

2. THE HIGH SPEED RAIWAY LINE TURIN-LYON

2.1. Main data and a bit of clarification concerning the tunnels.

- Despite the name, the Turin-Lyon doesn't pass to Turin town. Exiting from Gravio Musine tunnel, it takes the direction of Settimo Torinese where it connects with the ordinary and high-speed lines, Turin–Milan.
- The Turin-Lyon TAV length ranges between 254 and 265 depending of the France side option, about 20 to 30 shorter than the historical line which is 287 Km long (RFI data) and passing through the Frejus railway tunnel. The TAV fleeting train connection Turin to Lyon is only 247 Km long, as the historical line is used till Bruzolo, then the new line until Lyon.
- The well advertised 53 Km long tunnel, known as well as basic tunnel, is not the only one. There are other 4 tunnels in Italy for a total amount of other 41 Km. All tunnels are double tube, meaning that there is one gallery for each direction. In addition there are other 50Km of tunnel for priority-passing rails, inspections, access window and service tunnels, descents, ventilations, refuges for people, and so on.
- The Turin-Lyon is composed by three segments, Italian and assigned to RFI as general contractor, International and assigned to LTF (Lyon Turin Ferroviare) and a French segment, not yet assigned. The Italian segment is (see red track in Fig. 2.1-1) is 43 km long. Starts from San Didero, includes the tunnel Gravio-Musine tunnel (21.3 Km) and the northern Turin surrounding part, also called Gronda Nord of Turin, which is implemented as series of artificial tunnels, embankment, trench, viaducts, until Settimo. It includes as well two natural tunnels at Venaria (5 Km) and Settimo (2Km). The Gravio Musine tunnel has 4 service accesses, one in proximity of Condove two at Caprie and one at Almese.

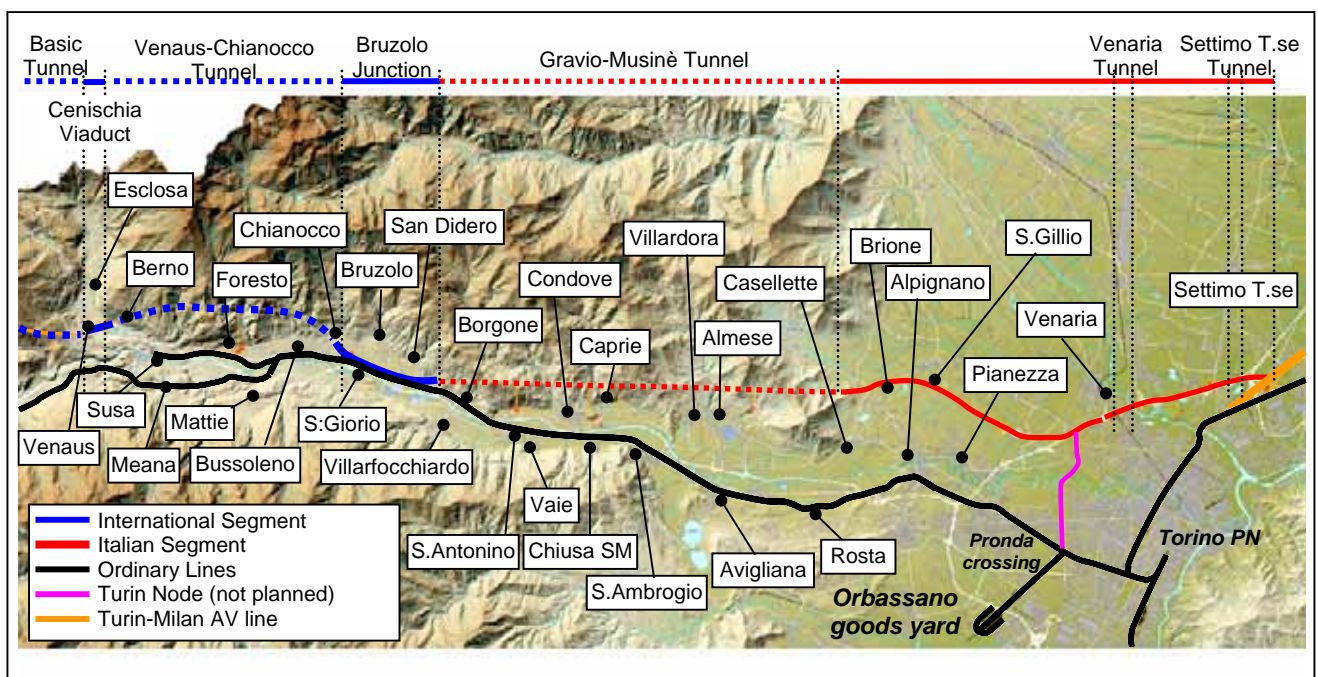


Fig 2.1-1 The Italian segment and the junctions with the existing lines

- The International segment starts from Saint Jean Maurienne (France) and ends at San Didero (Italy), after 72 Km. It is composed by the basic tunnel 53 Km long, until Venaus, a viaduct of about 1 Km crossing the Cenischia Valley and the subsequent 12.5Km tunnel until Bruzolo and the train temporary parking area of San Didero. The segment includes the Modane station at 360 meters under the ground level, reachable through a 4Km descent tunnel and equipped with priority-passing rails, crossing rails, a large refuge, tunnel control means and safety equipments. 35% of the international segment pertains to Italian territory and 65% to France.
- Four forced air ventilation stations inside the tunnel and connected externally, are providing the cooling system which together with the piston effect of the trains, are in place for removing the large quantity of geothermic and train dissipated heat. The tunnel mid way temperature is predicted around 45-50 degC.
- The France segment is 137 Km long of which 40Km are made of 3 tunnels, respectively Belledonne, Beron-Chartreuse, Dullin-l'Epine. Belledonne tunnel is the only one in the line having a single tube. The design of the France segment is mostly unknown.
- The complete project (see Tab 2.1-1) can be split in about, 119 Km of external line and 135 Km inside double tube tunnels, which becomes about 300 Km including as well service tunnel, refuges etc.

Turin-Lyon Official data Piedmont Region	Italiana Segment Km	International Segment			French Segment Km	Total	
		in Italy Km	in France Km	Sum Km		Km	%
At ground level	2.4		2.8	2.8	97.0	119.2	47%
Embankment	5.0	4.4		4.4			
Trench	6.0						
Viaduct	0.6	0.9		0.9			
Artificial tunnel	5.9				16.0	134.8	53%
Natural Tunnel - single tube							
Natural Tunnel - double tube	23.6	20.2	45.1	65.3			
Total	43.5	25.5	47.9	73.5	137.0	254.0	100%
% per Nation	100%	35%	65%	100%	100%		

Tab 2.1-1 Composition of Railway segment per typology

- The traffic of the line will be mixed, i.e. fleeting and freight trains. This choice makes the line less efficient as the freight trains travel at a speed lower than the fleeting trains (around 100Kmh). As a consequence it will be an High Capacity line rather than High Speed, as advertised. Other countries have chosen to build high-speed lines between big towns, 300-500 Km apart and keeping the freight trains over the ordinary lines.
- As understood from the LTF and RFI design documentation, the material extracted from the tunnels will amount to about 26 million of cubic meters, of which 16 in the Italian territory, equivalent to block of 1Km times 1Km and 16 meters tall. About the volume of the houses of a city of 250,000 people. The final report prepared by COWI for L. de Palacio [49] mentions 33 millions of cubic meters extracted for the international segment only. The discrepancy between the data is too wide to be technically explainable.
- Millions of cubic meters of sand and gravel, partly obtained by milling and fragmenting the excavated material and partly from local sites, will be needed for the concrete of the inner tunnel revetment, viaducts, trench walls and so on, mainly taken from extractions along the Po river. The volume of the concrete needed for the International segment only is 3.8 million of cubic meters.
- The electrical power to supply the line which will operate at 25KV, will be provided by two new power substations at Caselletto and Bruzolo, supplied respectively with a new 380KV power line from Leini and a twin 132KV power lines to Bruzolo. The precise track of the power lines has not been defined yet.

2.2. The historical line Turin-Modane

- The rail doubling completed in 1985 was done with the purpose of running more than 100 trains pair daily.
- Since more than 30 years express trains runs at 155 Km/h between Bussoleno and Alpignano (30Km).
- France TGV and Italian TAV are running since several years on the historical line, managed by Artesia, which is a Trenitalia and SNCF joint venture. Due to 6 M€ losses at the end of 2004, Artesia has cancelled all trains based on TGV/TAV material, scheduled between Milan and Lyon Part Dieu (Lyon centre) and passing on the historical line, because of the negative results, redirecting them to Paris via Simplon.
- Now it takes 4 or 5 hours to reach Lyon from Turin, of which 3:35 of real travel and the rest as waiting time at Chambéry (direct trains no longer exist). Turin to Paris journey takes only 5:21 (official Trenitalia-SNCF schedule– e.g. train 9241) because they are passing via Culoz instead at Lyon and are stopping nowhere.
- The average number of trains running daily in 2003 was 123 (87 transporting freight and 36 passengers) for the Bardonecchia-Bussoleno segment and 141 between Bussoleno-Turin, where the numbers of fleeting trains increase to 54 [1]. Globally the line was used only for the 38% of its capacity, now even less.
- The weaknesses of the line are (1) the steepness of its mountain track, Bussoleno -Bardonecchia - Saint Jean de Maurienne, (2) the profiles of the Frejus and other tunnels, constraining the high of the trucks to be transported, (3) the lack of electrical power in the Italian side and (4) some restrictions imposed by bridges, rail-crossings and absence of automatic block. Work for enlarging the profile (Gabarit) of the tunnel have started in 2004, with a forecast of completion in 2009.
- A "ferroustage" service (transport of trucks over railcar) between Aiton and Orbassano is in place with 4 daily trains for each direction since 2003. Each train can accommodate 18 trucks with high not exceeding 3.7 m due to Frejus tunnel limitation. Cutting the 360 M€ for granting and improving the ferroustage in the triennium 2005-2007 from the 2004 Italian financial plan, has forced the company managing the service to increase the ticket. Immediately the trucks have abandoned the service because of its cost and the waiting time for at both ends. The trip in the motorway is more expensive but it takes only about 2 hours.

2.3. The connections of the new High Speed line with the historical line

- Two connections are planned between the new Turin-Lyon and the ordinary line, at San Didero-Bruzolo (40Km west of Turin) and at Settimo. Rumours indicate a possible built up of a new goods yard nearby.
- A train stabling area, where trains transporting freight will temporary stop for being passed by the

TGV/TAV, will be build at Bruzolo, supporting train length up to 750m, longer train will have to be split.

- The Turin node and its city crossing at Corso Marche (close to western city border) will not be implemented due to its high cost (RFI data), even though the administration of the Piedmont Region and Province of Turin has asked several times RFI to reconsider it. People believes that one of the hidden reason of not doing it, is because of it impact on the city and the consequent dramatic increase of the opposition to the project.
- The absence of the Corso Marche interconnection together with a new goods yard at Settimo, will mark the death of the Orbassano site, which has been recently completed with significant amount of public funds and where several related commercial activities (e.g. agro-alimentary market) have been transferred from the town.

2.4. Traffic model of the Turin-Lyon

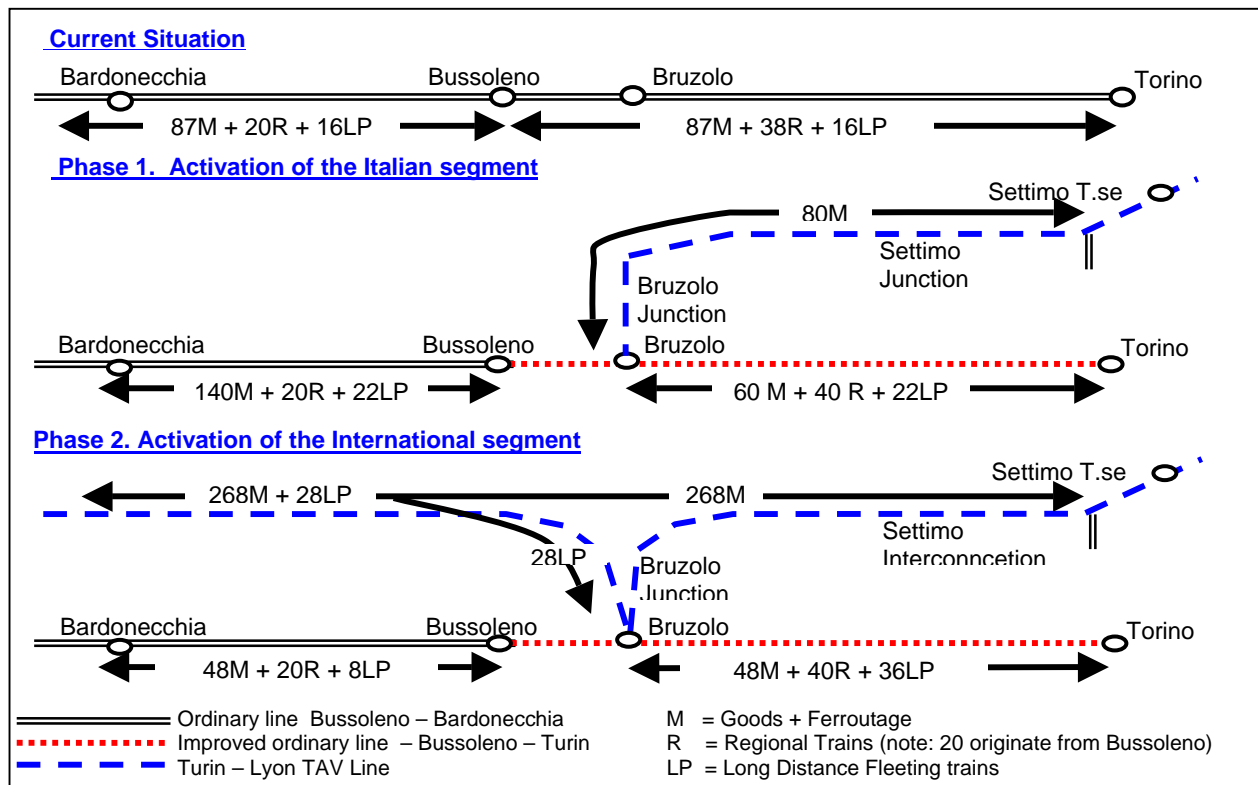


Fig 2.4-1 The traffic model of the Turin-Lyon and the actuation (without Turin crossing).

The model of the traffic is depicted in Fig. 2.4-1, where trains between Bussoleno and Bruzolo have been omitted for simplifying the scheme. Such number is however equal to the trains between Bussoleno and Bardonecchia, plus about 20 daily regional trains originating of ending at Bussoleno.

The actuation of the high speed and high capacity is performed into two phases, the former starting at the availability of the Italian segment and the latter once International segment will be operative.

As said before, the historical line was used in the 2001 at 38% of its capacity; 123 trains are travelling daily in the upper part and 141 are running between Bussoleno and Turin, or more correctly, between Bussoleno and Pronda crossing, where a number of train prosecute to or come from Orbassano goods yard.

In the first phase, the Bardonecchia-Bruzolo segment will experience 182 daily trains, of which 100 are carrying goods, 40 are devoted to “ferroutage” and 42 are fleeting trains. Eighty of the 100 freight trains will take the junction at Bruzolo, continuing on the Italian segment until Settimo, then only 30 of these will proceed to Milan. The freight trains will be the only one running on the Italian segment while all the other trains passing at Bruzolo will continue to Turin or Orbassano over the historical line, including the 20 regional originating/ending at Bussoleno and the 40 “ferroutage” trains. This means that the number of trains running daily in the Bruzolo to Turin segment will decrease from 141 of today, to 122.

The AV/AC project will be completed in the second phase. The number of train running between Bardonecchia-Bussoleno will decrease from 182 of the previous phase to 76, in particular 40 for freight, 8 for “ferroutage”, 8 long distance fleeting trains and 20 regional. The utilization of the historical line will drop to 22%, while 296 trains will transit daily in the International segment, 28 long distance fleeting trains, 148 for freight and 120 for “ferroutage” service. At Bruzolo junction, all fleeting trains from France will take the historical line (vice-versa for the trains Turin to France), while all freight and ferroutage trains will continue be the sole users of the Italian segment [10] if Turin crossing is not implemented.

Bruzolo-Turin segment of the historical line will experience a daily traffic decrease from 141 to 124 trains, including the 76 also running in the upper part, 20 regional trains originating/ending at Bussoleno and 28 long distance fleeting trains thought the International segment. This brings the line utilization to 33% of its capacity while only 8 "ferroustage" trains to/from Orbassano site remains as today, definitely not a good future planning. All this is a paradox because fast fleeting trains are constrained on ordinary lines and slow freight trains are running slowly on new lines. The results is that all trains will run slowly and the **Italian segment is built (with severe implications) just for freight trains!!!**. See later the implications of this.

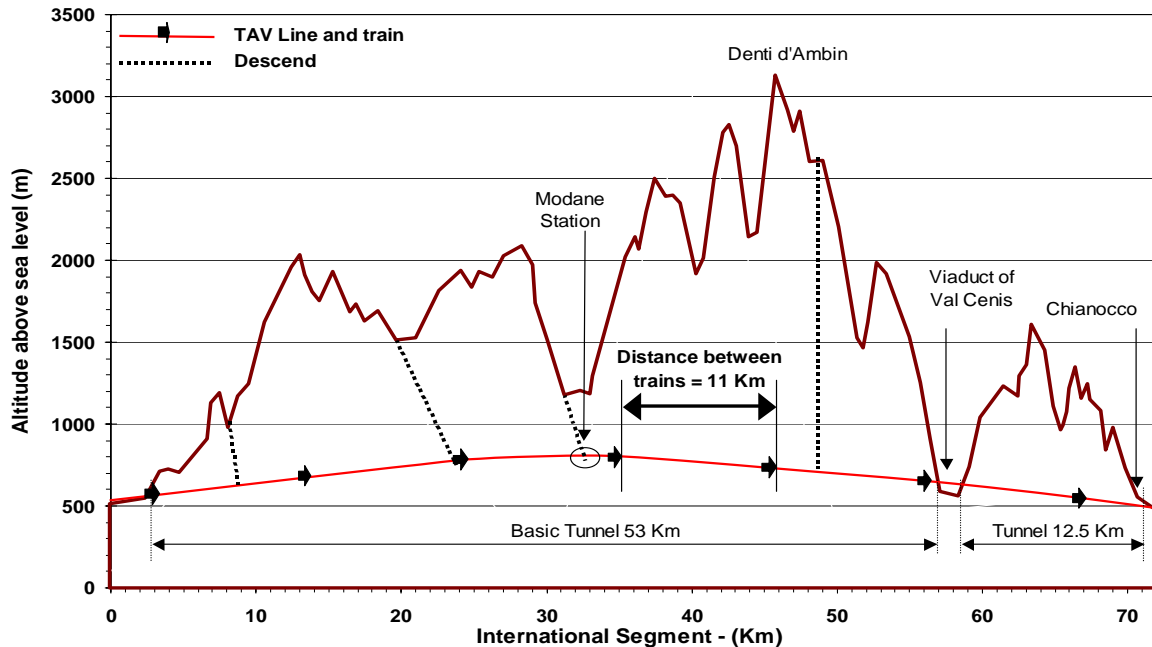


Fig 2.4-2 International Segments and trains running in one direction

The traffic management into the International segment is not yet clear and there is more then one hypothesis. 180 daily tracks distributed over 20 hours (the other 4 hours are for maintenance) will be enough to let all trains passing in both directions at the same speed of 100 Km/h, in particular the 134 freight trains and 14 long distance trains for each of the two directions plus a 20% margin for absorbing traffic unbalance. The trains inside the International segment will transit every 6.5 minutes spaced by 11Km as shown in Fig 2.4-2, but fleeting train speed would be penalized.

Three hypothesis are made for operating the national segment [10].

The first considers 240 tracks per direction over 20 hours a day, i.e. a track every 5 minutes and all trains travelling at 100Km/h. In such a case (Fig 2.4-3) up to 9 trains per direction could run together into the international segment.

The trains are spaced by 8.3 Km, which is the distance run by a 100Km/h train, in 5 minutes.

A fleeting train ① could run the basic tunnel with other 6 trains and the only safe points of the international segment are the Modane station and the Venaus viaduct. The safety, in particular the perceived by the users, could be weak, despite the modern signalling techniques and the automatic block.

By running 147 trains/day (134 freight and 14 TGV), this hypothesis has a margin of 93 unused tracks, being the capacity equal to 240 tracks/day. A safety improvement could be achieved by freely 3 tracks before and after each fleeting train. This is most likely the operating condition in the technical promoters minds.

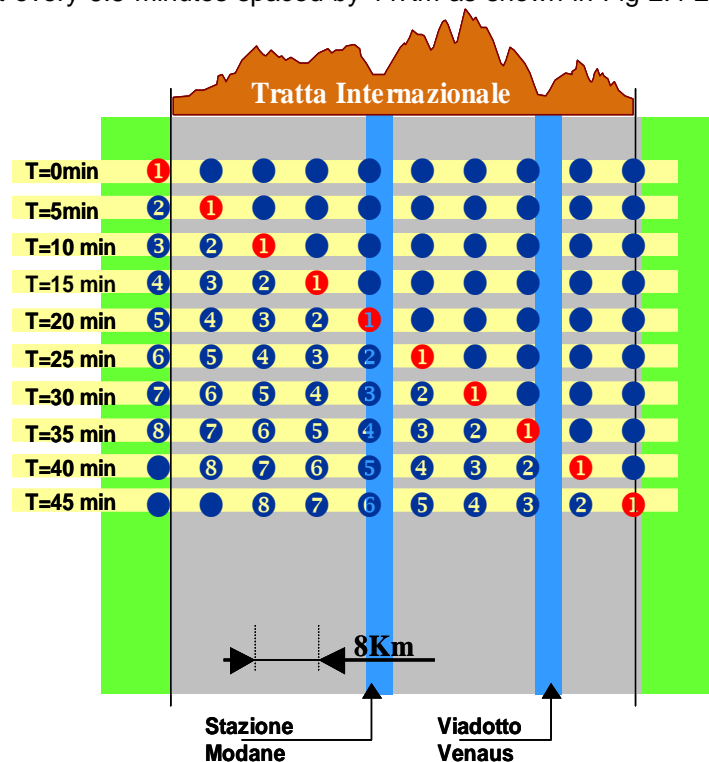


Fig 2.4-3 International Segment operating model – RFI Hypothesis 1

The second hypothesis considers as well 240 tracks per day, interleaved by 5 minutes. The difference is the destination of the tracks for allowing a fleeting train transiting at about 200Km/h, a speed double of the freight trains.

The TGV will take only 22 minutes to run entirely the international segment, while the freight trains will take 44. To implement this at least 5 tracks in front to a TGV trains have to be free, so to avoid that the fleeting trains has to decelerate because of a preceding freight trains. This method grants always a safe recovery place for a fleeting train.

At the entrance of a TGV (7) into the international tunnel, all freight trains shall have already passed Modane station and when the TGV transits at the station, all freight trains shall already passed Venaus viaduct. When the TGV passes over the viaduct, then Bussoleno tunnel is free and the last freight train has already taken the national segment. Same is for the other direction.

This approach, shown in Fig 2.4-4, is only theoretical because pending on the general security allowances and certification of the line. Few tens of seconds of delay of a train will dis-synchronised the entire traffic of the line.

In addition, the crossing rails at the Bruzolo interconnection allow a maximum safety speed of 100Km/h and as a consequence the TGV will have to reduce the speed under this limit. Among all hypothesis, this is the less probable because it requires wide temporary parking rail areas at both tunnel entrances, for recovering the freight trains waiting for the TGV passes.

The third hypothesis uses the new line for freight only, having all fleeting trains passing over the historical line. The TGV speed will be anyhow greater than the current, tanks to the historical line improvements, but the management of the new line will be much simpler, safer and the Bruzolo interconnection less complex.

The Piedmont Region operating hypothesis has even a more complex management of the line because of the TGV transits also in the national segment, causing in the Gravio Musinè tunnel, a safety problems similar to one of the basic tunnel. Such hypothesis can only be adopted should the Turin crossing (Corso Marche) be implemented; otherwise the TGV travelling on the national segment cannot pass through Turin.

A study by Polinomia Institute for the CMBVS, confirms a TGV speed inside tunnels of about 120 Km/h.

It would be curious knowing what the passengers will feel once under 2500 meters of mountains and with 2 or 3 freight trains in front and the same number of trains afterward.

The last observation comes from France, where the maintenance of the high speed line Paris-Lyon is such that no trains are passing overnight because rectifying of the rails take place every two nights. This is necessary to reduce the noise while the TGV are running at 270 Km/h. This is tells that the idea of the Turin-Lyon promoters of concentrating the freight train overnight is in conflict with the maintenance, except if the real number of freight trains is much, much lower than the advertisement.

The degradation of a high-speed railway line used by slow and heavy freight trains is a factor worsening the maintenance and increasing the management cost of the line.

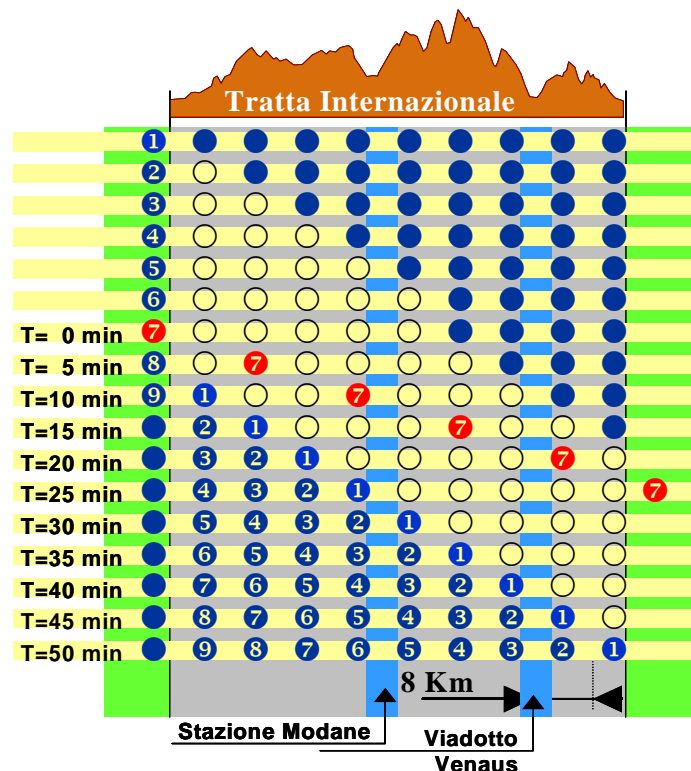


Fig 2.4-4 International segment operating model – RFI Hypothesis 2

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