AUTOMATIC TRAIN ROUTE SETTING IN CZECH REPUBLIC

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The operation of railway traffic from a single dispatching control centre ensures high quality of traffic management. Even better traffic control could be achieved through the automation of the dispatchers' routine work. It saves dispatchers´ time which he can be devoted to solving conflicts caused by delayed trains.

The process of planning the traffic and the execution of this plan are two independent activities which have to be done simultaneously. The dispatcher of the remote controlled lines has not just to optimize the railway traffic, he has to care for the properly train route setting as well. The new system of automatic train route setting should help him by doing much work on above mentioned activities for him. System that fulfils these requirements is automatic train route setting system. System or train dispatcher just decides how to handle the conflict situation and the function of automatic train route setting will execute the command at the proper time. This trend can be also seen in other countries.

Very helpful for dispatchers who control the railway traffic is the graphic timetable. There is a common used application called GTN on Czech railways which is supplied together with the electronic interlocking from the AZD Praha. This application shows the actual and expected graphic timetable in the most appropriate form for dispatcher and moreover provides many other support functions. New designed function of the graphic train route editor enables precising the predicted timetable and consequently gaining the most probable prediction in the next moments. Given that GTN knows the actual timetable, dispose of data of trains and knows the exact train location in real time, the GTN is nowadays a powerful tool for decision support for traffic control staff. Therefore, GTN is an essential part of the system of automatic train route setting which is now being developed. Using the existing electronic interlocking, their remote control and the GTN application seems to be the easiest way how to implement automatic train route setting system on the infrastructure of the Czech railways.

Keywords: interlocking system, traffic control, information system, control system

1 Need for ASJC

Modern interlocking systems reduce the work of train dispatcher in a few mouse clicks. On the other hand since the number of interlocking systems controlled from one centre is increasing its operation becomes more demanding. Therefore it is necessary that more operations are being performed automatically.

The main task of interlocking is setting the routes. The route setting command has to be released in the proper time. For example while crossing the trains it has to be released right after the first train's

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arrival so that the departure of the waiting train is not delayed. The train dispatcher knows in advance how to handle the situation and which actions have to be undertaken and in which order. However he cannot apply them all at once since the traffic situation does not allow it. He needs to follow the traffic and make them one by one. Therefore the manual route setting is time consuming. Moreover most of the routes repeat periodically during the day since it is set in advance in a timetable.

Clearly we could save dispatcher's time by implementing the automatic train route setting (ASJC). This time can be than devoted to other tasks. Alternatively one person would be able to control bigger area.

It has to be stressed that using the simple automatic route setting without optimization requires strict respect of the timetable. Otherwise a fluent traffic cannot be achieved. However given that during the railway operation many changes in the predicted time schedules occur a simple software planning the actions strictly according to the timetable would fail to achieve the goal. This is especially the case of freight trains. The routes would be then set too much in advance or worse, would not correspond to the actual train on the line.

Another problem would arise with the setting of shunting routes. These concern again especially freight trains and tend to be irregular. To deal with these cases the automatic route setting system has to be replaced by manual control, or alternatively both types of control have to be allowed. The automatic setting of shunting routes alone can only be applied to the stations where the traffic is perfectly predictable, for example the regularly locomotive exchange in the border station. For this reasons the implementation of the automatic setting of shunting routes is not considered for the moment.

From the above mentioned is clear that the entire system of ASJC is based on the exact knowledge of the train position and must provide the possibility of human interference. Another condition that has to be fulfilled is the correct functionality of interlocking in the entire controlled area.

This article is concerned with the automatic train route setting. Automatic setting of the shunting routes can be successfully achieved by technical solutions different from train route automation. The article does not deal with this topic.

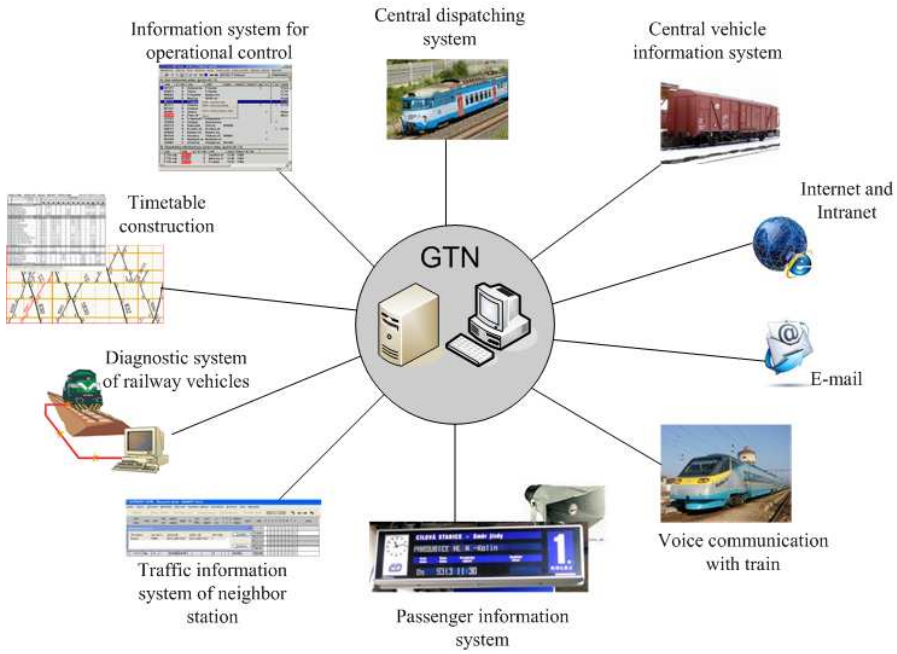
Comment: Given that the shortage ASJC (automatic route setting) has been used for a long time, it is also used for automatic train route setting.

2 Technical resources for ASJC in Czech Republic

One possibility is to design a brand new complex system of traffic control and interlocking which would already include the ASJC functionality. However this solution is only applicable when building a new transport system which is independent on the existing interlocking systems. Otherwise it is necessary to ensure the compatibility of the new system and the existing one.

Given that the majority of the main lines in Czech Republic are already equipped with the electronic interlocking of the 3. category it would be ineffective replacing them. Thus it is necessary to deal with the integration of the ASJC functionality into the existing electronic interlocking.

Direct implementation of the ASJC functionality into the existing interlocking is not possible. It would require redesigning the conception of the interlocking system completely. It seems to be feasible to provide the ASJC functionality as a software shell above the existing systems with the particular adjustments in commanding and eventually technological part of interlocking. Advantage of this solution is relatively little interference into the already running appliances.



However from the operational point of view connecting of several interlocking into the DOZ (Remote controlled appliance) systems and its joining with GTN (Graphic-technological shell of signaling system) which dispose of timetable data appears to be the most appropriate solution. DOZ includes several stations and therefore it provides enough information for the ASJC system from the stations on the train route. Theoretically it is possible to use ASJC just in one isolated station as well. GTN has all features needed for the ASJC function:

- it cooperates with the train running system which is integrated in interlocking,
- prognoses the development of the traffic in the real time,
- it is interconnected with higher information and control systems in the railway traffic management and provide therefore the maximum of information about trains,
- it is possible to implement into the GTN the functionality of ASJC.

The important part of the technical implementation is the data transmission system between the two subsystems. Especially the matter of safety has to be considered. Information and control systems (GTN as well) run in the open transmission system while the interlocking operates in closed transmission networks (in accordance with norms ČSN EN 50 159-1 a ČSN EN 50 159-2). Therefore an appropriate interface (a gate) in the system structure has to be designed. This interface should be naturally approved by the appropriate authority.

The approval process in connection with ASJC must be undertaken for:

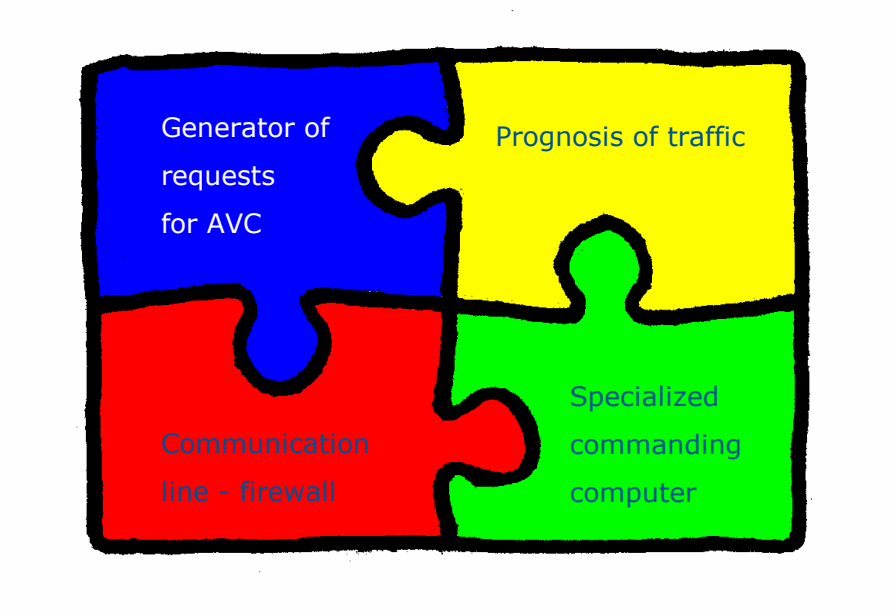
- the interface (gate) - to prove that joining the open and the closed transmission system did not increase the risk of unauthorized access into the closed transmission system of interlocking which is approved according to ČSN EN 50 159-1,
- modifications in interlocking - implementation of process which transforms the requirement for the automatic route from the extern source into the command which is compatible with interlocking according to norms ČSN EN 50 126, ČSN EN 50 128 a ČSN EN 50 129.

3 Design of ASJC

The automatic train route setting is based on the mutual cooperation of the electronic interlocking and the information and control system GTN.

When we claim that ASJC is system, than we can decompose it into subsystems according the features it uses:

- prognosis of traffic in GTN, conflict detection and solution,
- GAVC (automatic train route generator) - GTN generate on base of the time method the requirements for setting the AVC (automatic train route),
- GZPC (commanding computer of interlocking connected with GTN) transforms the requirements for AVC into the standard interlocking command,
- communication line - specialized firewall between the GTN and GZPC for separation of the open and closed data network



GTN prognoses the traffic situation, display or straight solve the conflicts. With aspect on the railway infrastructure data it is necessary to count with the data connection between GTN and ETCS/RBC or better with CSV (central system of rail exclusions). This is needed for the system supplying with data about exclusions and speed restrictions.

On behalf of modified traffic prognosis in GTN it is possible to generate requirements for automatic train route setting. It is important to determine the right moment for the sending out the command because there are many significant factors. The analysis of this timing is a fundamental matter and exceeds the dimension of this article. The undertaken analysis shows the time method provides better results than the space method. In fact, combination of both would be the ideal solution. But the implementation in the Czech conditions would be rather complicated.

The main task of the GAVC is sending the request for setting the route into the commanding level of interlocking - so called automatic train route - AVC, in the proper time. The commanding level of interlocking - GZPC - consequently check the legitimacy of the request, whether the request is in conflict with the other one and check the AVC for the process safety. In case of positive result the GZPC converts the AVC into the standard interlocking command which is consequently executed in the safe kernel of interlocking (technological and executive level).

The interlocking reacts to the requirement for automatic train route setting from GAVC in the same way as if it was generated by human operation. The degree of automation depends on the traffic prognosis in GTN which must have minimum conflicts as possible.

4 Problems connected with ASJC implementation

Problems which concern the ASJC implementation are listed here. The authors admit that the list does not have to be complete. Therefore it is necessary to open discussion among experts, that will lead to solution of problems mentioned below or identification another ones, here not listed.

a) Intrusion of closed transmission systems of interlocking

b) Traffic-safe algorithms

c) Setting the train route in proper time

d) Synchronous and correct time in all subsystems

e) Trustworthiness of data from superior information and control systems

The comprehensive description of the problematic points was already published in 2005 in [1]. However significant progress has not been achieved in many matters, namely on the part of infrastructure manager and the technical-safety approval authority. The effort from AŽD Praha to start professional discussion led to proposal of technical specification for ASJC which infrastructure manager (SŽDC) elaborated in 2009. This proposal was marked up by AŽD Praha especially because the implementation into the existing interlocking systems is not possible without their complex redesign.

Further changes in connection with ASJC are expected in the user menus and indications of electronic interlocking.

5 Conclusion

The new designed system of automatic train route setting respects the logic of the electronic interlocking system and is composed as a software innovation of the existing and working established interlocking. It fully makes use of the traffic-prediction module of Graphic-technological shell of signaling system and extends it by the generator of requests for automatic train route setting. For the successful implementation of this system it is important to solve the intrusion of closed transmission systems of interlocking, define the traffic-safe algorithms, determine the moment for sending the request for setting the route and ensure the trustworthiness of data from superior information and control systems.

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