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Translation

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Specification of criteria for the computer-aided production of passenger and freight train timetables

*Définition des critères concernant l'élaboration des horaires des trains de voyageurs et de marchandises
à l'aide de systèmes informatiques*

*Festlegung der Kriterien zur Erstellung der Personen- und Güterzugfahrpläne mit Unterstützung von
DV-Systemen*



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Contents

Summary	1
1 - General.....	2
2 - Objectives and measures to attain them	3
2.1 - Timetable planning geared to applicants for train paths	3
2.2 - Improving the quality of timetables and operation	3
2.3 - Increasing the efficiency of the planning process	3
2.4 - Creating the basis for capacity management	4
2.5 - Communication between players.....	4
3 - Specifications required by timetablers	5
3.1 - Introduction	5
3.2 - Specifications linked to the general organisation.....	5
3.2.1 - Organisation.....	5
3.2.2 - Timetabler's work station	6
3.2.3 - Functional specifications	6
3.3 - Specifications linked to timetable calculation.....	7
3.3.1 - Calculation of running times.....	7
3.3.2 - Timetable inquiry information	7
3.3.3 - Basic data required for timetable calculation	7
3.3.3.1 - <i>General</i>	7
3.3.3.2 - <i>Data for each class of tractive unit</i>	8
3.3.3.3 - <i>Special features of railcar units</i>	8
3.3.3.4 - <i>Data for each class of hauled stock</i>	8
3.3.3.5 - <i>Infrastructure data</i>	9
3.3.3.6 - <i>Standard train data</i>	9
3.4 - Specifications linked to infrastructure capacity management.....	9
3.4.1 - Location of conflict points.....	9
3.4.2 - Realistic graphic displays.....	10
3.4.3 - Stability of timetable grid	11
3.5 - Specifications linked to the production of timetable documents (IT and/or paper).....	11
3.5.1 - General	11
3.5.2 - Working documents for the timetable	11

3.5.3 - Documents for operational use	12
3.5.4 - Commercial documents, statistics, other IT interfaces	12
4 - Summary of theoretical system functions.....	13
5 - Conclusions and recommendations to Railways	14
Bibliography	15

Summary

After a description of objectives, this leaflet provides in point 3 a detailed list of all specifications which may be of relevance to the Railways when compiling Passenger and Freight train timetables by computer. The catalogue incorporates the requirements of infrastructure managers and operating companies in full coherence with European Union directives.

Each company can pick and choose in the catalogue those specifications which best meet its needs, for use in its IT system when compiling timetables.

1 - General

In the past, timetables were produced manually by all European Railways. This also required, and to some extent still does involve, a number of time-consuming activities such as:

- ascertaining running times from the tables of standard runs,
- calculation of the running time of a train from individual running times,
- plotting the time-distance line for the train on the timetable graph.

It was therefore absolutely necessary to create an IT-based system to assist and relieve the timetable planner in designing the timetable, thereby considerably accelerating and simplifying the entire iterative process of producing the annual timetable.

With this aim, several European Railways have started to set up data-processing systems to assist in timetable planning.

It is now necessary, for these systems and for all Railways which do not yet possess such systems, to formulate standard specifications from the standpoint of the user, in the form of a catalogue of requirements. This catalogue would cover all possible requirements according to the Working Group. UIC Railways are recommended to take from this catalogue those parts which are relevant to their needs.

This approach is also in harmony with the directives of the European Union (EU) regarding the development of Community Railways, and with the arrangements for access to railway infrastructure. Here there is a mandatory requirement that in future new undertakings entering the market shall also enjoy non-discriminatory access rights. For the purpose, a system of capacity allocation and infrastructure charging will have to be established, applied in accordance with the same principles throughout the Community, and based on non-discrimination.

The catalogue of requirements for computer-assisted timetable planning is intended as a contribution towards meeting this objective. For further details on this aspect, see point [3 - page 5](#).

The overall catalogue contained in this leaflet is purely recommendatory for all Railways.

2 - Objectives and measures to attain them

This leaflet defines the timetablers' requirements for their national data processing systems. In collaboration with the other players involved, it is intended to formulate data-processing applications for the combined production of passenger and freight train timetables.

Computer-assisted timetable planning should accelerate the process, assist in more rapid transfer of information to customers, improve the quality of timetable production, and altogether contribute to making transparent the requirements of EU Directives on non-discriminatory access of third parties to infrastructure capacity. The existence of data structures based on the specialist catalogue of requirements for the computer-assisted production of timetables may also enhance the capacity for Railways to communicate with one another. Potential users of infrastructure capacity will approach the track capacity managers with differing and generally competing requirements. The needs of passenger traffic for fixed running times are in conflict with the overwhelmingly market-oriented demands of freight traffic.

For timetable planning this means that, in addition to operating factors such as feasibility, stability, etc., commercial factors such as train-path prices will also be of relevance.

This development gives rise to the objectives set out below for the future computerised timetable-planning system.

2.1 - Timetable planning geared to applicants for train paths

- Planning which accommodates the need to meet the requirements of applicants for train paths (e.g. destination and arrival time).
- Allowance for short-, medium- and long-term requirements.
- Information to customers on paths/infrastructure, quality and price.

2.2 - Improving the quality of timetables and operation

- Planning of consistent paths to improve punctuality.
- Indication of track possessions to ensure technical feasibility of train running.
- Assistance in timetabling by indicating further conflicts.
- Incorporating functional tools to evaluate the quality and stability of timetabling.
- Systematic calculation of running times.

2.3 - Increasing the efficiency of the planning process

- Relieving the timetabler of routine tasks.
- Other applications also able to access and use available master data and algorithms.

- Automatic calculation and plotting of time-distance lines.
- Interactive facility between operator and screen for example:
 - movement and copying of train paths,
 - copying of time-distance lines.
- Alternative solutions with evaluation of time, costs, etc.
- Simple operation through multiple use of identical data (e.g. typical train, journey route, running conditions, departure/arrival times, etc.).
- Allowance for individual running, headway and recovery times.
- Provision for operating (feasibility, stability, etc.) and commercial (train path price, risk, etc.) criteria in planning.

2.4 - Creating the basis for capacity management

- Increasing the capacity of routes and junctions through timetable planning measures.
- Pricing and sale to customers according to path capacity (passenger, freight and third parties).

2.5 - Communication between players

- Creation of well-defined IT interfaces.
- Interactive facility between operator and screen.
- Use of common databases:
 - line and vehicle data (only that part of content relevant to the timetable),
 - running times and running time calculation (direct).
- Data interchange (paths requested, paths offered) with customers:
 - freight,
 - passenger,
 - third parties.
- Information for timetable users geared to their needs.
- Statistical analysis of timetable data.
- Computer-assisted communication between timetablers.

3 - Specifications required by timetablers

3.1 - Introduction

The system should meet the three following main requirements:

1. Planning of timetables.
2. Management of infrastructure utilisation: identification of conflicts, stability of timetable grid.
3. Output of timetables on paper and/or data carriers. The system could be designed to administer timetable studies and requests.

3.2 - Specifications linked to the general organisation

3.2.1 - Organisation

- Only one party responsible for each train.
- A train or a train section may be modified only by the timetablers of the railway on which it runs.
- The work of the Railways may be organised by geographical sector, lines or sections of lines for each class of train.
- Facility to change the definition of sectors in the system.
- Facility to view other geographical sectors.
- Facility to transfer responsibility for a sector from one planner to another while upholding the principle that only one planner has authority to act at any one time.
- One planner may be responsible for several sectors.
- Exchange of information between planners may take place via the system, both within and between different organisational sectors.
- The system should be capable of administering short-, medium- and long-term projects, together with very short-term timetables for special trains.
- For each timetabling period, several options should be planned (total number of train movements scheduled).
- The alternatives for a given planning period may be transferred wholly or in part to another planning period.
- In the planning of paths, there should be provision for several planning statuses (as a minimum, there should be a distinction between "planned" and "final" status).
- The acceptance/approval of planning status should be transparent and capable of definitive recording.

- Administering the scheduling of operations.

The information system shall be capable of administering this structure, but also able to deal with changes to the organisation. It should however be sufficiently flexible to enable changes in the organisation to be implemented quickly. In view of the special facilities and extensive data output, a central database for all timetables is required.

3.2.2 - Timetabler's work station

The work may be undertaken:

- either on a graphic display,
- or with the aid of a number of tables, depending on the nature of the task.

3.2.3 - Functional specifications

- Input of planning parameters such as:
 - type of traffic,
 - weight and number of vehicles,
 - length of train,
 - type of hauled stock,
 - tractive unit(s): type - number,
 - speed,
 - recovery margin,
 - lines to be used.
- A train is valid only for the duration of one timetable period.
- Inputs by the planner are checked for plausibility and logical errors.
- The timetable planned must be feasible.
- It is possible to plan with minimum time allowances.
- The planning of regular clockface services is aided by the system.
- Location of a route number is assisted by selection with the aid of a map.
- The input of departure and arrival stations produces a proposal by the system with preferences (optional inclusion of other parameters such as loading gauge restrictions).
- After input of the parameters required for timetabling (typical train, line, origin and destination points), the path is planned by the system (forwards and/or backwards from each location and time).
- Analysis of a path selected in terms of price, economic risk (e.g. specified quality relative to contractual penalty payments), etc.
- Train-based presentation of the information on a graphical display screen (complete summary of a train journey over all sectors).

3.3 - Specifications linked to timetable calculation

3.3.1 - Calculation of running times

There are two possible methods:

- Determination of timetables taking into account running times, stopping times, any track possessions, buffer allowances and other supplements based on typical trains (calculated and stored beforehand).
- Determination of timetables taking into account running times, stopping times, any track possessions, buffer allowances and other supplements, and calculated (within the system) for each train.

In both cases, it is necessary to have a database containing details of the infrastructure, tractive units and hauled stock, in order to supply an algorithm with the required data to calculate train running.

3.3.2 - Timetable inquiry information

- Departure and/or arrival time.
- Booked time at one or more intermediate points.
- Possible specification of a maximum speed between two points.
- Stopping times.
- Possible instructions on safety using standard references or separate information for each train.

3.3.3 - Basic data required for timetable calculation

3.3.3.1 - General

- Only data content with timetable relevance is included.
- Data is retrieved via the existing databases where available.
- Route data, data on tractive units and rolling stock (data with timetable relevance) from which trains can be assembled is retrieved.
- Only timetable data of relevance to the user is provided.
- Only finished results are transferred.
- No personal data is processed.
- Data protection requirements from the operating standpoint:
 - the processed data is for internal use only,
 - at any point in time the rights to handle the data are always vested in the timetabler.
- Data storage on a daily, weekly and monthly basis.

- Central responsibility for data security at working-sector level.
- Backup copies to be kept physically separate from the application.

3.3.3.2 - Data for each class of tractive unit

- Weight.
- Length over buffers.
- Distance between pantographs.
- Maximum speed.
- Curves relating to tractive effort at wheel flange (allowing for differences in line voltage).
- Tractive effort interruption times.
- Coefficient of centrifugal mass.
- Individual supplementary data (such as fouling of structure gauge, wind risk, special features, e.g. for steam locomotives, etc.).
- Braking capacity.
- Optional data.

3.3.3.3 - Special features of railcar units

- Tare weight, weight under normal load.
- Power consumed by heating and/or air conditioning.
- Rolling resistance.

3.3.3.4 - Data for each class of hauled stock

- Weight per vehicle, maximum number of vehicles.
- Length over buffers.
- Maximum speed.
- Power consumed by heating and/or air conditioning.
- Rolling resistance.
- Coefficient of centrifugal mass.
- Braking capacity.
- Optional data.

3.3.3.5 - Infrastructure data

- Grouped by line number in accordance with classification criterion.
- Detailed description of signalling installations.
- Works operating instructions with their validity.
- Periods when line closed temporarily / permanently.
- Track: start of significant point - end of significant point - name of route.
- Operating point on the rail.
- Rectified profile.
- Electrical power supply (electrical profile for direct current).
- Speed by class of train.
- Facilities for switching from one track to another.
- All instructions required for the printout: e.g. radio channel.
- Station and route data of timetable relevance.
- A validity date must be given, at least for speeds.

3.3.3.6 - Standard train data

- Key features of each typical train: speed, weight, locomotive, braked-weight percentage, stopping sequence, standard length or maximum length.
- Grid of relevant parameters (e.g. weight in 100 t stages).

3.4 - Specifications linked to infrastructure capacity management

3.4.1 - Location of conflict points

Conflicts may be of the following types:

- train sequencing,
- conflicting routes,
- converging routes,
- diverging routes,
- intersecting routes,
- head of train against head of train,

- opening of the line (especially track possessions for engineering work),
- etc.

Conflicts may also arise involving connections (minimum time which must be allowed for connections).

For paths with shared routes on the same days of the week, the conflict at each point is expressed in specific terms by a headway limited in time and depending on 5 factors:

Infrastructure	Track layout
Type of track operation	
Signalling	Block type

Identification of the conflict should take place on the timetable listed in the documents, so that the graphics validated in the planning may also be used for operational purposes.

- Conflict recognition is permanently active during planning, i.e. it is on-line.
- Conflict recognition is based on train-running days.
- Conflict recognition takes into account different line protection methods (in particular when headways overlap).
- Conflicts detected are displayed immediately (where applicable by special colours).
- Elimination of the conflict is not mandatory, i.e. it should be possible for the planner to accept conflicts, while realising their existence.
- The following special conflicts are also recognised:
 - ban on trains meeting at stations with level-crossing access to platforms, with no technical protection,
 - checking on periods when the line is closed to traffic,
 - passenger and freight trains passing on high-speed lines (tunnels),
 - checking that electric locomotives are not routed over non-electrified running lines and loop lines,
 - out-of-gauge loads,
 - weight restrictions,
 - maximum load, drawbar loads and maximum compressive forces,
 - adequate track and platform length in stations,
 - priority for heavy freight trains at certain locations,
 - bans on electric train heating,
 - etc.

3.4.2 - Realistic graphic displays

Based on the system for identifying conflict situations, with the aim of improving the quality of forward infrastructure planning:

- calculating the utilisation of a line,

- calculating the average time available,
- stability of the timetable grid in the event of minor disruption,
- provision for train running strategies,
- provision for train turnround times and allowance for the number of platforms at a station,
- determination of indices to evaluate planning quality in terms of throughput, stability, etc.,
- specific action on the part of the timetabler.

3.4.3 - Stability of timetable grid

This application facilitates the selection of a timetable grid from various models:

- creation of an incident panel,
- integration of these standard incidents in the various grids for the purpose of observing the effects on the timetable and determining the time required for a return to normal conditions (with measurable quality criteria),
- incorporation of functional tools, e.g. UX-SIMU (simulation procedure for evaluating and analysing timetable quality and line capacity), etc.

3.5 - Specifications linked to the production of timetable documents (IT and/or paper)

3.5.1 - General

The following applies to all documents:

Output as draft or final version on the date of introduction or amendment:

- Possible selection by class of train,
- selective output of timetable information,
- production of timetable excerpts in graph and table form (train lists, trains at a particular operating location in time order).

3.5.2 - Working documents for the timetable

- Timetable times at all points.
- Specific graphics (e.g. timetable graphs, timetable graph excerpts, station simplifiers).
- Standard printout with details of the train planned.

3.5.3 - Documents for operational use

- Trains over a section of line in chronological order.
- Summary with timetable times at stopping points, in numerical order of train class.
- At any point: trains in chronological order.
- Graphics (e.g. timetable graphs, timetable graph excerpts, station simplifiers).
- Working documents for traincrew and station staff.
- Selection of trains for one route, for one period of time and one sector.
- List of all trains.
- List of all trains on a certain day of the week.
- List of all trains running on a particular day of the timetable year, or on a group of days as identified by code.
- List of certain classes of train.
- etc.

3.5.4 - Commercial documents, statistics, other IT interfaces

- For commercial needs.
- For regional or local level, for operating department needs.
- For the rostering of tractive units, train crews, vehicles and rolling stock.
- For the control of installations.
- Statistics.
- For other producers of data with timetable relevance.
- Where applicable, with databases.

4 - Summary of theoretical system functions

A system for computer-assisted planning of paths should perform the following functions:

1. It will represent the means of communication between suppliers of train paths and their customers.
2. It is the key instrument for timetable planning, providing information on:
 - the feasibility of the timetable,
 - the quality of the timetable(s) planned
 - prices.
3. It ensures the provision of planning data to subsequent users (e.g. public timetable, statistics).
4. It assists the user in the planning of new and/or upgraded lines, new services and vehicles, through simulation of the new situation.
5. It represents the interface between timetable databases planned or already in existence, for the use of the data they contain e.g. infrastructure data.
6. It assists in the selling of paths through the rapid facility for planning a path from A to B, together with an indication of the price for such a path.

5 - Conclusions and recommendations to Railways

All specifications set out in this leaflet are recommendatory and bear no relation to the specific form of organisation of an individual railway.

The requirements defined in this leaflet are intended as aids, especially for those Railways which do not yet have IT applications for timetable planning.

It is not considered essential that existing data processing systems should be affected with or modified.

With the requirements of point 3 - page 5 an attempt has been made to list the most comprehensive possible catalogue of detailed specifications for a logical method of timetable production. In consequence, the catalogue contains requirements which are not relevant to every railway.

Railways are therefore recommended to use only those requirements from the full catalogue which are essential to them in relation to their method of working and their technical facilities.

By choosing from the specifications set out in point 3, Railways have the possibility, in collaboration with the relevant UIC bodies, to describe and implement IT applications for the production of railway timetables.

To summarise, Railways are recommended - where this has not occurred or is planned:

- to define their own specifications for an IT system for timetable planning on the basis of the overall catalogue provided here, and
- in collaboration with their IT departments, to implement these specifications in the form of an IT concept for the production of passenger and freight train timetables,

taking into consideration the objectives stated in point 2 - page 3 above.

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