NEW VIEWS OF CAPACITY OF THE RAILWAY LINES

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1. INTRODUCTION

Transport system as well as other large systems may be decompose into subsystems. From function view of point is suitable make decomposition on stationary subsystem (network) and mobile (vehicles). One of the main characteristics of transport system is its capacity. In railway transport mode we can find very close relationships between parameters of infrastructure and train's parameters. Organising of railway operation (scheduling) complements the inputs which significant influence resulting capacity of railway lines and all network. This paper describes some new problems and views which bear on capacity of the railway lines.

2. DIFFERENT VIEWS OF CAPACITY

The transport sector in Europe is presently oriented to a gradual deregulation and liberalisation, with emphasis on competition between the various transport modes. This process of liberalisation access on railway infrastructure together wit the rising volume of traffic and increasing demands in terms of quality and quantity requires the new demands on definition of available railway-infrastructure capacity.

Up to now used definition of line capacity[2] as static value does not fit to actual condition.

Railway infrastructure capacity depends on the way it is utilised. The basic parameters underpinning capacity are the infrastructure characteristics themselves and these include the signalling system, the transport schedule and the imposed punctuality level. Capacity is based on the interdependencies existing between:

- the number of trains (per time interval, e.g. trains per hour),
- the average speed,
- the stability (margins and buffers have to be added to the running time of trains and between train paths to ensure that minor delays are suppressed instead of amplifying and so causing (longer) delays to other trains;
- the heterogeneity (the differences in running time between different train types worked on the same track).

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[2] Capacity of railway line is so volume (number) of trains which is on a given technical parameters of railway lines and timetable preservation, can be on surveyed line in certain period permanent and regularly managed.

Due to differences in requirements, capacity is viewed differently from the position of the market, infrastructure planning, timetabling and operations. These are summarised in Fig.1.

	Customer needs	**Infrastructure planning**	**Timetable planning**	**Operations**
number of train path	expected – peak	expected - average	requested	actual
mix of traffic and speed	expected - peak	expected - average	requested	actual
infrastructure	quality need	expected conditions	existing conditions	actual conditions
journey time	as short as possible	time supplements for expected disruptions	time supplements for expected disruptions	delays caused by operational disruptions
Other requirements	translation of all short and long-term market-induced demands to reach optimised load	maintenance strategies	- time supplements for maintenance -connecting services in stations -requests out of regular interval timetables (system times, train stops, ...)	-delays caused by track works - delays caused by missed connections -additional capacity by time supplements not needed

Fig. 1: Different views of capacity

While capacity demands from the market standpoint are oriented towards satisfying peak values, infrastructure planning by contrast must be oriented towards a definition of capacity that, on average, guarantees profitable utilisation of the infrastructure. From a timetable point of view, capacity considerations bring together a given infrastructure and existing demands for train paths.

From an operational point of view the capacity situation is always in flux and depends on current infrastructure availability, progress with building measures, delays, diversions and the number of additional trains. Each of these different situations is correct in terms of its own specific background. The parameters mean, however, that each viewpoint leads to a different capacity-requirement result.

As mentioned already above, there are different views of capacity and a unique true definition of capacity is impossible.

3. WHAT DOES IT MEANS CAPACITY?

The capacity of any railway infrastructure is:

- the total number of possible paths in a defined time window,
- considering the actual path mix or known developments respectively and the Infrastructure Manager's (IM) own assumptions;

- in nodes, individual lines or part of the network;
- with market-oriented quality,
- which must also take account of the IM's own requirements.

Infrastructure capacity is related to the ability of the particular infrastructure to offer train paths in accordance to market needs as represented by customer requirements.

The IM customer is the Railway Undertaking (RU) which expresses its requirements in the form of path requests. These path requests result from the combination of:

- end customers' (passengers, carriers) needs and requirements,
- the needs of RUs themselves (e. g. type, utilisation or maintenance of rolling stock).

The path request is related to a typical running time (depending on the performances of the rolling stock) and a departure time or arrival time and IM should be comply with the requirements of these parameters.

During the negotiation process in respect of capacity allocation, an iteration process occurs between RU requirements and IM offers. As long as the alteration following the iteration is accepted, the market needs are fulfilled. The infrastructure is not to be considered as saturated. Requirements for punctuality (time supplements and buffer time) are incorporated in any case.

4. CAPACITY CONSUMPTION

The level of capacity consumption is the only value that can be measured objectively by reference to all parameters mentioned in the definition.

The formula for determining capacity consumption shall be as follows:

$$k = A + B + C \,[\text{min}] \tag{1}$$

k: total consumption time [min]
A: infrastructure occupation [min]
B: buffer time [min]
C: supplements for maintenance [min]

$$K = \frac{k}{U}.100 \,[\%] \tag{2}$$

K: capacity consumption [%]
U: chosen time window [min]

$$U = k + u \,[\text{min}] \tag{3}$$

u: unused capacity [min]

Infrastructure occupation

Infrastructure occupation is the result of the compression process, i.e. all single train paths are pushed together up to the minimum theoretical headway according to their timetable order, without recommending any buffer time.

Buffer time

Buffer time is time that is inserted between train paths in addition to the minimum interval between trains that arises depending on the signal systems. It serves to reduce transfer of delays from one train to the next.

Supplement for maintenance

The supplement for maintenance may either be part of infrastructure occupation or may be shown as an additional supplement.

Unused capacity

The difference between capacity consumption and chosen time-window is unused capacity. The amount of unused capacity is determined by the possibly *usable capacity* and *lost capacity*.

Usable capacity shall exist if unused capacity can possibly be used for additional train paths, providing they meet the customer requirements (typical characteristics of the paths) for the area considered.

The additional train paths shall be incorporated into the original timetable before compression. .Afterwards, a new analysis of capacity consumption is necessary.

Lost capacity is a time when no further train paths can be added.

5. CONCLUSIONS

The limiting factor of the occupation time does not derive from the difficulty of drawing new paths, but from the level of buffer time (stability requirements), i.e. possibilities for drawing additional paths always exist, but one must stop at a certain level due to stability requirements specific to the timetable.

The remaining question is the value of infrastructure occupation time (% of time window) that must not be exceeded. It then appears impossible to assess standard precise values. As a matter of fact that, several parameters must be taken into account:

- infrastructure reliability,
- rolling stock reliability,
- the interdependency of the line section with other line sections,
- the level of quality required by Railway Undertakings,
- the margin on journey time,
- the number of trains per hour,

- the length of the line section and the possibility to organise overtaking or crossings within it.

For this reason, only the status of *recommended* value can be given as a guideline, which must be further developed through complementary analysis taking into account the above-mentioned criteria. These complementary analyses require high level expertise, which should be solving within institutional research Theory of Transport System.

6. REFERENCES

[1] UIC Code 406 Capacity. International Union of Railways (UIC) - Paris, 2004, ISBN 2-7461-0802-X

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7. ANOTACE

Příspěvek se zabývá problematikou kapacity železničních tratí. V souvislosti s liberalizací přístupu dopravců na dopravní cestu se jeví potřeba novým způsobem přistoupit k jejímu posouzení. Metodika UIC upozorňuje na nové okolnosti, které je potřebné vzít v úvahu, ale neřeší je do všech podrobností.

8. ABSTRACT

The paper deals with issues of capacity of railway lines. Liberalisation of access to railway infrastructure brings the need of new conception of its calculation. UIC methodology refers a new circumstance which is necessary to take into, but it is not in detail solved yet.

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