Orient/East-Med Corridor: Proposal for a Future Operational Concept and Its Impact on Infrastructural Development

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10 ORIENT/EAST-MED CORRIDOR: PROPOSAL FOR A FUTURE OPERATIONAL CONCEPT AND ITS IMPACT ON INFRASTRUCTURAL DEVELOPMENT

Resume

Abstract
In order to strengthen the Orient/East-Med (OEM) Corridor by the means of railway transport, certain measures are necessary. Considering the insights gained from planning and developing the concept of transalpine railway transport in Switzerland, the future capacity of the corridor and plans for the required expansions in time are proposed. This primarily requires the definition of the assumed services and thereafter a determination of the capacities of the sectors in order to define the required expansions. The project should function as a continuous railway network spanning across many country borders so that not much time is lost at border-crossings.

Keywords
Capacity – double-stack container – cross-border connection – long-term planning for freight and passenger traffic

Orient/East-Med Corridor: Ein Vorschlag für ein künftiges Betriebskonzept und seine Auswirkungen auf die Infrastrukturentwicklung

Kurzfassung
Um den Orient-/Ost-Mittelmeer Corridor (OEM) mit Hilfe des Schienenverkehrs zu stärken, sind bestimmte Maßnahmen erforderlich. Unter Berücksichtigung der Erkenntnisse aus der Planung und Entwicklung des Konzepts des alpenquerenden Ei-

senbahnverkehrs in der Schweiz werden die zukünftige Kapazität des Korridors und die Pläne für die erforderlichen zeitlichen Erweiterungen vorgeschlagen. Dies erfordert in erster Linie die Definition der übernommenen Leistungen und anschließend eine Bestimmung der Kapazitäten der Sektoren, um die erforderlichen Erweiterungen zu definieren. Das Projekt soll als durchgängiges Eisenbahnnetz Ländergrenzen überschreitend funktionieren, so dass der Zeitverlust an den Grenzübergängen möglichst gering bleibt.

Schlüsselwörter
Kapazität – Doppelstockcontainer – grenzüberschreitende Anbindung – langfristige Planung für den Güter- und Personenverkehr

1 Experience from Switzerland – an operational concept for the Alpine transit Switzerland's policy

The construction of the two very long railway tunnels at Lötschberg (34 km) and Gotthard (57 km) required years of planning. It had to be ensured that the structures could also be integrated into the existing railway network of the Swiss Federal Railways (SBB) and that a significant benefit for passenger and freight customers could be achieved.

The capacities of neighboring countries such as Germany, France and Italy also had to be clarified.

From 1985 to 1990 the traffic flows in transalpine traffic were recorded. At that time, around 70 million net tons were transported by road and rail. It was forecast that this would double by the year 2020 (i.e. in 30 years) as transit traffic through the Alps. The volume of goods forecast for road and rail in the Alpine arc was around 140 million net tons.

Swiss politicians decided to make rail capacities available for 70 million tons. For passenger transport, it was decided to speed up the journey time between Zurich and Milan by at least 1 hour (Swiss Federal Council 1990). The following work showed that with the base tunnels at Lötschberg and Gotthard/Ceneri, as well as adjustments to the existing route network, the capacity of around 400 cross-border and national freight trains can be made available to freight traffic from the northern to the southern border and vice versa.

The paths made available in Switzerland for cross-border traffic were laid down in a Lugano Treaty (1996). Each of the countries undertook to make the corresponding capacities available on rail in good time (Swiss Federal Council, 1996). In spite of this high number of daily freight trains, the aim is to provide sufficient train paths for half-hourly intervals with meticulous planning in the timetable and a corresponding operating concept for long-distance and local passenger traffic.

The operating concept is characterized by the fact that train paths can be booked for freight traffic on the network (Trasse Schweiz AG 2018) and that departure and arrival times can be offered to customers for trains with long distances. As with passenger transport, planning for cross-border freight transport can start reliably with a timetable.

After the opening of the base tunnels (2007 Lötschberg and 2016 Gotthard), the positive balance can be drawn:

> The routes for freight traffic are available

> The travel times between the north and south of Switzerland could be shortened by about 1 hour

Today it is possible to use the same solution approach on the OEM to record the current capacity reserves for passenger and freight transport and to record possible expansions for capacity increases. Not only route sections between large centers have to be considered, but also, if necessary, detours to centers, which can solve many problems (noise, space and capacities for urban railway systems) in one fell swoop. The approach of extension before new construction can be valuable for financing.

2 National and international passenger transport

2.1 General development

The amount of passenger transport is rising in all European countries. In and around major cities there is an especially high demand for mobility. The main cause is commuter traffic, because almost all infrastructures have to be designed to handle peak-hour loads (Fig. 1).

In many countries, long-distance trains travel at intervals of an hour or even half-hourly, connecting the major cities. The S-Bahn networks usually operate with intervals up to every fifteen minutes, specifically during the peak hours, i.e. from 7 am to 9 am and from 4 pm to 7 pm. This schedule requires a lot of expensive infrastructure (tracks and stations) which partially have a low usage. Train stations which are flooded by people at 8 am or 6 pm serve as an example. The overcrowding at peak-time results in bad pedestrian circulation in bottlenecks such as underpasses, like traffic on roads. In contrast, there is a yawning emptiness in the concourses during the afternoons. Then, only the stores in the booming railway shopping centers attract visitors. On weekends, the stations are often used even less (Fig. 2).

Similar observations have been made of train use. Depending on the connection and amount of trains per day, the utilization rate varies on particular routes between full capacity and roughly 30% utilization (SBB 2018). In order to increase demand for railway trips, the offer for customers has to be continuous throughout the whole day.

Switzerland, a world champion in train usage in terms of kilometer per inhabitant (Fig. 3), proves that a half-hour interval between large cities and an integrated half-hour service for the overall network brings customers back to using trains.

Fig. 1: The Zurich Central Railway Station crowded at peak-hour / Source: Author

Fig. 2: The Zurich Central Railway Station at off-peak-hour / Source: Author

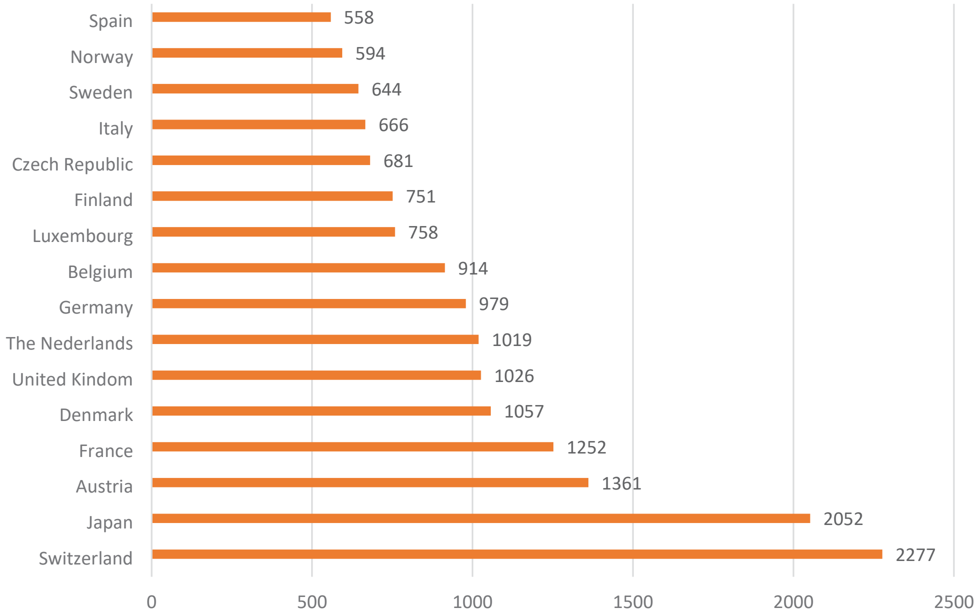

Fig. 3: Rail kilometers per inhabitant and year (2015) / Source: UIC (International Union of Railways) statistics for 2015

2.2 Cross-border connections on the OEM Corridor

When introducing high-speed passenger services in Europe in 1981, long-distance rail services experienced a renaissance throughout Europe. In 2008, around 100 billion passenger kilometers were made by high-speed passenger services. The OEM Corridor is not suited for continuous high-speed operation on the whole route from the North Sea to Athens/Patras or Istanbul. Regarding a maximum travelling time of 4 hours (corresponds with a 50:50 modal split between rail and air transport), the sections need to be identified along which competitive rail passenger services can be offered. Table 1 shows these proposed sections, including their distance and desired travel time.

On long-distance routes, i.e. over 800 km, there are usually only few direct services, often just 1 or 2 trains especially if considering the connections mentioned below, as can be seen for example in the timetable for 2017 (ERT 2017).

> Hamburg–Prague–Budapest (14 h)

> Belgrade–Sofia (11 h)

> Belgrade–Thessaloniki (15 1/2 h)

> Sofia–Istanbul (11 h)

> Bucharest–Thessaloniki (18 h)

Relation	Rail distance	Desired travel time
Hamburg – Berlin – Dresden	450 km	< 3h
Berlin – Dresden – Prague	350 km	< 2,5 h
Prague – Vienna	400 km	< 3h
Budapest – Belgrade	400 km	< 3 h
Belgrade – Sofia	400 km	< 4 h
Sofia – Istanbul	550 km	< 4,5 – 5h
Sofia – Thessaloniki	300 km	< 4 h
Thessaloniki – Athens	500 km	< 4 h

Tab. 1: Desired travel time (system time) between major cities along the OEM Corridor / Source: Author

Naturally, it cannot be ruled out that some connections on this route will furthermore offer direct daily and night. In order to gain travel time of at least an hour, the trains should operate on newly constructed (or upgraded) subsections of the route, allowing higher speeds (up to 200 km/h, considering rolling stock). This makes sense for particular daily routes or maybe seasonal connections, i.e. 'Interrail-Connections' for young voyagers, people scared of flying or tourists, who want to enjoy a trip to the countryside.

For connections with travel times under 4 hours, an hourly or 2-hourly service should be planned for the determination of the infrastructure. This depends on the internal demand on the particular route. For example, the route Hamburg–Berlin requires an hourly service, while a 2-hourly service presumably should suffice on the route between Sofia and Thessaloniki. Different route speeds also have to be considered. Additionally, it is not reasonable to design routes with high speeds over 250 km/h for passenger services if the route is operated with mixed modes (freight/passenger services). This would automatically lead to very high costs and a large loss of capacity, or long waiting times (for trains to pass) for freight trains and other (conventional) passenger trains.

Expansions on the corridor Hamburg/Rostock/Bremerhaven–Berlin–Dresden–Prague–Vienna/Bratislava–Budapest–Belgrade/Sofia–Athens/Istanbul allow significant travel time savings and timetable improvements inside the countries and in cross-country traffic. The routes will be included in the network of European high-speed railways sector by sector after implementation. A continuously optimized speed for passenger services of 160 km/h seems to be reasonable for all parameters under consideration.

At least as important as the actual speeds, or the travel time savings, are connections at the stations and then good connections to the agglomerations (Fig. 4). The travel time for the voyager is the sum of the travel time and waiting times. System times of approx. x.55 or x.25 allow for optimal connections at interchange stations, reducing waiting times to a minimum.

The long-distance connections should include the most important tourist places and run at reasonable times of the day (8 am to 6 pm). A daily connection is sufficient in most cases. Due to experience with long train routes, integration into the interval system of the individual countries is not recommended because the trains are quite susceptible to delays and thus usually have to be replaced at certain hours (peak-hours).

It is advisable to draw up an international concept timetable for the OEM Corridor first. The individual countries can then build their national timetables upon this. The timetable can certainly be developed in stages. However, it is worthwhile to choose a top-down approach to avoid ineffective infrastructure investments. With the development of an overarching passenger transport concept, it is easy to find gaps for freight train paths in between passenger services.

2.3 National (domestic) concepts

Additionally to the international passenger and freight train connections mentioned above, national concepts of the individual states must be included to determine capacities along the corridor. It is currently difficult to predict how the demand for regional transport will develop. Generally spoken, the demand in countries such as Romania, Bulgaria or Greece is lower than in more central European countries (see Endemann in this book). In order not to plan infrastructure expansion too conservatively, an hourly connection between the centers of the countries is to be assumed. For regional services, a 1-hourly service is also to be assumed for every mixed traffic line. This is mainly used to determine the node systems.

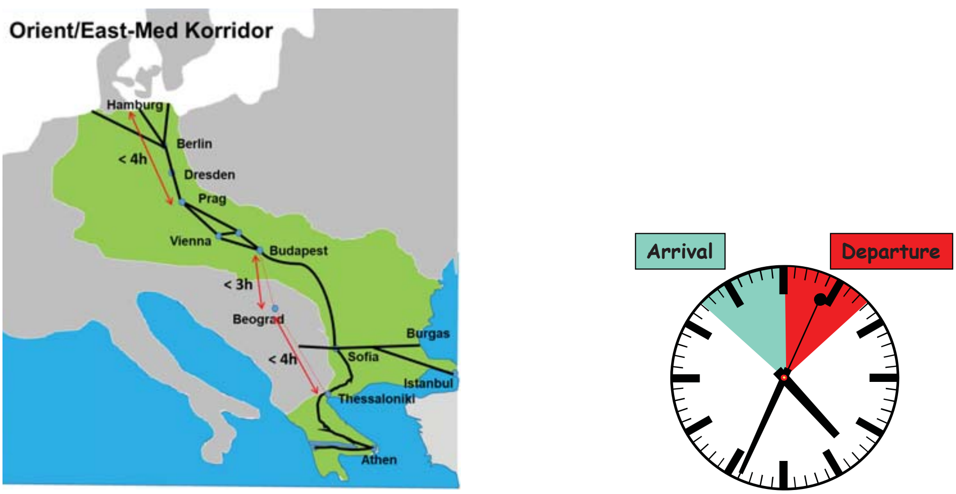

Fig. 4: Travel time = travel time + waiting time / Source: Author

As an example, the node principle (Fig. 5) shows possible connections within 4 hours. At the same time, connections from one high-speed connection to another must be offered.

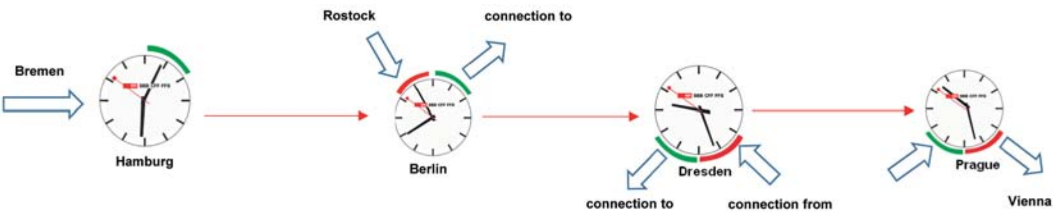

Fig. 5: IC/EC train paths with ideal arrival and departure times at the nodes: an example of the Hamburg–Berlin–Dresden–Prague axis / Source: Author

3 National and international freight transport

3.1 General development

Derived from the aforementioned passenger transport concept, a freight transport concept is to be developed with continuous routes through the entire corridor. No trains will run from Piraeus to Bremerhaven, but it must be possible to use the continuous lines in both directions across different national borders. Freight trains must be allocated to cross-border routes, without hours of border stops due to reintegration into the timetable system of each country (Fig. 6).

For a higher market share, the railway must achieve high productivity. This is possible when long and heavy freight trains can be formed. Some of the existing lines with narrow radii, poor network conditions and a lack of crossing or overtaking possibilities are not suitable for such trains. The profiles of the routes must also be adjusted for container transport. The less special rolling stock is required for loading, the cheaper it is to produce or acquire standardized wagons.

Today’s transport needs of the economy require customer proximity. Transport must be provided at the time of day requested by the customer and arrive on time. Freight trains cannot therefore be moved to marginal hours only, where fewer passenger trains run (night hours).

3.2 Cross-border connections on the OEM Corridor

The routes of the OEM Corridor are particularly suitable as excellent relief routes from the south (Piraeus/Thessaloniki ports) to the north (as far as the Vienna/Prague/Budapest/Northern Italy area) instead of the massively congested Rhine-Alpine Corridor. The corridor along the Rhine threatens to become an unsolvable bottleneck for freight traffic, as regional passenger traffic (sometimes every quarter of an hour) and dense long-distance traffic (every half hour) close the gaps in and between the large agglomerations.

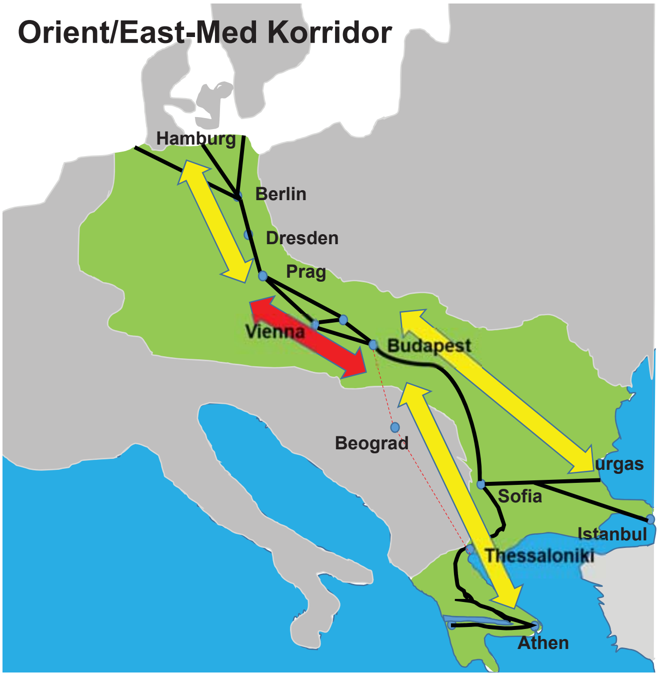

Fig. 6: Example of freight flows port – inland (yellow) or international transport (red) along the OEM Corridor / Source: Author

Along the Budapest–Piraeus section of the OEM Corridor, free routes are available for a faster connection for shiploads from Southeast Asia. A ship takes about 4–8 days from Piraeus to Rotterdam (also applies to other North Sea ports, depending on the stops) (COSCO 2018a). This means, for example, that a container ship can be expected to circulate around 8–15 days faster between Asia and Europe and vice versa. The transport of goods from Asia via Piraeus (as part of the New Silk Road) to a terminal in the Budapest area and from there to northern Italy or the greater Vienna/Bratislava//Prague area will be about 5 days faster than via the North Sea ports due to the longer train journey.

In Piraeus about 3.69 million TEU (twenty-foot equivalent unit), in contrast to Rotterdam with its 12.3 million TEU, were shipped in 2016 (COSCO 2018b). Assuming that approximately 10% of units are transported to and from Sofia/Budapest by train, this would result in 15 and 25 trains per day (Tab. 2). According to current observations, however, only about 20 trains (number to be determined, inquiries so far unsuccessful) run per week, which suggests that a large proportion of the arriving containers are transported away by ships and/or trucks. Whether this is due to a lack of train capacity, transport times or reloading ship/train in the port of Piraeus cannot be precisely determined at present. There may also be insufficient demand for rail transport due to unreliable delivery times (strikes/poor organization) or, of course, price factors.

The volume of goods expected for 2040 on the Piraeus corridor towards Sofia/Beograd and Budapest is expected to double compared to the current container volume. Assuming that the rail share towards Budapest/Sofia continues to be 10%, paths must be available for 35–45 trains with 50–70 containers each per day (Tab. 2).

Action	2016	2040
Containers handled in Piraeus	3‘670‘000	~7‘000‘000
Days in operation per year	300	300
Containers per day in operation	~ 12‘200	~ 23‘500
Share to/from Sofia/Belgrade/Budapest (Assumption)	10 %	10 %
Railway share to/from Sofia/Belgrade/Budapest (Assumption)	1‘200	~ 2‘400
Amount of containers (TEU) per train (length 740 m)	50–70	50–70
Amount of trains (both directions) per day to Budapest via Serbia (Assumption)	n. a	35–45
Amount of containers (TEU) per double-stack train	-	250–300
Amount of trains (both direction) per day to Sofia/ Budapest (Assumption)	n. a.	8–10

Tab. 2: Future parameters along the OEM Corridor / Source: Author

In addition to the New Silk Road, an internal volume of goods also has to be expected. The number of cross-border freight trains today has not yet been determined. Assuming that international freight traffic with bulk goods will also increase, an additional 30–50 freight trains with a maximal length from 740m per day in both directions must be expected per border crossing. At the same time, an equal number of train paths must be made available for domestic traffic.

This means that up to 150 freight trains per day in both directions are expected on the central sections of the corridor from the North Sea to the Mediterranean. The route occupancy of today’s sections is characterized by large fluctuations and further development is to be examined in more detail in a next step. This is also the basis for assessing the requirements for expansions on the OEM Corridor. A central feature of such large projects is the targeted staged construction of the buildings and sections of the line. It should be noted that no buildings are built on reserve, but that the systems can be used quickly and thus also perform well for reasons of economy.

4 Recommendations and further research

4.1 Capacity studies

The next steps are to define the number of planned connections for long-distance and local passenger transport as well as for national and international freight transport. It is also necessary to determine the intervals (hourly, half-hourly or even quarter-hourly) at which trains are to run. Then, the individual slots of the different train categories must be defined. An example of a possible capacity overview for the corridor section is given in Figure 7.

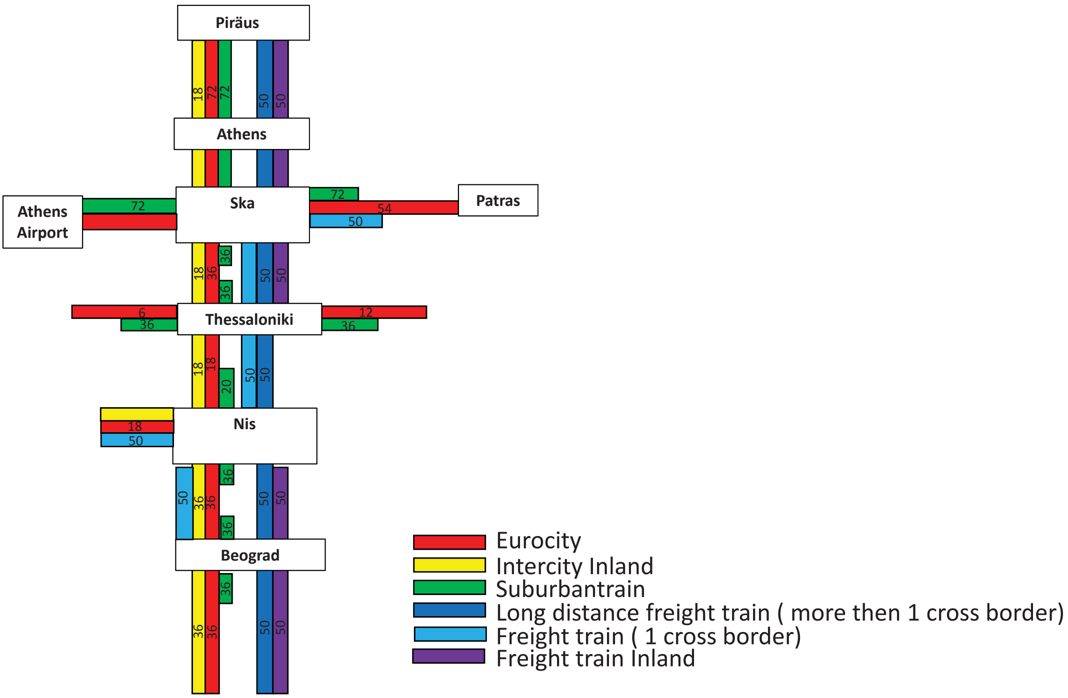

Fig. 7: Example for capacity in long-distance and local passenger transport and in freight transport: The Piraeus–Beograd line / Source: Author

4.2 Optimizing the slots for passenger and freight service

For all required relations including:

> high-speed/EC/IC connections,

> long-distance daily connections,

> local trains,

> domestic freight/cross-border freight (1 border crossing)

> long-distance freight transport connections over several countries,

it is necessary to develop a comprehensive operating concept. Figure 8 shows how a mixed traffic route should planned.

In a first step the slots for the Eurocity/Intercity and long distance trains must be determined. This needs coordination between the countries involved (neighboring states). After fixing the local passenger service, coordination of the long distance freight trains has to follow.

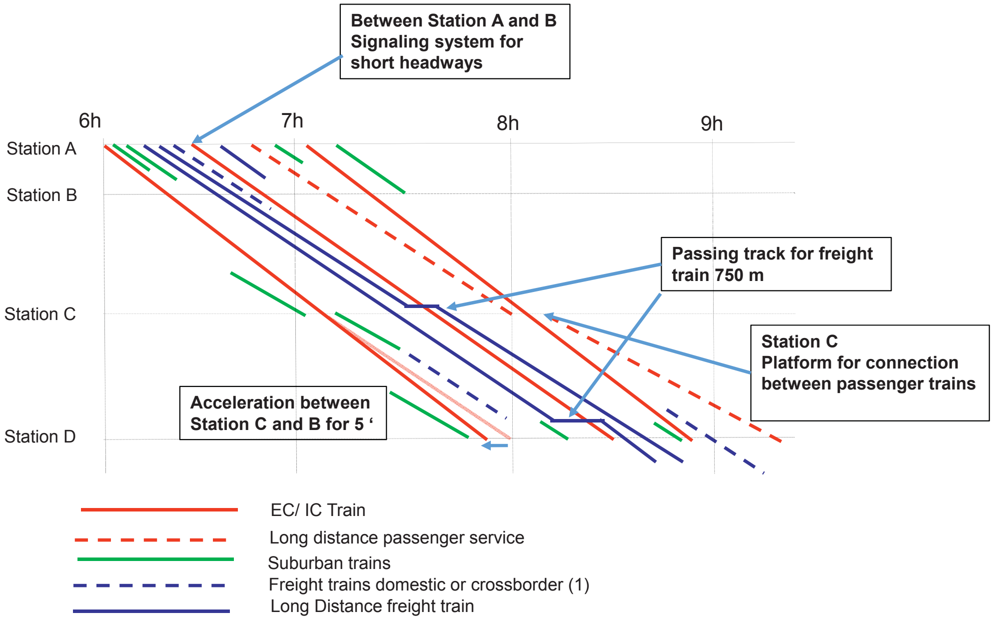

Fig. 8: Examples of possible paths for passenger, freight and local trains incl. necessary infrastructure / Source: Author

With this procedure, it is also very easy to determine the sections of the route and the nodes where infrastructure measures are necessary. The detailed infrastructure facilities, passing tracks, possible accelerations on line sections and platform facilities can then be derived from this planning process. It will also ensure that slots do not have long stays across borders.

4.3 Double-stack container transport as a chance on OEM

In several countries, double-stack trains offer economically attractive transport over long distances of up to 5000 km (e.g. Canada/USA). Double-stack container trains are distinguished by the fact that the containers are loaded in two layers and the trains are up to 4000 m long (Fig. 9).

Fig. 9: Double-stack containers / Source: Author

For the OEM Corridor, there is a unique opportunity to bring further or new insights into double-stack container transport in Europe with an additional study. The faster connection via Serbia should be used by 'conventional' trains with normal profiles and the route via Bulgaria should become a double stack profile. It would probably be the only corridor in Europe that could be put into operation over a distance of about 1000 km. The special requirements such as profile and problems with the catenary place the highest demands on this operation.

Today, double-stack container traffic, which started in India in 2009 (Singh/Lal/Mehta et al. 2009), is almost exclusively operated with diesel-powered locomotives. The problem of catenary height in mixed traffic has not yet been solved. Double-stack container traffic on the section from Thessaloniki to the Budapest area could be a possible recipe for success. From there, the trains would be regrouped for onward travel on the network of eastern Europe and northern Italy and transported to their final destination by 'normal' 740 m container trains.

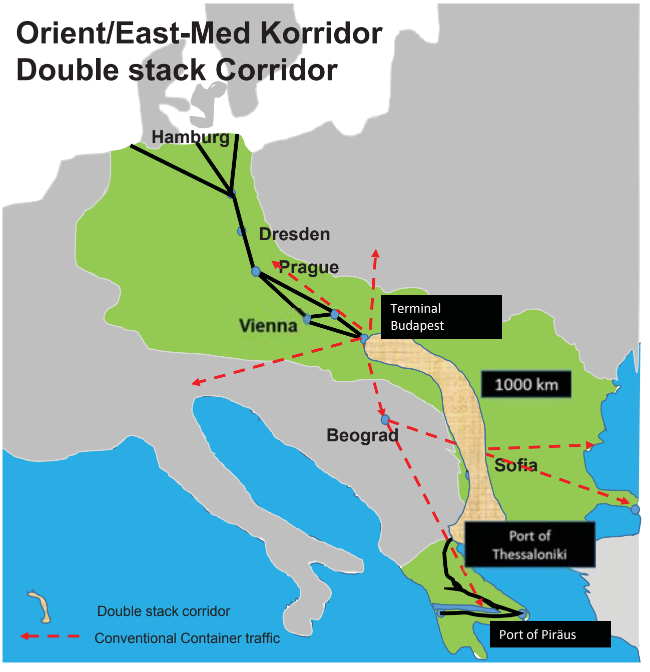

Fig. 10: Corridor for possible double-stack container transport / Source: Author

Different models are conceivable (Fig. 10). For example, regular container trains could run from Piraeus to Thessaloniki, which would then be extended to heavy haul trains. Current investigations primarily deal with questions of profile on the long routes. Especially bridges, tunnels and, given the weight of the trains, also the gradients have to be examined. Such trains are rather unsuitable for mixed traffic due to the long braking distances and slow accelerations. Therefore, the possibilities of separate routes will have to be examined for certain sections. Only an in-depth investigation will provide certainty about this type of transport.

There is a unique opportunity in the European railway network to offer a corridor for long and heavy trains: an efficient line for fast and lighter freight trains from and to Greek ports via Skopie–Nis–Belgrade and a line for long and heavy freight trains via Bulgaria–Romania–Budapest.

The topic of automated trains should also be considered more closely for such long distances. A feasibility study offers the unique opportunity to learn more about infrastructure investments and profitability.

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