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INFORMATION SYSTEM OF RAILWAY UNDERTAKINGS TRAIN TRACK REQUIREMENTS

ABSTRACT

The paper describes the facilities of a new application serving for entering railway undertakings requirements related to train tracks in the conditions of the Czech Republic. The application is a part of a new information system of the train timetables configuration. The train editor represents a distributed application consisting of a database server, application server and a client program. It contains most of the data of trains available in the programming schedule. In addition to features for working with trains, it provides a variety of analytical tools and printing of tools for railway workers and passengers. In order to coordinate compiling of the timetable by the infrastructure manager, a train-making procedure was designed based on the stages of the train.

KEY WORDS

timetable, train, information system, distributed application

1. INTRODUCTION

The making of train timetables in the Czech Republic has been successfully provided for more than ten years using four information systems. The creation of a train timetable begins in the CEV system [1] in which the railway undertaking enters its requirements for a train track. The railway undertaking subsequently specifies the train engines in the ASO system. Finally, the infrastructure manager calculates in the SENA system [2] the time location of the train and provides additional information. The master data (railway system, engines and wagons) are maintained by EXPERT system.

The CEV application works with a local database consisting of binary files. Local databases are synchronized usually at night with the central database via exports and imports. While the users can work with their local train database offline independently of other users, the changes made by them, on the other hand, will be reflected in other databases following the data exchange usually the next day. During the exchange, data may be lost if entered by multiple users on the same day.

Since the commencement of the development of CEV system (1996), computer technologies have moved forward significantly, and therefore 2006 saw the start of the development of a new train editor and other applications involved in the creation of a timetable.

2. NEW INFORMATION SYSTEM

The new concept of the train timetable is based on two information systems: KANGO and KASO [3]. The structure of these systems and links between them are illustrated in *Figure 1*.
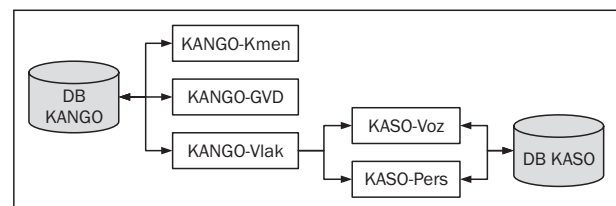

*Figure 1 – Information systems
for making of train timetables*

The KANGO system is primarily designed for the infrastructure manager. It consists of the following subsystems:
– KANGO-Kmen – master data editor – replaces the EXPERT application,
– KANGO-Vlak – train editor – replaces the CEV application,
– KANGO-GVD – serves for construction of the timetable and making of most of print outputs – replaces the SENA system.

The KASO system is intended solely for railway undertakings and contains the following subsystems:
– KASO-Voz – used for production of circulations of engines and trains – replaces a part of the ASO system,
– KASO-Pers – used for creating turns of train and locomotive crews – replaces partially the ASO system.

KANGO subsystems work over a common central database, which contains a database of master data, trains and users.

The applications KASO-Voz and KASO-Pers read the master data and data from the database of trains through KANGO-Vlak. For information circulation pattern they use their own central database.

The master data and trains data by other information systems operated in the Czech Republic are available in the original and the new format. The original format is represented by text files, the export of which is ensured by the KANGO-Vlak application. The new format is provided through web services. Trains data interchange with the international Pathfinder system [4] is provided by KANGO-Vlak through export and import of XML files.

The KANGO-Vlak system and its communication with other KANGO and KASO applications is described below.

3. DISTRIBUTED APPLICATION

Each KANGO and KASO sub-system uses its application server that provides an interface for database access and provides control of the recorded data. In the majority of cases, the appropriate application server reads and writes from/to the database only such information data to which it is entitled. The data it uses only for reading, it reads and updates from another application server. For example, KANGO-Vlak application server reads the data on the trains from the database server, while the master data are read from the KANGO-Kmen application server.

The KANGO-Vlak system is developed in the C# programming language. It is executable under operating systems that support the Microsoft .NET Framework platform. It consists of a client program and an application server. Its structure is shown in *Figure 2*.
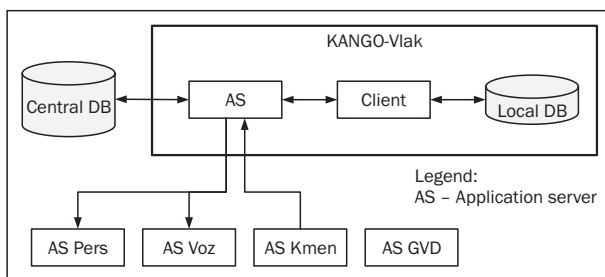

Figure 2 – KANGO-Vlak Structure with ties to other parts KANG and KASO

The client program keeps a copy of the central database. This copy is stored in the local database. If a client connects to a database for the first time, a new local database is created; otherwise, automatic synchronization is performed of the local and remote databases.

The synchronization can be done in two ways:
– Synchronization of the basic tables is made at the forefront upon opening up the database while synchronization of the other tables, especially train

routes, is carried out in the background upon opening the database. When synchronizing the foreground, the user must wait for the completion of the operation, while almost all operations can be performed with the background synchronization.
– All the synchronization is performed on the forefront upon opening the database. This method should be used if a client logs on to the server periodically. If they have not logged in for a longer period, large volumes of changed data may suddenly transfer from the server to the client with no response by the application and thus the users have no information about the synchronization process.

The client application provides also working offline not connected to the application server. In such case, it reads the data from the local database and does not allow the user to make changes.

The local database is stored in a Microsoft SQL Compact Edition Database Server, which is freely available. The database is encrypted and password-protected.

KANGO-Vlak is a distributed application based on Microsoft .NET Remoting technology. If the client changes the object synchronously sends the application server data to be written into the database. After successful registration of the data, the client may continue working. The application server then files in the asynchronous mode for each client logged into the queue, located on the server, a change event. Reports on the changes are taken from the queue in two ways by the type of the client:
– If the client shares the same intranet with the application server, the application server module automatically sends it the reports on the changes, as the client IP address is available from the server.
– If the client is in a different space of IP addresses than the application server, the client asks for updates at set time intervals, and if there is such an update, it records it.

After receiving an update report in one of the mentioned ways, the client will integrate the change in its memory and write it into its local database.

The clients of the KANGO-Vlak application server include also KASO-Voz and KASO-Pers application servers.

The train database tables are shared by two systems: KANGO-GVD and KANGO-Vlak. Both these systems directly record the data on the trains to the database and read the data from it. Some tables may be written to only by one of the systems while the other one can only read the data. The other tables may be written to by both systems, but each only in its records and other records may be only for reading. There are exceptions treated with testing timeliness of the data entered. KANGO-GVD and KANGO-Vlak Application Servers train are not linked. Each gets the information on changes in the train database in their own way.

The KANGO-Vlak Application Server has a registered notification event handler for Oracle database server, which occurs with a train phase change. The handler reads data on the notified train from the database, updates its data in the application server memory and sends the event of change to individual clients.

The KANGO-Vlak application server loads the required master data at startup from the application server KANGO-Kmen and registers a handler there in the event of incoming master data updates. These events are processed in a similar way as the notification of changes on trains from the Oracle server.

4. DATABASE STRUCTURE

The KANGO-Vlak Application includes most of the data available in timetable planning. The database can be divided into the following groups of data:
– Basic data on the database – such as the date of the period of validity of the timetable, a list of public holidays, a list of changes to the timetable.
– Users – users of the application and their rights.
– User areas of traffic points and sections – any set of traffic points and sections, which are used as areas of user's scope of authority and for defining tracks and areas used by various tools, such as with the calculation of indicators.
– Trains headings – train data independent of the track, such as the number and name of the train, a list of substrates and contents of the freight train.
– Train Routes – a list of traffic points the train and the following data pertaining to them:
    – general information – such as cancelling a train, special train, percentage of handbrake power;
    – train schedule;
    – arrival and departure time data, station tracks of the stay and the running tracks;
    – disposition of the railway undertaking to the arrival and departure time data and minimum stay of the train;
    – activities – such as technical check, replacement of the engine.
– Details in the train route related to the section of the train route which may have a defined schedule of its validity within the train trip calendar:
    – transport types of trains – the train specification with respect to traffic regulations;
    – commercial types of trains – a train specification for passengers;
    – railway undertakings;
    – ordering party of the train;
    – engines;
    – locomotive and train crews;
    – trains – a list of cars, including the order;
    – train characteristics – such as weight, length, rolling resistance, braking system, maximum speed;

– notes for individual cars;
– timetable notes for passengers – such as bicycle transport;
– design commands – textual requirements of the railway undertaking to the infrastructure manager.
– Through carriages – are defined as a sequence of trains or engines in the routes of each train.

5. TRAIN EDITOR FACILITIES

The KANGO-Vlak Application is primarily designed for editing trains. For this purpose, it includes the following features:
– selection of trains and filtering of the list of trains according to a given combination of parameters,
– introduction and cancellation of trains,
– defining and changing a train's route in a graphical view of the railway network,
– editing one or a group of trains,
– copying a train with an option to turn its route,
– connecting trains, the routes of which are successive,
– mass renumbering of trains.

For the analysis of the proposed timetable application, it includes the following tools:
– comparison of two train databases,
– calculation of basic indicators of transport,
– searching the existing and non-existent connections between trains.

The program allows you to print the following equipment intended for railway staff or passengers:
– Marshalling plan for freight trains;
– Section 3 of Train Formation Plan – List of stations forming shuttle trains;
– Section 4 of Train Formation Plan – List of stations forming balance trains;
– Review of restrictions on the movement of trains;
– Train Guide – information leaflet available for passengers in higher quality trains;
– Overview of higher quality trains – a part of the time schedule book for passengers.

Other application outputs include the following sets for internal use:
– a simplified time schedule,
– a list of trains passing through, ending or starting in a selected traffic point,
– a list of train stations, where the initial technical check is carried out,
– a list of basic data of passenger trains,
– a list of occupied and vacant train numbers,
– a list of completion of the basic data of trains needed for the construction of the timetable.

6. USER RIGHTS

The KANGO-Vlak system is primarily intended for the railway undertaking for entering requests for train routes. Users are also infrastructure manager's staff, who can enter additional data trains, trains, browse trains and enter the railway undertakings' trains that do not have KANGO-Vlak program at their disposal.

Each user is assigned the following rights:

- Type of user – the system provides four types of users: train-maker, railway undertaking, infrastructure manager, and administrator. A "train-maker" type user has basic rights. A "railway undertaking" has the same rights as the user of the "train-maker" type and furthermore can modify the users having a subset of their rights. A user of the "infrastructure manager" type has the same rights as the user of the "railway undertaking" type and furthermore can modify the infrastructure manager's data. A user of the "administrator" type has all rights.
- Scope of activities – any set of traffic points and sections. If a train route entry relates to a traffic point, it may be edited by the user, if this traffic point belongs to its scope. A similar rule applies to the information relating to the train route section.
- A list of railway undertakings, whose trains may be viewed and edited by the user.
- A list of intervals of train numbers that the user can introduce and cancel and edit data in the heading of the train.
- A list of intervals of train numbers in which the user can edit the data in the route of a train, except for engines, trains, locomotives and train crews (hereinafter referred to as train objects).
- A list of intervals of train numbers in which the user can edit the entered train objects.

7. TRAIN FORMATION PROCEDURE

Train data required by a railway undertaking and the actual data maintained by the infrastructure manager are reported in a pair of trains: the required and the actual ones. The required train is entered into the KANGO-Vlak system by the railway undertaking as a train requirement to the infrastructure manager. The actual train is made up by copying the desired train and adjusted by the infrastructure manager in the KANGO-GVD system (hereinafter referred to as the designer). The designer can enter the time data in the train route, as well as details of the station and track rails and that within the construction field of KANGO-GVD (approximately the area of the Czech Republic). At the traffic points, where the railway undertaking allows it, they may also change the sequence of traffic points of actual train's route.

The data related to a part of the route which does not belong to the design area of the KANGO-GVD are loaded into the required train by KANGO-Vlak user directly or imported from the Pathfinder Information System.

The train goes through its formation on to the mentioned stages shown in Figures 3 and 4. The phases of the required train can be changed by the user who is entitled to introduce a train.

The procedure for forming a train is as follows:

1. The beginning of creating a new timetable is based on the data from the previous schedule. The database contains just the required trains of the previous timetable, which are at the *transferred requirement* stage. The actual trains do not exist in the database.

2. A user of KANGO-Vlak has an option to introduce a new train or use a train from the previous timetable. In both cases, such a train gets to the *requirement formation* stage. At this stage, the train from the beginning of its creation or transfer is visible to all users who are entitled to view trains of the given railway undertaking.

3. KANGO-Vlak users, who are entitled to edit the train, fill in the details of the train's route, which lies in their scope. At this stage, these users are entitled to enter the train objects as well.

4. Users entitled to introduce a train, may check the box "Access to editing of engines". After checking it, the engines can be edited only by a user who is entitled to do so. Unchecking the box may be done by a user who is entitled to edit engines. A user who is entitled to edit the engines, on their entering they check the box "Acceptance of the Engines".

5. Similar procedure is used for editing other train objects. Unlike engines, there is no checkbox with these objects checkbox "Acceptance of <train object>".

6. In the event that the required train can be passed on to the infrastructure manager for the construction, an authorized user changes the phase of the train to *ready for construction*. The KANGO-Vlak system allows transition of the train to this phase, if relevant data are filled in and the box "Acceptance of the Engines" checked. An authorized user can return the train from the *ready for construction* phase to the *requirement formation* phase and proceed with entering the requirement.

7. The KANGO-GVD Application Server searches the required trains at the set time intervals in the database, which are at the *ready for construction* stage. It automatically copies the found train to the new actual train that is passed to the *construction* phase and also sets the corresponding required train to the *construction* phase.
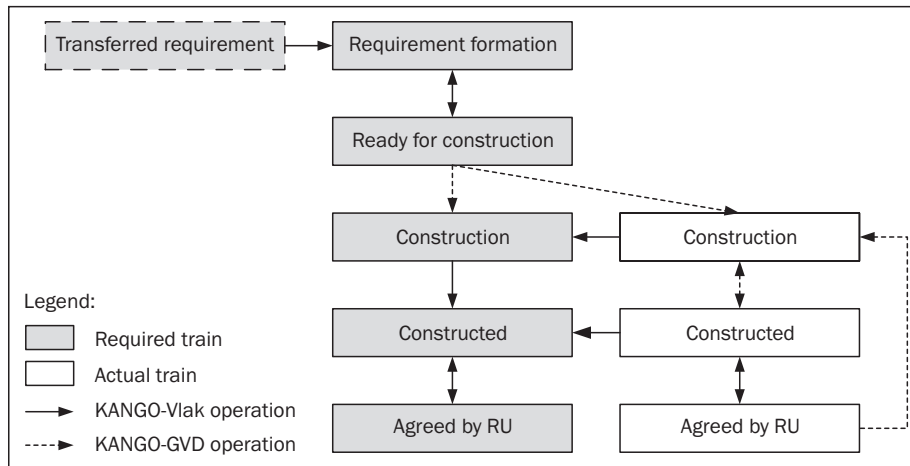
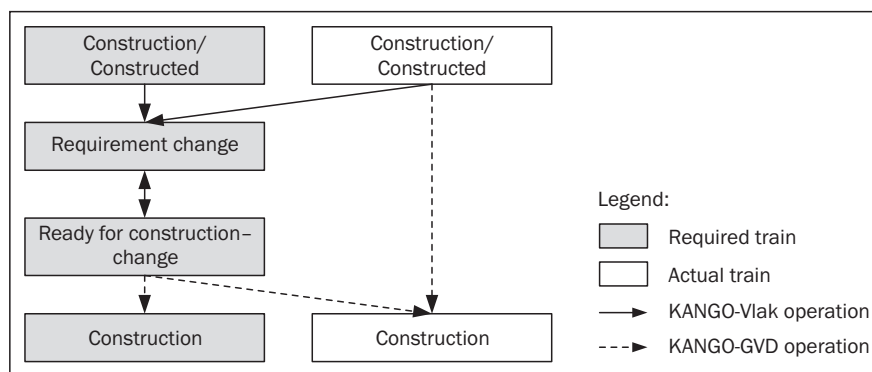Figure 3 – The basic procedure for forming a train

Figure 4 – Procedure when changing the railway undertaking's train requirement

8. The traffic points of an actual train contain also information about the phase of the train. After creating a new actual train, its traffic points are in the *construction* phase. In the traffic train route points where construction was completed, individual engineers set the *constructed* stage. Once the *constructed* stage is set in all the traffic points of the train route which belong to the KANGO-GVD construction area, the KANGO-GVD system automatically sets the stage for the whole train to *constructed*. The designer may later transfer the real train back to the *construction* phase and continue the construction.

9. Once an actual train gets to the *constructed* phase, the KANGO-Vlak application server receives the notification from the Oracle database server on a train phase change and imports the data entered by designers in an actual train to the corresponding required train, which it converts to the *constructed* phase.

10. If an actual train is in the *construction* phase, the user of KANGO-Vlak can carry on importing the updated data with the chosen required train from the corresponding actual train.

11. If the required train is in the *constructed* stage, an authorized user of KANGO-Vlak can change its stage to *agreed by railway undertaking*. At the same time, the KANGO-Vlak system automatically transfers the corresponding actual train also to the *agreed by railway undertaking* stage. At this stage, it is no longer possible to edit the train data. Anytime later, however, the mentioned user may return the pair of trains to the *constructed* stage.

12. If the actual train is in the *agreed by railway undertaking* stage, the designers are entitled to change its stage to *construction* and implement the change in its data.

13. If the required train is at the *construction* or *constructed* stage, the KANGO-Vlak user cannot edit the train. If they want to change its details, an authorized KANGO-Vlak user must first transfer the train to the *requirement change* stage. After completion of the requirement, the authorized user may change the stage of the required train to *ready for construction – change* or return it back to the *requirement change* stage.

14. Once the KANGO-GVD application server detects the required train in the *ready for construction – change* stage, it automatically copies from the required train all the information, which the railway undertaking is entitled to enter, to the corre-

sponding actual train. After copying, it sets the actual and required train to the *construction* stage. The procedure under point 8 follows.

15. A train can only be deleted by a KANGO-Vlak user who is entitled to introduce the train, with the train being at any stage. In such a case, the required train as well as the corresponding actual train is deleted from the database.

16. Usually, at the end of creation of the time schedule, the user of the infrastructure manager in the KANGO-Vlak application can lock the train. A locked train cannot be edited by any user. The locking can be done at any stage of the train. Unlocking may be done by the user of the infrastructure manager or the administrator.

8. CONCLUSION

The CEV and KANGO-Vlak applications were designed and developed by the author of the paper. The KANGO and KASO systems are currently in the testing operation. They are expected to be deployed in the routine operation at the end of 2010. Their introduction will significantly improve and accelerate work on the timetable.

The development of the KANGO-Vlak application will continue. It is planned to replace the offline data exchange with the Pathfinder system with an online communication via Web services, to establish a feature of late request for train route or registration of train route discounts.

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ABSTRAKT

INFORMAČNÍ SYSTÉM POŽADAVKŮ DOPRAVCŮ NA TRASY VLAKŮ

Článek popisuje možnosti nového aplikace sloužící k zadávání požadavků dopravců na trasy vlaků v podmínkách České republiky. Aplikace je součástí nového informačního systému sestavy jízdního řádu vlaků. Editor vlaků představuje distribuovanou aplikaci složenou z databázového serveru, aplikačního serveru a klientského programu. Obsahuje většinu údajů vlaků dostupných v rámci plánování jízdního řádu. Kromě funkcí pro práci s vlaky poskytuje různé analytické nástroje a tisk pomůcek pro železniční pracovníky a cestující. Za účelem koordinace sestavy jízdního řádu s provozovatelem dráhy byl navržen postup tvorby vlaku založený na fázích vlaku.

KLÍČOVÁ SLOVA

jízdní řád, vlak, informační systém, distribuovaná aplikace

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