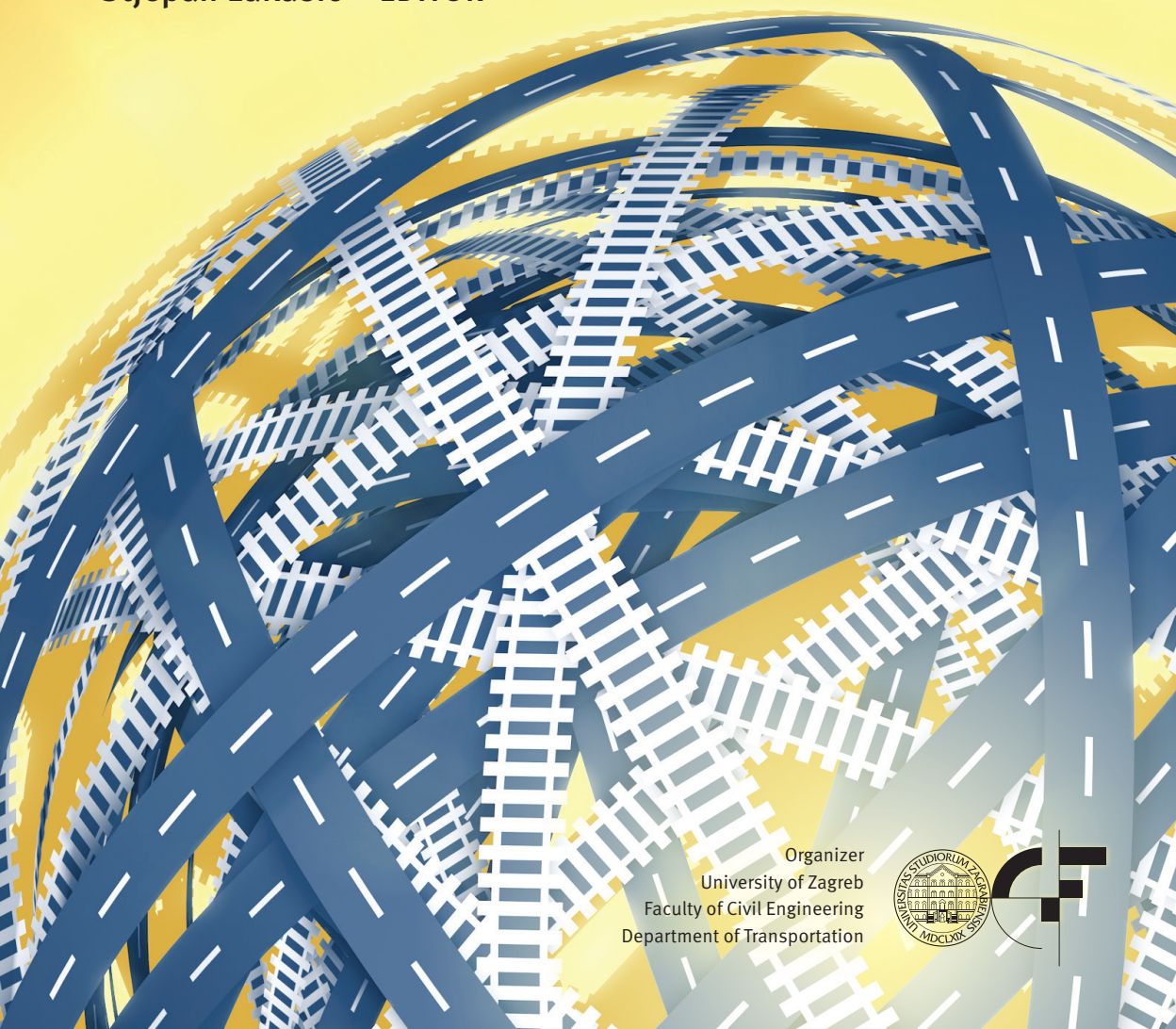
CETRA 2016

4th International Conference on Road and Rail Infrastructure
23-25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

Stjepan Lakušić – EDITOR



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SOLVING A BOTTLENECK ON A STRATEGIC POINT OF THE HUNGARIAN RAILWAY NETWORK

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Abstract

This paper is about solving a railway infrastructure bottleneck around Budapest, which currently slows down cargo trains the most. The solution includes a direct passenger link via Budapest Airport and a short high speed line, which would decrease the travel times of long distance trains, and which allows to increase the frequencies of Budapest suburban trains. All the new services are planned by fitting to the integrated periodic timetable based infrastructure development strategy. The new infrastructure parts are at the beginning of the planning phase. The first part is about the capacity of the current railway network and about demands of freight transportation. It analyses the demands, and points out the bottlenecks of the network, i.e. where the capacity is not enough. It locates the bottleneck which is responsible for decreasing the circulation speed of cargo trains the most. The second part is about passenger transportation demands in the region of Budapest. The current problems are: poor transportation links to Budapest airport; poor usage of railway lines for urban transportation; impossibility of making more frequent train services on suburban lines. It defines the lacks of railway infrastructure, which make it impossible to fulfil those demands. The third part describes the previously planned solutions for the presented problems, then points out why those solutions were not efficient enough. Taking into account the lessons learned, the most efficient solution will be shown in the last part. This solution is capable of solving all the previously described problems. It contains a third track between Kelenföld and Ferencváros stations (crossing the Danube in Budapest); two new stations in important hubs in the south of Budapest (Közvágóhíd, Népliget); and a new partially high speed line between Budapest and Monor, connecting the terminals of Budapest airport. These solutions are planned by using integrated periodic timetables.

Keywords: ITF, railway infrastructure development, freight trains, rail capacity, suburban railway, urban railway

1 Freight transportation directions through Hungary

1.1 Regional trade

26% of Hungarian export goes to Germany, the second largest export partner is Romania with 5.6%. The export to all neighbour countries is altogether 23%. The import from Germany is 25%. From all neighbour countries it is 19% (first 3 are Austria, Slovakia, and Romania with ¾ of 19%). That means that the majority of Hungarian trade is with Germany, Austria, Slovakia and Romania. These countries are reachable on the southeast–northwest corridor. [2, 3]

1.2 Continental trade

Most of the freight traffic in Europe is inside Europe's core area, the so called 'Blue Banana'. From all the other European regions, the majority of freight traffic goes to or comes from the Blue Banana region. From Hungary, the Blue Banana region is reachable via Northern Austria and Western Slovakia. Also Northern Italy is reachable via Austria, because of better infrastructure and services compared to the routes via Croatia and Slovenia. From the Balkans, the whole Blue Banana region is reachable as well on the southeast–northwest corridor of Hungary. [1] [2]

1.3 Intercontinental trade

At the moment there is no significant intercontinental traffic via Hungary. Asia–Europe freight traffic is mainly on sea, partially by airplanes. Only less than 1% is on rail, mostly on Trans-Siberian Railways, and via Belarus and Poland. If in the future the intercontinental traffic will increase, it can increase only on the southeast–northwest corridor through Hungary, because that makes a connection between the Silk Way, respectively the ports of Aegean Sea, and the Blue Banana region. The same route could be used by Mediterranean Africa–Europe traffic.

1.4 SE-NW railway link through Hungary, bottleneck

As all the international freight traffic goes on the southeast–northwest corridor through Hungary, and the Hungarian railway network is very Budapest-centric, all the international freight traffic has to go through Budapest (Figure 1). At the moment there is no unsolvable capacity problem of cargo trains, but on a bit higher traffic level Budapest could be a significant bottleneck. We can assume higher rail freight traffic, because of the expected economic development of this region.

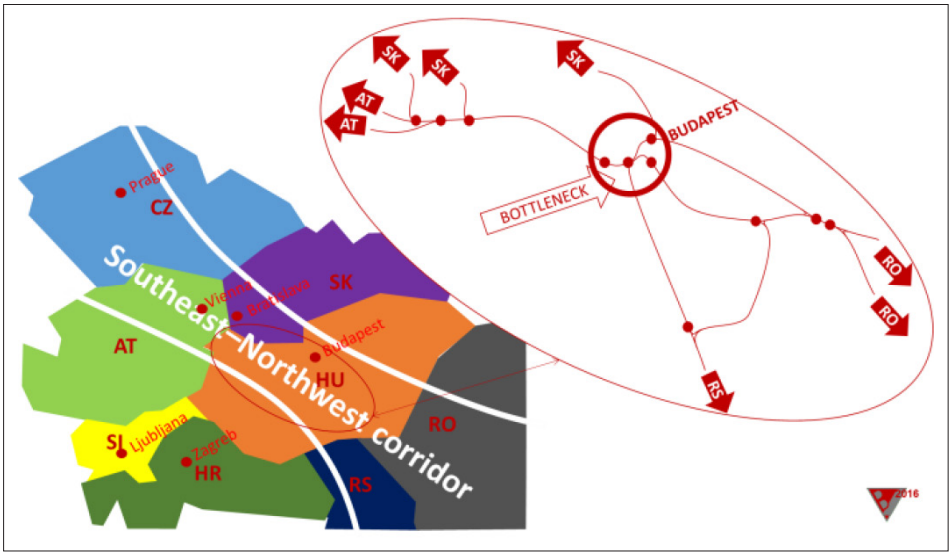

Figure 1 The vast majority of freight traffic through Hungary defines a southeast–northwest corridor. On that direction the bottleneck of the railway network can be found within Budapest

2 General timetable structure of Budapest suburban lines and special capacity stress of heterogeneous traffic

The main reason that a metro or a suburban line with homogeneous traffic can have a much higher frequency than railway lines with heterogeneous traffic, is the equal steepness of their time-distance graph (timetable path). On a line with homogeneous traffic there are only stopping-trains by unified trainsets (same accelerating capabilities). This means parallel paths which can achieve the maximal capacity utilization of a double track (direction separated) railway line.
On the main suburban lines of Budapest there are commuter trains, suburban semi-fast trains (mainly zoning trains), long distance trains (InterCity and fast trains) and freight trains. All of these train types have a timetable path with different steepness. That causes ineffective capacity utilization: less capacity. Integrated Periodic Timetable (ITF) with defined transfer nodes results in a standard pattern. The different steepness of the paths ensures half hourly periodic frequencies, which is not enough in city transport. Because the gaps are periodically closed between the stopping-trains and the fast trains, freight trains have to get out of the way of passenger trains several times. Therefore the lines with high frequency suburban and long distance services have a low capacity for cargo trains with slow timetable paths. [4]

2.1 Demands of the Budapest region

At the moment on the current railway infrastructure there are suburban services with thirty minute intervals. On the double track lines with heterogeneous traffic it is impossible to make more frequent services with stopping-trains. The demands of passenger transportation in the region of Budapest are to make suburban and urban services with fifteen minute intervals.
Airport linking: Budapest airport has poor transportation links to Budapest city. There is no railway link, no metro line; it is connected only by a bus line. The capacity of the bus line is too low and the travel time is too long. Budapest needs a faster and higher capacity link, from the city centre, and from northern and western districts of the city as well. As the Budapest airport is the only significant airport in the country, connections from the other cities of Hungary and from the whole region would be important.

3 Previously planned solutions: V0 and FEREX

3.1 V0, the cargo line

There was a not realised project constructing a brand new line only for cargo trains, via Komárom—Székesfehérvár—Kecskemét—Szolnok to avoid the Budapest bottleneck. But
- constructing a freight line avoiding Budapest is too expensive,
- many cargo trains cannot use it because of geographical reasons (e.g. Slovakia and Budapest are not on the planned line),
- many trains cannot avoid Budapest because of operational reasons,
- it cannot solve the suburban frequency problem, because it is caused by the fact that faster and slower passenger trains use the capacity of the tracks in an ineffective way

The project cannot be economically viable.

3.2 FEREX, the airport express

There was a cancelled project to connect Budapest city to Budapest airport, with an airport express train. The project proposed a new line in the airport area and a dedicated newly built third track from Budapest-Keleti via Kőbánya-Kispest to that area. Even though the passenger number of the airport is increases every year (2013: 8.5 million; 2014: 9.1 million; 2015: 10.3

million), it is not enough to finance a point-to-point railway link. A dedicated railway link could be economically viable only with over 20 million passengers. The airport express would have made a connection only to the city, and it would not have been a solution for Eastern Hungary. Because there are not enough passengers, and because the point-to-point link would be very expensive, this project would never be economically viable.

4 The smart solution

It seems logical to take away freight traffic to use its capacity for increasing suburban service, but as we will see (visualized on Fig-2. left side), it does not help in increasing suburban trains frequency. The capacity of the line is depending on the number of fast and slow paths. Effective solution: rising capacity utilization by homogenization of traffic (making paths as parallel as it is possible installing new tracks at least on those line sections where the traffic is the heaviest). Taking away faster trains to use their capacity for increasing (sub)urban and freight traffic (visualized on Fig-2. right side). If we build new tracks for the faster trains, the stopping-trains and the cargo trains can use the old tracks, sharing capacity, because their speed is more similar, so their paths are more parallel to each other.

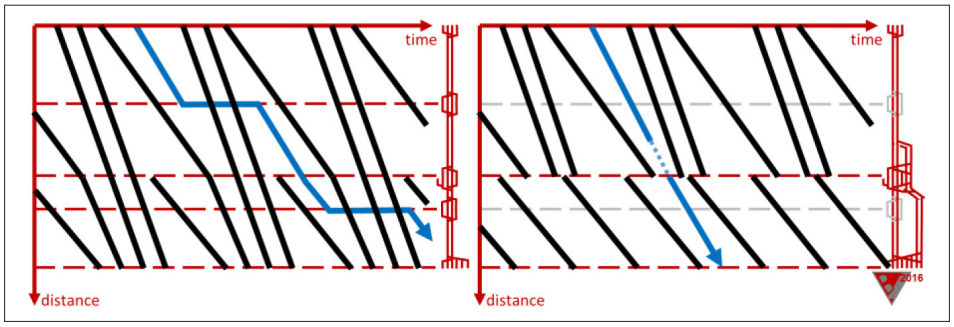

Figure 2 On the left: typical timetable structure on major Budapest suburban lines. The blue path is the fastest possible freight path. On the right: increasing capacity by new tracks for faster trains in the inner zone. The blue path shows that the freight train is faster, even though the frequency of suburban trains is doubled

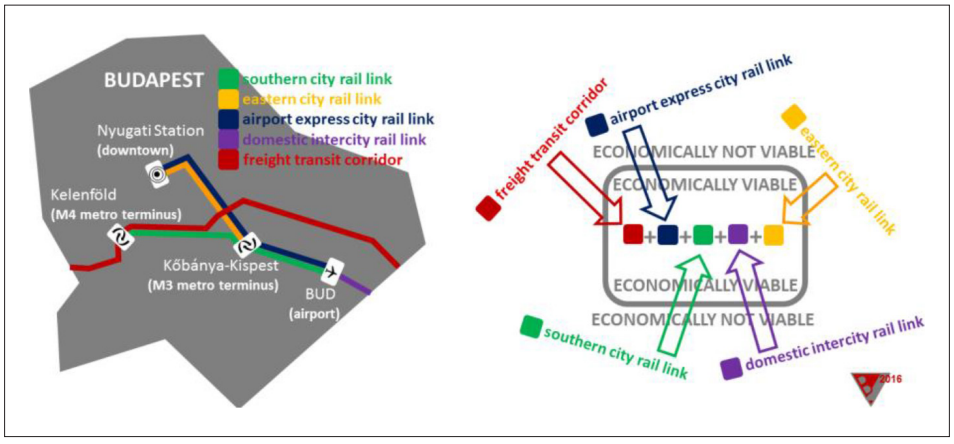

Figure 3 Several needed infrastructure development projects are not economically viable alone but economically viable together

The ideal solution is to build different lines for fast trains (long distance and suburban fast trains as well), but we have to find a solution which solves the problem of the cargo traffic, which connects the airport to the city and which allows to increase suburban and urban train frequencies, because separated projects are not economically viable, Figure 3.

4.1 Three in one solution

As we see a point-to-point airport express link and a separated cargo line wouldn not be economically viable, we propose to build a new thirty km long double track line for fast trains between Kőbánya-Kispest and the suburban train terminus Monor via Budapest Airport terminals. This solution would result in a cost-effective way of connecting Budapest airport to the city and to other parts of Hungary, and it would take away the fast trains from busy suburban lines, which link southwest suburbs to the city. Between Budapest and Szolnok there are two parallel lines (Budapest—Újszász—Szolnok line and Budapest—Cegléd—Szolnok line) with long distance and suburban traffic, Figure 4. The proposed new line would be connected only to the Budapest—Cegléd—Szolnok line, but it would create the possibility to run all the long distance services on that direction. As a result of this, the Budapest—Újszász—Szolnok line would remain only for the cargo and suburban trains, resulting in a much higher capacity for those segments.

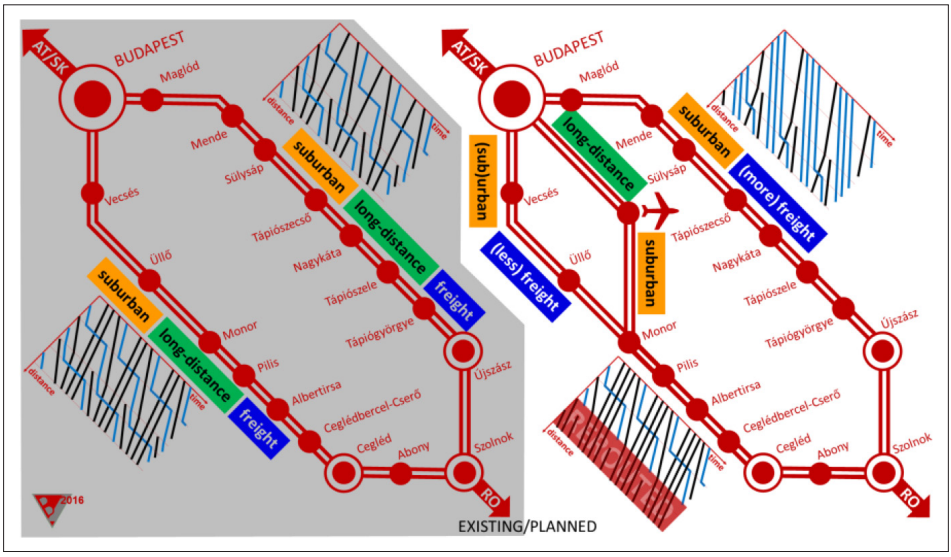

Figure 4 Mixed freight suburban long-distance services today, and separated functions after the proposed project

4.2 Two in one solution

The narrowest bottleneck for cargo trains is the bridge over the Danube (section between Kelenföld and Ferencváros). For increasing the capacity of this section we propose a third track. The new three track line will be useable for more suburban and more freight services as well.

4.3 Cost effective airport link

On the proposed new line four long distance trains, two suburban zoning trains from Budapest-Nyugati, and two suburban trains from Kelenföld (west hub of Budapest) would run. In

total there would be six trains per hour from Nyugati (every ten minutes). These trains would not be new services, these services are existing today as well, but in another line. They would connect the airport without increasing the operational costs. The two suburban services from Kelenföld are also running today, but only between Kelenföld and Kőbánya-Kispest. Those services would be extended to Budapest Airport.

4.4 Increasing capacity for suburban trains

On the inner section of the old line between Kőbánya-Kispest and Monor all the fast trains would be removed, therefore it would be possible to create fifteen minutes frequencies in suburban services. Also on the parallel Budapest—Újszász—Szolnok line there wouldn not be any long distance trains anymore, so the suburban capacity could increase there as well. But because the suburban fast trains (zoning trains) cannot be removed, the fifteen minute interval would not be possible yet.

4.5 Budapest freight corridor

Because all the long distance fast trains will be removed from the hundred km long Budapest—Újszász—Szolnok line, here the capacity for freight services would increase a lot, and the speed of all cargo trains could be higher, because they would not have to stop waiting for the fast trains passing by, Figure 5.

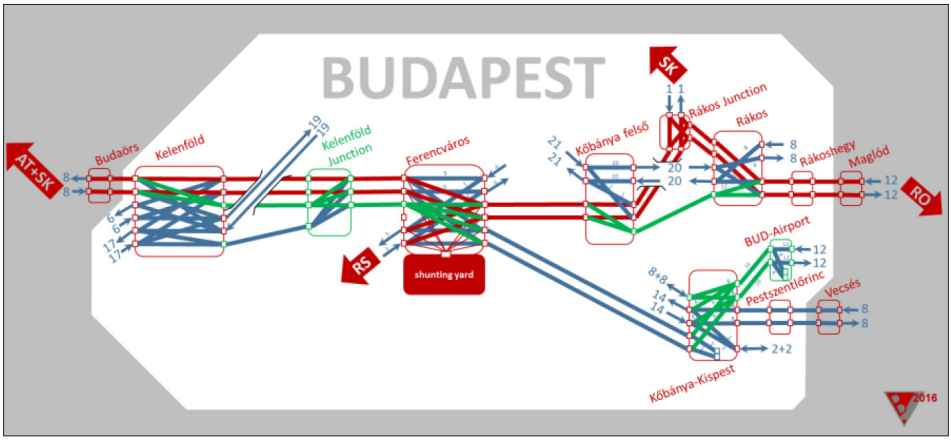

Figure 5 This figure shows the routes of cargo trains (red), all proposed new tracks (green) and the routes and number of passenger trains in a two hours period (blue)

4.6 Connection in stations

To increase capacity, it is very important to build connections in a way which minimalizes level crossings between trains. For this, it is important to plan all the routes: To minimalize the number of level crossings we propose that all the long distance trains which use the new line run to or from Budapest-Nyugati station, Figure 6.

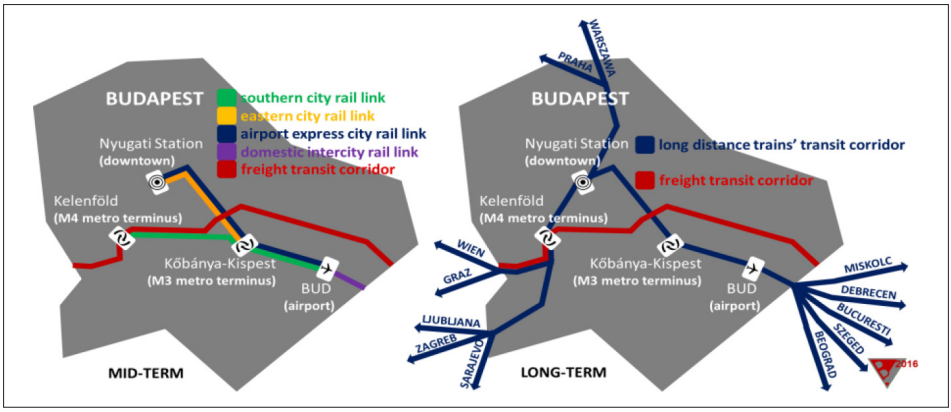

Figure 6 All currently planned projects are steps for the final aim to free the whole Budapest railway infrastructure from the long distance trains by creating a dedicated corridor for them

5 Conclusion, long-term vision

Infrastructure development always needs a huge amount of public money, and railway infrastructure is generally less popular than roads or motorways. In the railway sector it is especially important to plan a kind of infrastructure improvements that can ensure solutions for several problems. The planned railway link through Budapest International Airport seems to be a good example for this approach. It not only offers a sustainable connection from Budapest and also from Eastern-Hungarian cities to the airport (by existing services). It also allows to increase the frequency of suburban trains to a fifteen minute interval (which is the minimum for being able to take part in the city transport system) and it creates enough free capacity to establish a freight transit corridor through Budapest. This project has to be combined with some other connecting infrastructure development projects which have multiple functions as well.
It is important to plan in a cost effective way, but it is not enough. It is also very important to fit each project into a long-term strategy. The main problem of the railway system in Hungary is that it is Budapest-centric. For being able to significantly increase any kind of rail traffic, we have to remove long distance trains on the rest of the lines as well. The proposed solution with further development is suitable for solving this problem on the Budapest—Újszász—Szolnok and on Budapest—Gödöllő—Hatvan lines as well. It also fits to the tunnel under the city and the Danube between Budapest-Nyugati and Kelenföld stations, which is in the long term transportation concept of Budapest area. [5]
The planning of the project is running, the authors participate as experts in this. The paper reflects their professional views and not the official position of the represented companies.

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