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Translation

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Railway telecommunications links - Improvements to be expected from the use of telecommunications for operating purposes

Liaisons de service par télécommunications - Améliorations à attendre de l'emploi des télécommunications dans l'exploitation

Fernmeldedienstverbindungen - Verbesserungen, die durch Verwendung fernmeldetechnischer Einrichtungen im Betrieb zu erwarten sind



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Summary

Modern railway operation today requires direct, rapid and permanent contacts between the different levels of management.

It is therefore essential for these different levels to be properly and instantly informed so that they can take rapid action on any matter coming within their scope and issue the necessary instructions.

Such organisation is valid only if it has proper telecommunications facilities, the characteristics of which may differ depending on the service demanded of them. Introducing such facilities generally calls for large-scale capital investment.

The purpose of this leaflet is to assemble information on the experience acquired by the different Railway Undertakings (RUs) in connection with the rationalisation of operations and development of methods made possible by the ever increasing use of telecommunications.

Other leaflets, numbered in sequence, deal with the purely technical aspects of the different telecommunications systems that may be used.

The procedures for improving the operating methods of a railway differ according to its size, the density of its traffic and, above all, to the organisation of its management structures. Depending on whether this organisation is wholly centralised (single headquarters) or fully decentralised (regional headquarters with large-scale autonomy) or else partly centralised (central headquarters with departments directly involved in the performance of certain operating tasks, and regional headquarters or divisions with limited autonomy), the telecommunications facilities required are organised in different ways.

However, irrespective of the organisational structure adopted at headquarters, telecommunications problems generally follow the same pattern in terms of the operation of a line with specific characteristics or the management of a large establishment (station, depot or workshop).

This leaflet therefore deals successively and separately with the telecommunications problems to be resolved at three levels:

- management in general,
- line operation,
- management and working of establishments of a certain size.

It also examines the possibilities offered by radio systems as a means of contacting moving trains from certain fixed points or from other trains, and of communicating within the same train.

Lastly, it lists the criteria to be taken into consideration where setting up international links that are becoming increasingly necessary between RUs.

Against this, the present leaflet does not deal with the telecommunications equipment used for the operation of signalling installations, as the characteristics of such equipment depend too specifically on the particular system adopted.

Neither does it deal with high-speed lines equipped with special telecommunications systems for automatic train control (ERTMS, GSM-R).

1 - Possibilities offered by a general telecommunications network for improving operating methods

1.1 - General

The need for RUs to have a general telephone network distinct from the public network is unanimously acknowledged.

When seeking ways of improving operating practices, the solution adopted at the different organisational levels generally involves centralisation of the command process, whether in terms of administrative, financial and accounting management, rolling stock fleet management, or even management of train dispatching operations. Specialist bodies with particular skills - because they have been trained for specific tasks and are able to have a more general view of problems - are better equipped to make pertinent decisions at the right moment than individual managers who, despite consulting one another, are nevertheless bound to have only partial views of the problems at issue.

However, these bodies, if they are to function properly, must be kept fully informed and must be in a position to act very rapidly at executive level. The means to do so are provided by the telecommunications network.

A modern telecommunications network for railway use comprises a set of specialised networks:

- a general telephone network,
- a general data transmission network,
- a radio network and a ground-to-train radio network,
- a supplementary telecommunications system (remote control and multiple call, hot-box detection, detection of vehicles or rocks on the line, chronometry, video and sound systems, etc.).

1.2 - General telephone network

The form and size chosen for this network depend primarily on the management organisation adopted for the operation of the railway concerned.

A small railway, where the management process can be handled by a central body in direct contact with the operative staff, only needs a central automatic exchange serving the different establishments.

However, when a railway network reaches a certain size and top management must pass through one or more intermediate organisational levels to give orders to operative staff, the general telephone network is more complex.

If the management organisation has highly independent regional headquarters, each of these may have a local telephone network.

Automation of the general telephone network means faster call set-up and high efficiency circuits.

In order for the telephone service to be as simple as possible for the user, it is preferable to opt for systems whereby a particular extension number can be obtained without having to worry about the route through which the particular call will be channelled. It is also important to look for means of calling users by dialling a minimum number of digits. Lastly, it would be extremely useful for calls from outside a called user's local centre to be made by always dialling the same number to contact the user (irrespective of the origin of the call) and for this number to contain a limited number of digits.

Some RUs have opted for allocating the same call number to staff performing the same duties in each of the regional headquarters, districts and establishments.

These methods are recommended for RUs which decide to set up a general telephone network and for those planning to reorganise their existing systems along new lines.

The new generations of ISDN exchanges provide for a range of functionalities that can be programmed to user requirements, such as:

- multi-call,
- number display of caller,
- voice messaging,
- call transfer,
- receipt of direct calls from public operators,
- re-call on occupied subscriber,
- detailed invoicing for each department,
- central management, etc.

However, the general telephone network, even though it is comprehensive and sophisticated and reaches out to the smallest unit of the RU, cannot, on its own, resolve all the management problems posed by the operation of a modern railway; other links are needed.

1.3 - General data transmission network (DT)

In some instances, data transmission has better resources available than the telephone network. For this reason, many RUs have plans to establish a "General DT network".

As the centralisation of information required at different organisational levels involves the transmission of information at short notice often in coded form, the use of DT becomes virtually unavoidable. A general DT network can also be warranted when the information sources are numerous and scattered.

However, when any RU goes so far as to process the coded information in the form of data in one or more computer mainframes, it would seem rational for such information to be transmitted through a separate specifically adapted DT network.

Nevertheless it is recommended, when a general DT network is being built or up-graded, to allow for the immediate or subsequent possibility of reliable transmission of data usable with computer processing equipment.

1.4 - Possibilities of introducing modern management organisation by means of a general telecommunications network

In RUs operating general telephone and DT networks such as those described above, modern management structures contributing towards technical and especially economic improvements to operations are numerous and extremely varied. Possibilities for developing others are far from exhausted.

These management structures, whether or not they involve the use of modern computer-based systems, have one common feature, which is that they are based on a concentration of functions:

- whether it be a matter of centralising data at a high level of command where operational decisions are made,
- or whether it be a matter of carrying out at one single point in a given area work hitherto performed in various different establishments.

Organisational structures in the first category are generally of a certain size and cater for operations over the whole rail network. This category includes, for example, wagon fleet management, centralised seat reservation systems, centralised charging of freight consignments, stores management, revenue and expenditure accounting, development of various statistics essential to rail business monitoring, etc. All this operates at either central headquarters or regional headquarters level.

Organisational structures in the second category are less ambitious: they sometimes centralise data for transmission to those in the first category. They only cover one limited sector of the rail network and frequently even only one large establishment combined with a few smaller peripheral ones considered as satellites.

2 - Possible improvements to the operation of lines through the use of telecommunications equipment

2.1 - General

The efficiency and throughput of any line depend to a considerable extent on the telecommunications system serving this line and the stations on it.

As each line has its own characteristics, most of which are specific to the nature of the region served, it is very difficult to group lines into categories for which optimum criteria for a telecommunications system could be defined.

The difficulty is all the greater in that, for any two lines handling a fairly similar volume of traffic, the distribution of this traffic does not always follow the same pattern - one line may have one or two large stations with a few very small ones, whilst the other may only serve medium-size stations.

However, the telecommunications systems used are sufficiently different for a distinction to be made between two main line categories:

- lines with decentralised operation,
- lines with centralised operation;

and for each category to be subdivided into:

- non-electrified lines, and
- electrified lines.

Before examining which telecommunications system would be most suitable for these main categories of line, it is essential to list the different types of circuit which can be used and to specify their operating characteristics.

NB : The term "circuit" as used in this leaflet has a very general meaning and carries no implications as to the manner in which the circuit is established: it can be physical with 2 - 4 wires or hypothetical.

A distinction should be made between:

- those circuits which do not serve any intermediate points, and
- those which do.

2.2 - Definition of circuits

2.2.1 - Direct circuit

This circuit links two establishments with no break, and excludes the possibility of serving any intermediate point.

2.2.2 - Semi-direct circuit

This term is used by some RUs to define a circuit which serves a number of large intermediate establishments on the same line.

2.2.3 - Omnibus circuit

NB : Some RUs also use this term to denote a sequence of direct circuits between each station, which can or cannot be interconnected.

This type of circuit serves all establishments on the same line and perform a clearly defined function or even several similar functions.

On circuits under points 2.2.2 and 2.2.3, telephone units are parallel connected: they can be called simultaneously or individually by means of a selective call system or a coded call system.

In some cases, only one extension (traffic controller) has the possibility of calling each of the other telephone extensions. Quite frequently, there is also the possibility of calling all extensions on the line simultaneously (general call). The circuits' other telephone extensions can only call the traffic controller's extension. Any two telephone extensions wishing to communicate must therefore obligatorily go through the traffic controller's extension. Several RUs call this a "centralised selective call circuit".

In other cases, each of the circuit's telephone extensions must have the possibility of calling any other telephone extension after making sure that no other call is in progress, since in principle there can only be one call on the circuit. This type of circuit is sometimes known as a "decentralised selective call circuit".

NB : However, there are devices whereby two inter-communicating extensions are made to use only that portion of the circuit connecting them, leaving the possibility for another conversation on the other portion(s) of the circuit. Such practice, which is not without its drawbacks, nevertheless remains exceptional.

Many RUs have replaced decentralised selective call circuits with an automatic telephone network.

2.3 - Types of circuit installed on lines

2.3.1 - Station-to-station circuit

This is, in point of fact, a series of direct circuits between successive stations, whereby each station is only able to call either of the two stations flanking it.

In some cases, direct lines can be set up by the stations, to give any two railway stations separated by one or several stations the possibility to inter-communicate.

This station-to-station circuit is used for exchanging service calls of all types including, on some lines, calls dealing with train movements (block section, presentation and acceptance of trains, emergency announcements, etc.).

On other lines, this circuit excludes calls relating to safety, for which there is a dedicated circuit.

2.3.2 - Safety circuit

This is an "omnibus" circuit serving stations and telephone extensions within the block section: there is sectional switching at each point served and so there can be no doubt as to the identity of callers; some RUs exclude any possibility of direct linkups between any two stations or telephone extensions that are not immediately adjacent, except in cases where, at certain times, some stations and telephone extensions are disconnected and cease to function within the block section.

2.3.3 - Omnibus operating circuit

This circuit serves all stations and serves as a track-up to the station-to-station circuit either because the latter has been purposely earmarked for "traffic" safety calls (as mentioned above) or because the number of calls to be handled exceeds the possibilities of the station-to-station circuit, or again because the policy is to give the stations served access to the general telephone network without however turning each establishment on the line into a distant user of an automatic exchange.

Such circuits can serve not only all stations but also, if required, all centres involved in the operation of the line and located on it - for example locomotive depots or sheds, home base of permanent way and electric traction staff.

This type of circuit has been replaced in almost all cases by an automatic telephone network.

2.3.4 - Direct and semi-direct circuits

If the volume of telephone traffic is such that the above circuits cannot cope, recourse may be had to a direct circuit between two particularly large establishments on the line or even to one or several semi-direct circuits covering, in general, stations of a certain size.

Such circuits can be built either with sectional switching at each point served, which can moreover be disconnected to allow direct calls with the adjacent telephone extension on the same circuit or with a telephone extension adjacent to the station-to-station circuit. They can also be continuous circuits with selective calls. Even in this latter case, it is useful to be able to link up a telephone extension adjacent to the station-to-station circuit through one of the extensions of this circuit.

However, when the general automatic telephone network reaches directly the main stations on the line at least, it is preferable to use this network - even if this means building up its facilities - rather than adopting semi-direct circuits.

2.3.5 - Traffic flow control circuit

NB : Some RUs still call these "dispatching circuits" by their English name.

This circuit enables the line traffic controller to make direct calls to sedentary staff who are, or can be involved in the traffic control process.

This is a circuit with centralised selective calls, which is accessible at all times and without special call connection, to any staff member needing to make an urgent call to the controller, who must be on permanent stand-by.

For his part, the controller must be able to call up rapidly any telephone extension on the line, or several of them simultaneously or even all concurrently (general call). This highly specialised circuit is not likely to be interfaced with the automatic telephone network, or used for inter-station calls.

When traffic over two successive sections of the same line is monitored by two different controllers, they should be able to consult one another. To avoid setting up an extra circuit linking them directly, it is possible for a system to be introduced whereby, if required by either of the controllers, their two circuits can be connected up for them to communicate with each other. Even when such interconnection is established, staff on the line must nevertheless be able to intervene on the circuits and to converse with the controller when guidance is urgently needed.

When the traffic control process also covers a branch line connected to the main line, the control circuit must include an appropriate extension.

Lastly, during off-peak traffic periods, it may be useful to entrust train monitoring over several lines normally handled by several controllers from the same centre, to one single controller. The control desks, in this case, must incorporate very simple, highly reliable devices ensuring the easy transfer of circuit ends from one desk to another.

2.3.6 - Level-crossing signal circuits

At some RUs, the level-crossing service depends on telephone messages transmitted by the stations, concerning more particularly delays to scheduled trains and the operation of optional, special or extra trains.

These level crossings can be provided with telephone extensions connected:

- to an announcement circuit linking the level crossing directly with the stations on either side or with only one of them,
- to an omnibus circuit existing for other purposes, as specified by the respective RU,
- to a circuit specifically for level crossings.

2.3.7 - Signalling maintenance circuits

This type of circuit is more particularly used on lines with automatic block signalling, to link the relay boxes with the signal boxes or with the stations on either side of them.

These are omnibus circuits, generally with sectional switching at each point served.

2.3.8 - Télécommunications maintenance circuit

This is generally an omnibus circuit tapped at each point served.

2.3.9 - Track maintenance circuit

On particularly busy lines requiring frequent maintenance work rendered difficult by the short time intervals allowed by the train traffic pattern, some RUs advocate the use of a circuit (generally only comprising sockets into which portable telephone units can be plugged) at fairly regular intervals along the line, to serve stations and sometimes even the offices of track supervisors.

This is a very special type of circuit used only during periods of work on the line.