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TRACE, a new concept for planning, control and the adjustment of rail traffic

M. Deerenberg
EDS CVI, Utrecht, The Netherlands

Abstract

The Netherlands Railways have developed a new integrated concept for managing the modern railway (planning, control and adjustment of the train operations). This paper describes, after a brief introduction on the general concept, the functional and technical architecture of the traffic control subsystem in the new concept.
Described are the role in the concept, the main functions of the system and the software solutions, which garantee a good performing system in a nation wide approach for traffic control.

1 Introduction

The world of the railways is very much in a state of flux. Throughout western Europe, rail transport is competing more and more keenly with other forms of transport. The market demands increasing quality in the transportation of people and goods. Trains must run more frequently, more quickly and more punctually. This means that the quality and capacity of the whole railway company must improve, and consequently so too must the quality of the traffic control organisation.

The train can only fulfil this major role if planning, adjustment and control of the operational process is optimised. As a consequence, the Netherlands Railways have developed an integrated concept, TRACE (Train Control and Execution), for managing the train operations in a modern rail company.

The paper describes the concept of the traffic control subsystem in the TRACE architecture. Chapter 2 gives an overview of the overall concept, which has been developed for the Netherlands Railways. Chapter 3 gives a brief introduction on the role of the traffic control organisation in the modern railway. Chapter 4 an 5 concentrate on the functional and technical architecture of the traffic control subsystem. Chapter 6 finishes with a series of concluding remarks on the meaning of the described approach for the traffic control organisation in a railway company.

2 TRACE

TRACE is an advanced information system for rail traffic production (planning, control and adjustment). TRACE is a product for improving the quality and capacity of a rail company. It is a product of integrative thinking which is entirely geared to the efficient and effective control of the rail company's primary operations. TRACE consists of three clusters of subsystems:

- planning of products and processes in the long term (several years before the timetable year) and the short term (the day before execution), both centralised and decentralised;
- traffic control for planning and adjustment of the product plan on the day of execution;
- process supervision of local rail-traffic management, shunting, provision of passenger and customer information, deployment of train personnel and rolling stock.

The three clusters are outlined in Figure 1.

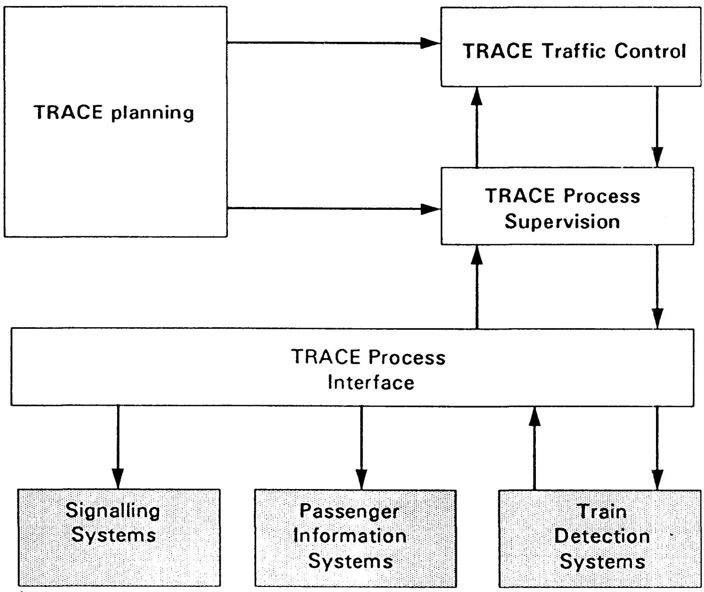

Figure 1: TRACE Architecture

The overall goal of TRACE is a better control of the production process, and thereby a better product:

- more extensive analysis in the planning phase;
- better means for prioritizing of interests (transportion of people versus transportation of goods).
- less (secondary) delays and fewer connections lost;
- better customer information in case of irregularities;
- more flexibility, enabling short-notice responses to variations in demand;
- more efficient deployment of train personnel and rolling stock;
- lower costs for planning and process supervision.

3 Traffic control

Traffic control is concerned with the daily control of train transport within a certain area. In view of increasing traffic volumes, the traffic control organisation will in future inevitably not only have to deal with:

- increasing pressure and
- increasing complexity;

but at the same time, will also have to meet the need for:

- greater operational decisiveness and
- better information for customers.

In order to be able to meet these opposing demands, the traffic control organisation will at all times need to have an understanding of the progress of the transport process. Only then is it possible to achieve effective and efficient adjustment geared to the quality of the transport product: a coherent set of timetable, rolling stock and train personnel planning.

Changes in, or departures from, the timetable planning might have consequences for the rolling stock and train personnel planning (for example, a driver of a delayed train might not be in time to be deployed in his next train). Figure 2 presents the coherence of these three types of planning.

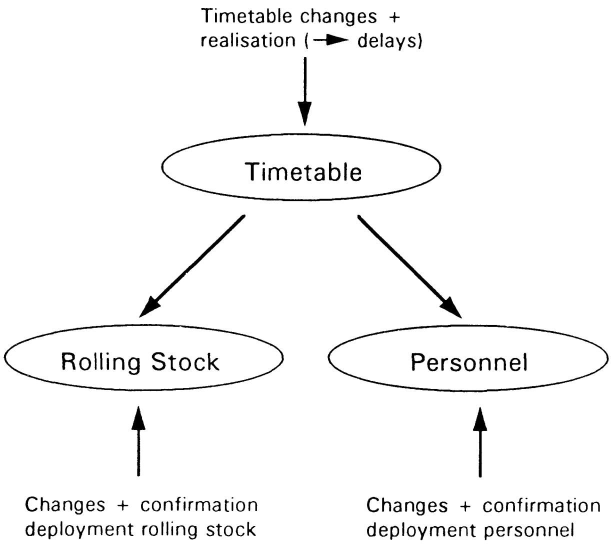

Figure 2: Coherence timetable, rolling stock and personnel plan

4 TRACE Traffic Control System

The TRACE Traffic Control System (TTCS) offers graphical applications which support traffic control by simultaneous presentation of:

- the planned transport product;
- the actual situation;
- the bottlenecks to be resolved.

If required, traffic controllers can adjust plans with regard to timetabling and the deployment of rolling stock and train personnel, with TTCS automatically generating messages for other traffic control locations. Besides, changes in, or departures from, the timetable are automatically processed in the rolling stock and train personnel plan. Therefore, TTCS always contains an actual and consistent plan, which enables the identification of bottlenecks.

TTCS consists of six applications:

- Timetable Diagram reproduces the actual timetable for one or more sections. The traffic controller can make changes to the timetable diagram.
- Rolling Stock Circulation is a graphic representation of the rolling stock circulation plan. It is an aid for monitoring and adjusting the deployment of rolling stock.
- Train Personnel Circulation is a graphic representation of the train personnel circulation plan. It is an aid for monitoring and adjusting the deployment of train personnel.
- Train Position provides an overview of the execution of timetabling, including train delays, for one or more sections.

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- Confirmation of Deployment records the actual deployment of rolling stock and train personnel. Data from deployment recording are passed on to the rolling stock and train personnel circulation.
- Message Facility selects, from among the messages generated automatically (in the case of plan deviations and changes), the relevant messages for a traffic controller on the basis of personally defined selection criteria.

In Figure 3 an outline of the TTCS applications is given.

TTCS provides functions for maintaining the life cycle of the product plan. Every night a new product plan is converted from the TRACE Planning system and electronically distributed to all traffic control sites. 24 Hours after execution the product plan is archived and made available to a management information system for analysis.

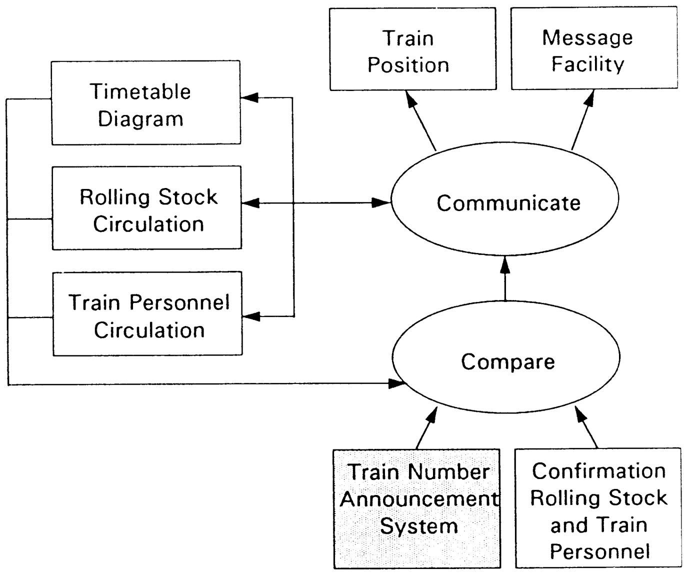

Figure 3: TTCS applications

Every traffic control location may have one or more integrated traffic control work stations. One or more traffic control areas can be managed from a work place manned by one person. Thanks to advanced work distribution, it is possible to tailor the work to local conditions; during peak time, traffic control is performed by several people, while at quiter hours this can be carried out from a single work station by one individual.

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5 TTCS Technical Architecture

TTCS is a comprehensive and complex software system. To develop and manage this system in a controlled manner a modular construction was necessary. Furthermore, the operational independency of TTCS functions is an important reason for subdividing the software into modules.

Highest level of a module is a task (VMS process). For communication between tasks not a hierarchical, but a client/server-structure is applied. communication is mainly achieved via message facility (DecMessageQueue) and shared memory (global sections). Tasks consist of several layers. Every layer shields data and functionality from other layers in the task. Between layers well-defined interfaces exist and communication between layers is hierarchical. In principal, this layer structure (see

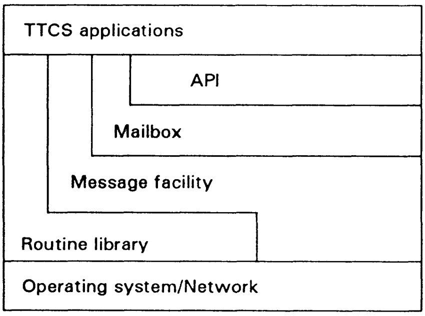

Figure 4: TTCS layer structure

Figure 4) is valid for every task that communicates with another task via messages. Other ways of communication use parts of these layers (for instance, skipping the Application Program Interface (API)).

Within the TTCS software several task groups can be distinguished:

- Databases and dataservers
- Application tasks
- Daily processing tasks
- Communication tasks
- Operational support tasks

Databases and dataservers. Heart of the TTCS software is the database that contains the timetable, rolling stock and train personnel plan. The database is

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accessed by dataservers. Dataservers shield the rest of the software from the specific database characteristics. Because of the necessary independence of TTCS tasks several 'instances' of the dataserver are used.

Application tasks. Application tasks comprise the functionality that is directly used by traffic controllers. Application tasks can be divided in applications and application servers. Applications are the interface to the user, while application servers store voluminous data in memory, to enable applications to have quick access to that data.

Alphanumeric applications (for example, data management functions) consist of a single task, while graphical applications consist of two tasks: a receiver task and a presentator task. This subdivision is necessary to be able to receive information from the application servers and simultaneously maintain the man-machine-interface.

Application servers pass updates of the database on to the applications. An application server is not a transparent 'cache': the application has to indicate which data has to be managed by the application server and for which data the dataserver has to be consulted directly.

Application servers were necessary for TTCS to achieve a satisfactory performance. Several instances of a TTCS application use the same instance of a application server.

Daily processing tasks. This group comprises tasks that are executed as daily batchprocesses. (conversion, distribution, backup and archiving).

Communication tasks. These tasks maintain the interfacing and communication with other TTCS systems (of other traffic control centres) and with external systems. For relatively simple communication (for instance, with TRACE Process Supervision and the external Train Number Announcement System) a single communication server is used. For more complex communication TTCS uses four communication servers:

- Nationwide Mutation Handling, for sending and receiving nationwide mutations on a 'functional level';
- Mutation In, for handling incoming messages on a 'technical level';
- Mutation Out, for handling outgoing messages on a 'techical level';

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- Coordinator Nationwide Mutations, to secure overall database consistency

Operational support tasks. This group comprises tasks with functionality on behalf of the system managers. It concerns functions to start, monitor and stop applications.

The technical structure of TTCS is outlined in Figure 5.

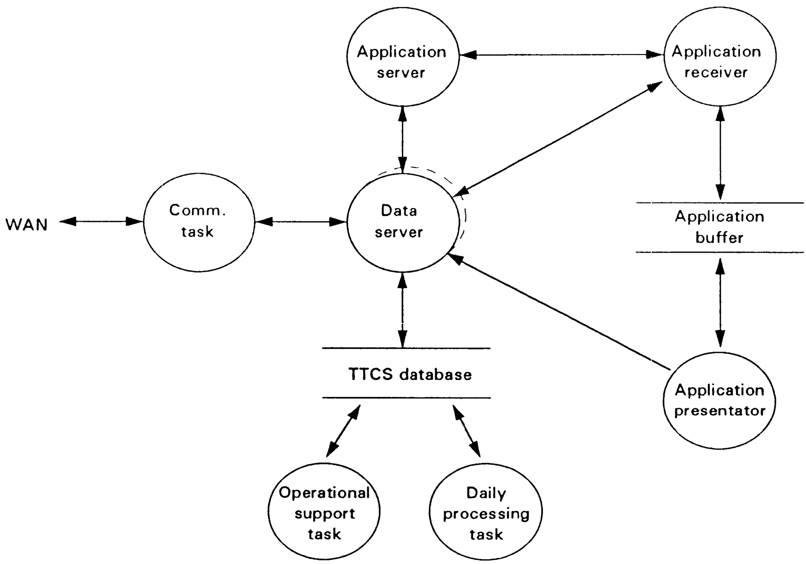

Figure 5: TTCS Technical Architecture

6 Conclusion

For a traffic control organisation, introduction of TTCS means that:

- a change in, or departure from, a plan only needs to be recorded at one location, namely at the source; this reduces the potential for mistakes and also the time involved in the recording process;
- internal communication at and between locations improves substantially; this leads to the improved elimination of disruptions to the rail service and better opportunities for explaining the current situation to the customer (thus, better information for the customer since one is better informed);

- the overview of the current situation improves significantly; this will lead to better and more anticipatory decisions; furthermore, an increase in area is possible;
- the course of the transport process is better recorded; as a result, opportunities for adjustment and evaluation are significantly increased.

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