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OR

Functional model for the remote control of traction units

Modèle fonctionnel de la commande à distance des unités motrices
Funktionsmodell für die Fernsteuerung von Triebfahrzeugen

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

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VI - Traction

Application:

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Contents

Summary

The purpose of this document is to produce a general model that describes in a functional manner the remote control of traction units.

The document makes direct reference to *UIC Leaflet 556* which deals with data transmission on the train bus and specifies the functions that take place between the vehicles concerned (locomotives, multiple units, railcars, trainsets and driving trailers) including the rules under which the necessary telegrams are formed, transmitted and processed.

Four different control types are defined covering the basic functions that are always to be guaranteed for remote control and the more complex ones that allow more flexibility in the remote control of the traction units but may not be always available on existing rolling stock.

1 - Scope

This Leaflet is applicable to all traction units and driving trailers that are equipped with a train bus in accordance with *UIC Leaflet 556* (see Bibliography - page 37).

This Leaflet can also be applied to other kinds of rolling stock, e.g. EMUs, DMUs (see List of abbreviations - page 36) and high speed trains, in order to develop the remote control application based on an existing standard and to achieve interoperability.

This Leaflet is applicable to both diesel and electric traction vehicles.

2 - General

2.1 - Introduction

This leaflet specifies the implementation of the remote control of traction units using the telegrams specified in *UIC Leaflet 556* for this purpose; additional telegrams, if needed, have to be agreed inside the "Steering Group UIC – Train bus".

In spite of the large variety of the existing railway vehicles and their different functional characteristics, a single reference model which includes the different operating procedures that can be present on a given vehicle has been developed.

This leaflet does not standardise the functions which take place within the individual vehicles or the design and arrangement of the control equipment, but only the application interface among vehicles. However, a standardized behaviour of certain remote control functions may affect the specification of the corresponding local functions of each vehicle and, consequently, have an impact on the implementation of the application software.

The introduction of standardized traction unit remote control functions raises the problem of how these can be exhaustively tested with a reference base, the structure and performance of which reproduces the contents of *UIC Leaflets 556, 557 and 647* (see Bibliography - page 37). The procedure to assess the conformity to these leaflets is specified in point 6 - page 33.

This leaflet forms part of a set which consists, among others, of the following (see Bibliography - page 37):

- *UIC Leaflet 541-5* Brakes;
- *UIC Leaflet 550* Power supply installations;
- *UIC Leaflet 550-1* Electrical switch cabinets on passenger stock;
- *UIC Leaflet 553* Heating, ventilation and air-conditioning in coaches;
- *UIC Leaflet 555* Electric lighting in passenger rolling stock;
- *UIC Leaflet 556* Information transmission in the train (train bus);
- *UIC Leaflet 557* Diagnostics on passenger rolling stock;
- *UIC Leaflet 558* Remote control and data cable;
- *UIC Leaflet 652* Diagnostics on tractive units and driving trailers.

This implies that some remote control functions, for example doors or brake operation, are described in the documents listed above and are not specified in this leaflet.

2.2 - Basic concepts

Basic concepts applied throughout this leaflet are:

- this leaflet needs to deal with a minimum set of signals. It only contains the essential ones in order to achieve the correct duty of the remote control system functions;

- this leaflet does not standardise the functions related to particular features specific to the different railway operators or manufacturers. These are to be dealt within national technical standards and the related signals have to be placed in the national reserve; in such a way information completeness is guaranteed and confusion at the international higher level is avoided;

- the signals described in this leaflet are chosen on a large common base in order to provide all the information and to prevent any misunderstanding. All the basic signals on which remote control is based can be generated directly by devices placed on the driver's desk;

- if not otherwise specified in the leaflet, both the leading and the slave vehicles perform the same logic operation after a command. The implementation of the command can obviously be different on each vehicle;

- not all commands issued by the leading vehicle are explicitly acknowledged by the slave vehicles, but the leading vehicle can check the status of the trailing vehicles by means of their R2 telegrams;

- each vehicle shall protect itself in every condition. This means that the remote control commands that are recognised as unsafe shall not be executed. If the communication is interrupted at any time each vehicle in the composition shall put itself in a safe state.

2.3 - Operating conditions

The conditions to allow the Remote Control application to work properly are:

- the control system of the involved vehicles is active;

- the train bus is in normal operation according to *UIC Leaflet 556*.

For the majority of the functions described here a leading vehicle shall be present in the composition. The activation of the driver's desk identifies the leading vehicle.

For the purpose of traction remote control the leading vehicle is also referred to as the "Master". All other involved vehicles are referred to as "Slaves".

3 - Types of remote control

In order to guarantee a minimum level of compatibility for the interoperability and to allow the most advanced implementation of remote control systems, four different types of control (control types 1, 2, 3, 4) are introduced here; these are applicable both to electric and to diesel traction.

The concept of remote control is based on the functional representation of each vehicle. This means that any traction unit is seen from the train bus as a set of functions and a set of state variables. The different types of control include different functions to allow the remote control of interoperable traction units.

The first type of control (Control Type 1 or CT1) is the basic one and shall be always guaranteed when interoperability of the remote control of traction units is required.

Besides the functions covered by CT1 (see List of abbreviations - page 36), some other options, which can simplify the operation of the trains and which are thought to be useful in improved remote control systems have been considered. These options are included in control types 2, 3 and 4.

The Master learns during the train bus inauguration how many traction units with electrical or diesel traction equipment are in the train and which types of control they support. This allows the Master to properly request the Slave to initiate a particular type of control necessary to perform a specific remote control command, independently from the types of control supported by the other vehicles. In any case, the types of control that can be activated within the train composition at a certain moment are only those supported by the leading vehicle.

The available control types 2, 3 and 4 may be dynamically combined with control type 1 according to the request of the Master; for example it is possible to have control 1+2+3+4, control 1+3, control 1+2+3 and so on.

In the next points the different control types are described in greater detail.

3.1 - Control type 1 (CT1) - Mandatory control system

This defines the minimum requirements that each vehicle involved in the remote control application must fulfil.

Control type 1 distinguishes between electric and diesel traction for certain functions and allocates these to the control types 1e (CT1e) and 1d (CT1d) (see List of abbreviations - page 36).

There is no difference in the functional model between CT1e and CT1d for the majority of the functions. However, due to the obvious technical differences, some of them are specific to electric or diesel traction units.

The activation of traction takes place separately in CT1e and CT1d. If the Master supports both control types it is possible to use the complete functionality of all the electric and diesel traction units that are in the train.

CT 1 commands are sent broadcast mode, i.e. they reach all the Slaves at the same time.

3.2 - Control type 2 (CT2) - Control type with selective traction unit operation

Control type 2 (see List of abbreviations - page 36) is introduced to selectively command different traction units in the train in order to better manage complex train configurations and particular operating conditions.

Once CT2 is activated between the Master and the Slaves that support it, CT2 commands have higher priority over the corresponding CT1 commands. However, when a safety related behaviour is involved, CT1 commands have higher priority over the corresponding CT2 commands and the control type of the Slave is reset to CT1. In all other cases an explicit CT2 order is requested to reset the control type to CT1.

3.3 - Control type 3 (CT3) - Control type with distributed speed control

Control type 3 (see List of abbreviations - page 36) is introduced to allow the Master to transfer the speed control function to another vehicle.

In any case the speed of the train shall be controlled by just one vehicle.

A distinction between electric and diesel traction is not necessary.

3.4 - Control type 4 (CT4) - Control type with interactive procedures

This type of control allows monitoring of status and operative conditions of the Slaves, report of faults and alarms and management of the necessary corrective actions.

Two basic functionalities are provided by CT4 (see List of abbreviations - page 36):

- authorisation request issued by a Slave and subsequent permission from the Master in order to achieve a proper management of faults and diagnostic events;

- test request issued by the Master and related report of the test results from the Slave.

Due to the interactive procedures needed for this type of control, it can only be implemented on vehicles equipped with a suitable display and input device.

Diagnostic communication is achieved by exchanging directly the text of the messages and of the menu of the proposed choices to cope with the event. The operator selects the proper options and the corresponding code is sent to the vehicle that issued the authorisation request.

4 - Functional model

4.1 - Remote control process

The technology of the various traction units (locomotives, EMUs, etc.) within the various railway operators can be very different, considering, for example, the setting up of the traction power (contact breakers, switch gear, converters) and its control (relay logic, analogue and digital electronic equipment, microprocessors).

Because of the existing technical differences, there are also large differences in the input and output of the control equipment. Therefore it is not possible, in most cases, to use the signals transmitted over the train bus to directly control the equipment or to obtain these signals directly from the control equipment.

For this reason, signals that contain all the necessary information are defined for the train bus. These signals must be "translated" in each vehicle in order to work with the actual control equipment. This process is represented in Fig. 1.

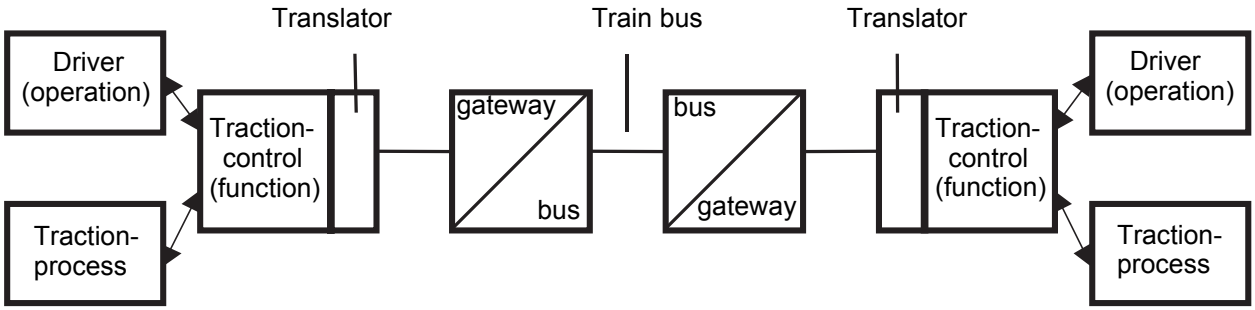


Fig. 1 - Logic diagram of the remote control process

4.2 - Macrofunction definition

Traction units are very complex systems and different solutions for their design have been developed by different manufacturers and operators. All of them, however, converge to the same operational results and so it is possible to deal only with primary signals according to the nature of this leaflet.

In order to properly define them, they have been arranged in functional modules, called macrofunctions, as listed below:

- train composition,
- primary energy,
- parking brake,
- air and pneumatics,
- auxiliary energy,
- traction and dynamic brake,
- equipment protection,
- data validation.

This organisation is shown in Fig. 2.

Each macrofunction contains a set of functions: the functions are described by the corresponding remote control signal, mapped in telegrams described in *UIC Leaflet 556, Appendix A*, as listed in the following paragraphs.

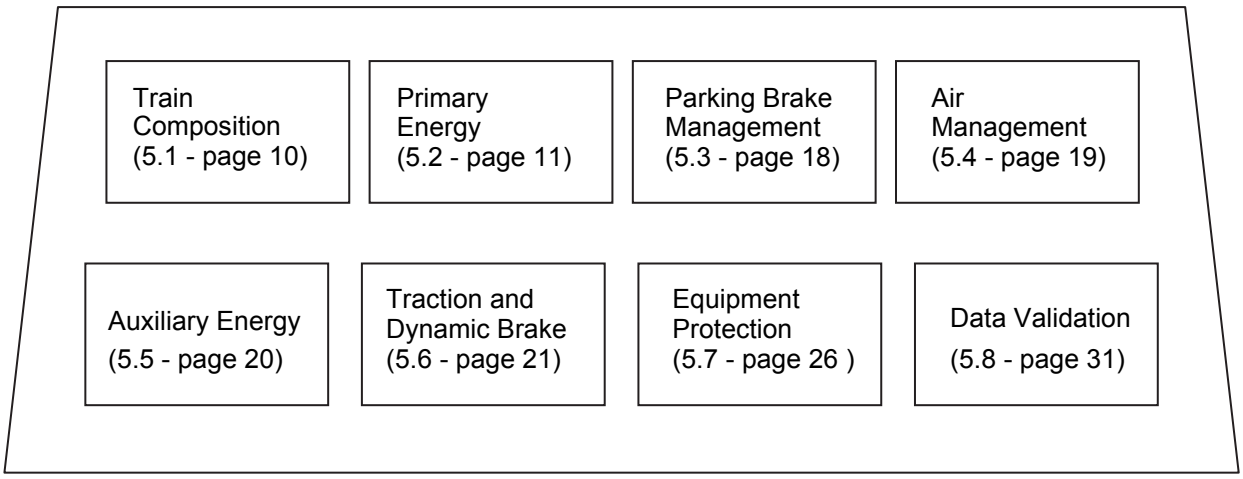


Fig. 2 - The macrofunctions structure

4.3 - Macrofunction structure

This leaflet fully specifies the structure and the meaning of each signal listed below. Each function shall be used as specified in the present document. The technical implementation of the function is not defined in this document and is left to railway operators and manufacturers.

Each macrofunction is described in detail by the following elements:

- the concept, which defines its function from the logic point of view;
- the interface, which correlates it with the other involved macrofunctions;
- the list of the signals.

Each signal is characterised by the following elements:

- the purpose, which identifies the carried information and its meaning, i.e. the logical behaviour of the related function on the train bus;
- the data specification, i.e. the details of the signal implementation on the train bus, including the telegram type (R=Regular or E=Event telegrams according to definitions given in *UIC Leaflet 556*) and the data format and encoding;
- the communication specification in terms of information flow and signal behaviour in time (permanent or impulsive);
- the number of the telegram, as stated in *UIC Leaflet 556, Appendix A*, in which the signal is mapped.

5 - Macrofunctions

In this section macrofunctions are described and the related signals are presented.

NB : Signals can be permanent or impulsive in time depending on the nature of the information carried.

Permanent signals (on the bus) have to be maintained as long as the logical command (i.e. on the driver's desk) persists.

Impulsive signals (on the bus) must have a minimum duration of 1 second.

All signals have to be considered as permanent if not differently specified by this document.

5.1 - Train Composition

5.1.1 - Setting of Control Type

This set of functions is related to information transmission among the vehicles in order to set up the remote control system and ensure its correct behaviour.

During the inauguration the leading vehicle gains all the information on the static properties of the vehicles in the composition; among the others, the leading vehicle receives information about which type of remote control it is possible to establish towards each vehicle, by means of static vehicle properties 49, 50, 53, 56, 143, 144 and 145.

Inauguration is described in *UIC Leaflet 556, point C.1*.

Static vehicle properties are described in *UIC Leaflet 556, point E.1*.

To enable the remote control operation, information is exchanged using the following telegrams, as described in *UIC Leaflet 556, Appendix A*:

4.1, 4.2R/1e, 4.2R/1d, 4.2R/2, 4.2R/3, 4.2R/4, 4.2M/1, 4.2M/2, 4.2M/3 and 4.2M/4.

Procedure:

- From the static vehicle properties listed above, which are distributed with the inauguration frame, the leading vehicle learns the properties of the vehicles that are in the train.

- From telegram 4.1, distributed with telegram R2, the leading vehicle learns whether these properties are available, that means ready to operate. From this and from the properties of the leading vehicle itself, the leading vehicle dynamically determines the remote control types which are supported and available.

- The leading vehicle must set the desired type(s) of CT1 by means of telegrams 4.2R/1e and 4.2R/1d (CT1e, CT1d, CT1e+CT1d). Set of the control type is allowed only if at least one vehicle is ready for remote control.

- If necessary, the leading vehicle can dynamically set the desired additional control types by means of telegrams 4.2R/2 (CT2), 4.2R/3 (CT3), 4.2R/4 (CT4).

- The Slaves report the readiness to be remotely controlled according to the different control types by the telegrams 4.2M/1, 4.2M/2, 4.2M/3 and 4.2M/4.

5.1.2 - Train integrity

The integrity of the train shall be checked by the Master by means of telegram 6.1, described in *UIC Leaflet 556, Appendix A*.

5.2 - Primary Energy

This macrofunction comprises all the functions and signals related to the energy providing system of the traction unit. Obviously, the management of primary energy in electric and diesel power cars is achieved with different technical solutions; however, the common target is to provide the energy for the operation of all the devices installed on board.

5.2.1 - Electric traction

5.2.1.1 - Selection of the voltage system

The voltage selection is normally done in the leading vehicle either by the driver and/or by means of an automatic device.

Each traction unit automatically checks the correctness of the imposed voltage system if it is able to do so.

Involved telegrams, from *UIC Leaflet 556, Appendix A*, are 4.3 and 4.4.

Procedure:

- Telegram 4.3 transmits to all traction units which voltage system has been chosen. Code "(value blocked)" shall be intended as "automatic choice". Code "Manual adjustment" allows selective administration of pantographs: If this code is set, pantograph(s) overriding is possible on all the train. After receiving this code, the Slaves will not be able to use pantograph(s) without a manual selection of it (them). The default Mode for all the Slaves shall be "No E Operation".

- Telegram 4.4 reports back to the leading vehicle which voltage system is active in each Slave. As in telegram 4.3, code "Manual adjustment" reports situations of pantograph(s) override on each Slave. If the voltage system or the automatic selection required by the Master with telegram 4.3 is not supported, the order is ignored and the "Selection not available" feedback is reported to the Master. If the selection required by the Master with telegram 4.3 can not be set, the order is ignored and the "No E-Operation" feedback is reported to the Master. The "No E-Operation" code has to be sent back also if no voltage system is selected by the Master.

5.2.1.2 - Selection and operation of the pantograph

To allow the proper choice of the pantograph(s), the following information, in addition to the selected voltage system, is necessary:

- UIC country code of the pantograph;
- shape (design) of the pantograph;
- position (front, rear) of the pantograph.

This and the other information for selection and operation of pantographs are provided by telegrams 4.5, 4.5/1, 4.5/2, 4.5/3, 4.5/4, 4.6, 4.7, 4.8/1, 4.8/2 and 4.7/2, described in *UIC Leaflet 556, Appendix A*.

In most cases, the line voltage selection and the position or eventually the country code of the pantograph are sufficient to determine which particular pantograph shall be raised. However, this leaflet also allows for the management of complex cases of different pantograph types, in the same country for the same voltage system.

Procedure:

- With telegram 4.5/1 the Master specifies the UIC country code of the pantograph to be raised. If the application doesn't request definition of a UIC code, the "No Choice" code has to be selected.
- Telegram 4.5/2 reports back to the Master which UIC country code of the pantograph has been selected by each vehicle.
- With telegram 4.5 the Master specifies the position of the desired pantographs (front, back, both, automatic choice). The pantograph choice is restricted to the pantographs related to the already specified voltage system and country code. If the automatic choice option is selected each vehicle is allowed to autonomously select the position of the pantograph to be raised, according to the selected voltage system and country code.
- Telegram 4.6 reports back to the Master which position of pantograph has been accepted or automatically set by each vehicle.
- With telegram 4.5/3 the Master specifies the shape of the pantograph(s) to be raised. This parameter is necessary to distinguish among different kinds of pantograph used in the same country under the same voltage system. If it is not necessary to distinguish between different pantograph shapes, once the UIC country code and the voltage system have been selected, the Default shape code has to be selected. The meaning of the A, B, C and D choices is specified at the national level by the railway operators.
- Telegram 4.5/4 reports back to the Master which shape of pantograph has been selected on each vehicle. The "Standard design" code is reported when it is not necessary to distinguish between different shapes; the "Not available" code is sent by the Slave when a not applicable order is received (pantograph can't be selected because device is missing or due to particular operating conditions).
- More generally, each Slave checks if its available resources and actual operating conditions are completely coherent with the orders in telegram 4.5, 4.5/1 and 4.5/3. If there is no complete matching, it will not be possible to operate pantographs under CT1 on that vehicle.

- If it is not possible to operate pantographs under CT1, as mentioned above, CT2 should be used to resolve such a conflict as specified below. In this case the driver operates pantographs under his own responsibility.
- The raising and lowering of the selected pantograph(s) is handled by means of telegrams 4.7 and 4.7/2. The code "error" shall be treated as an invalid command and pantograph(s) shall be lowered. The use of telegram 4.7 is mandatory for all kind of control types, while the use of telegram 4.7/2, obviously in conjunction with 4.7, is mandatory only for control types 2 and 4. If the Master is using only telegram 4.7, it can send either impulsive or permanent commands; if it is using also telegram 4.7/2, it must send a permanent command on telegram 4.7 and an impulsive command on telegram 4.7/2. Slaves that support only CT1 shall accept either the impulsive or the permanent command on telegram 4.7; Slaves that support CT2 or CT4 must accept only the impulsive command on telegram 4.7/2, and can use (if needed for whatever reason) the permanent command on telegram 4.7 only to gain information on what kind of command was last issued.
- Telegram 4.8/1 gives the status (raised or lowered) of the selected pantograph(s) of the Slave(s).
- With telegram 4.8/2 each Slave feeds back the overhead line measured voltage. Values are significant only if on the vehicle there is at least one raised pantograph. The value is referred to the nominal voltage reported by telegram 4.4.

CT2:

Control type 2 is handled by means of additional telegrams. Involved telegrams, described in *UIC Leaflet 556, Appendix A*, are 4.6E, 4.6A, 4.7E and 4.7A.

Procedure:

- With telegram 4.6E the Master requests each Slave to provide information about the available pantographs.
- With telegram 4.6A each Slave provides information about the available pantographs. Octet 11 contains the number of available pantographs. For each available pantograph a block of information is provided. The information of the first pantograph is reported below:

  a. Octet 12 bits 0-3 contains the number of the vehicle on which the pantograph is installed. In case of a trainset the vehicles are numbered according to the direction 1 of the TCN gateway.
  b. Octet 12 bits 4-7 contains the position of the pantograph in the vehicle. The position can be front, rear or middle.
  c. Octet 13 specifies the UIC country code of the pantograph.
  d. Octet 14 specifies the coded shape and voltage system of the pantograph.
  e. This structure is repeated for the subsequent pantographs (i.e octets 15-18 refer to the second one, etc). The order of the pantographs is defined by TCN direction 1 of the train bus node.

- Telegram 4.8/1 gives the status (raised or lowered) of the pantograph(s) of the Slave.
- Telegram 4.7E is a command to raise or lower a specific pantograph of a particular traction unit. If a CT1 "lower pantograph" impulsive command is issued on telegram 4.7/2, this prevails on any already given CT2 command "rise pantograph". The specific pantograph is identified by means of the UIC country code, position, shape and voltage: this information is repeated inside the command to allow forcing the pantograph to operate with a voltage system it was not designed for. (It is an alternative way to CT1 procedure for pantograph forcing). In this case the driver operates pantographs under his own responsibility.
- Telegram 4.7A is the answer to telegram 4.7E and means that the action initiated with telegram 4.7E has started.

5.2.1.3 - Main switch

If the "main switch ON" command is issued, all the main switches in the train are closed. If proper operating conditions are not satisfied on some vehicles, the "main switch ON" command is not activated only on those vehicles.

If the "main switch OFF" command is issued all the main switches are opened.

Both commands on the train bus are impulsive and shall have a minimum duration of 1s.

Each "main switch OFF" command has priority over any possible "main switch ON" command.

The status of the main switches is reported to the leading vehicle.

Involved telegrams, described in *UIC Leaflet 556, Appendix A*, are 4.9R and 4.10.

Procedure:

- Telegram 4.9R carries the commands to close and open the main switches of all the traction units in the train. When a Slave receive the command "main switch ON", it must perform this operation only if it is allowed by all other operating conditions. The physical command on each vehicle must be issued after a delay of N seconds (where N is the UIC address of the gateway in composition) from the time when the command on the train bus has been received, to avoid the sum of all the surge currents of the transformers (if present).

- Telegram 4.10 is the main switch status report to the Master.

CT2:

Control type 2 is handled by means of two additional telegrams, described in *UIC Leaflet 556, Appendix A*: respectively telegram 4.9E and 4.9A.

Procedure:

- Telegram 4.9E is a command to a Slave to close or to open the main switch.

- Telegram 4.9A is the answer to telegram 4.9E and it means that the command given by telegram 4.9E has been received by the application.

- The status of the main switches is reported by telegram 4.10.

5.2.2 - Diesel traction

5.2.2.1 - Start/stop diesel engine

Before diesel engine ignition, the Master can set the function "Preheat cooling water" using telegrams 4.39 and 4.43, described in *UIC Leaflet 556, Appendix A*.

If the Slave can't start the diesel engine(s) without preheating the cooling water, but the Master doesn't support this function, then the phase of preheating the cooling water will be started by the Slave upon receiving the command "Start engine".

Procedure:

- Telegram 4.39 is the command sent by the Master to all Slaves to start the preheating of cooling water.

- Telegram 4.43 is the report of each Slave. If a Slave does not support this function, if it does not need to set it or if the preheating is completed, it keeps the report to off state. In the other cases, it sets the report to on state, until the preheat operation is over.

If the "Start engine" command is issued, all available engines begin the ignition phase. If some vehicles are not ready (i.e. because they are in, or they are starting the "preheat state"), the command is not performed on those vehicles.

The shutdown command is sent by the Master to all Slaves.

Both commands have to last at least 1 second on the train bus.

In case of setting of both signals at the same time, the shutdown command is executed.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are: 4.11R, 4.12/1, 4.12/3 and 4.12/4.

Procedure:

- Telegram 4.11R is the command sent by the Master to all Slaves to start or stop diesel engines. The command is impulsive. If a vehicle is ready after the end of the start command, it doesn‘t set the ignition. To start it, a new command has to be issued.

- Telegram 4.12/1 is the status of the diesel engines on the vehicle.

- Telegram 4.12/3 identifies the diesel engine whose speed is reported by telegram 4.12/4. The code 0 is used if telegram 4.12/3 is meaningless for the vehicle, because number 0 is not allowed as the engine number.

- Telegram 4.12/4 reports the speed of the diesel engine specified by telegram 4.12/3. This information is available according to the list of properties of the vehicle.

- The Master must not ask for a specific diesel engine to report its speed: each vehicle with more than one engine cyclically sends the information of each engine, ensuring a minimum cycle of 1 second.

- The diesel engine of each vehicle is shut down not only by a command from the Master, but also in case of operation of the emergency shut down button or internal conditions of the vehicle.

Control type 1d+2:

If control type 2 is supported, telegrams 4.11E and 4.11A, as described in *UIC Leaflet 556, Appendix A*, are added to the previous ones.

5.2.2.2 - Special functions

They are:

- Train power supply,
- Transmission gear.

Train power supply function, if supported, is set usually when the diesel engine is on.

The Master sends the command to all Slaves. It has to last at least 1 second.

Each Slave reports its status.

Transmission gear has to be considered when the diesel engine is on.

The Master sends the command in a permanent way.

Each Slave reports its status.

Special function telegrams, as described in *UIC Leaflet 556, Appendix A*, are: 4.38/1, 4.38/2, 4.40 and 4.44.

Procedure:

- Telegram 4.38/1 is the command sent by the Master to all Slaves. The command is impulsive and has to last at least 1 second.
- Telegram 4.38/2 is the report of each Slave. If a Slave does not support this function, it keeps the report to the "off" state.
- Telegram 4.40 is the command sent by the Master to all Slaves for gear selection; allowed selections are "Fast gear" and "Slow gear". The command has to be kept until it is active. The default behaviour should be "Fast gear".
- Telegram 4.44 is the report of each Slave. If a Slave does not support this function or does not need to set it, it keeps the report to slow state.

5.2.3 - Parking mode

The parking mode of a train is the state where all the traction vehicles in the composition are unattended and in stationary status while auxiliary services and other devices (according to the operator's requirements) are running.

Such a status can be implemented in order to maintain energy supply to passenger and subsystem related services. Typical cases of parking mode application are change of the driver's cab, preconditioning of vehicles before passenger service, status retention during short stops.

Parking status can be entered **only** if the train is already powered. If this is not the case, then the driver must select and raise the pantograph(s) and close the main switch, as already described in this leaflet.

According to its target, this leaflet specifies the parking mode application and exit procedures in terms of functional model of train bus signals.

Details on which macrofunctions are involved and on the sequence the driver has to follow to set on/off the parking mode are up to operators and outside the scope of the present document.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.48 and 4.49.

Procedure:

- Parking status can be entered only if the train is already powered. If this is not the case, then the driver must select and raise the pantograph(s) and close the main switch, as already described in this leaflet;

- All Slaves are informed of the parking mode request from the Master by means of 4.48 “Parking ON Request”;

- Each Slave actually supporting the parking mode sets and reports 4.49 "Parking ON Progress";

- When a vehicle switches to the "Parking ON Progress" status, it has to retain the current status of its pantographs;

- If all Slaves report the "Parking ON Progress" status, the Master switches to this status and the driver is informed that the start of the procedure of parking setting is allowed. In such conditions of "Parking ON Progress" of all vehicles, all commands from the driver are sent as usual on the train bus, until the driver’s desk is disabled, but they do not have to be executed by the Slaves. Slaves have to keep the status of their devices as they were before the setting of the "Parking ON Progress";

- If there is an error during the procedure, or if at least one vehicle sets the "Parking OFF status" in telegram 4.49, the parking mode cannot be applied: the Master must reset the parking order by means of "No Parking Request" in telegram 4.48 and all Slaves must reset their status to "Parking OFF", regularly executing orders from the Master as usual;

- At the end of a parking setting procedure the driver’s desk is disabled while all vehicles are in "Parking ON Progress" status. Detecting the absence of a Master, all vehicles set their status to "Parking ON" in telegram 4.49, keeping the current status of auxiliary services and other devices until either a parking mode exit request is sent by the Master or a "Parking OFF" status is reported by at least one vehicle in telegram 4.49;

- When the driver enables the driver’s desk and a valid UIC leading vehicle is configured inside the composition, the leading vehicle is seen as the Master, and it can request all the Slaves to start the exit procedure from the parking mode by means of a "Parking OFF Request" in telegram 4.48. All the Slaves must set the "Parking OFF Progress" status and report it in telegram 4.49. When all the "Parking OFF Progress" feedbacks are received, and the Master is locally set to the "Parking OFF Progress" status the driver is informed that the start of the procedure of exit parking mode is allowed. In such conditions of "Parking OFF Progress", all commands from the driver are sent as usual on the train bus, but they do not have to be executed until the "Exit Parking Mode" command is received on telegram 4.48 or a "Parking OFF" status is reported by at least one vehicle on telegram 4.49;

- If there is an error during the procedure, or if at least one vehicle sets the "Parking OFF" status in telegram 4.49, the parking mode is immediately released: the Master must reset the parking order by means of telegram 4.48 "No Parking Request" and all the Slaves must reset their status to "Parking OFF", regularly executing orders from the Master as usual;

- At the end of a successful parking mode exit procedure, the Master release the parking mode by means of "Exit Parking Mode" command on telegram 4.48. All the Slaves enter the "Parking OFF" status, report it on telegram 4.49 and regularly execute orders from the Master.

When all the Slaves report the "Parking OFF" status in telegram 4.49, the Master must set telegram 4.48 to the default value "No Parking Request". The same kind of Control type that was set before entering the Parking mode applies.

5.3 - Parking brake management

The parking brake management macrofunction refers to the applications allowing the vehicle to maintain a static position. This macrofunction is not strictly related to the remote control of traction units and shall be implemented as described in the next section until the series of *UIC Leaflets 54X* has been finalized. Once these leaflets have been finalized they will apply.

Parking brake

The parking brake can be a handbrake, a spring brake, a permanent magnetic brake, or any other arrangement able to maintain the vehicle in a static position.

The command to apply or release the parking brake is given by the driver and/or by means of an automatic device.

If the "application of parking brake is permitted" command is issued, all parking brakes in the composition are set, if the operating conditions of the vehicle allow the application itself.

If the "release parking brake" command is issued, all parking brakes in the composition are released.

The status of the parking brakes is reported to the leading vehicle.

If the parking brake is applied, traction is blocked in all traction units.

If the hauled vehicles do not receive valid information from the leading vehicle, then the status of the parking brake must not change.

In order to allow compatibility with existing implementations, a CT2 procedure concerning the parking brake activation is also available.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.50 and 5.6.

Procedure:

- Telegram 4.50 carries the command that permits to apply or release the parking brake on all equipped vehicles in the train.

- The command issued by telegram 4.50 is impulsive, and shall have a minimum duration of 1 second.

- Telegram 5.6 reports the status of the parking brake.

CT2:

Control 2 type is handled by means of two additional telegrams, described in *UIC Leaflet 556, Appendix A*: respectively telegram 4.13E and 4.13A.

Procedure:

- With telegram 4.13E the Master issues the command to apply or release the parking brake to the selected Slave.

- Telegram 4.13A is the acknowledgement to telegram 4.13E and means that the action given with telegram 4.13E was started. After the execution of the command, the parking brake is physically applied.

- The state of the parking brake is reported by telegram 5.6.

- The driver can also give the command to release the parking brake by means of telegram 4.50. In this case the parking brake is released on all the vehicles and the current state of each brake is updated in telegram 5.6.

5.4 - Air management

The air management macrofunction deals with functionalities involved in the air control. The main items are the compressors and fans supervision.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.14/1 and 4.14/2.

Procedure:

- Telegram 4.14/1 is used to set the speed of the fans and to control the operation of compressors.

- In order to set the speed of the fans the telegram is used in the following way. With the "ON (maximum)!" code the fans on all traction units are commanded to run at the maximum speed (forced cooling). With the "OFF (minimum)!" code the fans on all traction units are commanded to run at the minimum speed according to the local operating conditions. When the "Auto!" code is issued, each vehicle is commanded to select the proper fan speed according to its operating conditions. If the Master has no possibility to select between the three position described, the value "Auto!" must be chosen as default in all vehicles. When receiving the "no reaction" code, each vehicle shall retain the previous command.

- In order to control the operation of compressors, the telegram is used in the following way. With the "ON!" code the compressors of all traction units in the train are commanded to operate. With the "OFF!" code the operation of the compressors of all traction units is stopped. When the "Auto!" code is issued, each vehicle autonomously selects the proper operation mode of the compressors according to its operating conditions. If the Master has no possibility to select between the three position described, the value "Auto!" must be chosen as default in all vehicles. When receiving the "no reaction" code, each vehicle shall retain the previous command.
- Telegram 4.14/2 is the report on the execution of the command issued with telegram 4.14/1. If, for any reason, a Slave cannot execute the command, then it reports the "no reaction" code.

5.5 - Internal energy management

The internal energy macrofunction is related to functionalities allowing train heating and internal services to be powered.

Train heating line

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.15R, 4.15/2, 4.16 and 4.19.

Procedure:

- Telegram 4.19 reports the status of the earthing switch of the vehicle. If the earthing switch is closed in at least one vehicle, the closing of the train heating contactor is prevented in all cars and the master must not send the close command.
- Telegrams 4.15R and 4.15/2 control the train heating line switch on and off. The use of telegram 4.15R is mandatory for all kind of control types, while the use of telegram 4.15/2, obviously in conjunction with 4.15R, is mandatory only for control types 2 and 4. If the Master is using only telegram 4.15R, it can send either impulsive or permanent commands; if it is using also telegram 4.15/2, it must send a permanent command on telegram 4.15R and an impulsive command on telegram 4.15/2. Slaves that support only CT1 must accept either the impulsive or the permanent command on telegram 4.15R; Slaves that support CT2 or CT4 must accept only the impulsive command on telegram 4.15/2, and can use (if needed for whatever reason) the permanent command on telegram 4.15R only to gain information on what kind of command was issued last. When a vehicle receives the switch on command, it is allowed to execute it after a time delay T=2*n s., where *n* is the UIC address of the gateway. If, at the end of the time delay, the train heating line is already energised, then the order is ignored. During the time delay, the presence of energy supply at pantographs is verified: if voltage is not available or disappears, the order is retained and timing is reset and restarted when voltage becomes available. If, at the end of the time delay, the train line is already on, the order is ignored.
- Telegram 4.16 reports the presence of voltage on the train heating line.

CT2:

In CT2, a control is available for the selective closing of the train heating line contactor of a specified vehicle, provided the line is not earthed and it is not already energised.

In any case, an opening command always has absolute priority over any closing one.

The train heating line contactor is opened on all power cars when the driver gives the command to switch off the voltage on the train heating line or vehicle conditions require such an action.

Control type 2 is handled by means of two additional telegrams, described in *UIC Leaflet 556, Appendix A*: respectively telegram 4.15E and 4.15A.

Procedure:

- Telegram 4.15E is used to close the train heating line contactor on a specific vehicle.

- Telegram 4.15A is the answer to telegram 4.15E and means that the action requested with telegram 4.15E has started.

5.6 - Traction and dynamic brake management

The traction and dynamic brake macrofunction concerns all functionalities directly involved in the travel control command.

Due to their different nature in traction control strategies, part of this macrofunction implementation is differently specified for electric and diesel locomotives.

5.6.1 - Direction of travel

The driver gives the command for the direction of travel (forwards/backwards). The command applies to all traction units in the train.

The status of the direction of travel is reported to the Master.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.21 and 4.42.

Procedure:

- Telegram 4.21 transmits to all vehicles which target direction of travel has been chosen. Reference direction is the one of vehicle 01 according to UIC inauguration, i.e. the direction of the Master.

- Telegram 4.42 reports back the selected direction of travel.

5.6.2 - Traction and dynamic brake

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.22, 4.23/1, 4.24, 4.30, 4.33/1, 4.33/2, 4.45/1 and 4.45/2.

The tractive effort of all traction units in the train is uniformly distributed according to their capabilities.

The traction target value is imposed by the driver (by means of control type 1 or 2) or by the speed controller (control type 3). It is coded according to the following rules:

- tractive effort is a positive value;

- dynamic brake is a negative value.

It should be noted that traction can be actuated only if all the necessary conditions (operators and manufacturer dependent) are fulfilled: this vehicle state is reported by telegram 4.22.

If traction is possible, the traction target value is simultaneously transferred to each traction unit by means of telegram 4.23/1.

The traction target value is expressed as a percentage of each vehicle's maximum possible tractive effort. Each vehicle converts the percentage value to the corresponding physical value.

If different types of diesel/electric locomotives are coupled, a single target value for the whole train does not guarantee the uniform distribution of the tractive effort among locomotives.

The leading locomotive is limited to the specific maximal pulling traction effort in the specific network. A locomotive between the first and last part of the train is limited to the specific pushing traction force. The locomotive which is the last vehicle in the train is limited to the maximum pulling traction effort in case of dynamic braking and limited to the maximum traction pushing effort in case of pushing.

Regarding the brake operation, the behaviour of a diesel engine is different from that of an electric motor, anyway the negative value has to be managed by each powered vehicle.

For all kind of powered vehicles, the actual traction value of each vehicle is reported by telegram 4.24.

If for whichever reason, the reference traction value becomes invalid, the last valid value is applied for 1 second (timeout) and after that, if it is not updated, the tractive effort is linearly decreased to 0 in 5 seconds.

Emergency release of tractive effort and main switch is requested by the Master by means of telegram 4.33/1. The feedback of this command is reported by Slaves on telegram 4.33/2.

If, for any reason, the Master must command the use of sand, this is achieved by means of telegram 4.30, that shall be interpreted by all the Slaves that support this function.

If a problem is encountered each Slave can alert the Master by means of telegram 4.2 (described in *UIC Leaflet 556, Appendix A*) in order to propose an inhibition of the traction. The implementation of this command inside the locomotive is not specified by this leaflet and is left to the application developer.

Procedure:

- Telegram 4.22 reports to the Master the readiness for traction or braking of the Slaves.

- Telegram 4.23/1 is the traction or brake target value imposed by the Master. The target value is expressed as a percentage, that means on each individual vehicle the percentage of the individual maximum traction or dynamic braking force as a target value in kN.

- The actuated traction or brake effort is reported by each Slave with telegram 4.24.

- For optimal working of the speed controller, the presently allowed maximum tractive and brake effort values are reported by each Slave respectively by telegram 4.45/1 and 4.45/2.

- Telegram 4.30 holds the command of the Master for the use of sand. This command shall be interpreted by all the Slaves that support this function.

- Telegram 4.33/1 holds the driver's command for the emergency release of traction effort and main switch. If such a command is detected, electric hauled vehicles must open the main switch and lower the pantograph(s), while diesel hauled vehicles must shut down the engine(s) and disengage the transmission.

- Telegram 4.33/2 holds the feedback from the Slaves to the driver's command for the emergency release of tractive effort and main switch.

Limitation of the current drawn from the line by electric trains

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.36/1 and 4.36/2.

The upper limit of the current drawn from the line by the train has primary importance for a proper traction value generation.

Each electrically powered vehicle controls the drawn current by itself during the conversion of the target tractive effort (expressed in percentage) to an absolute value. In order to allow this, the upper limit value of the current the train is permitted to draw from the line is sent by the Master to each Slave by means of telegram 4.36/1.

In order to guarantee the alignment of all vehicles behaviour and, consequently, the effective actuation of the train current restrictions, the following rules apply:

Each electric traction unit is informed about the maximum power on board each other unit (information is available from the NADI); let us call Pi the power of vehicle i.

Let us call I_L the upper limit for the current drawn by the train and reported by telegram 4.36/1.

The maximum current that traction unit i is allowed to draw from the line has to be calculated by vehicle i itself and has to be set at the following value:

$$I_i = (Pi/Ptot) \times (I_L - I_R) + I_R$$

where I_R is the total current needed by the vehicles hauled by traction unit i and Ptot is the sum of the maximum power values of each traction unit in the composition.

With telegram 4.36/2 the current locally drawn from the line is reported to the Master by each Slave.

It should be mentioned that telegram 4.36/1 is the current limit for the overall train, while telegram 4.36/2 is the current each Slave is presently drawing from the line.

5.6.3 - Traction primary resources availability on the train

In order to optimize the traction, information about availability of primary resources of the composition are needed. A CT2 strategy allows this to be done, using telegrams 4.20E and 4.20A as described in *UIC Leaflet 556, Appendix A*.

After each UIC inauguration, and at each change of the involved information, each Slave informs the Master about availability (number of working devices) of traction converters, driven axles, auxiliary converters and battery chargers.

This is achieved by means of telegram 4.20E.

The Master acknowledges receipt of the information by means of telegram 4.20A.

5.6.4 - Eddy current braking

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.46/1, 4.46/2, 4.46/3, 4.46/4 and 5.5/2.

Telegram 4.46/1 reports to the Master the readiness for eddy current braking of the Slaves.

Telegram 4.46/2 is the eddy current braking target value (negative values). The target value is expressed as a percentage of each vehicle's maximum possible electric braking effort. On each vehicle the relative value (%) is converted corresponding to the characteristic of the respective eddy current braking unit into a target value in kN.

The actual eddy current braking value of each vehicle is reported by telegram 4.46/3 (negative values).

The status of the eddy current brakes of each vehicle is reported by telegram 5.5/2.

For optimal working of the v-controller, the actual maximum instantaneously possible eddy current braking effort value of each vehicle is reported by telegram 4.46/4 (this value is always negative or zero).

5.6.5 - Speed control

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.23/1, 4.23/2, 4.25, 4.26, 4.27 and 4.28.

There is only one speed controller in operation in the train and it imposes the necessary traction effort on all traction units.

In the case of **control type 1** this is the one on the Master and it acts by means of telegram 4.23/1.

In the case of **control type 3** the speed does not necessarily have to be controlled by the Master.

The issuing of the authorisation is done automatically by the Master by mean of telegram 4.26. The authorisation is given to the first traction unit in the train that is able to do this.

More precisely, the speed control is assigned after the UIC inauguration has been concluded and it is given on the basis of the UIC address of the gateway.

The vehicle catching the speed control reports this by mean of telegram 4.27.

Information about availability of speed control capability for each vehicle, instead, is reported by telegram 4.25.

The desired target value for the speed is defined by the Master (by the driver, the train protection equipment, etc) and communicated via telegram 4.28.

The vehicle hosting the authorised speed controller reports the traction target value to the Master by means of telegram 4.23/2.

As traction reference, telegram 4.23/2, like telegram 4.23/1, is expressed in % (of the maximum effort available for each vehicle).

The Master validates the traction target value received by inserting it in telegram 4.23/1 and this value becomes valid for all the traction units in the train.

Consequently, the desired target value for the traction is, in any case, imposed by the Master and communicated via telegram 4.23/1, independently from its effective source.

In such a way the v-controller on a Slave calculates the effective reference value for traction on the basis of the Master's directives.

5.6.6 - Direct pneumatic brake

This function is not strictly related to the remote control of traction unit and shall be implemented as described in the next section until the series of *UIC Leaflets 54X* has been finalized. Once these leaflets have been finalized they will apply.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 4.30, 5.1, 5.2/1 and 5.4.

The driver gives the command to apply or release the direct pneumatic brake by means of telegram 5.1. The direct pneumatic brake is then applied or released on the Master and, if V < 10 km/h, also on the Slaves, this limitation is in order to prevent high longitudinal forces.

The driver is advised that the brakes are applied by means of telegram 5.4.

Optionally a brake force target value can also be specified, by means of telegram 5.2/1.

If, for any reason, the Master must command the use of sand, this is achieved by means of telegram 4.30, that shall be interpreted by all the Slaves.

CT2:

Control type 2 is handled by means of two additional telegrams, described in *UIC Leaflet 556, Appendix A*: respectively telegram 4.2E and 4.2A.

In control type 2 it is possible, for the Master, to exclude certain traction units completely or partly from application/release of the direct brake by means of telegram 4.2E.

The reception of telegram 4.2E is then acknowledged by means of telegram 4.2A.

5.6.7 - Other brakes

This function is not strictly related to the remote control of traction units and shall be implemented as described in the next section until the series of *UIC Leaflets 54X* has been finalized. Once these leaflets have been finalized they will apply.

Involved telegrams, as described in *UIC Leaflet 556, Appendix A*, are 5.14 and 5.5/1.

The Master gives the command to apply or release the magnetic brake by means of telegram 5.14. The magnetic brake is then applied or released on all units in the train that support this function.

The Master is advised of the status of the magnetic brakes by means of telegram 5.5/1.

5.6.8 - Emergency brake

This function is not strictly related to the remote control of traction units and shall be implemented as described in the next section until the series of *UIC Leaflets 54X* has been finalized. Once these leaflets have been finalized, they will apply.

Emergency brake management is handled using telegrams 5.8, 5.9 and 5.10, described in *UIC Leaflet 556, Appendix A*.

The Master can check if emergency brake override is operable by means of telegram 5.10.

The Master can issue a command for emergency brake override by means of telegram 5.9.

The status of the emergency brake is reported by telegram 5.8 and can be checked by the Master.

5.7 - Equipment protection

Basis: each traction unit in the train protects itself in all operating conditions.

The Equipment Protection macrofunction is the means to deal with different diagnostic and functional requirements in order to define a common information system related to the actions requested by the driver in particular situations.

As safety criteria require, faults or critical states have to be notified to the driver, who will act as necessary on the involved devices.

The equipment protection is a field involving an extremely complex set of signals, depending on different operator's and manufacturer's requirements. The international nature of this document prevents it referring to any particular solution, so only an abstract strategy can be the reference one.

Control type 4 has been defined to allow a proper and unambiguous management in such particular situations.

Primary features of the CT 4 telegrams are listed in the following table:

Information type	Possible implementation	Text features
Language	English Italian German French	No text
Message type	Alarm Fault Status 1-Key Authorization 2-Keys Authorization ... 8-Keys Authorization	Alarm message Fault message Status message 1-Key Authorization Request 2-Keys Authorization Request ... 8-Keys Authorization Request
Pressed Keys	Key 1 Pressed Key 2 Pressed ... Key 8 Pressed	No text
Tests	Automatic Brake test ...	No text
Status Request	General Status Request Dissectable Elements Status Request ...	No text
Status Information	Devices Status Dissectable Elements Status ...	ASCII text about Devices Status ASCII text about Dissectable Elements Status ...
Code	Priority Codes as specified in *UIC Leaflets 556 and 557*	A, A1, B, B1, C

Referring to the above table it has to be clarified that:

- *Language* refers to a code emitted by the Master to select the text language.

- *Message Type* is the type of information the telegram is transporting.
  It can be simply a Diagnostic Event Report, or a Status Request or Report, or an Authorization Request or Confirmation.

- *Number of pressed Key* reports authorizations from the Master, granted by the driver pressing a number of keys from 1 to 8.

- *Tests* is a Coded Message from the Master to a Slave to test devices.

- *Status Request* is produced by the Master to request device status information not foreseen in the R2 dataset.

- *Status Information* is provided by Slaves to answer Status Requests from the Master.

- *Priority Code* is the same foreseen by standard UIC normative.

5.7.1 - E Telegrams basic structure for Remote Control Diagnostics

Structure of the E Telegrams is described in *UIC Leaflet 556*.

5.7.2 - Remote Diagnostics Telegrams

For the remote control, in case of fault/alarm messages the telegrams 8.4, 8.3, 8.3A, 8.8, 8.8A, 8.9, 8.9A, 8.10 and 8.10A, described in *UIC Leaflet 556, Appendix A* shall be used. The use within the bounds of remote control is described in Appendices A.1 - page 34 and A.2 - page 35.

In the following points the usage of some of the fields in these telegrams is explained:

5.7.2.1 - Railway/UIC

It specifies the code of the operator managing the vehicle emitting the telegram.

For international applications, obviously involving different administrators, code to be specified is the UIC one, 0.

5.7.2.2 - Message Type

Different kinds of messages are foreseen for Remote Control application:

Alarms

Any Slave is allowed to send alarms to the driver in real time via the Diagnostic Monitor in case of relevant diagnostic events.

Faults

Any Slave is allowed to send fault data to the driver in real time via the Diagnostic Monitor in case of relevant diagnostic events.

Authorization Request

Any Slave is allowed to ask the driver for an authorization to manage a particular situation.

Such a process can be achieved in real time via the Diagnostic Monitor in case of relevant diagnostic events.

In general terms, the decision to validate one or more different proposed actions (remedies) has to be left to the driver.

To do this, in the Corrective Action Text the different possible actions are defined and each one is associated to a key on the Diagnostic Monitor. Telegrams 8.8 and 8.8A are used for this purpose.

It is worth noting that such a definition is unambiguously related to the Event, guaranteeing a clear and objective correlation to it and preventing potentially dangerous solutions. The combination of event-code and event-time inside the telegrams ensures this.

Different keys can be dedicated to support such a type of information. A number of them from 1 to 8 can be set.

Generally they are already available on the existing monitors, according to the different technologies applied by operators and manufacturers, for the local Diagnostic functions administration.

The driver acknowledges one solution[1] by pressing the corresponding key. The choice is reported in the telegram 8.10 to the requesting vehicle. In the acknowledgement telegram it is possible to advise whether another action/remedy is needed.

Status Request

With telegram 8.9 the Master is allowed to ask the Slaves for the status of their devices.

Different elements can be monitored. Please refer to the description of telegram 8.9 in *UIC Leaflet 556, Appendix A*.

Test Request

The driver on the Master is allowed to test different devices on-board remote Slave traction units.

Different elements can be tested. The Slave traction unit advises by telegram 8.8A which tests are allowed.

Please note that it is always the Master that starts the communication.

5.7.2.3 - Event Code

E telegrams are unambiguously associated with their sources and their destinations, so misunderstandings between vehicles are prevented.

However, it is possible for a single traction unit to send more than one telegram, and even to manage different events in a same telegram.

1. Definition is flexible and dependent on the event. It has to be defined by the System Engineer depending on the type of event and its remedies.

As it is mandatory that the related acknowledgement has to be unambiguously associated to each event, a reference is necessary.

It can be simply the fault-code plus the event-time. This reference is used in the whole telegram to display the possible remedies, for selections and authorisations of the Slaves. Please refer to telegrams 8.8, 8.8A, 8.10 and 8.10A in *UIC Leaflet 556, Appendix A*.

5.7.2.4 - Fault Code

To prevent misunderstanding, this code is significant only when all diagnostics units participating in the train share the same database.

As such a case is quite unusual, the fault-code is normally used only as a reference for an unambiguous association of events.

5.7.2.5 - Octet 25: Fault Priority

A bit to 1 means the related priority is the true one.

5.7.2.6 - Text Length

The length of text (= number of octets, two octets for each UNICODE-letter) describing the Event is the content of the field.

Please note that the Event Description can not be mixed up with the Corrective Action it requests, that is separately specified.

5.7.2.7 - Corrective Action Length

The length of text (= number of octets) describing the suggested Corrective Action to manage the Event is the content of the field. Each corrective action is associated to one key.

5.7.3 - Implementation Example

An example can be useful to investigate how the defined telegrams can be applied. A dummy situation is proposed here just to simulate an implementation.

Let us suppose a first fault (priority A1) happened on board a running Slave and an authorisation is necessary to restore normal operation mode in the convoy. Regarding corrective actions, let us suppose one between two possible ones (Exclude fault device = press key n.2/Maintain fault device in operation = press key n.4) has to be confirmed by the driver.

Let us call "source" the fault device.

1. In such a situation, the Slave hosting the fault signals the event in telegram 8.4R. Automatically or after an action of the driver the Master requests A1-faults from the Slave.

2. Within the telegram 8.3A the Slave informs that an authorisation is needed.

3. The description of the possible remedies is transmitted with the telegrams 8.8 and 8.8A.

4. The decision of the driver will be sent with telegram 8.10 to the Slave, and processing of the authorisation will be acknowledged with telegram 8.10A.

Please refer to Appendix A.2 - page 35 and *UIC Leaflet 556, Appendix A*.

When telegram 8.10A is received from the Master, on its diagnostic monitor the message:

"Fault source"

is shown and

F2 = exclude source
F4 = maintain source

appear. The two keys (F2, F4) are enabled as inputs and driver pressure on key number 2 or key number 4 is expected.

When the slave traction unit receives such an acknowledgement, the requested order is executed and the E telegram protocol is closed.

5.7.4 - Implementation Notes

It is evident that text instead of code is a more flexible solution, as no limits preclude designers and operators' management of special diagnostic events.

Obviously, from a Slave point of view, to foresee an admitted order from the driver and to wait for it is the usual choice, as, more generally, to wait for the acknowledgement telegram. In any case, the vehicle has to protect itself, regardless of the reception of the acknowledgement message from the Master.

A missing acknowledgement has to be interpreted as a missing confirmation and not as a validation. Consequent actions shall be arranged inside the application.

5.8 - Data validation management

Data validation is generally administered by implementing default values after a timeout has elapsed without a new validation.

However, if involved data invalidation occurs during Remote Control activity, an unambiguous behaviour is requested. So:

- the following actions have to take place on the Slaves when a traction target value invalidation occurs:

  a. The traction target value is controlled as stated in the traction/brake macrofunction specification inside this document. For electric traction units, the main contactor is opened and the pantograph lowered after a timeout of 6 seconds has elapsed without a validation. For diesel traction units, the engine speed has to be decreased linearly to idling and the train line, if activated, has to be switched off.
  b. If the direct brake is applied, it releases automatically after a time-out of 6 seconds has elapsed without a validation.

- All other signals listed in the present document must be set to the default value after a timeout of 500 ms. has elapsed without a new validation. If a default value is not specified for a signal, then a safe default value must be chosen by the developer of the application.

5.9 - Check variables management

Check variables validate the contents of train bus signals at **application** level, consequently a check variable has to be considered as reliable information only if the overall communication mechanism is working properly.

The following rules apply:

- A check variable set to Valid means that the application receiving it has to consider as reliable the contents of the signal set linked to such a check variable, allowing the normal proceeding of the remote control operation;

- A check variable set to Invalid means that the application receiving it has to consider as not reliable the contents of the signal set linked to such a check variable, generating and managing an exception at application level of the remote control operation in progress. Specific management of such a situation is application related and outside the scope of this document;

- Forcing of check variables is related to the simulation mode of the application in order to allow the test of the application itself. A check variable can be set to Forced only by an application in simulation mode. A check variable set to Forced means that the application receiving it has to consider as reliable the contents of the signal set linked to such a check variable, but management of such a signal set has to follow the rules foreseen for the application in simulation mode. Rules for the simulation mode are application specific and outside the scope of this document. If a simulation mode is not available, a forced check variable has to be considered as an invalid check variable.

6 - Type test procedure

Remote Control equipment has to be type approved by the office authorised by UIC before use in international services. If possible, the type approval should be done in conjunction with the type approval of the train bus node as specified in *UIC Leaflet 556*. The specification for suitable test equipment is under development.

Appendix A - Principle of use for diagnostic data in trains

A.1 - Information for the driver - Change of status for an A1 fault

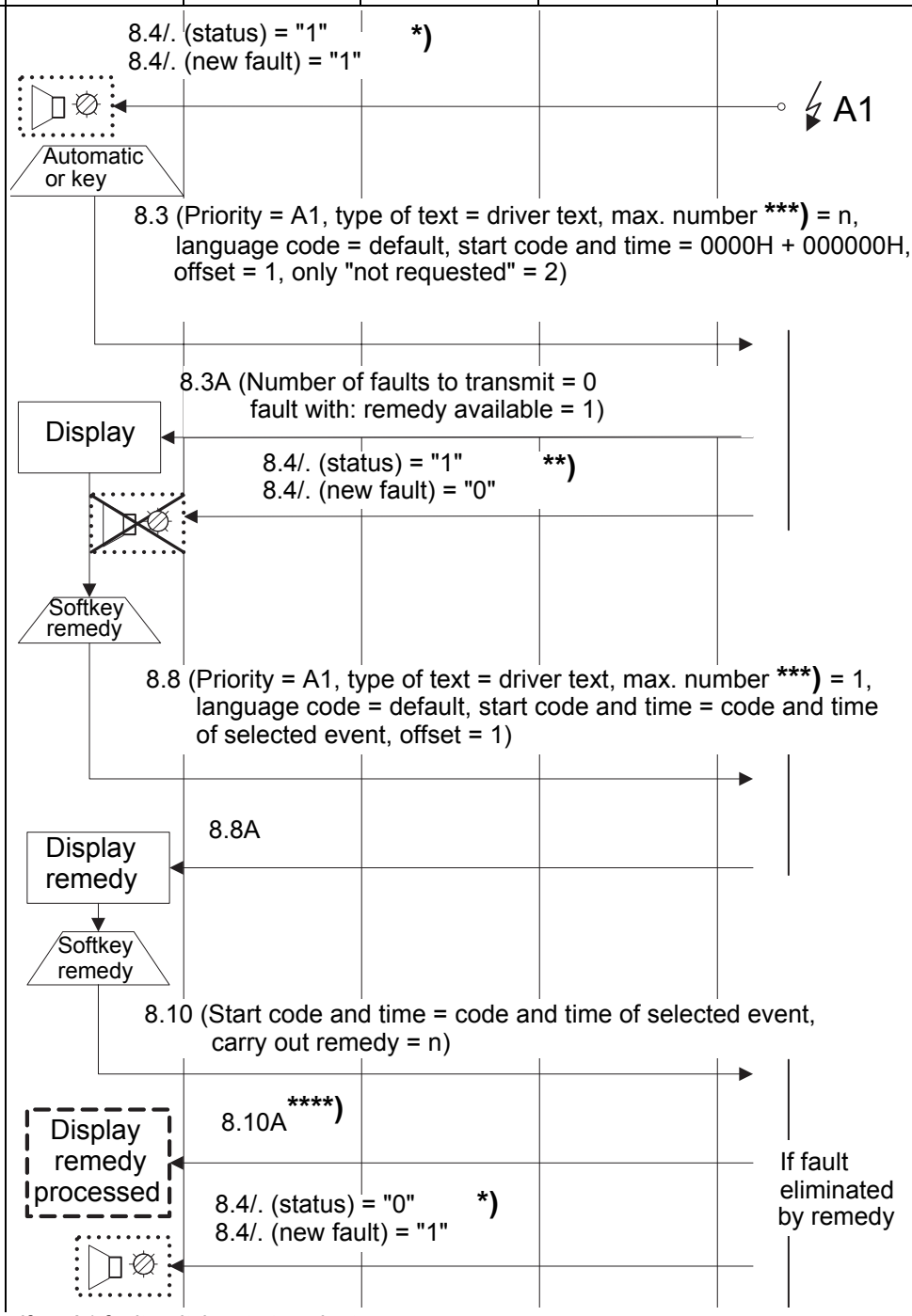
Point	Type of use	Type of information/Information path/Information proccessing				
		Leading vehicle (master)	Any trailing power unit (slave)	All coaches	Any coach	Any trailing power unit (slave)
5.7	Information for the driver (change of status for an A1 fault)	8.4/. (status) = "1" *) 8.4/. (new fault) = "1" Automatic or key 8.3 (Priority = A1, type of text = driver text, max. number ***) = n, language code = default, start code and time = 0000H + 000000H, offset = 1, only "not requested" = 2) 8.3A (Number of faults to transmit > 0 fault with: remedy available = 0) 8.3 (Priority = A1, type of text = driver text, max. number ***) = n, language code = default, start code and time = code and time of last transmitted fault, offset = 1, only "not requested" = 2) 8.3A (Number of faults to transmit = 0 fault with: remedy exist = 0) Display available 8.4/. (status) = "1" **) 8.4/. (new fault) = "0"			A1	
	Text in another language	language key 8.3 (Priority = A1, Type of text = driver text, max. number ***) = 1, language code = **choice**, start code and time = code and time of fault, offset = 0, only "not requested" = 0) Display available 8.3A				

Remarks: Same principle of use if an A1 fault switches to transient

in this case:		and for:	
*)	8.4/.(status)=0 8.4/.(new fault)=1	**)	8.4/.(status)=0 8.4/.(new fault)=0

***) max. number means:
maximum number of diagnostic events that can be transmitted in the same answer telegram (choice n corresponding to the display or the performance capability of the receiver)

A.2 - Information for the driver - Use of remedy

Point	Type of use	Type of information/Information path/Information proccessing				
		leading vehicle (master)	Any trailing power unit (slave)	All coaches	Any coach	Any trailing power unit (slave)
5.7	Information for the driver (use of remedy)					
	Choice of text in another language same as Appendix A.1					

Remarks: Same principle of use if an A1 fault switches to transient

in this case:		and for:	
*)	8.4/.(status)=0 8.4/.(new fault)=1	**)	8.4/.(status)=0 8.4/.(new fault)=0

***) max. number means:
maximum number of diagnostic events that can be transmitted in the same answer telegram (choice n corresponding to the display or the performance capability of the receiver)

****) if "another remedy exist" = 1: other remedies or tests are available for the event or test which can be addressed by using telegrams 8.8/8.8A or 8.10/8.10A

List of abbreviations

CT1	Control type 1
CT1d	Control type 1d
CT1e	Control type 1e
CT2	Control type 2
CT3	Control type 3
CT4	Control type 4
EMU	Electrical Multiple Unit
DMU	Diesel Multiple Unit

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