

DECIDING FOR THE RIGHT TIMETABLE PRODUCTION SYSTEM

RAILWAY IS THE MOST INTEGRATED AND COMPLEX TRANSPORTATION SYSTEM. ITS COMPONENTS REQUIRE SIMULTANEOUS AND COMPREHENSIVE MANAGEMENT. IN THIS CONTEXT, THE TIMETABLE PRODUCTION TOOL IS THE KEY LINK IN OPTIMISING THE NEEDS OF THE DIFFERENT ACTORS AT DIFFERENT PHASES IN A COORDINATED AND ITERATIVE WAY.

AT THE HEART OF RAILWAY OPERATIONS

As for all businesses with large amounts of fixed assets on their balance sheets, planning over different time horizons is essential in the railway industry. In this context the timetable plays a central role, when considering long term strategic investments in rolling stock or infrastructure and planning for the optimal usage of these resources in daily operations.

An existing timetable, in a narrow sense, might be considered as a necessary prerequisite for railway operations. In a broader sense though, the development of the timetable forms part of the operations itself. So timetable development, from the long term planning down to the production of the next day's operations, may be viewed as the true production process; the production of the timetable.

stages. In order to enable the flow of information between these actors, the timetable itself serves as an indispensable platform for communicating intent and requirements.

All these stakeholders have diverging and sometimes conflicting needs which have to be resolved within the process. Public authorities regard the railway's offering as just one part of the overall intermodal transportation system, while train operators are mainly interested in the profitable allocation and efficient use of their resources and in increasing the demand to maximize the revenues. On the other hand, infrastructure managers, being the true coordi-

nators of all traffic on their network are mainly focused on optimising capacity usage and operational stability.

In such a complex and integrated environment, thorough design of the timetable production process and all its sub-processes is crucial. Not only the competencies and responsibilities of all parties involved, but also all the interfaces between them, need to be clearly defined. Further on, it is essential to choose the appropriate modelling granularity at each stage of the production process. At the end of the day, any timetable design system will only be as good as the processes it needs to support.

IT IS ESSENTIAL TO CHOOSE THE APPROPRIATE MODELLING GRANULARITY AT EACH STAGE OF THE PRODUCTION PROCESS

During this production process, that typically covers a long time period, the requirements on the granularity of the railway model, particularly the infrastructure model, vary to some extent. Ten years ahead of execution it is of little interest if a train stops on one platform or another. At this planning stage such detailed specification is not only unnecessary, but could actually form an obstacle to the process.

DIFFERENT ACTORS HAVE DIFFERENT NEEDS AT DIFFERENT PHASES

Many parties are involved in the development of the timetable at different points of time. The main stakeholders are public authorities, infrastructure managers and train operators. All of them contribute to the design of the timetable at different

Figure 1
The timetable is at the heart of Railway Operations

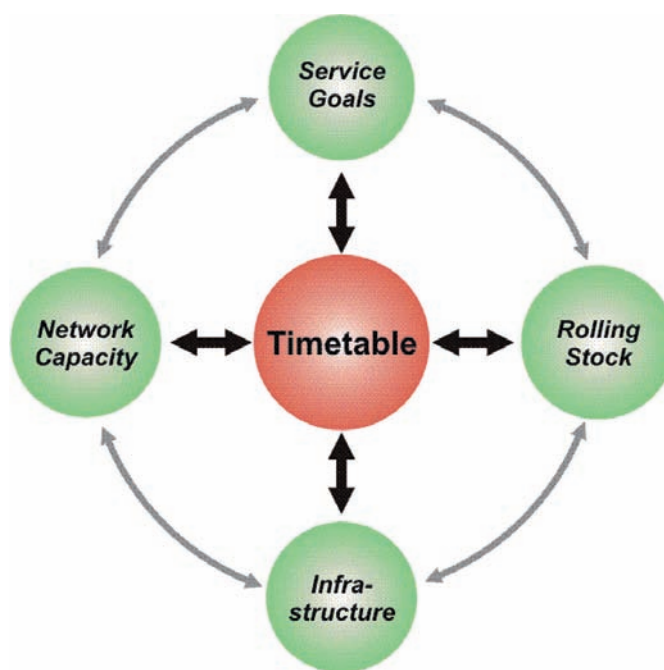
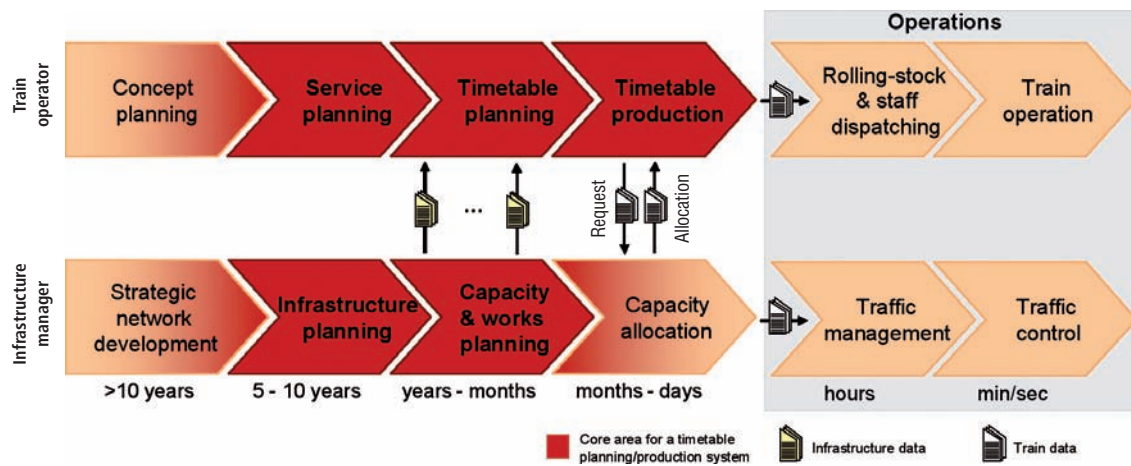


Figure 2
The core areas for a timetable production system in the railway service production process



COMPLETENESS LEADS TO CLARITY

A railway timetable can be regarded as the solution to a complex optimisation problem. The quality of the solution is highly dependent on the scenarios investigated and effects analysed. Hence it is essential in an early stage, to develop a large number of feasible timetable scenarios that are then, in the flow of the process, further examined and evaluated according to various performance indicators such as passenger load, trip time variation, costs of new infrastructure, capacity and resource usage or robustness.

Any IT system that is well suited for the early stages of the timetable production process should support the efficient creation of different timetable scenarios, in order to enable truly creative timetable design. This requirement demands two features from the system: a simple infrastructure model, and the possibility to separate and integrate different types of railway traffic, such as suburban, regional, long distance and freight traffic.

A flexible infrastructure model, in this context has two advantages: First, it allows fast and easy modelling of even large regional or national net-

works and it also simplifies the construction of slots by relieving the timetable planner from many irrelevant infrastructure details at this stage of the planning process. Second, the separation of different types of railway traffic, allows the timetable planners to concentrate on variations in subsets of all slots and trains in a timetable and then recombine these subsets into different timetable scenarios.

The ability to conveniently construct many timetable scenarios is indispensable to creative timetable designing as is the ability to efficiently analyse variations between them. The provision of complementing tools in order to examine the timetable through various views such as graphic timetable, commercial timetable, netgraph, track occupation diagram and rolling-stock roster is another feature that railway planners should require from their timetable production system.

It is essential for infrastructure managers to have tools at hand that support the analysis of a timetable’s operational stability by statistical or deterministic means. Local micro simulations of a timetable can be a useful approach to detect stability and capacity issues early on.

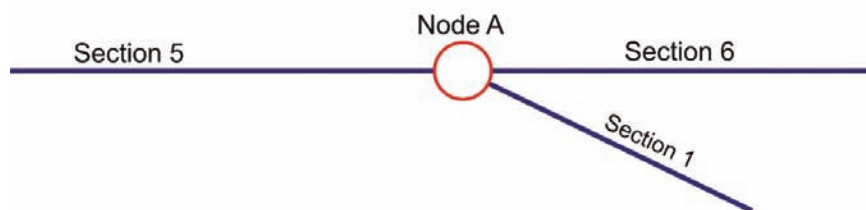
“ THE ABILITY TO CONVENIENTLY CONSTRUCT MANY TIMETABLE SCENARIOS IS INDISPENSABLE TO CREATIVE TIMETABLE DESIGNING ”

However, simulations are not a replacement for timetable planning. Moreover, because of the detailed infrastructure model required to run simulations, this approach can actually be very costly and is usually only applied to restricted subnets of the whole network at a late stage of the timetable production process.

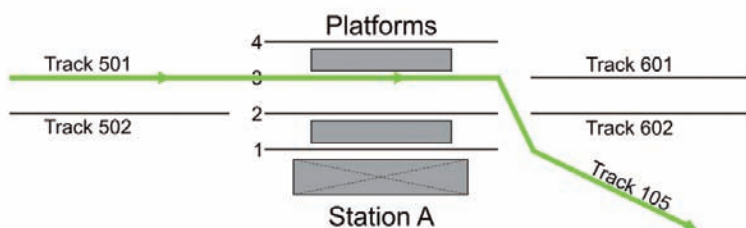
Rolling stock rostering is another important task for train operators in order to obtain early estimates on the costs needed to operate a train service. Changes in the trip times between different timetables are part of the basic quality perception of a rail service for passengers and have an essential impact on the demand for transportation services. Hence trip time comparison forms an essential element of timetable analysis too.

Figure 3
The different levels of detail needed for various examples of infrastructure analysis

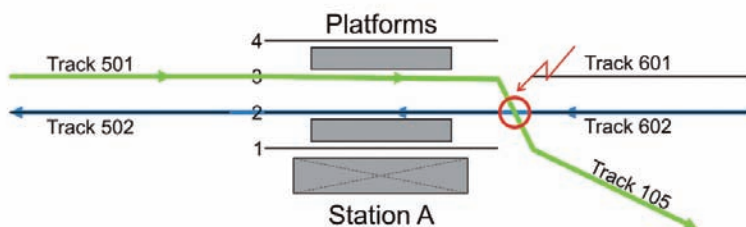
Level 1: Service Planning



Level 2: Slot Management



Level 3: Conflict Detection



GRANULARITY OF SPACE AND TIME

In order to cover a long time period of the process the infrastructure model should provide the ability for continuous refinement. This can be achieved, for instance, by offering the option to add information about a node's topology, which is not needed in the early stages of the process, but is necessary, for example, to run conflict detection methods at a later stage.

In general, the timetable production system should be able to deal with different, however coexistent, levels of granularity of the infrastructure. This allows the user to switch from one level to the other according to his planning needs.

The evolution of the infrastructure model's gran-

ularity is usually crucial for the ability to combine it with other systems which might rely on very detailed operational elements such as signals or switches. For the interactions between train operators and infrastructure managers, it is also essential for the system to offer support to deal with changes in the infrastructure due to long and short term construction and maintenance work.

In order to have a true timetable production system, it is imperative to integrate the timetable production system with the infrastructure manager's slot ordering and allocation processes and portals. This matter is gaining importance with the progress of railway liberalisation and open network access.

Different systems that cover different stages of the production process for different stakeholders will necessarily have large areas of overlap. It is generally a difficult question and subject to a lot of discussions as to which system should cover which part of the process. The answer to this question ultimately lies in the production process' design, which determines what information must be available at which stage of the process.

BEYOND FIXED INTERVAL TIMETABLING

We have already indicated the significance of a flexible railway infrastructure model above. Next we briefly discuss the importance of a flexible train model, which can help to extend the efficient construction of slots beyond pure fixed interval timetables.

The introduction of interval timetables in many parts of Europe has significantly reduced the complexity of the timetable production process. The interval timetable's high degree of repetition has made it possible to reduce dramatically the number of slots that need to be constructed. This in turn has led to a great increase in infrastructure capacity usage, while at the same time has reduced operational costs of the train operator.

One shortcoming of the regular interval timetable is argued to lie in the rigidity of the concept, which prevents the train operator to follow demand more flexibly. Particularly in long distance traffic, a move towards a more



demand-oriented timetable planning may be observed in order to help maximize the revenues. The result of this trend, not surprisingly, will be a multiplication of the number of individual slots that have to be constructed and maintained.

One way of keeping the consequent cost increase under control, is to provide the timetable planners with tools which facilitate, at least partially, the simultaneous construction of many slots. This, for instance, may be achieved by incorporating a more flexible model of the interval train with the functionality to allow it to benefit from the partial interval timetable characteristics of the related train family.

CONCLUSIONS

While the importance of the timetable for the railway industry is obvious, the significance and

the complexity of the timetable production process have often been underestimated. This might be a reason why many railway sector players are still using outdated or improper IT tools and systems, which in turn insufficiently support the timetable production process.

Modern railway infrastructure and high-performance rolling stock are essential for perceived high-quality passenger transportation services. But ultimately the timetable determines many crucial decision factors, like overall trip time and available intermodal connections, of the passengers' travel choice. Critical operational cost drivers, such as personnel and rolling stock deployed, are determined by the timetable as well. Consequentially the timetable production process should be regarded as the core production process in the railway industry and as such has to be supported by the right production systems and tools.

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