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DISCUSSION OF DIFFERENT TOPOLOGIES FOR STATION RESNIK

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***Abstract** – The planned redesign of station Resnik in the south of Belgrade is a good example of questions popping up for the future track topology. Of course, it strongly depends on the traffic forecast and the planned timetable. The challenge is to find a solution which offers a high utilisation of station tracks but also some reserves for future demand. Thereby, operational conflicts should be minimised by the layout itself. Looking at the costs of such a measure, one half is the investment and the other half is the maintenance during the life cycle. Therefore, too many tracks and switches will require more maintenance than less infrastructure assets. In this paper several solutions will be presented and discussed upon their advantages and disadvantages.*

Keywords – railway planning, railway stationlayout, infrastructure design, simulation.

1. INTRODUCTION

The topology of historical railway stations typically has a high level of complexity due to several steps of past extensions. When having the chance to renew all infrastructure assets in a railway station, the main question is what do we need now and in the future in terms of switches and tracks. The challenge is to define a topology which meets all operational requirements today and in the future since the renewed infrastructure should last for 50 years or even more. As an input for this planning task only the relations of train services are well known. The timetable for each train service might be still open but at least the frequency of services will be defined. Of course, in the future an increase of services might be required. Therefore, the topology should allow conflict free operation of all kind of services. Another important parameter is the minimum headway between different services which can be simulated by software tools like OpenTrack [1]. In this paper we assume short blocks with ETCS Level 2 to achieve headways of less than two minutes [2]. State of the art methods for analysis of station layouts are described in [3] and inspired this paper as well.

2. REQUIRED CONNECTIONS

Figure 1 shows all railway lines joining station Resnik. On the left side, there is one double track line with InterCity (IC), Regional (R) and S-Bahn (S) services. Note, that the S-Bahn service is starting and ending in station Resnik. Also on the left side there is a single track line only used for cargo trains (GZ). On the ride side, there are two double track lines with mixed operation as well. This figure is now the starting point for the development of different infrastructure topologies.

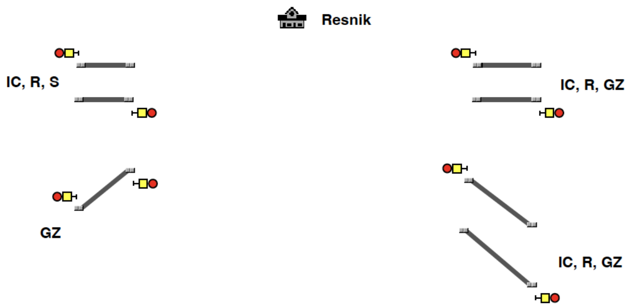

Fig.1. Boundary conditions for station Resnik

3. DEVELOPMENT OF DIFFERENT INFRASTRUCTURE TOPOLOGIES

The first scenario of infrastructure layout is the minimal layout. Therefore, number of switches and station tracks is minimized. All required connections are established. Switches at the right side of the station allow parallel running of trains in same or opposite direction. In this scenario the turning S-Bahn service is blocking one track while the driver is changing cabin. As a benchmark criteria the number of required switches is only 11 with only 3 station tracks. For the maintenance budget this scenario is definitely interesting and worth to be considered. Of course, crossing train paths lead to operational conflicts. Therefore, the application of this layout is limited by the traffic density even if switches allow same speed for diverging branches like for the straight option.

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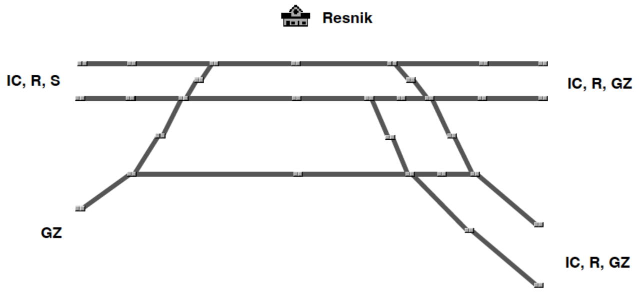

Fig.2. Minimal layout

For highly frequented lines a conflict-free layout with bridges and tunnels is the better solution to prevent operational conflicts simply by design. A solution is presented in figure 3. This topology allows parallel operation on all double track relations while sorting in and out of cargo trains on the left side is possible without operational conflicts as well as on the right side for fast trains (IC) and regional trains (R). The turning local service S-Bahn has its own track and is therefore not blocking any stopping or passing train. 12 switches and 4 station tracks are required in this layout.

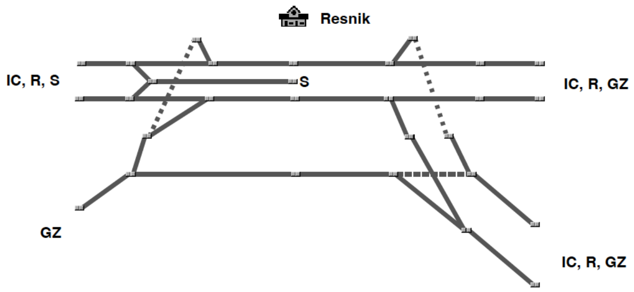

Fig.3. Conflict-free layout

Of course, there might be an additional requirement for the design of s station to store cargo trains. There might be also an operational reason for such a break like change of driver or any other logistical reason. Another reason could be the capacity of the lines. This would also justify to have additional station tracks for cargo trains. This offers the opportunity to split the station into a passenger and a freight part. This layout is presented in figure 4. In figure 4 three tracks have been added for storing cargo trains. Of course, this number can be extended upon request. To conclude, this scenario requires 15 switches and 6 station tracks

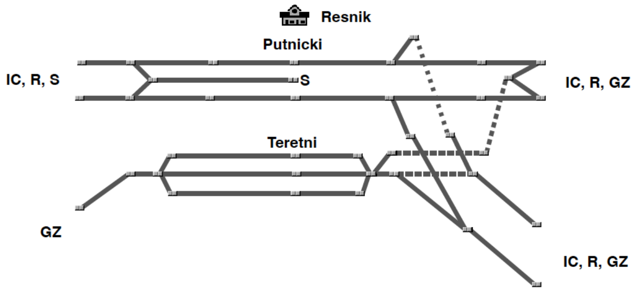

Fig.4. Design by function layout

To allow passengers to change trains in station Resnik at least two additional station tracks are required. The extension is presented in figure 5. For the passenger part of the station the direction based approach was chosen. The other option would be the line based approach which could be interesting for passengers turning direction of travel in Resnik. Since the majority of passengers will be interested in Belgrade, this option is less worth to be realized. The overall number of switches is still 15 but now with 8 station tracks.

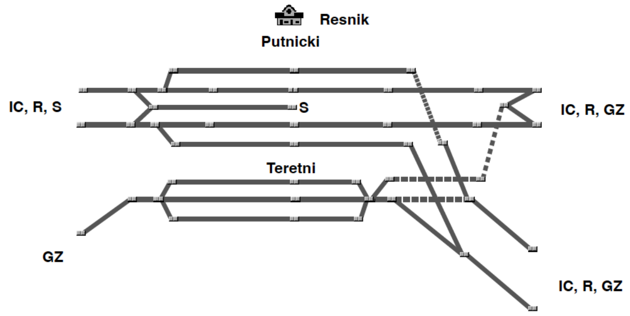

Fig.5. Extension for passenger change

After these several extensions one might ask to reduce again complexity of the topology. If we agree to mix passenger and cargo trains again, all trains can use the same tracks in stations. This approach can be used when track speed limit is not too high. As long as we are not operating high speed trains, this approach can be a good solution.

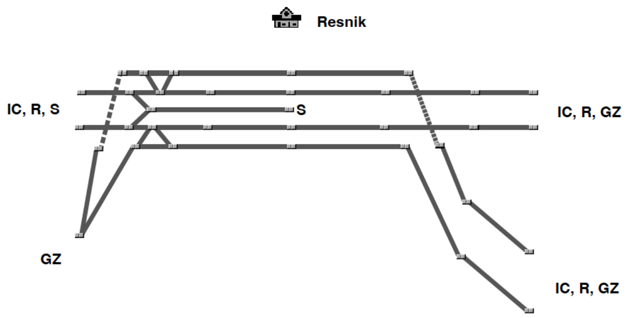

Fig.6. Another Simplification

Figure 6 shows this simplification of the topology. Unfortunately, the switches do not allow conflict fee operation of cargo trains and InterCities (IC) although the overall number of switches is now 12 with 5 station tracks. To solve these conflicts another solution is proposed in figure 7.

This scenario requires 12 switches and 7 station tracks to allow conflict-free operation in all relations. Of course, it might take some time to convince traditional railway engineers to investigate this layout during the planning procedure but it looks promising in terms of life cycle costs and operational performance.

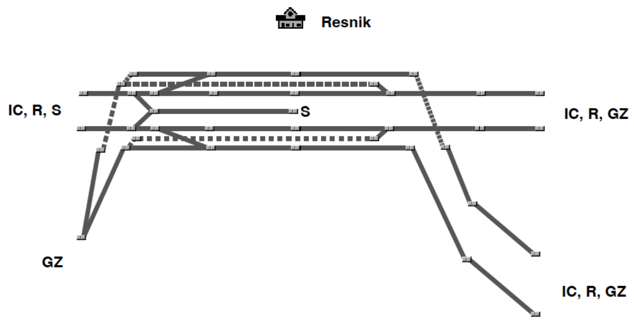

Fig.7. Final proposal

4. CONCLUSION

The development presented in this paper for the design of a railway station topology shows the complexity of requirements. Taking into account the life cycle costs for all infrastructure assets like switches and station tracks as key parameters the topology must definitely meet the operational requirements on one hand but on the other hand it should be also efficient in terms of maintenance. For further investigation only conflict free layouts should be considered in the planning process. Of course, the argument is well known that if you have the chance to rebuild a station you should foresee possible extensions which might be required in the future. The answer is coming from the minimum headway times. By application of a microscopic simulation tool the planner can simulate if the number of station tracks is sufficient or not. Obviously, the stopping pattern of trains has a strong impact on this result. Less stopping requires less station tracks. This rule is valid for passenger trains as well as for cargo trains. Additionally, the dwell time is a crucial parameter for the possible headways and thereby strongly influencing the capacity of stations.

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