchandise, which today almost entirely is dependent on road and air transport.

The OverNight Express ran six times a week in both directions, leaving Amsterdam at 18.00 and arriving in Milano at 07.50 following morning. The return run departs Milano at 20.00 and reaches Amsterdam at 10.37. A guaranteed journey time of less than 14 hours, against a minimum of 35 hours for conventional freight trains and 22 hours for intermodal trains, made the service competitive against both road and air transport.

While the passenger portion conveys modern sleeping as well as seat cars, the freight portion consists of former DB postal vans. They are running through from Amsterdam to Milan. No loading or unloading or attaching and detaching of wagons does occur on intermediate stations. The train crew on the passenger portion of the train, which runs through from start to destination as well, looks also after the freight. This means that the load is accompanied under the whole transport, which otherwise is a privilege of cargo going by truck.

After the start by the end of May 2000, the number of freight wagons rose within three month from three to six per train. Under the same time the load factor increased from 30% to 70%, corresponding to a total of over 4 000 bookings per month.

In order to be able to carry even frozen goods Railion Benelux had in cooperation with its partners in EFFORRT (European Food & Flower Overland Road and Rail Transport) also developed reefer swap bodies and containers and special intermodal wagons allowing a speed of 160 km/hour. The prototypes were expected to be approved and available in 2001.

Railion Benelux and NS International considered also the introduction of other European destinations for combined passenger and goods trains.

10.7 Ideas for European and Scandinavian networks

The FEX project

Within the framework of the German-French Deufrako co-operation, SNCF and German DB were studying the possibilities for joining together to operate high-speed freight traffic between Frankfurt and Paris. The FEX (Freight-express) project has the explicit aim of developing high-speed freight trains based around either ICE or TGV technology. The wagons must be able to load air cargo containers and will therefore probably be equipped with the same type of roller floor that aircraft have. The trains will operate between Cologne and Brussels and running time between the Paris and Frankfurt termini will be 6 hours. Newly laid high speed stretches or substantially upgraded stretches of track will mainly be used.

The service is principally aimed at the express and door-to-door freight markets. Great importance is attached to integrating the rail and air freight systems. The trains will stop at the airports in Cologne/Bonn, where an AirRailCargo terminal is planned, and Frankfurt/M, that already has an air cargo terminal with a rail connection, but which is not as it stands adapted to the planned type of high-speed freight traffic. In France, a rail connection is being planned for Charles de Gaulle airport. In the long term, the intention is that the Paris-Frankfurt pilot route will have connections from Brussels and Paris to London, between Brussels and Amsterdam and between Frankfurt and Zurich. This "basic network" is intended to be later a part of a coherent pan-European high-speed rail freight network[26].

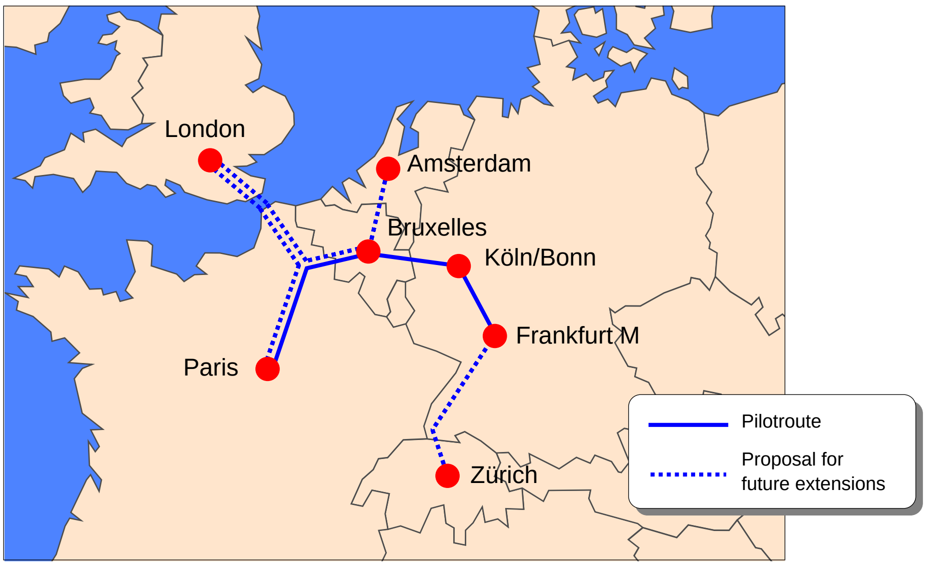

Figure: Pan-European high-speed rail freight network as proposed in the FEX project.

26 "Highspeed auf Schienen für eilige Güter", BahnTech, nos. 2 and 3/1998

High speed rail freight for Scandinavia

The opening of new high-speed lines in Scandinavia, stepwise creating high-speed corridors between the most densely populated regions in Scandinavia opens up new opportunities to develop high-speed rail freight services.

Of special interest is the Europa- and Gotalandsline project, linking Stockholm, Gothenburg and the Oresund-region and connecting in Hamburg with the Central-European high-speed network.

The map on next page illustrates how the new infrastructure could be used to establish new high-speed freight services on these lines. These services could even cross national borders and continue to destinations in neighboring countries – or connect to services in these countries. Travel times from Stockholm to Hamburg could then be in the same range as for mail trains between Stockholm and Malmo today.

In order to fully utilize the potential it is however crucial to develop even terminals along the line and to improve the interconnection with other transport modes, not least air. If this aspect is taken into consideration already in the planning phase, the chances to realize plan for high-speed freight services will improve significantly.

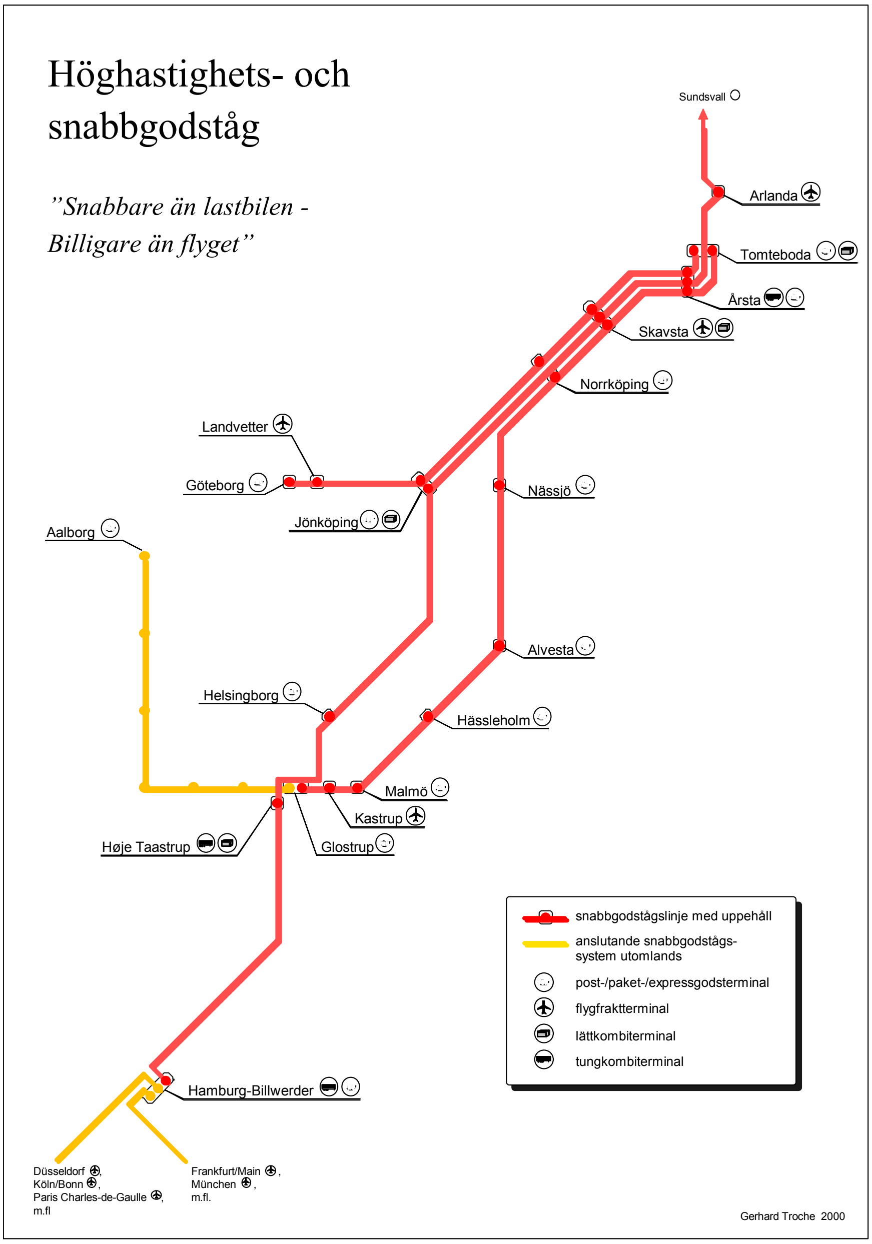

Figure: Outline of potential high-speed rail freight services in the "European Corridor" after opening of new high-speed lines.

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