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BIS - track infrastructure information system

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Abstract

BIS is a computer system for storing and retrieving information about the Swedish rail infrastructure. BIS consists of different, independent subsystems using a common reference system for positioning objects along the track. The development of the system started in 1988 with the separation between The National Rail Administration (Banverket) and The Swedish State Railways (SJ). In 1990 the development of the reference system was finished and the input of the railway network started. Since then other subsystems have been developed and connections to other systems have been created.

BIS-ref	describes the rail network as nodes and links
Permanent way	rail, sleeper, ballast and insulation
Bridges	technical information of railway bridges
Geometries	track geometry in plane and profile
Signals	ATC-transponders, signals and speed-signs
Agreements	cables, pipes etc.
Roadcrossings	level crossings, bridges (road)
Accidents	railway accidents
Other objects	any user defined objects
Electric	catenary, catenary support
Traffic	statistical data about railway traffic

System specification

Computer	VAX/VMS or ALPHA/VMS
Database	Ingres
Graphics	X-windows
Network	DECNET or TCP/IP

1. Introduction

In 1988 the Swedish parliament decided that railway infrastructure should be managed by a special authority reporting directly to the Government.
This authority, the National Rail Administration (Banverket), is responsible for the planning, construction and maintenance of the Swedish rail infrastructure. The operation of trains and stations remained with the Swedish State Railways (SJ). Large sums of money will be invested during the 1990s in various railway projects. Therefore it was decided to start the development of a new information system in order to manage information about the rail infrastructure.

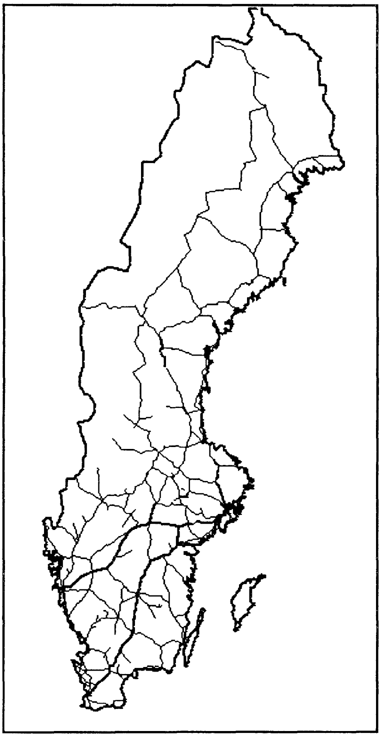

Figure 1. The Swedish rail infrastructure 1995 - excluding the inland line (1100 km)

Total length	9 780 km
Double track	1 390 km
Electrified	7 320 km
ATC lines	6 810 km
CTC lines	5 580 km
UIC rail 60 kg/m	1 565 km
Points	19 100
Railway bridges	2 917
Road crossings (total)	13 490
separated	2 410
full- or half-barrier	2 060
Tunnels	97

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2. System Specification

When analyzing the demands of the new system several problems concerning the flow of information were identified.

2.1 Problems of Former System

The information about the rail infrastructure was scattered on different computer systems without any connections.

Some objects were updated in several computer systems by different persons. The result of this was that an object could exist in different systems with different positions and information.

Only a few persons had knowledge about, and access to these systems. Therefore it could take a very long time to get the required information.

On different levels within the organization there are needs for different kinds of information based on the same data.
E.g. Staff on the production units need to know detailed information about one specific point in the yard, while staff at the head office need to know how many points of a specific type, and with certain attributes we have in Sweden, in each district or along a specific route. How many of these are located in curves?

Fore some information there were only manual registers.

2.2 Demands of New System

A common reference system for positioning of objects

A combination of alphanumerical and graphical user interface

One system for all information about an object

It must be simple and fast to search for information

One system for all users in different levels within the organization

Possibility to search for information with user defined selections.

Possibility to search information from different registers simultaneously.

The most demanded information about the most important objects must be included in the system.

3. System Description

BIS is a computer based system for storing and retrieving "track referred information".
The system consists of several sub-systems independent of each other with a common core consisting of a reference system and a system for administrative divisions.

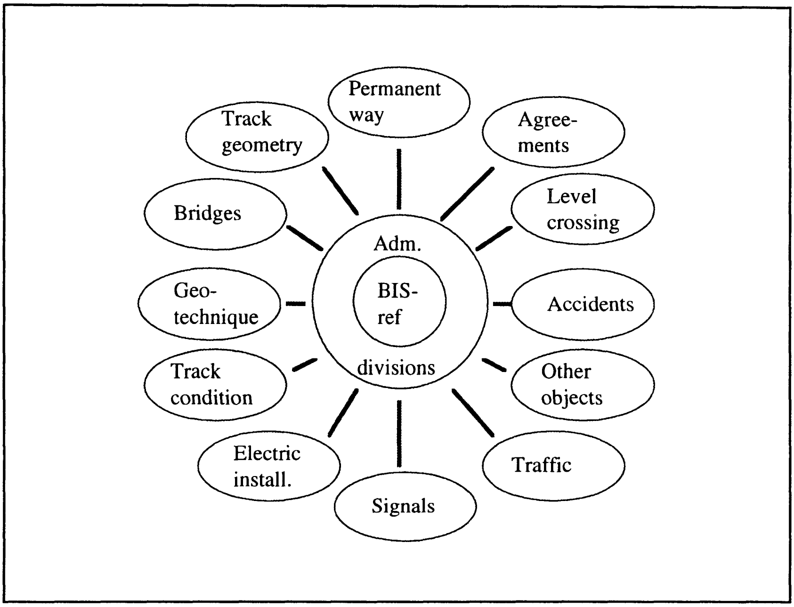

Figure 2: Subsystems of BIS.

3.1 Reference System BIS-ref

BIS-ref is the core in which the railway network is defined consisting of nodes and links.
At the macro level the nodes are the stations and the link is the connection between two stations. A link at this level can consist of one or several tracks. At this level each station has geographical coordinates which makes it possible to present the reference system as a map.
At the micro level the nodes are points and buffer stops. A link is simply the track between two nodes. All positions are given at this level.
The purpose of BIS-ref is:
- to serve as a basis for positioning objects in the different sub-systems.
- to present the railway network and objects graphically in maps.
- to make it possible to logically "travel" through the railway network.

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3.2 Positioning Objects

The object X in figure 2 is positioned along the link A2-B1 with a distance of 3500 meters from node A2.
This is the basic way to give a position to an object in BIS.
Traditionally all positions are referring to kilometer signs. This is also possible in BIS since all kilometer signs are registered in the system, each one positioned to one or several links, and thus we can easily transform a position referring to a kilometer sign to a position along a link and vice versa.

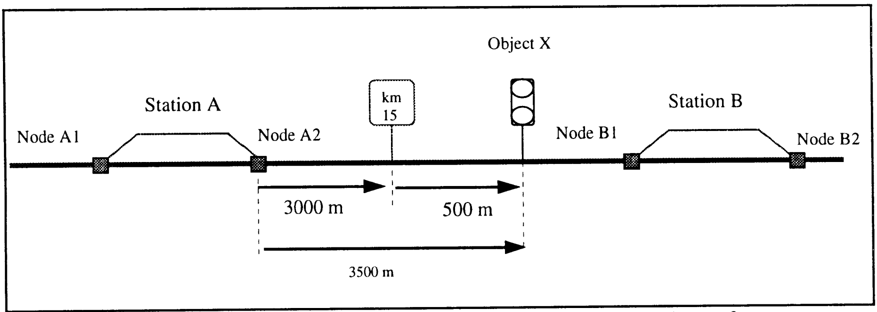

Figure 3: The principles for positioning an object towards the reference system

3.3 Geographical Coordinates

It is possible to register geographical coordinates to an object but at present we do not use them for positioning in the reference system.
The main reasons for this are:

Time and cost	It was calculated as the cheapest and fastest way to get started. The techniques to measure track length are well known. It would probably have been 5 to 10 times more expensive and time consuming to capture the geographical coordinates.
Tradition	Almost all information that has been transferred to BIS, manually or imported from another system, was referring to kilometer signs and easily transformed to BIS-positions.

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3.4 Administrative Divisions

In this system it is possible to create different administrative divisions of the railway network. E.g cities, counties, BV districts, track sections, track numbers, main tracks, side tracks, track owners etc. etc.
Each division is independent of the others and positioned along the track.
When an object is given a position it also, automatically, gets the administrative divisions that is defined at that particular point.

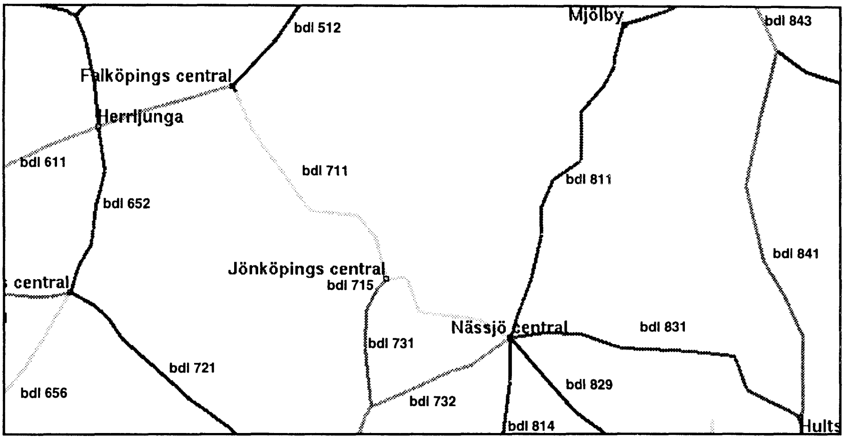

Figure 4. Presentation of different track sections defined in the system for administrative divisions.

3.5 Subsystems

Surrounding the reference system and the system for administrative divisions we have developed several subsystems each one handling different kinds of objects independent of the other subsystems.
The connection to the reference system is always the same - the position of the object along the track.

Other subsystems	Holds information about
Permanent way	rail, sleeper, ballast and insulation
Bridges	technical information of railway bridges
Geometries	track geometry in plane and profile
Signals	ATC-transponders, signals and speedsigns
Agreements	cables, pipes etc.
Road crossings	level crossings, bridges (road)
Accidents	railway accidents
Geotechnique	geotechnical investigations and objects
Track condition	results from track condition measurements
Electrical istallations	catenary, catenary support
Other objects	any user defined objects

4. Searching for Information in BIS

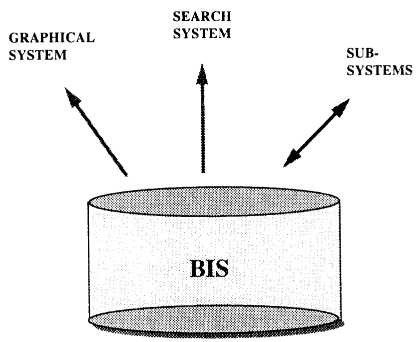

Figure 5. Different ways to search for information in BIS

4.1 Subsystems

The different subsystems are used when the users wants to enter data into the system or alter existing data.
Each subsystem has different authority levels that makes it possible to give users read- or write access to the system.
In combination with this authority check there are also a general function that controls that the users, with write access, only can enter or change data belonging to the districts where they are employed.
In the subsystems it is also possible to run different reports with the possibility for the user to define the content and set conditions for the selection. To work in the subsystems the users only need an ordinary alphanumeric terminal.

4.2 Search system

The search system contains several alphanumeric functions that allow the users different ways to search for information from one or several subsystems concurrently.
Examples of possibilities are:

- Search one or several objects with selection on section number, station or along a route
- The distance between two stations in the network
- Total track length for one adm. division (district, track section, county etc.)
- Report generator where the users define their own selections and contents of their reports

4.3 Graphical system

In the graphical system the railway network is presented as it is defined in the reference system. Any changes in the reference system will appear on the map. By using the mouse the user can zoom in an area of interest and by clicking on a station in the map a schematic map of the station yard will appear. It is possible to search for information at all levels.

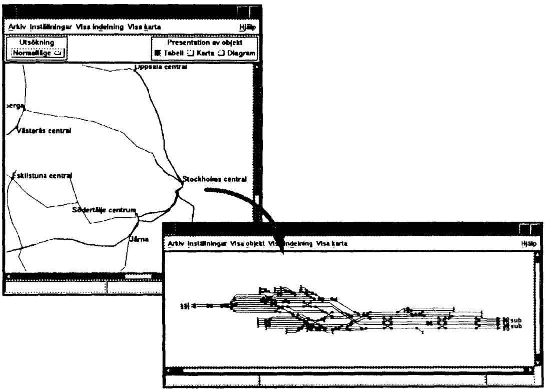

Figure 5. It is easy to present a schematic map of any station in the system. In all maps the user can search for and present different objects.

It is also possible to select a route by clicking at the stations where to start and end. Along this route it is now possible to search for objects. The result can be presented as a table, on the map or in a chart.

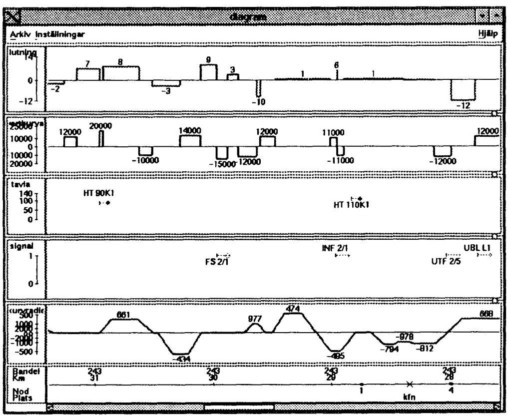

Figure 6. Example of data presented in a chart.

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5. Interaction

The interaction with other systems plays an important role in the efficiency of information management of the infrastructure.
Input of data needs only to be done in one system. Necessary information can then be transferred between the different system when needed.
This is an important factor of maintaining a high quality of data.

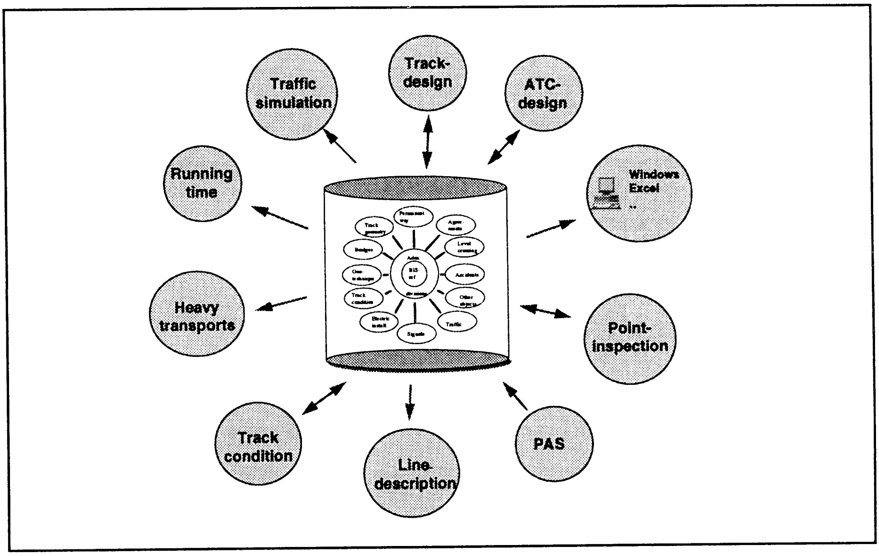

Figure 7. Connections to other systems.

There are functions for transferring data between BIS and other systems within Banverket.

- Traffic simulation (SIMON)
- Running time calculation (RTP)
- Heavy transport calculation
- ATC-design
- Point inspection system
- Track condition measurements
- Production planning system (PAS)
- Track design and adjustment
- Line description for traffic operators
- Spreadsheets on VAX and PC

6. BIS usage

At present we have approximately 1300 registered users representing all organizational levels within Banverket. Input of data is done by specially trained persons on each regional or district office.The quality of data is ensured by internal regulations.
Some examples of usage of BIS information are:

- Long term planning
  traffic simulation
  running time calculations
- Budgeting
- Design
  track design and simulation
  maximum speed calculations
  ATC design and simulation
- Input to track adjustment
- Source of railway statistics
- Handling of agreements
- Handling of level crossing matters
- General information

Additional benefits

- Information from different registers can be searched for simultaneously
- The information is now available for everyone
- It is easy to search for information, because of standardized applications
- There is one common reference system for all positions
- Improved quality of data, because of the interaction with other systems and the demands from over 1300 users

The design of BIS makes the system very flexible. As the subsystems are independent of each other it is possible to add new sub-systems, modify or remove existing sub-systems without affecting any other sub-system.