RELATIONSHIP BETWEEN CAPACITY AND SCHEDULING IN RAILWAY SYSTEM

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1. INTRODUCTION

Timetable planning in particular is complicated for railways, primary because railways have a single degree of freedom (whereas road transport has two degrees and air three). All overtaking of trains or meeting of trains (on single track) and crossing of trains (at junctions) have to be planned in detail if delays are not to result. Railway scheduling is critical to the effective utilisation of railway infrastructure and in the planning of future infrastructure developments to optimise the use of network and resources. Capacity of the railway infrastructure and mainly its utilisation has very close relationship to scheduling

2. INFRASTRUCTURE CAPACITY

Generally the capacity of a transport infrastructure facility signals its ability to accommodate a flow of people or vehicles. A transportation facility's capacity (design or practical) is typically defined from am engineering perspective with reference to a level of service or quality flow, that will provide satisfactory traffic operations. Occasionally [1], capacity has been viewed, from an economic perspective, as a threshold notion, as the minimum traffic volume for which a facility is justifiable.

Railway infrastructure capacity [2] means the *potential* to schedule train paths requested for an element of infrastructure for a certain period. Train path means the infrastructure *capacity needed* to run a train between two places over a given time-period. Situation, when exist free infrastructure capacity but appropriate train path for railway undertaking (RU) need not be in disposal and requirements on train path cannot be satisfied, is not so rare.

Where after coordination of the requested paths and consultation with RU applicants it is not possible to satisfy requests for infrastructure capacity adequately then the infrastructure manager (IM) must declare that element of infrastructure on which this has occurred to be congested. After that the infrastructure manager should carry out a capacity analysis and a capacity enhancement plan.

The objective of capacity *analysis* is to determine the restrictions on infrastructure capacity which prevent requests for capacity from being adequately met,

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and to propose methods of enabling additional requests to be satisfied. This analysis identifies the reasons for the congestion and what measures might be taken in the short and medium term to ease the congestion.

The analysis considers the infrastructure, the operating procedures, the nature of the different services operating and the effect of all these factors on infrastructure capacity. Measures to be considered should be all include in particular re-routing of services, re-timing services, speed alterations and infrastructure improvements.

A capacity enhancement plan shall be developed after consultation with users of the relevant congested infrastructure. It must identify:

a) the reasons for the congestion,
b) the likely future development of traffic,
c) the constraints on infrastructure development,
d) the options and costs for capacity enhancement, including likely changes to access charges.

It also, on the basis of a cost benefit analysis of the possible measures identified, determines what action shall be taken to enhance infrastructure capacity, including a calendar for implementation of the measures.

3. RAILWAY SCHEDULING

Railway scheduling is process by which the demand for rail transport (passenger as well as freight) is brought together with supply side constraints (such as available infrastructure capacity, rolling stock, staff) to produce timetables and resource plan that meet the demand at an appropriate level of cost. This process is also known as train planning.

Railway scheduling is undertaken at different times for different reasons:

- Strategic planning,
- Tactical planning.
- Operational planning and control.

Scheduling in all three horizons defined above follows a similar high-level process (see Fig1).

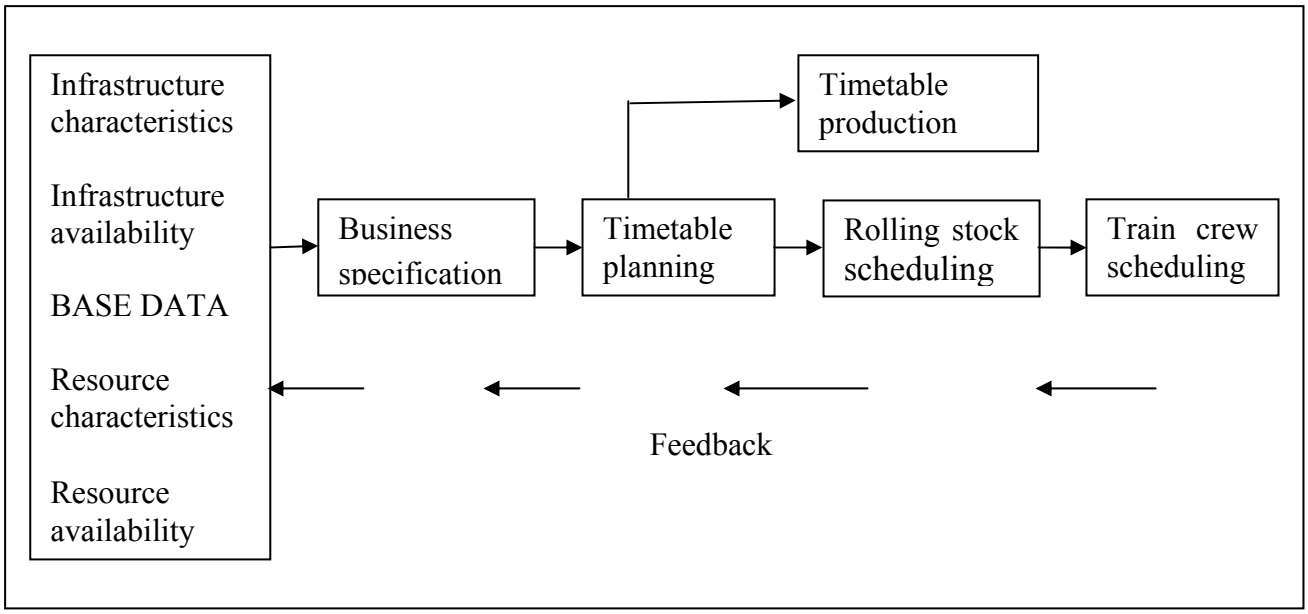

Fig.1 Overview of railway scheduling process

a) Base data

The process starts by initially defining:

- Infrastructure characteristics – number of tracks and their construction parameters, train speed can travel, signalling, etc.
- Infrastructure availability – statement of when infrastructure is unavailable (definition of a maintenance window).
- Resource characteristics – whether particular rolling stock can run on particular routes (limitation include gauge, curvature, weight, signalling interface) and the performance characteristics of particular rolling stock on particular routes)
- Resource availability – rolling stock numbers, numbers of staff, location, etc.

b) Business specifications

It is normal for several, potentially conflicting business specifications to be produced – these specifications come from the differing requirements of customers of the railway. Specifications come from separate railway undertakings (RU) competing for access to the infrastructure, each provides its own requirements (international, intercity, suburban regional, freight trains).

c) Timetable planning

The train service specifications are passed to the timetable planners, whose task is produce timetables that are "conflict free" (so that if the timetable was worked to exactly in practice, no train would be delayed by any other).

d) Rolling stock scheduling

All the services in the timetable have to be allocated to rolling stock diagrams. It is possible to be certain how much rolling stock is required to operate the timetable (which might be different the input resource availability).

e) Train crew scheduling

All the rolling stock diagrams have to have matching train crew diagrams, taking into account how many crew are required.

f) Timetable production

Once timetable development is complete, documentation can be produced for passengers, carriers and staff.

4. PROCESS OF SCHEDULING AND COORDINATION

In connection with scheduling process we can define *working timetable* as the data defining all planned train and rolling-stock movements which will take place on the relevant infrastructure during the period for which it is in force.

The IM manager should be as far as is possible meet all requests for infrastructure capacity including requests for train paths crossing more than one network, and take account of all constraints on applicants, including the economic effect on their business.

The IM manager may give priority to specific services within the scheduling and coordination process (e.g. public-service requirements, development of rail freight). The IM consults interested parties about the draft *working timetable* and allow them at least one month to present their views. Interested parties stall include all those who have requested infrastructure capacity as well as other parties who wish to have the opportunity to comment on how the working timetable may affect their ability to procure rail services during the working timetable period.

During the scheduling process, when the IM encounters conflicts between different requests he shall attempt, through coordination of the requests, to ensure the best possible matching of all requirements. When a situation requiring coordination arises, the infrastructure manager shall have the right and tools, within reasonable limits, to propose infrastructure capacity that differs from that which was requested. The principles governing the coordination process are defined in the network statement.

5. CONCLUSION

Appropriate capacity-allocation schemes for rail infrastructure coupled with competitive operators should result in a better balance of transport between modes and capacity-allocation schemes should encourage railway infrastructure managers to optimise use of their infrastructure. On the other hand railway undertakings should

receive clear and consistent signals from capacity allocation schemes which lead them to make rational decisions.

In order to take into account the needs of users of railway infrastructure capacity to plan their business, and to the needs of customers and funders, it is important that the infrastructure manager ensures that infrastructure capacity is allocated in a way which reflects the need to maintain and improve service reliability levels. It is desirable for railway undertakings and the infrastructure manager to be provided with incentives to minimise disruption and improve performance of the network.

6. REFERENCES

[1] K.J. Buton, D.A. Hensher: Handbook of Transport System and Traffic Control. Pergamon, 2001

[2] Directive 2001/14/EC of the European Parliament and of the Council on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification, Official Journal of the European Communities, 2001

7. ANOTACE

Příspěvek se zabývá vazbou mezi parametry jízdního řádu a požadovanou propustností železniční infrastruktury. Nový způsob přidělování kapacity dopravcům vyžaduje i nové přístupy ke konstrukci jízdního řádu. Přidělení kapacity ještě neznamená, že bude pro dopravce k dispozici i vhodná trasa. Nedostatek volné kapacity naopak vyvolává nutnost učinit opatření k jejímu zvýšení – nejen opatření v oblasti konstrukci jízdního řádu, ale také investiční. Význam strategického plánování, konstrukce jízdního řádu a využití dopravní infrastruktury má rozhodující vliv na posílení kvality železničního systému.

8. ABSTRACT

The paper is deals with relationship between timetable parameters and required capacity of railway infrastructure. The new concept of allocation of railway capacity to railway undertakings calls for innovative approach in scheduling. Allocation of capacity does not need automatically that appropriate train path for railway undertaking will be in disposal. On the other hand, lack of free capacity produces measures to its increase (not only in frame of scheduling processes, but also in investment sphere). Importance of strategic planning, scheduling optimisation and utilisation of railway infrastructure has the crucial effect to quality improvement of railway system.

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