(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 552 998 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.07.2005 Bulletin 2005/28

(51) Int Cl.[7]: **B61L 19/00**, B61L 1/20, B61L 5/18

(21) Application number: **04425235.1**

(22) Date of filing: **31.03.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **09.01.2004 IT FI20040007**

(71) Applicant: **Elettromeccanica CM S.r.l.**
51034 Serravalle Pistoiese (PT) (IT)

(72) Inventors:
- **Cappellini, Mario**
  51100 Pistoia (IT)
- **Cappellini, Roberto**
  51016 Montecatini Terme (Pistoia) (IT)

(74) Representative: **Martini, Lazzaro**
Studio Brevetti Ing. Dr. Lazzaro Martini s.r.l.
Via dei Rustici 5
50122 Firenze (IT)

(54) System for the diagnosis and operation of apparatuses for generating and distributing power supplies, in particular for railway's safety and signalling plants

(57) The present invention refers to a system for the diagnosis and operation of apparatuses intended for generating and distributing power supplies, in particular for railway's safety and signalling plants, characterized in that it comprises a plurality of peripheral units (UP) provided with means for connection to a power supply device (AA) and means for detecting the efficiency of the controlled device and able to feed a signal relating to any detected defect.

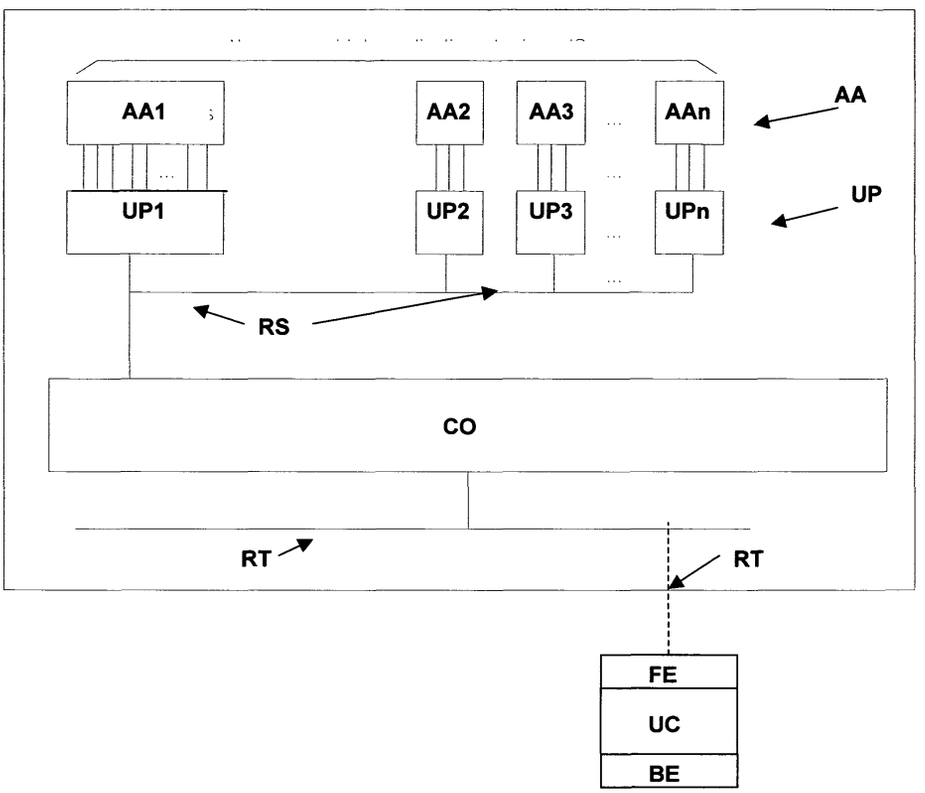

Fig. 2

EP 1 552 998 A2

Description

[0001] The present invention refers to a system for the diagnosis and operation of apparatuses intended for generating and distributing power supplies, in particular for railway's safety and signalling plants.

[0002] At present, the railway's safety and signalling devices (also called IS plants in the present description) are made up of all those apparatuses that form a signalling system for trains' fail-safe circulation, that is, such a system that in case of any failure of one or more elements making up a plant's single device or assembly of devices, the safety conditions will not fail: for example, a failure by which a device is not able to provide an all-clear way signal to a train, implies the circulation to be stopped.

[0003] The safety and signalling apparatuses include both station and network's plants.

[0004] In the stations, the said apparatuses provide for the circulation, manoeuvring, dwells and composition of trains, etc. The devices are installed, supported by suitable frames, within the relays room and allow carrying out manoeuvres and controls on the so-called "yard's utilities" which consist of signal fittings, grade crossings, switch points, rail circuits, etc.

[0005] Along the railway line, the safety plants are installed within cabins and service sites (also called PDS in the present description).

[0006] The cabins or automatic block sites (also called PBA in the present description) are those buildings wherein there are installed, supported by suitable frames, the devices which allow performing the manoeuvres and controls on the signal fittings present along the line on rail circuits for the automatic spacing of the trains (line's automatic block), etc.

[0007] Also present along the railway line are special stations, so-called service sites (PDS) which are not used by the passengers but are necessary for carrying out particular manoeuvres on the trains. Included in the service sites are: communication sites (also called PC) which, in case of a rail's failure, allow switching from a rail to another; junction or crossroad sites (also called PJ) which are located near the junction between two lines to allow the passage of trains from a line to another.

[0008] The station's plants IS may be more or less complex depending on the dimensions of the station's yard and, therefore, on the utilities being present; they are more complex than the PDS and PBA plants.

[0009] Owing to the importance of the IS plants in the railway environment, their power supply must be provided with continuity, that is, by providing energy sources, as an alternative to the supply mains, allowing to keep the same plants live in case of a black-out.

[0010] This is obtained by equipping the stations and PDS with devices such as generator sets and, where necessary, continuous-power switchboards which provide a supply on hand consisting of storage batteries.

[0011] Present in the relays room there are distributing boards (supply or modular panels) which allow generating, on the basis of the voltage provided by the switchboard, the supply voltages typical of the IS devices (24 Vcc, 48 Vcc, 80 Vcc, 150 Vcc, etc.).

[0012] In the railway line's cabins, the power necessary for the IS devices is provided starting from the adjacent stations or PDS via transformation boxes (1KV station box for the supply of the automatic block) which feed a high-voltage (1000 V) distribution line.

[0013] Provided in each cabin is a transformation box (1kV box of the railway line) which, starting from the 100V-distribution line, generates the 150V ac voltage for powering the cabin.

[0014] The cabin's utilities are then powered with voltages generated in the supply panel, starting from the 150V ac of the 1kV-box.

[0015] The supply systems for the FS- safety and signalling apparatuses provide, generally, state and alarm indications through relay contacts which are able switch upon defect or failure situations.

[0016] The current railways specifications dictate that the supply devices shall gather a cumulative alarm signalling to be wired to the devices for the control of the station's traffic (which devices may consist of the manoeuvring bench located in the traffic manager's office) or to a centre for controlling the trains' circulation (for example, of DCO type).

[0017] Such a signalling is essentially limited to the provision of general information about defects or failures, without specifying the nature thereof.

The staff in charge of the maintenance of the supply devices IS must therefore go to the site to carry out the manoeuvres and/or replacements as necessary to restore the plant's. However, having received no indication relating to the type of failure, the IS personnel not always is provided with all the material required for repairing the failure. The intervention time may be significantly long (requiring even a few hours).

A typical example may be provided by a failed cable (for example, due to an insulation defect) of the 100V-supply line for the PBA). Such failure causes a tripping of the switch for the protection of the station's 1kV cabin that feeds the length of railway line in question. The times necessary in this case to detect the failed cable may be significantly long and requiring the intervention of at least three persons, one being in the station ahead of the line, one in the other end of the line and one that has to go along the line, cabin after cabin, to carry out the necessary sectionings on the switches of the 1kV-boxes in order to isolate the failed length.

[0018] Another important aspect relates to the maintenance of the supply plants.

Some devices, such as the generator sets, for example, require periodic service interventions for checking the proper start capacity of the motor, the state of the battery, the levels of fuel and oil, etc.

In the case, for example, that a problem occurs in the motor of the generator set, the existing cumulative

alarm-signallings do not allow obtaining preventive alarm information. Accordingly, the problem is either detected upon the service intervention or it occurs when the generator set should intervene because of the lack of power: in this case the provision of energy is not ensured.

[0019] The object of the present invention is to overcome the above said drawbacks.

[0020] This result has been achieved, according to the invention, by adopting the idea of making a system having the characteristics disclosed in the claim 1. Further characteristics being set forth in the dependent claims.

[0021] Among the advantages of the present invention, one is that a series of modules is provided which allow, locally or from a central supervision site, carrying out in real time the diagnosis and operation of the supply devices which made up the supply plants in question; that it is possible to control, from a central supervision site, the information gathered by the peripheral sites located within the stations, the service premises and the line's cabins; that it is possible, by connecting to said modules, for example via a portable computer provided with a serial port, to require the stored data and the processed diagnostic information; that the system maintains its characteristics unaltered also after prolonged periods of non-use.

[0022] These and other advantages and characteristics of the invention will be best understood by anyone skilled in the art from a reading of the following description in conjunction with the attached drawings given as a practical exemplification of the invention, but not to be considered in a limitative sense, wherein:

- Fig. 1 is a block diagram relating to a possible exemplary embodiment of an interface for a peripheral unit according to the present invention; and
- Fig. 2 is a schematic diagram relating to a possible embodiment of connections according to the present invention.

[0023] In its most general construction, a system according to the invention may comprise a central control unit UC, a plurality of peripheral units PU provided with means for connection to one or more supply devices AA, means for detecting the efficiency of the controlled-supply devices, and means for identifying the occurrence of possible defects. Provision is made for a transmission means, that is, a communication network RT disposed and acting between the central unit and the peripheral units.

[0024] The transmission network RT can be constructed in different modes: by routing the transmission via a modem on a dedicated line (usually available along a railway line); by transmitting data through optical fibres; by using radio-transmission or other suitable transmission means.

[0025] The system according to the present invention will be described below in details in conjunction with the advantages that can be obtained therefrom in the railway environment.

[0026] The central unit UC of the present system can be subdivided into two levels: first or front-end level FE, and second or back-end level BE.

[0027] The first level FE carries out the function of interface and communication with the peripheral units UP. Based on the characteristics of the transmission means RT, the first level comprises one or more units of data transmission which interface, on one side, with the communication guidelines, and on the other with a processor that controls the communication with the peripheral units UP. Preferably, the exchange of data takes place by using communication protocols allowing a suitable protection of the information exchanged with the peripheral units UP.

[0028] The second or back-end lever BE provides for the processing of the collected information and for interfacing the operator. It consists of a processor or, in more complex cases, of a network of processors which houses the system's software. The software being used is based on a data-supervision, control and acquisition package (SCADA) adapted for the operation of the line protocol, that is, custom-tailored for the operation of the transmission protocol being used. The operating software supervises over the operation of the whole system and allows setting and modifying its configuration after any subsequent expansions thereof. This occurs by simply updating the data-base of the system. The said software allows programming the enquiry frequency, the type of messages to be delivered, and the transmission parameters. The operator-interface software allows processing the gathered information and displaying the same on the monitor. Such software makes use of particularly powerful graphic interface able to make the operator's activity extremely intuitive ("user friendly"). Each element of the monitored plant is representable by an icon to which various conditions can be associated relating to more or less complex logic boolean combinations which concern the actual states and values of the input quantities acquired by the system. Similarly, commands can be given by simply acting with the pointer onto identifying icons. Also possible is to control in a permanent memory (for example, a hard-disk) a file of the historical registred events, and to print the parameters from the peripheral units as well as the state variations of the controlled members and the alarm signallings, if any.

[0029] The supply devices AA to be' controlled relevant the peripheral units UP, may be more than one and located in different positions (for example in a relays room and central room in case of stations).

[0030] To this end, to avoid carrying out wirings from each of the supply devices AA to a data-concentrator for the diagnosis, the peripheral units are provided with interfaces having special characteristics.

The special characteristics of the interfaces are the fol-

lowing: possibility of joining together the functions of passive interface and diagnosis device, that is, providing the passive interface with an "intelligence" or capacity of its own; possibility of communicating and exchanging data between different interfaces via a field bus RS formed, for example, by a serial RS485, optical fibre or other standard field bus, so that the wirings for the collection of data be reduce to a few connections (two to four supply and field bus wires).

[0031] Shown in Fig. 1 is a block diagram with an exemplary embodiment of intelligent interface with bus RS485.

[0032] The intelligent interfaces make it possible to carry out the following functions:

- interfacing the diagnostic system with the supply devices, which can take place directly or via suitable voltage transducers (read-out transformers) or current transducers (read-out TA in alternate current or hall effect in direct current); these transducers being schematically represented by the block B in Fig. 1;
- conditioning the electric analog quantities (voltages and currents) to make them suited for reading by a microprocessor or microcontroller; the conditioning function being represented by the block C;
- reading and sampling the analog signals; such function being represented by the block D;
- analysing the collected analog and digital data, with the possibility of processing the diagnostic algorithms in order to evaluate the state of the controlled utility and to store the results; this function being represented by the block E;
- transmitting, on request and by means of remote controls, the acquired and processed data to the supply device AA; this function being represented by the block G which, in a possible embodiment, may consist of a communication gate on field bus RS485, with relevant outputs G1 and G2.

[0033] Also shown in Fig. 1 is a block F representing the supply of the peripheral unit UP via the two wires F1 and F2.

[0034] To carry out the last two functions above mentioned, it is necessary to provide the interface with a microprocessor or microcontroller capable of acquiring information, processing the data by implementing the diagnostic algorithm, storing the acquired information into memory, generating the alarm signals as necessary, transmitting data and alarms on request.

[0035] In order to implement particularly complex algorithms, it is necessary to interrelate the information acquired by different interfaces located in different points of the plant.

For example, it may be necessary to activate certain controls only when particular conditions of the plant do exist. To this end, the interfaces must be able to communicate between them to share acquired data and/or processed information. This can take place through a serial RS485 (or by a standard or other suitable type of field bus).

[0036] It is thus possible, by using the intelligent interfaces, to construct a distributed intelligence network for the control and telecontrol of the devices which make up the supply plants IS.

[0037] Possibly present within such architecture will be a interface of master type more powerful (with higher processing capacity) than those of slave type and which collects, via the field bus, the information processed by different interfaces and implements more complex diagnostic algorithms.

[0038] It thus follows from the above that the wiring to be made when installing the intelligent interfaces consists of:

- wiring from the interface to the supply device, to be varied depending on the device to be controlled and thus on the number of analog and digital signals available;
- two (or four) wires for the serial bus which allows the interfaces to communicate to each other;
- two wires for the supply of the interfaces.

With reference to the example of Fig. 1, the wiring to the supply devices is indicated by the blocks A1, A2, ..., An representing connections (that is, transducers or sensors) each of which being linked by two terminals to a relevant supply device AAi.

It should be pointed out that passing from one interface or peripheral unit UP to the other, there are provided only four(or six) wires, two of which for the supply and two (four) for the communication of data, as shown in Fig. 2.

[0039] In Fig. 2 AA1, AA2, ..., AAn indicate the supply devices, UP1, UP2, ..., UPn indicate the corresponding interfaces of the peripheral units, RS indicates a transmission network between the interfaces, CO indicates a data-concentrator, RT indicates the transmission means for connection to the central unit UC, and FE and BE indicate the two levels of the central unit UC.

[0040] Among the advantages deriving from applying a system of telediagnosis by remote control to the supply devices according to the invention, the following can be cited.

A first advantage consists in the possibility of providing the central unit UC, in real time, with data about the operating conditions of the supply devices installed in the peripheral units UP, along the controlled railway line under control, both in the stations, in the PDS and in the cabins as well.

[0041] Each of the peripheral units UP comprises one CPU which, on the basis of data collected by the device to which is connected (digital signals available from alarm contacts, and analog measures made through the insertion of suitable transducers), makes it possible: to store the changes in the operating state of the supply device by associating time information (date; hour,

minute); to process diagnostic information about the monitored device and to signal any alarm situation; to provide any indication of maintenance based on the detected state.

The information can be saved in a nonvolatile memory of flash type. At any moment, the operator can require locally, via a serial interface, the unloading of the CPU's internal memory into a portable PC.

[0042] The intelligent modules also allow to carry out telecontrols on the supply devices by acting on motorized switches and disconnectors which are present, for example, on sectioning and protection boards and on railway line and station's 1kV-boxes.

In case of serious anomalies in some parts of the supply system, it is possible to enable an automatic control of the plant's re-configuration through the CPU of the intelligent control module. The CPU, therefore, provides for analysing the failure situation and isolating the out-of-order devices by possibly restoring power availability. The automatic re-configuration can be enabled or disabled during the setup stage of the CPU through a command to be delivered on the programming serial interface. In case the telecontrol system is centralized, such function can be enabled or disabled also from the central supervision site. The operator in the central site can then carry out manually the telecontrols on the switches of the sectioning board.

[0043] The advantage obtainable in some cases can be outstanding, especially, when anomaly situations take place which require the direct intervention of the service personnel: in these cases, the telecontrol system allows temporarily overcoming the failure by powering the plant again. In the meantime, the maintenance personnel, on the basis of the indications provided by the telecontrol system, can arrange for the intervention by reaching the site with all the materials suitable for the repair to be carried out, thereby reducing the repair time.

[0044] When considering the case above cited of an insulation defect on a cable length for 1000V distribution to the railway line's cabins, instead of sending line personnel to make the sectionings in the cabins as necessary for detecting and thus isolating the failed cable length, it is possible to act directly from the central control unit UC. The operator, after taking note of the failure situation (switch trip alarm of the station's 1000V box that feeds the length), can use the remote control to make the necessary sectionings in order to detect and isolate the failure and possibly restoring the plant's power.

[0045] A failure which, in order to be eliminated by a direct intervention on the line by the service personnel would require some hours (considering that, in some cases, the cabins are accessible with difficulty because located within tunnels or on viaducts, etc.), the same failure can be repaired in a few minutes by using the telecontrol and remote control system. The saving in terms of time, resources, and interruption of trains circulation is evident.

[0046] The troubleshooting and re-powering procedure can be performed also automatically by the supervision software if enabled by the operators.

A further important advantage relates to the periodic maintenace operations that can be made from the central site. In the case of the above cited generator set, instead of sending personnel to the site for controlling the motor's efficiency, it is sufficient to operate, by means of the remote control, a start test of the set (no-load test or load test of the generator set). The command can be given either directly by the central unit UC's operator or by programming the control system to perform the start or load tests automatically in order to check the proper operation of the generator set.

It is in fact possible to program the CPU of the peripheral unit (or intelligent control module) UP associated with the generator set so as to carry out tests automatically with a preset frequency (for example, every week, every 15 days, etc.).

When, during the test, the system should find a defect or an irregular operation in the generator set, the CPU would store the alarm signalling and make it available to the personnel in charge of the plant's maintenance.

[0047] The peripheral units or interfaces differ from each other depending on the supply devices to which they must be applied. By way of example, they may include: a module for controlling a single switchboard, such as of UPS IS702 / ACEI IS344 from PL IS379 and battery; a module for controlling the supply panel of a station or PBA; a module for controlling board-modulated QM6 or QM12; a module for controlling and remote control-operating the sectioning and protection board; a module for controlling and remote control-operating the GE-Section CC/CA Board; a module for controlling and remote control-operating station and line's 1kV-boxes; or other types of modules according to the devices present on the supply plant.

Claims

1. A system for the diagnosis and operation of apparatuses intended for generating and distributing power supplies, in particular for railway's safety and signalling plants, **characterized in that** it comprises a plurality of peripheral units (UP) provided with means for connection to a power supply device (AA) and means for detecting the efficiency of the controlled device and able to feed a signal relating to any detected defect.

2. A system for diagnosis and operation according to claim 1, **characterized in that** it comprises a central unit (UC), and a communication network (RT) disposed and acting between said central units (UC) and peripheral units (UP).

3. A system for diagnosis and operation according to

claim 2, **characterized in that** the said central unit (UC) is provided with data-transmission means (FE) interacting bidirectionally, through said network (RT), with said peripheral units (UP) so as to allow remote control of the supply devices (AA).

4. A system for diagnosis and operation according to claim 1 or 2, **characterized in that** the said peripheral units (UP) are provided with microprocessor or microcontroller means able to carry out the conditioning of analog signals on input from said supply devices (AA).

5. A system for diagnosis and operation according to claim 1 or 2, **characterized in that**, in correspondence of a peripheral unit (UP) means are provided (A1, A2, ..., An) for connection to a device (AAj) which comprises sensor and/or transducer means.

6. A system for diagnosis and operation according to claim 1, **characterized in that** the said peripheral units (UP) are provided with interfaces connected to each other by a data-transmission network (RS).

7. A system for diagnosis and operation according to claim 1, **characterized in that** the said data-transmission network (RS) comprises a field bus.

8. A system for diagnosis and operation according to claim 1, **characterized in that** the said peripheral units (UP) are provided with transducers allowing voltage and current readouts, and with means for transferring the analog or digital signals deriving from said supply devices (AA).

9. A system for diagnosis and operation according to claim 1, **characterized in that** the said peripheral units (UP) are provided with processing means able to perform, in case of defect or following a received command, a re-configuration of the state of the controlled device.

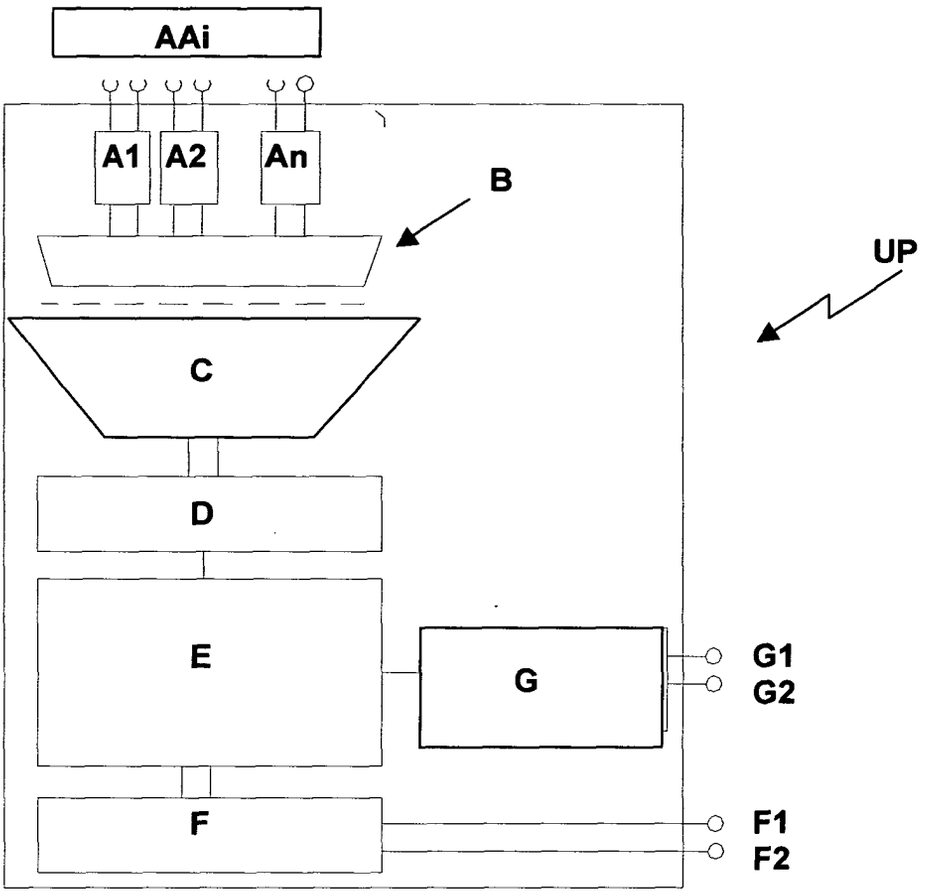

Fig. 1

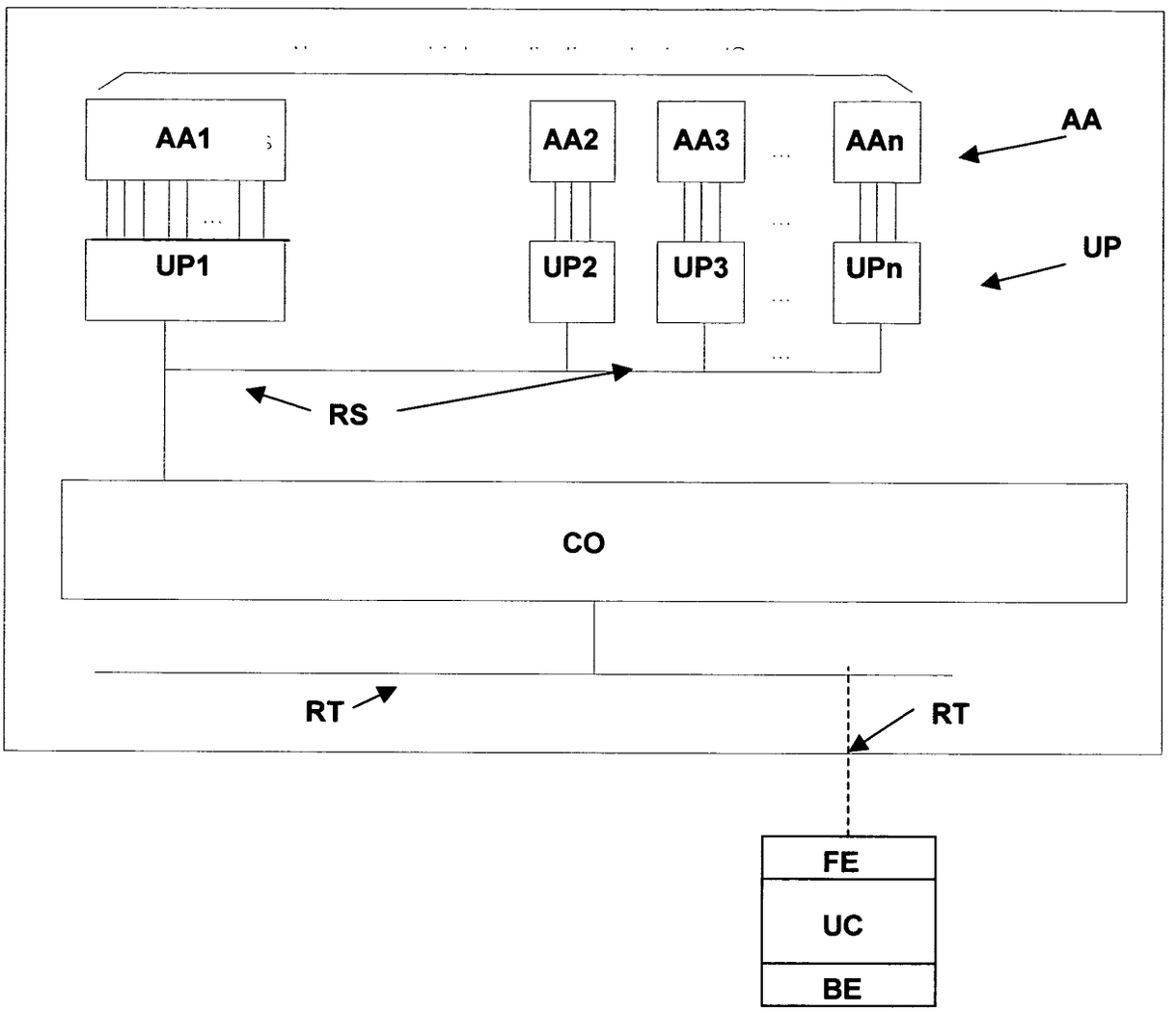

Fig. 2