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Translation

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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Contents

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,
- detailled 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.

2.3.10 - Warning circuit

It must be possible for this circuit to be used at any time by any member of the staff who observes an accident or an anomaly affecting safety on an electrified line, in order that he may notify directly the centre responsible for the line's electric power supply: this centre may be the sub-station control centre, a sub-station, an isolating-switch control station, a current feeder station, etc.

NB : Some RUs have a similar organisation for non-electrified lines; the open-track units, in this case, are placed either on the station-to-station (point 2.3.1 - page 6) or on the safety circuit (point 2.3.2 - page 7) and can thus give the alarm to the stations on either side.

This circuit is set up along the whole section of line for which the energy supply is monitored by the centre controlling it.

Telephone units are parallel-connected to this circuit at significant points along the line: stations, junctions, sub-stations, etc., and on the open track at points as regularly spaced out as possible. Mean density of the telephone units is roughly one per kilometre.

Generally speaking, there is no need for a call system since contact can be made at whatever moment required via the loudspeaker equipment. In the rare cases where this is not so, arrangements should be made for central control to be alerted, by simply lifting the receiver in any one of the points along the line.

2.3.11 - Sub-station control circuit

This circuit is available to a controller responsible for the electric energy supply, who is thus in a position, as and when required, to reach a sub-station, a supply station, a parallel-connected station if necessary, an isolating-switch control station or one of the stations responsible for operation of isolating switches, to give them instructions on operations to be carried out, including whether to switch on or switch off overhead lines, link couplings, and more generally, all operations necessary to provide the proper power supplies for the line. Conversely, the controller can be reached from all these points.

This is known as a "centralised selective call circuit".

In some cases, such operations are remote controlled by the controller himself, which means that he must be provided with remote-control and remote-operated circuits covering all the points concerned.

2.3.12 - Sub-station omnibus circuit

This circuit interconnects the power-supply sub-stations of the line as well as those stations which may be involved in supplying power to overhead lines situated on the open track or in certain railway stations and sometimes to the electric energy supply point.

This is known as a "decentralised selective call circuit". Similarly to all decentralised selective call circuits, these are replaced by the automatic telephone network in most cases.

2.3.13 - Overhead line maintenance circuit

This circuit is available to maintenance staff all along the line for use in reaching stations on either side of their worksite from telephone units placed at certain points.

This is an "omnibus circuit".

2.3.14 - Circuit for work protection management module

This is a "dedicated omnibus circuit".

The protection management module is a computer-based voice-recognition system integrated into the architecture of a computer-based relay interlocking system with the essential task of ensuring work protection management and functioning automatically, as required by works regulations, together with application of the safety measures applied which are the responsibility of the operations departments.

Special telephone sockets are positioned along the tracks allowing the operator to communicate with the protection management module using a portable telephone terminal (portable telephone with high acoustic definition).

A pre-determined dialogue procedure controls communication between the operator and the system.

2.4 - Telecommunications equipment to be installed on lines with decentralised operation - Anticiped traffic improvements

Traffic safety on such lines generally depends on action by safety inspectors operating from stations or signal boxes.

These lines are the most numerous: they vary in length, ranging from the small local line to the main line over which many types of train are operated.

Because the characteristics and method of operation of such lines vary appreciably according to the regions served, it is very difficult to be specific as regards the telecommunications equipment to be installed on them.

The information below is therefore given purely as an indication and refers to equipment installed generally on lines of growing importance.

Such equipment can take different forms.

2.4.1 - Lines with a very light volume of traffic, which only handle local freight traffic, are generally short and not electrified. They rarely feed traffic to large stations.

Telecommunications equipment used:

- station-to-station circuit (point 2.3.1 - page 6)

- sometimes backed by a selective-call omnibus circuit (point 2.3.3 - page 7) serving main stations on the line.

NB : Some RUs tend to dispense with telecommunications systems in stations on lightly-used lines and to equip them on the other hand with a main subscriber line on the public network.

With such equipment, it is possible to develop a cost-effective organisation for operation of a line, involving for example, the centralisation at a railhead, of charging of consignments, accounting operations, wagon standing-time monitoring, etc. These are tasks which would normally be performed by each of the different stations, whose staff can thus be sharply reduced in number and sometimes dispensed with altogether. In such cases, the railway station's telephone extensions must be made available to the local goods train staff and to permanent way staff.

2.4.2 - Lines handling a slightly larger volume of traffic, but which, because they do not cater for any transit traffic, keep local passenger and freight feederline status. These are generally single-track lines, equipped as a rule with very simple signalling systems; they are electrified in some instances.

Telecommunications on such lines remain simple, generally consisting of:

- a station-to-station circuit (point 2.3.1 - page 6),

- a selective-call omnibus circuit serving the whole line (point 2.3.3 - page 7), in some cases, an omnibus safety circuit (block section) linking the stations and extensions intervening in the traffic process (point 2.3.2 - page 7),

- in the case of electrification, a warning circuit covering the line supply points (point 2.3.10 - page 9).

2.4.3 - Lines handling a certain quantity of **transit traffic**, in addition to **local traffic** and thereby having to cope with a significant volume of traffic generally requiring the use of special block-section (manual block) systems.

Some RUs have developed their general telephone network sufficiently to cover, if not all the stations on such lines, at least those of some importance. Nevertheless, installations on these lines include:

- a station-to-station circuit (point 2.3.1),

- a safety circuit covering the stations and signal boxes involved in block system operation (point 2.3.2),

- a level crossing announcement circuit (point 2.3.6 - page 8);

and when the general telephone network does not cover stations on the line or only covers some of them, they include:

- one or several selective-call circuits (point 2.3.3 or 2.3.4 - page 7) depending on the length of the particular line and on the volume of telephone traffic to be handled.

When several of these circuits are found to be necessary, it is not always advisable to have the successive stations on a line section covered by each of these circuits. It is frequently preferable to have only a limited number of stations of similar importance on a given circuit, with the other stations allocated to different circuits.

When these lines are electrified, they are provided with special circuits, as specified for main lines.

2.4.4 - Main lines, whether electrified or not, have to handle such large volumes of traffic that the use of special telecommunications systems is quite justified. These are double-track lines generally equipped with the automatic block system and with a traffic controller.

At RUs with a large general telephone network, stations on such lines are connected up to it.

Even then, these organisations generally find it necessary to equip the line with:

- a station-to-station circuit (point 2.3.1 - page 6),

- sometimes a safety circuit for safety inspectors (generally of the omnibus operating circuit type, point 2.3.3 - page 7),

- a control circuit (point 2.3.5 - page 7),

- a level-crossing announcement circuit (point 2.3.6 - page 8),

- maintenance circuits (points 2.3.7, 2.3.8 and 2.3.9 - page 8),

- possibly a circuit linking the automatic block signals to the stations and, if the lines are electrified, with:

  - a warning circuit (point 2.3.10 - page 9),
  - a sub-station omnibus circuit (point 2.3.12 - page 9),
  - a sub-station control circuit (point 2.3.11 - page 9) possibly combined with sub-station remote controlled and remote-operated circuits and with parallel-connected units,
  - an overhead-line maintenance circuit (point 2.3.13 - page 9).

When the general telephone network is not sufficiently extensive to cover all stations on the line, circuits additional to those mentioned above must be provided to handle a telephone traffic which can vary in volume depending on the type of operating organisation it is wished to introduce.

On lines of a certain volume of traffic (see points 2.4.3 and 2.4.4 - page 11), the telecommunications systems mentioned make it possible for operations to be organised in many different ways, since users have at their disposal telecommunications systems ensuring proper flow of telephone traffic.

Some RUs have thus set up control centres to direct the traffic flow within a particular zone comprising several lines, and intervene not only in train movements through the traffic controllers - who then come under their orders - but also assess whether extra or optional freight trains need to be scheduled, the tractive units to be supplied and even sometimes the train crews to be assigned to such trains. These control centres can in certain cases have access to dedicated circuits, as distinct from the control circuits (linking them up directly to certain train-forming stations or to locomotive sheds, for example).

2.5 - Telecommunications equipment on lines with centralised operation - Anticipated traffic improvements

Traffic on such lines is totally controlled by a line supervisor who has full responsibility for train safety and movement.

Stations do not therefore intervene in the traffic process, except in the event of failure of components in the centralised control system. In such cases, they must be in a position to guarantee train safety, which means that the line's telecommunications equipment must be designed accordingly.

The centralised operating system is valid both for lightly-used local lines and for very busy lines worked by trains of all types. The telecommunications equipment differs according to the type of line involved.

2.5.1 - Lightly-used lines (only used by local trains)

NB : Some RUs tend to dispense with telecommunications systems in stations on very lightly-used lines and to equip them on the other hand with a main subscriber line on the public network.

In every case, the line supervisor performs all operations concerning train movement and safety. His duties sometimes also include commercial activities.

Generally speaking, these lines do not have any signalling or only have a very simple signalling system. In this case, the line supervisor only rarely has remote direct control over the signals and switches; this operation is then performed, according to instructions issued by him, by either the station staff, or by train staff when the stations are no longer manned.

The line's telecommunications equipment can be quite simple:

- an omnibus circuit serving all stations - with centralised selective-call system (point 2.3.3 - page 7) - sometimes and only if sedentary staff continue to work at the station with back-up, by,

- a station-to-station circuit (point 2.3.1 - page 6), used in case of failure of the above circuit.

The operating improvements that can be expected from the centralised control of a lightly-used line are primarily of an economic order since they derive from a reduction in sedentary station staff and sometimes from their total withdrawal.

2.5.2 - Busy lines

There can be no question of the line supervisor being entrusted with commercial operations on such lines.

Stations must therefore have the necessary telecommunications equipment to perform these duties.

The following paragraphs only deal with equipment relevant to train movement and safety, as well as to the maintenance of installations, this being a vitally important factor in such cases.

These lines usually have very comprehensive signalling systems, with train headway ensured by means of an automatic block system.

Operation of the signals and switches situated on main lines or giving access to them is placed under the responsibility of the line supervisor:

- who either issues working instructions to the sedentary staff,

- or remote-controls such signals and switches himself.

NB : In some cases, the line supervisor may also be responsible for working certain switches on service tracks.

In the latter case, the telecommunications equipment must incorporate highly-reliable remote-controlled and remote-operated circuits.

As a rule, the line supervisor himself controls traffic on the line. The corresponding telecommunications equipment must therefore be adapted to allow contacts to be made between line supervisor and train staff. Station telephone units must consequently be installed in such a way that they are clearly visible and readily accessible to train staff at any time.

The general line equipment incorporates the circuits necessary for train movement and safety. These include:

- a station-to-station circuit (point 2.3.1 - page 6), which is required in any case for exchanging communications of all types, and is vital for safety reasons, should central control fail to function correctly;

- a control circuit (point 2.3.5 - page 7) which, for some RUs, offers the advantage of covering not only the stations but also field telephones (located along the line at intervals of one kilometre generally and on station service tracks at suitably selected points), which can be called by the line supervisor and which are at the disposal of train staff and possibly of maintenance staff wishing to call the line supervisor. Some RUs use line telephone links for this purpose in place of a control circuit;

- a continuous circuit for signals terminating with the line supervisor when the line is equipped with an automatic block system, in order that staff on stopped trains can arrange for their train to be identified and, if required, obtain authorisation to proceed beyond a stop signal or one that is off altogether, particularly in the event of a signal failure;

- possibly a level-crossing announcement circuit (point 2.3.6 - page 8);

- remote-controlled and remote-operated circuits required when the line supervisor operates the switches and line signals directly;

- the circuits specific to electric traction:

  - a warning circuit (point 2.3.10 - page 9),
  - a sub-station control circuit (point 2.3.11 - page 9) which, when sub-station control is the responsibility of the line supervisor, can be one and the same as the control circuit which must then serve the sub-stations,
  - if necessary, a remote control circuit for the sub-stations and parallel-connected telephone units when the line supervisor also controls power supplies.

- the circuits necessary for the maintenance of:

  - signalling installations (point 2.3.7 - page 8),
  - remote-controlled and remote-operated installations,
  - overhead equipment (point 2.3.13 - page 9),
  - hot-box detectors,
  - detection of vehicle, rocks, etc. falling on a line.

Ground-train radio (see point 4 - page 29).

The operating improvements that can be expected from the centralised organisation of traffic on a busy line are obvious. They are even more significant for a single-track line in that its traffic throughput is increased substantially. Moreover, during periods of traffic expansion, such an organisation makes it possible to postpone until later the moment when the track must unavoidably be doubled.

From the safety angle, the improvements derive primarily from elimination of any risks of misunderstanding among the different railway staff members intervening in the train running process.

From the economic standpoint, RUs do concede that whilst the investment for implementation of a telecommunications programme might appear considerable, it is nevertheless largely justified by the resulting staff savings.

It is essential, however, that concentrating the control and operating processes at a line supervisor level should be matched by greater reliability of the telecommunications installations, since any failure carries implications for the whole area where operation is centralised.

All appropriate measures must be taken to this end (standby circuits and equipment, highly-skilled maintenance staff, etc.).

Where the future is concerned, it can reasonably be expected that the advantages of concentration will be exploited to the full, by developing even further the automation of various routine operations which can be pre-programmed and thus performed at the most suitable time. Introduction of such programming, quite apart from increasing the throughput of a line thus equipped, will make it possible for a line supervisor to be placed in charge of a larger zone of action and even given responsibilities for several busy lines since he will have been relieved of all routine operations.

3 - Improvements in stations operating practices through introduction of modern telecommunications systems

3.1 - General

It would be unthinkable for a station to be managed administratively and run nowadays without a telecommunications system varying in sophistication according to the volume of traffic handled.

Over and above the telecommunications equipment for integrating the particular station into the general organisation of the particular RU and of the line serving it, specific telecommunications needs arise whenever the station concerned begins to handle a volume of traffic of a certain size.

Communications problems arising within a large station are multiple and varied, but telecommunications means available for solving them are equally numerous, and provide a whole range of possibilities.

3.2 - Range of telecommunications systems available to stations

3.2.1 - Telephony

The amount of telephone equipment in any given station depends on the size of the station. Some of the links to be made must retain their specific purpose and must be independent of all others. However, the telephone links set up for the station's general services are rarely distinct from the railway's general network or from the circuits equipping the line serving it. As a rule, outside calls are received on an automatic exchange which then distributes them to the different telephone extensions.

A station can have various types of telephone links:

3.2.1.1 - Basic links between two telephone extensions

These connect any two members of station staff who need to coordinate in performing a given task or to exchange information on a given subject.

If the two people have to receive outside calls, these may be channelled on to only one of the telephones which must then have the possibility of transferring the call to the other.

3.2.1.2 - Link between one extension and a limited number of telephones

This links up one of the station staff with colleagues working in other jobs at the station. This arrangement precludes any simultaneous telephone conversations.

In some cases, the member of staff may be able to establish a connection between two of his colleagues; his telephone unit is then known as an "exchange" telephone.

If all the staff served need to be able to receive outside calls, these come in on the "exchange" unit which must be equipped to put the call through to each of the other telephone extensions.

3.2.1.3 - Links between several telephone extensions through an automatic exchange: local network

This is the comprehensive solution whereby the different units can be interconnected in pairs and several calls can be made at the same time. The number of calls possible simultaneously must be worked out on the basis of the traffic to be handled, so as to spare users having to wait longer than is strictly necessary.

If there is an automatic exchange, the system is usually connected to the general telephone network and service calls can, as a result, go through directly. In some cases, outgoing calls will also be possible directly. Some extensions can also be reached directly from the public network.

3.2.2 - Telegraphy

Telegraphy works via teleprinters and the associated equipment, which is being replaced by fax, data transmission, etc.

3.2.3 - Data transmission

General links between the services at a station are achieved via the local data transmission network (TCP-IP, X 25, FR, ATM).

These solutions allow point-to-point or multi-point transmission of information.

3.2.4 - Intercoms

Intercom links are used primarily for communication between two individuals, thus avoiding use of the telephone and leaving users their hands free to do other work during the call.

3.2.4.1 - Basic link between two users

Each user can call the other and converse with him.

3.2.4.2 - Link between one unit and several others

The main intercom unit can be used to put the caller through to one or several other parties with whom he can converse simultaneously.

3.2.5 - Loudspeakers

Microphone-loudspeaker links offer a broad range of possible applications. They enable one-way links (with a few rare exceptions) to be established between a manager and staff who have to receive his advice or instructions.

Such links can be used both inside the premises, even in offices, and outside on worksites.

They are a convenient means of addressing larger gatherings.

3.2.5.1 - Link between a manager and a member of or group of operative staff

The microphone is connected to only one suitably located loudspeaker.

3.2.5.2 - Link between a manager and several offices, several worksites or a scattered group of people

The microphone is connected to several suitably located loudspeakers.

In such cases, precautions must be taken to avoid interference and resonance phenomena, which frequently create difficult problems for technicians.

If, as part of his duties, the manager has to be in different places at the station from which he must nevertheless be able to communicate with his staff, several conveniently located microphones can be used for him to communicate via the loudspeakers.

When these microphones are likely to be used by other members of the staff, measures must be taken to ensure that there is never more than one microphone working at any given time.

3.2.5.3 - Broadcasting recorded information

The loudspeakers of a particular worksite or station can be used to broadcast information pre-recorded on records or magnetic tapes, or information assembled on request using basic recordings.

3.2.6 - Radio communication

Against this, radio links offer greater operational flexibility and make it possible for contacts to be established with staff working in scattered places not programmed in advance in the work schedules.

Definition of the equipment used

This can be:

- transmitters,
- receivers,
- transmitters and receivers,

and in this latter case, the equipment can operate either:

- one way, i.e. with transmission and reception occurring only alternately,
- two-way, i.e. with simultaneous transmission and reception.

The equipment can be either stationary or mobile:

- stationary equipment is installed permanently, usually in a station building,
- mobile equipment can be:
  - mounted on board a vehicle. This is then on-board equipment,
  - installed for a time in a given place without being used during the transfer from one point to the next. Such equipment is transportable,
  - available to staff when travelling for use during their journey: such equipment is portable.

The links that can be established with this equipment are manifold and can be extremely varied in nature. Applications are already quite numerous and their number will continue to increase in line with the development of new organisations requiring coordination between staff not working in a fixed place.

The general characteristics of the equipment vary depending on its nature and the conditions of operation. Staff favour equipment that is easy to use, reliable, does not require any adjustment on their part and is available for use during their working hours.

With this equipment the following links can be arranged.

3.2.6.1 - Basic link between two units

This enables two railwaymen doing the same job to hear each other when one of them has to move about when performing his duties, or when they are both forced to move about in their work.

It can also be used by a manager to issue instructions to a vehicle (locomotive, tractor, lorry, service vehicle, etc.).

This link can be two-way or one-way.

It can be arranged either between a fixed unit and a portable one, or between two portable units.

3.2.6.2 - Link between one main unit and several others

This is designed to enable a manager to issue instructions to staff in different places either simultaneously (using one frequency only) or individually (using several frequencies).

Such links are generally of the one-way type, but there is nothing to stop them being two-way if required.

The main unit can be fixed or portable; the others are generally portable.

3.2.6.3 - Two-way links between several units (portable ones in particular)

These links make it possible for staff moving about within the same building or worksite to communicate in twos through a coded-call system.

Some of the units so equipped can be integrated into combined networks consisting of other radio sets, intercoms, even extensions on the automatic telephone network.

NB : All these functions have been standardised in the new GSM-R digital radio system.

3.2.6.4 - Shunting radio link

Using radio for shunting purposes cannot be envisaged without taking specific precautionary measures. There are even cases of commands relating to the safety of personnel, where permanent monitoring for correct functioning is necessary, since any interruption of the link is considered a hazard and triggers clearly defined pre-determined safety measures.

3.2.7 - Video system

In particular, it enables a staff member to operate equipment not directly visible from a distance, and at the appropriate moment, to monitor the approaches to a specific point, to identify visually information on moving vehicles passing through a given point, etc. or on fixed boards.

NB : Some RUs do use CCTV cameras to observe train tail lamps, the image being received on a screen located in the control room concerned. Other RUs, which use different colour lights for tail lamps, do not accept this system for the time being.

3.2.8 - Remote-controlled links

These rather special types of link make it possible for appliances or equipment to be remote controlled. Owing to their very specific characteristics, depending on the objective to be attained as well as the type of appliances to be operated, these links are not dealt with in the present leaflet and are only mentioned.

3.2.9 - Miscellaneous telecommunications systems

Apart from the systems listed above, others are used to resolve specific problems such as the operation of indicator boards, remote identification of train or wagon numbers, passenger and staff safety, etc.

3.2.10 - Combination of several telecommunications systems listed above

In practice, it is sometimes found necessary when setting up a link, to combine two or more telecommunications systems. There is in actual fact nothing to prevent two links set up using different systems from being interconnected (for example, radio link-up with conventional telephone circuit, or loudspeaker reception of a telephone call, etc.).

Generally speaking, the development of the programme for telecommunications systems to be used in a large station must be conducted in step with work organisation studies. This frequently means making available to one manager a large number of links which it is then recommended to concentrate in a desk console within his ready reach.

3.3 - Equipment common to large stations (passenger or freight terminals, and marshalling yards)

The telecommunications problems arising in large stations depend both on the type of service provided there and on the organisation adopted in such stations.

The equipment for a passenger station is therefore fairly different from that of a freight station. However, certain telecommunications installations are common to both. These are:

3.3.1 - General station organisation

Means required to operate the station's general services:

Local telephone network covering the whole station area and also serving any other establishments in the locality (sheds, shops, permanent-way offices, stores, etc.): this network is in general fully automatic and interconnected with the RU's general telephone network.

3.3.2 - Coordination between train movements and shunting operations

In addition to the links that can be arranged through the local telephone network, it is generally necessary for other and more specialised ones to be set up, particularly when the coordination of train movements is entrusted to an operator usually known as the "traffic controller" at some RUs. This person must be in a position at all times to receive information from any point within the station, so as to have a comprehensive view of the situation should trains run out-of-schedule or in the event of incidents causing the shunting programme to be altered and certain operations to be deferred for a time.

He must be able to contact without delay:

- the station signal boxes and, for this purpose, must have at his disposal basic telephone links (point 3.2.1.1 - page 16) with each of them;

NB : When there are many such links, they should preferably be combined into a small specialised automatic network, distinct from the local automatic network serving the station.

- shunting staff either by radio (point 3.2.6 - page 18) or loudspeaker (point 3.2.5.2 - page 18);

- if required, shunting locomotives and accompanying shunting crews, with whom he can communicate by radio or by an induction system (point 3.2.5 - page 17).

It makes sense for the terminals of these different links to be centralised at one single point, within reach of the traffic controller, on a central console (see point 3.2.10 - page 20).

In addition to this equipment, which is specific for concentrating control of shunting operations, it is rational to provide for:

- direct interconnection of the signal boxes by telephone (point 3.2.1.1 - page 16);

- the identification of trains stopped at station entry signals by the signal boxes concerned, through basic telephone links terminating at the foot of the signals (point 3.2.1.1 - page 16);

- the control of tractive units by shunting supervisors, using radio links (point 3.2.6.1 - page 19 :

  - either by radio using portable units (point 3.2.6 - page 18),
  - or by light signals close to the official at the front of the train and controlled by the member of the staff at the rear (point 3.2.9 - page 20).

3.3.3 - Train service periods

The "duty over" signal is given by the staff concerned either through:

- a luminous indicator signal, or

- through a radio link using a portable radio unit.

3.3.4 - Monitoring of track maintenance gangs - Track gang safety (during cleaning of points and point motors, snow clearing, track and overhead-wire repair following accidents, etc.)

It is highly important for station management staff to be kept informed about the progress of work, so that routing of train movements and shunting operations to be carried out during maintenance work can be worked out accordingly.

It is just as important that, for their safety, gangs be informed of train movements on the track where they are working and on adjoining tracks.

Means to be deployed:

- suitably located loudspeakers connected up to a microphone inside the control centre (or at the disposal of the traffic controller) with generally a direct view of the gang(s) monitored (point 3.2.5.1 - page 17);

- or, preferably, a two-way radio link between the same control centre and the gang foreman, even with each of the members of the gang (point 3.2.6 - page 18).

3.4 - Special equipment for large passenger stations and their associated premises

The problems more particularly relevant to passenger stations concern first and foremost passenger information, seat reservation, train services and links to be set up with train washing and stabling yards, which are generally located away from the actual station.

3.4.1 - Passenger information

Means to be employed:

Loudspeakers on platforms, in waiting rooms, entrance halls, station buffets and other public concourses (see point 3.2.5.2 - page 18), served by one or more microphones at the disposal of the traffic controller if any, of an inspector or of a clerk allocated to train announcing work.

NB : On centrally operated lines, the line manager can be made responsible for passenger announcements in several stations on the line.

Some announcements may be pre-recorded on records or magnetic tape (see point 3.2.5.3 - page 18), particularly at frontier stations where multilingual announcements are recommended.

In some cases, it may be worthwhile installing loudspeakers (see point 3.2.5.2 - page 18) in the station forecourt so that passengers can be given instructions on the directions to be followed on busy days. The microphone is then at the disposal of a specially selected station clerk.

- boards indicating the train departure platforms which can be operated by different systems: magnetic or electronic programmers or by remote-controlled electromechanical device (point 3.2.9 - page 20);

- boards indicating the stations served by the trains on the different platforms, operated as above (point 3.2.9 - page 20) or CCTV screens relaying pictures from a camera placed in front of a passenger information panel in a station office (point 3.2.7 - page 20);

- remote-controlled boards announcing train delays (point 3.2.9 - page 20), some RUs have replaced these boards by CCTV screens (point 3.2.7 - page 20), thereby multiplying the number of points within the station where train delay indications are given at no extra staff cost.

3.4.2 - Information and automatic seat reservation

Accessible to the data transmission network via a separate terminal (stations, tourist office, travel agency, etc.), the telephone network or the public internet network.

3.4.3 - Transfer of empty trainsets from or to maintenance yards

In the case of dead-end passenger stations more particularly, trainsets are frequently backed into stations or maintenance yards. The driver then finds himself at the rear of the train, whilst at the front end there is a railwayman whose job is to supply him with information on the position of the signals encountered.

By setting up a radio link (see point 3.2.6.4 - page 19) between this railway employee and the driver, reverse-working is safer and faster.

3.4.4 - Train repair yards

Since maintenance yards are generally located close to train formation and stabling areas, it is particularly relevant for the various operations taking place there to be coordinated, and for motive power units to be controlled by radio. Some RUs have gone so far as to create a control centre responsible for coordinating the work performed respectively by rolling stock maintenance staff and by shunting staff, in addition to mere shunting operations.

These control centres need links whereby they can contact all the gangs as well as the passenger station in order to organise the transfer of empty trains to this station and the removal of train sets destined for the yard under optimum conditions.

The telecommunications equipment for such a control centre includes links:

- by loudspeaker (point 3.2.5.2 - page 18) with rolling stock staff,

- by radio with the shunting supervisors or motive power units,

- by telephone (point 3.2.1.1 - page 16) with the traffic controller of the passenger station or, if none exists, with the people in charge of the different yards within the station.

3.5 - Special equipment for large freight stations

The problems specific to freight stations concern work on platforms, as well as in loading and unloading yards, and cartage operations.

3.5.1 - Operations to be performed on freight platforms

It is strongly recommended to avoid compilation of documents and statements by field staff. Their job should merely consist in identifying all relevant information and passing it onto the offices concerned.

Means to be employed in the freight forwarding office:

- radio links between platform and office staff in connection with charging operations more particularly, and preparation of documents where necessary (point 3.2.6.1 - page 19 or point 3.2.5 - page 17).

Means to be employed for comparing parcels and their documents at transfer stage or on arrival:

- links to be set up between the supervisor and the office:

  - either by radio system installed on the platform (point 3.2.6 - page 18),
  - or by mobile microphones and loudspeakers (point 3.2.5).

Means to be employed for compiling parcels delivery forms:

- links to be set up between the person arranging for the lorry to be loaded and the office:

  - either by radio systems (point 3.2.6),
  - or by mobile microphones and loudspeakers (point 3.2.5),
  - or by recordings on magnetic tapes which are subsequently sent to the office and played back on tape recorders,
  - or by CCTV, with the labels on parcels first displayed in front of a camera (generally fixed) and subsequently read on a screen in the office (point 3.2.7 - page 20).

The different organisational options made possible by these methods are all designed to speed up the operations to be performed and lead to significant savings in terms of staff.

3.5.2 - Monitoring of cartage operations

Proper monitoring and control of collection and delivery vans can result in optimum use of these vehicles whilst making it possible to deal very rapidly with home-collection requests reaching the freight office after departure of the vans. This facility is particularly appreciated by railway customers.

Means to be employed:

- radio link between central office and vans (see 3.2.6).

3.5.3 - Operations to be performed in loading-unloading areas or yards for full wagonload traffic

It is even less advisable to compile documents in loading/unloading areas than on freight platforms. To perform such work, it is recommended to arrange:

- a link through the local telephone network between sales office staff and staff supervising yard operations who have items of equipment at different points of the loading/unloading area for the purpose, (point 3.2.1.3 - page 17),

- a radio link (point 3.2.6) between the rolling stock office staff and checking staff for compilation of the record of wagons.

3.6 - Special equipment for marshalling yards

The telecommunications equipment used in marshalling yards differs very considerably according to the operating methods adopted for these yards. These methods themselves vary greatly from one RU to another, and sometimes even within the same RU, depending on the size of the station or on the type of traffic handled by it.

It would be extremely difficult to produce a specimen list of telecommunications systems to be used, all the more so as these systems do not depend solely on the general organisation of yard work but also on the methods used for monitoring the use and movement of wagons over the whole rail network.

Within the general context of individual control of wagon utilisation, very special telecommunications means must be employed in order to be able to monitor wagon movements by computer, see *UIC Leaflet 404-1* (see Bibliography - page 33).

Within the general context of wagon forwarding, it is advisable for a marshalling yard to know in advance the destination of the wagons it is meant to process. In this way it can work out the train sequences for splitting up the train in order to shorten wagon standing time on yard tracks and programme well in advance those freight trains which are due to leave the yard in the ensuing hours.

The marshalling yard can receive all relevant particulars from the preceding formation yard either by telephone or by DT. In the first case, it only needs to be served by the RU's general telephone network whilst, in the second, it must necessarily be connected to the general DT network. This second solution is by far the best one, since reception is faster and does not require the presence of a member of the staff, added to which the information received is more reliable than that transcribed manually from a telephone message.

Obviously, the marshalling yard notifies the other yards or destination stations of the composition of the trains it will be forwarding them, in the same way and through the same telecommunications channels.

Within the marshalling yard itself, telecommunications can avoid the use of too many staff.

Record of arriving trains

When the yard receives details of the train consist as indicated above, it is simply a matter of checking these particulars when the train arrives.

When train consist details are not received in advance, records are compiled during the course of in-situ checks, in which case the staff member responsible should be issued with a radio unit whereby he can dictate train consist details either to a wagon office clerk, who can thus compile a check-list directly (with several copies) to serve several purposes, or can dictate into a tape recorder which records his text for use later on.

The person responsible for checking can also be issued with a portable tape recorder for use in recording details of the consist of one or even, in some cases, several trains, the tape being subsequently remitted to the wagon office.

Comparison of documents and wagons

Some RUs arrange for documents to be sent directly to the destination station, the wagon in this case being forwarded on the basis of its label.

Others arrange for documents to be dispatched at the same time as the wagons, and comparisons are carried out at each stopover point. In such cases, it is advisable for comparisons to be made when compiling the record of wagons that have arrived; the sheets are then checked at the office. The operation will be simplified by using two radio units, one (portable) issued to the field staff member, the other (stationary) located in the office, thereby enabling the two staff members to consult one another when discrepancies are noted (see point 3.2.6 - page 18).

Record of trains forwarded

In stations where data is centralised, it is possible to avoid having to produce a record of this type on the spot.

In other stations, it is recommended to proceed as indicated above for trains that have arrived.

Compilation and distribution of the shunting list

If several copies of the record of the train that has arrived are properly received or compiled, the record can easily be completed by the central office and then used as shunting list. Distribution of this list to the people concerned, short of using messengers, can be effected:

- either by mechanical transmission means or by means of a compressed air tube system,

NB : Several RUs have given up air tubes owing to their cost.

- or by DT.

In the latter case, DT links must be arranged between central office and the different work positions where the list is required.

Organisation of shunting operations

Telecommunications means to be employed:

- radio link between hump foreman and the driver of the tractive unit pushing the train towards the hump (point 3.2.6),

NB : In some cases, this link is used for remote control of the tractive unit from the hump cabin.

- link between hump cabin and the signal box (when these are not housed under the same roof. The link can be arranged by:

  - intercom (point 3.2.4.1 - page 17) or operation of a display panel (point 3.2.7 - page 20) (indication of destination of the wagons)
  - in some cases, remote control of a signal box fitted for automatic switch operation (point 3.2.8 - page 20).

- link between the signal box and field staff (shunters in particular) by microphone and loudspeaker (point 3.2.5 - page 17) or else by means of a radio system, the field staff being then issued with portable receivers (point 3.2.6).

- link between field staff and the signal box:

  - frequently by intercoms between different points of the sorting sidings and the signal box (point 3.2.4 - page 17),
  - sometimes via two-way loudspeakers within the siding and reception through loudspeaker in the signal box (point 3.2.5 - page 17).

Monitoring of wagon inspectors

The importance of monitoring the work of these field inspectors out checking wagons on arrival and departure frequently means their being issued with portable radio units (see point 3.2.6 - page 18) in order to communicate with their foreman. These units must be particularly lightweight to avoid overburdening the wagon inspectors who are already carrying various tools and, at night, a lantern. If these portable units are transmitter-receivers, they can also be used for testing the brakes of trains after their consist has been established.

Central marshalling yard control office

Several RUs have concentrated the control of train movements and yard operations in a central control office. This is geared for receiving information from all the different points within the marshalling yard and must be able to reach all its operational points. It must also have ready access to the other establishments such as locomotive sheds, rolling stock workshops or maintenance sidings, etc.

To this end, it must not only be connected to the local telephone network, but also be provided with a certain number of direct links by telephone or radio (directing wagon staff from this central office, for example).

3.7 - Equipment for medium-size stations

These are stations which have the necessary facilities for handling passenger and freight traffic and, as a rule, the required installations to fulfil a role in the running of trains over the line(s) serving them: stabling sidings, signal boxes, block section control points, junction signal boxes, possibly locomotive sheds and rolling stock maintenance yards, etc. Staff from several departments work in these stations.

They are served:

- usually by the RU's general telephone network, either directly when the latter is sufficiently developed, or through the intermediary of a circuit serving the line,

- sometimes by the general DT network,

- by circuits equipping the line(s) serving it, the number and type of which depend primarily on the importance of the particular line(s) and on the method of operation used (centralised or decentralised working).

These stations are provided:

- for general service, with an automatic local telephone exchange. When this exchange includes a position which is not permanently in use, changeover devices are necessary to connect certain circuits to permanently served extensions.

- dedicated internal telephone circuits:

  - between signal boxes
  - between signals and signal boxes

- where necessary, with special links by telephone or radio to resolve specific problems that might arise in the station.

3.8 - Equipment for small stations

These are stations which only handle a small volume of traffic. However, their telecommunications equipment can vary rather appreciably, depending on whether they provide a comprehensive passenger and freight service combined possibly with some involvement in train movements (stabling possibilities, for example), or a freight service exclusively with nevertheless some involvement in the train running process, or else an exclusively passenger (train halt) or freight service with no involvement in the train running process (in general establishments with no signalling or with signals operated from the signal box of a neighbouring station or on orders from the line supervisor).

These stations do not, as a rule, have their own telecommunications installations and are covered by the circuits equipping the line on which they are located. The telephone units connected to these circuits serve the different points concerned within the station.

NB : For example, the control circuit - if any - serves the place where the safety inspector is based, whereas the omnibus circuit with selective calls terminates in the station master's office. The two functions are sometimes covered by the same person.

They are hardly ever reached from the general telephone network except through the intermediary of one of the circuits equipping the line. It even happens frequently that they cannot be reached from this general network.

The telephone systems with which they are provided usually have only one extension (at the disposal of only one member of the staff). However, when the railway station has several centres of activity, it may be fitted with exchange units that can transfer outside calls on to other extensions in the station or establish links between two separate phones (see point 3.2.1.2 - page 16) without being tuned into the connection themselves.

4 - Possibilities offered by radio links with trains

4.1 - General

The UIC has identified the need for a band of common radio frequencies as a key factor in achieving interoperability within an international railway communications system (see Bibliography - page 33).

The RUs use radio links for trains with two different modes of operation defined in conformity with the specifications of the UIC Operating Committee:

1. Duplex mode with voice privacy, one feature of which is duplex functioning

2. Semi-duplex mode, without voice privacy.

The radio links with the train are achieved from fixed posts installed along the track. Their spatial distribution should be dense enough to secure an adequate quality of communications over the entire length of the line.

The requirement of permanent monitoring of the radio link means that a carrier frequency must be emitted continuously from the fixed posts.

If the zones to be served are extensive and contain at least three fixed posts, it is generally necessary to use three alternative frequencies for the fixed emitters and a fourth frequency for the mobile transmitters. Reception frequency switching in mobile receivers must be achieved using an automatic device. Using the simplest technique possible, the four frequencies have been combined following a standard scheme to form a "quadric-frequency group".

Developments in radio technology have yielded useful solutions for links:

- between fixed points and moving trains,

- between moving trains,

- or between sections of the same train.

4.2 - Radio links between fixed points and moving trains

These links have two distinct aspects:

- they are either service links with the driving crew,

- or they are commercial links - available to passengers - with the public network.

Service links are generally arranged between the traffic controller and the driver in order to improve line throughput.

The traffic controller is thus able to secure accurate information about the position of trains in the event of disruption on the line, to issue instructions and to be informed rapidly of any incident.

For their part, drivers can ask for instructions in the event of a locomotive breakdown and can request assistance.

Some RUs plan to use these links for giving orders to start and instructions to proceed past a stop signal, this being particularly useful on lines with centralised management of operations.

In some cases the fixed point(s) may be located in one or several stations on the line. The link is then between the driver and a station clerk responsible.

To meet customers' needs, a radio telephone can connect a pay phone on board the train with the public telephone network.

Such facilities can only be justified for commercial reasons as part of a policy to provide a top-quality service to passengers on some trains over specially equipped lines.

4.3 - Radio links between moving trains

Such links are not operational at the moment: any information the driver might have to pass on to another colleague can be relayed through the intermediary of the traffic controller for him to retransmit to the drivers concerned.

However, it is possible that sometime in the future, such links could prove useful, especially to control the respective speeds of trains or to announce accidents if such occur.

4.4 - Radio links between two sections of the same train

Such links can be arranged:

- either between the driver at the front of the train and the guard,
- or between the driver at the front of the train and the driver of the booster locomotive,
- or between the banking locomotive and a staff member at the front end of the train (backing operation, or remote control in case of reversible train sets.

NB : When there is no control circuit on the train.

The link between the guard and the driver at the front can speed up operations in stopping stations and can allow the transmission of information (payload, brake weight) or of instructions (start orders) according to the regulations applied on the line.

The link between the front locomotive and the booster locomotive can in particular facilitate starting and avoid coupling breakages on mountain lines with steep gradients.

In some cases, radio links could be used to remote control a motive power unit incorporated into the train, but they would then need to be particularly reliable and, in all events, monitored on a continuous basis.

Links between the banking locomotive and a staff member in the front cab provide a solution for two-way working either by transmission of instructions or even by remote control of the banking locomotive. In this case too, radio links must be monitored continuously.

5 - Improvements to international services

5.1 - Need for international telecommunications links

As international exchanges develop and gather momentum, there is an increasing need felt by RUs to coordinate their policies as regards the organisation of forwardings, the development of commercial agreements, the speeding up of rolling stock repair work, etc.

The simple exchange of service telegrams as provided for in *UIC Leaflet 461* (see Bibliography - page 33) is no longer adequate today, and the need for more comprehensive links permitting more direct contacts to be developed across frontiers is recognised by all the RUs.

These links must be arranged at different organisational levels:

- between general headquarters,
- between regional headquarters or adjacent divisions,
- between stations on either side of a frontier.

The RUs are of the opinion that it would be desirable for these links to be automatic, more particularly those between the main operational centres of railways IRTN (International Railway Telephone Network).

In order to achieve this effective interworking of the different national telephone and DT networks, it would be necessary for the RUs who use different techniques for their automatic systems to study the means of making them interconnectable and plan the necessary investments to this end.

As long as this general interconnection of telecommunications networks remains an impossibility, every effort must be made to facilitate international links so that their quality is satisfactory at technical (see *UIC Leaflet 752, 753-1 and 753-2* (see Bibliography - page 33)) and operating level.

5.2 - Links between distant points

5.2.1 - Telephone links

The RUs may agree to set up fully automatic connections for certain links. The system used is then fully automated.

5.2.2 - Data transmission (DT)

Whenever possible, the automatic exchanges of adjacent RUs should be linked by circuits to provide automatic intercommunication.

International circuits between networks must be connected to the central exchanges at the highest level of the network.

When two networks of different RUs cannot be linked through fully automatic circuits because of system differences or for other reasons, the solution consists in introducing a semi-automatic service involving only one re-transmission, preferably in the arrival country.

This semi-automatic system must also be adopted for transmission operations with the networks of RUs using a system of automatic re-transmission with routing by the messages themselves.

When the automatic DT network of an RU includes extensions for providing information, these must be equipped to intervene in international traffic for the re-transmission of messages to several recipients.

5.3 - Links between adjacent RUs

These links are particular to stations located on either side of a frontier.

They are generally set up through dedicated circuits similar to some of those listed in point 2 - page 5:

1. by telephone

   - station-to-station circuit
   - safety circuit,
   - control circuits frequently going as far as the first station past the frontier,
   - level-crossing announcement circuit,
   - where required, circuits specific to electrification: warning, sub-station omnibus, overhead-line maintenance;

2. by DT

   - basic link through computers (point-to-point);

3. by radio

   - reference has been made to *UIC Leaflet 751-3* (see Bibliography - page 33) concerning analog radio systems and the frequency plan to be used for ground-train radio links along international lines. The frequencies will be assigned as agreed bilaterally or multilaterally between the RUs responsible for assigning frequencies in conformity with proposals put forward by the railway companies of the interested countries, and preferably amongst the quadric-frequency groups contained in Appendix A to the leaflet;
   - all those countries that are signatories to the GSM-R protocol agreement will in due course have at their disposal a GSM-R system (digital radio system). One of the reasons justifying the choice of technology for the GSM-R network is that it allows interoperability to be implemented for the railway networks of different countries. In order to achieve interoperability it is therefore necessary to have international connections between the mobile switching centres (gateway MSCs). Trains can thereby run in two or more countries using a single GSM-R unit for the entire journey.

For a number of RUs, these links also extend to the control or monitoring centres to which these stations are attached.

The links are generally arranged through direct circuits, but the possibility of recourse to the general telephone networks - since the control or monitoring centre of an RU is a distant user of the closest automatic exchange on the other RU - or possibly to the general DT networks, should not be ruled out.

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3. Miscellaneous

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