



TECHNICAL AND ECONOMIC STUDY

MIXED FREIGHT-PASSENGER TRAIN

BARCELONA – FRANKFURT

This study was carried out on behalf of the OBJECTIF TRAIN DE NUIT association with the support of the Occitanie and Grand Est regions, SNCF Réseau and Ferrocarrils de la Generalitat de Catalogna.

Bringing time reliability from passenger trains to goods trains, and the cost effectiveness from passenger trains to freight trains

The idea of creating a mixed passenger-freight train at night is based on the **complementary nature of the night passenger train and freight train concepts**. The economic deficit of the night passenger train operation is compensated by the **economic viability of the freight train, while the passenger train provides the expected guarantees in terms of reliability and punctuality**. The combination of these two concepts into a single mixed train then makes it possible to compensate for the deficiencies of each.

SUCH A CONCEPT ALREADY EXISTED...

Although the idea may seem innovative, **various mixed passenger-freight train services have already existed in the past**. In 2000, the mixed train «Overnight Express» combined **overnight sleeper and fast freight between Amsterdam and Milan**. The wagons used were adapted to facilitate the loading of goods and to allow higher speeds. Other mixed train services have existed, such as the **«Meteor» service from Hamburg to Munich, or the Auto-Train service in France, which served many destinations in France from Paris**. Semi-high-speed freight services with speeds of up to 250 km/h have been tested in Italy, with extensive work on modifying the wagons so that they can run at such speeds. However, the financial equilibrium of these services remains fragile and depends essentially on the existence of a sufficiently large volume of freight, balanced in both directions and profitable throughout the year.



Choice of route between Barcelona and Frankfurt

Several route scenarios have been analysed: they are shown on the map below. **Scenario (1) via Switzerland is the first one that was studied with the aim of reconciling a Spain-Germany and Spain-Switzerland service.**

The service (1466km) is not longer in distance than the passage through Nancy:

- **The journey time for this scenario is relatively longer due to the long journey times in Switzerland**, particularly between Lausanne and Bern.
- Passing through Switzerland involves **two border crossings**, which can have a negative **impact on travel time and comfort**.
- **Arriving in Strasbourg from the south** at the height of the morning or evening rush hour requires the train to be turned around at the station.
- The gauge is limited to the GA gauge between Lyon and Geneva, which means that low-floor wagons have to be used.

Route (3) via Metz and Saarbrücken is detrimental to services to Alsace, as Strasbourg is **no longer served. This route is suitable for freight, as it has a B1 gauge from end to end, but is not acceptable for passenger services.**

The service scenario (4) using the Revermont line via Besançon and Belfort represents a gain of 95 km compared to scenario 1 with a journey time reduced by one hour. However, this scenario also has disadvantages: **an arrival in Strasbourg from the south** which is difficult, especially as the freight coupon should be separated before perhaps Mulhouse, and **gauge constraints similar to the scenario via Switzerland.**



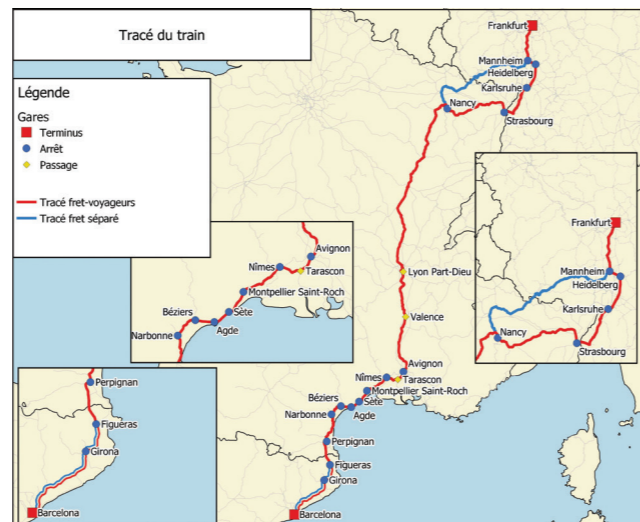
The route via Nancy was therefore chosen. It has a **fairly fine service to Catalonia and Occitania as far as Avignon**, then a night service as far as Nancy with a **daytime service to Alsace via Strasbourg and to Baden-Württemberg and Hesse via Karlsruhe, Heidelberg, Mannheim and Frankfurt.**

Other night services could then be studied in order to create a real Lunatrain network as shown in the figure opposite.

THE BARCELONA - FRANKFURT TEST TRAIN

The mixed night passenger-freight train service between Barcelona and Frankfurt requires an adaptation of the route to the technical requirements indispensable for freight traffic. The chosen route totals **1495 km** and offers a **fine service to the regions of Catalonia and Occitania up to Avignon**. A night service is then provided to Nancy, before a day service from Strasbourg to Frankfurt. The route thus presented offers the advantage of being able to envisage a **subsequent unbundling of the service into several routes**. This initial test on a relevant corridor can then be duplicated on other night services depending on the attractiveness of the product.

The proposed timetables are attractive even for a full end-to-end journey with late day departures and early morning arrivals. The journey times presented above take into account the **speed limits imposed by the infrastructure and the actual longitudinal profiles as well as optimisations on rolling stock and operating conditions**. The resulting timetables allow for some flexibility in service.

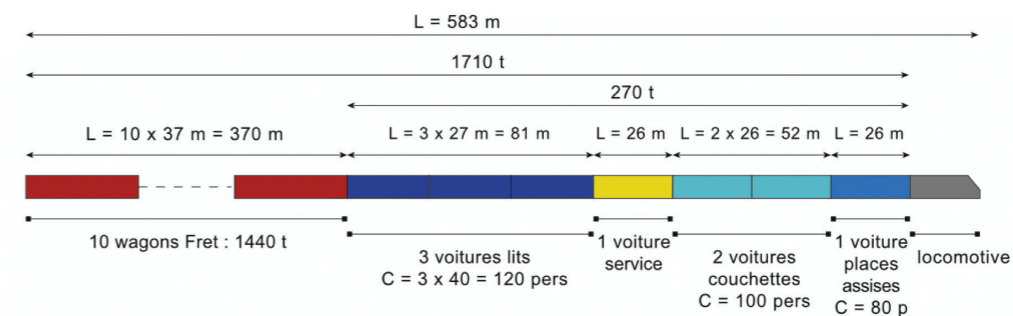


TECHNICAL ANALYSIS

The freight and passenger coupons are attached and detached in Figueras¹ and Nancy², which means that goods can be transported from Barcelona to Mannheim and Frankfurt with a combined length of 967 km, i.e. two thirds of the route.

Similarly, the **rolling stock used for both freight and passenger transport is not subject to any constraints in terms of gauge, traction capacity or running speed**. The train envisaged is as follows, with a capacity of 10 double 106-foot freight wagons for a mass of up to 1,440 gross tons, and 300 passengers distributed according to different levels of comfort.

Following an in-depth analysis, it seems preferable to start the service with wagons already approved for 140 km/h on lease, with the possibility of extending



¹The unhooking of the freight and passenger coupons is planned to take place north of Figueras in the LFP (ex TP Ferro) facilities in Llers (a few km north of Figueras). LFP has been consulted on this possibility and has given its agreement.

²The freight wagons will be removed in Nancy to avoid having to do it in Strasbourg where it would be necessary to turn the train around.

ANALYSIS OF THE PASSENGER MARKET

The introduction of a mixed night passenger-freight train requires consideration of the **current market situation for both services**. At present, there is a trend in several European countries to reduce the supply of night passenger trains. **In France, night trains have been gradually phased out since the 1990s**. This elimination has accelerated since 2012 with 8 lines successively eliminated between 2012 and 2017. The reason for this is the difficult profitability of the operation of these lines and competition from coaches since the liberalisation of the market in 2015. Four night train lines remain in France today, all subsidised by the State. However, the trend seems to be reversing with the resumption of the Paris - Nice and Paris - Tarbes trains by 2022.

The same is true in Italy and Spain, where night train services are gradually being reduced. The service offered by the Austrian operator ÖBB is an exception, but it shows that a well-organised service can find its place. After taking over the business of the German operator DB in 2016, it is the only operator of night trains in Germany and Austria. Austria's situation gives night trains certain competitive advantages: low taxes, little competition from low-cost air transport

the range to 160 km/h wagons 10 years after the first results of the service. These wagons are less expensive, easy to obtain and allow higher payloads.

A first analysis of the graph allows us to conclude that the train is operable: In Languedoc Roussillon, the reticular planned in the medium-term horizon reserves a path between Barcelona and Montpellier. The path also falls outside the maintenance windows of the railway line Perpignan - Figueras. For the night route between Avignon and Nancy, the path will still be traceable to the night works because of the possibility of dual routes south and north of Lyon. For the Strasbourg route, in the morning, the path will be inserted between Strasbourg and Kehl between the half-hourly TERs to Kehl and the quarter-hourly TERs to Basle. The passage into Germany via Heidelberg facilitates insertion in the morning.

and a central geographical location make it possible for night trains to hold their own. In addition, the current "flying shame" movement, as well as the current difficulties of the airlines, is an **incentive for a general redevelopment of the night market**.

The traffic forecast made in the study, taking into account current passenger traffic for rail, car and air, estimates that the implementation of the passenger part of the service would attract between **150,000 and 220,000 passengers with a load factor of between 70% and 100% for the year of implementation**.

The price levels envisaged are as follows:

Prix moyen TTC (€2020)	distance (km)	Places assises	Couchettes 6 pers	Couchettes 4 pers	Wagons-lits 3 pers	Wagons-lits 2 pers	Wagons-lits 1 pers
Barcelone - Perpignan	191	34					
Barcelone - Montpellier	351	41					
Barcelone - Strasbourg	1 257	50	66	77	88	110	165
Barcelone - Francfort	1 454	55	72	83	94	116	171
Montpellier - Strasbourg	906	41	57	68	79	101	156

ANALYSIS OF THE FREIGHT MARKET

The attractiveness of rail freight compared to road: price, regularity and reliability. The price of transport is the first criterion for choosing a mode. In order to be competitive, and taking into account transport and distribution times, the cost of rail must be 15% to 25% lower than road transport. Regularity and reliability are the second criteria of choice. The whole issue rests on the days of circulation, as a regular service is one of the keys to modal shift. **Revenues were therefore based on a charge of around 0.03€ / tonne.km.** The transport from Barcelona to Frankfurt (1460 km for the freight route) of a 20-tonne TEU costs €876 per journey. By comparison, the same journey by road transport costs €1064 for 18t on average, i.e. 35% more. Even with lower costs (Romanian and Bulgarian flags), rail transport remains competitive.

The flows between Spain and Northern Europe are considerable (13 million tonnes exchanged between Spain and Germany), almost exclusively by road. **It is therefore possible that a well-organised, attractively priced and sufficiently reliable service could find its place.**

On the basis of the market study, **annual freight traffic of between 380,000 tonnes with a 50% load factor and 608,000 tonnes with an 80% load factor can be envisaged.**

In the south, the freight coupon is loaded and unloaded in the multimodal freight facilities of the port of Barcelona or near the international gauge serving these facilities. In the north, the freight coupon transits via Metz to Saarbrücken and Frankfurt. The two multimodal loading and unloading facilities are located in Frankfurt and Mannheim.

ECONOMIC ANALYSIS

Total revenue is the sum of passenger and freight revenue. Taking into account **passenger numbers and ticket prices according to the different comfort options available (seat, sleeper, sleeping car), passenger revenues amount to €12 million per year. The revenue for freight is estimated 23 million, which is almost double the passenger revenue in one year. The total revenue thus amounts to just over €35 million per year.**

The common costs correspond to the operating costs which are broken down into three categories: operating costs, capital costs and structural costs. 25 million per year, but could be reduced to **€15 million per year after optimisation.** The freight service adds costs for wagon maintenance and driving. These amount to €8 million per year, giving total costs of **€23 million per year based on the optimised estimate for common costs.** In addition to these costs, there are tolls paid to infrastructure managers for each network used in Spain, France and Germany. **The total of these charges amounts to €4 million for one year of operation of the service.**

	Bilan économique et financier - Millions Euros 2020 HT		
	Hypothèse optimisée	Hypothèse moyenne	Hypothèse minimale
Voyageurs / an (milliers)	153,6	153,6	153,6
Voyageurs.km / an (millions)	776	776	776
Trains.km / an (millions)	1,1	1,1	1,1
Recettes	35,6	35,6	35,6
<i>dont voyageurs</i>	12,3	12,3	12,3
<i>dont fret</i>	23,3	23,3	23,3
CEX	-23,1	-28,1	-33,6
<i>dont voyageurs</i>	-14,8	-19,4	-24,6
<i>dont fret (marginal)</i>	-8,3	-8,7	-9,2
Péages	-3,9	-8,2	-12,5
Total	8,6	-0,7	-10,5
Marge (%)	24%	-2%	-29%

Three hypotheses were tested
In the medium hypothesis, the train's economic balance is balanced, thanks in particular to the operation of the freight section.

A socio-economic analysis, including the train's environmental and safety externalities, concludes that the balance sheet is very largely positive, according to the evaluation rules in force.