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(54) System and method for remotely and centrally controlling guided vehicles and trackside devices

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The present invention concerns a system and a method for remotely controlling trackside devices (21) of independent track sections (S1, S2) and/or on-board devices (22) of independent guided vehicles (11), wherein said independent guided vehicle (11) is configured for moving along a trajectory defined by a track (4) of at least one independent track section (S1, S2), the system (1) comprising:

- at least one trackside or on-board device (21, 22) configured for exchanging at least one I/O signal (T, G) with a communication module (23) and being controlled by performing an application logic on said I/O signal (T, G);
- the communication module (23) configured for enabling an exchange of said I/O signal (T, G) between the trackside or on-board device (21, 22) and a remote centralized processing system (3);
- the remote centralized processing system (3) comprising communication means (33) for communicating with each communication module (23) for exchanging said I/O signal (T, G), said remote centralized processing system comprising at least one processing module (PM) configured for performing said application logic for controlling said trackside or on-board device.

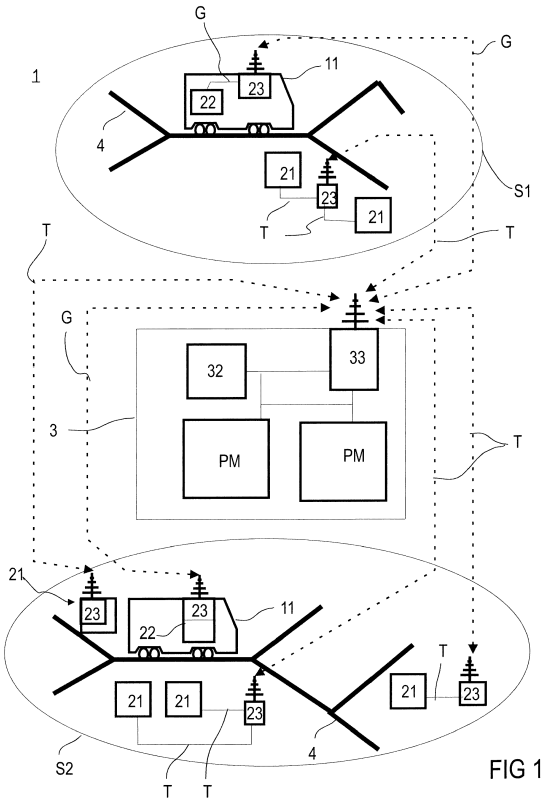

FIG 1

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Description

[0001] The present invention concerns a system and a method for remotely and centrally controlling guided vehicles and trackside devices installed at points along a route or track followed by the guided vehicle, as well as in said guided vehicle.

[0002] The present invention is directed to the remote control of guided vehicles and trackside devices configured for being installed on the route or track followed by the guided vehicle and which are for example configured for exchanging data with the guided vehicle, or performing some measurement,' or providing a signal to the guided vehicle, or ensuring the safety of the guided vehicle, or of the public, etc. Such trackside devices are or comprise sensors or fields elements. Typical examples of trackside devices are axle counters, track circuits, point machines, switch, check points, light signals, level crossings, as well as devices reinforcing the safe movement of the guided vehicle. "Guided vehicle" according to the present invention refers to public transport means such as buses, trolleybuses, streetcars, subways, trains or train units, etc., as well as load transporting means such as, for example, overhead traveling cranes, freight trains, for which safety is a very important factor and which are guided along a route by guiding means, for example at least one rail, in particular by two rails, in the proximity of which said field elements are installed.

[0003] Nowadays, trackside devices and guided vehicle devices (i.e. devices on-board the guided vehicle) usually comprise control systems and/or components performing logical functions/operations either for controlling the trackside device or an on-board device of the guided vehicle or for processing a signal or data provided by the trackside device or on-board device. Said control system and/or components performing application logic, logical functions/operations in order to control a trackside device or an on-board device, and/or in order to analyze a signal of/for a trackside device or an on-board device will be called hereafter "processing module" for simplicity. Each processing module is a device capable of performing application logic for controlling a trackside or on-board device, or a group of trackside and/or on-board devices, or for performing logical operation on a signal outputted by or inputted to a trackside/on-board device, or to a group of trackside/on-board devices. Said trackside or on-board device may comprise for example sensors or a field element that outputs, or needs as input, a signal that has to be processed by a logical function provided by the processing module. Said processing modules are usually installed in the guided vehicle or along the track or directly in the trackside device, for example close to sensors or to said field element or in the field element.

[0004] According to prior art techniques, a guided vehicle network, i.e. a set of tracks that connect at least two locations, e.g. two cities or metro stations, is divided into independent track sections, wherein each independent track section is a section of track which comprises trackside devices and at least one processing module, wherein the processing module performs application logic for at least one of said trackside devices and wherein the processing module of an independent track section is independent from another processing module configured for cooperating with another trackside device of another independent track section. By cooperate, we understand "controlling the trackside device and/or processing a signal inputted to/outputted by the trackside device". Independent track sections are section of tracks independently managed by distinct trackside systems, wherein the trackside system comprises at least said trackside device and processing module. In other words, two track sections, respectively a first track section and a second track section, are independent track sections if the application logic controlling/governing their respective trackside devices or used for processing signals inputted to, or outputted by, their respective trackside devices is performed by two independent and different processing modules, respectively a first processing module and a second processing module, wherein each processing module is specifically dedicated to a trackside device, or a group of trackside devices, of a single "independent" track section, i.e. the first processing module is specifically dedicated to and specifically cooperates with trackside devices of the first so-called "independent" track section and the second processing module is specifically dedicated to and specifically cooperates with trackside devices of the second so-called "independent" track section, each processing module being free of any configuration for controlling trackside devices and/or processing input/output signals of trackside devices of another independent track section. Independent track sections might be located in a same network, or in two different networks, e.g. a network in Europe and a network in Australia. When the two independent track sections are consecutive track sections of the same network, then their respective processing modules might comprise an interface and some application logic to control the boundary region of the consecutive two independent track sections.

[0005] In particular, each independent track section comprises at least one processing module that cooperates with at least one trackside device of the independent track section and is independent of another independent track section which comprises another processing module cooperating with at least another trackside device. Two track sections are independent from each other, and so-called independent track sections, if their respective processing modules performing application logic that controls a trackside device or processes a signal inputted to / outputted by the trackside device are independent from each other, i.e. their respective processing modules are each free of any configuration for controlling a trackside device of the trackside system of the other independent track section. In other words, independent track sections are track sections whose working is independent from each other. Each trackside device of each in-

dependent track section is thus associated to a "single" processing module of said independent track section, which performs application logic for controlling said trackside device or another trackside device of said independent track section and only of said independent track section.

[0006] The same applies to guided vehicles, wherein an independent guided vehicle is a guided vehicle comprising a processing module that cooperates with at least one of the on-board devices of the independent guided vehicle, and wherein each on-board device of the independent guided vehicle is controlled, or a signal outputted by/inputted to the on-board device processed by said processing module independently from the working of another processing module installed on-board of another independent guided vehicle. Independent guided vehicles are guided vehicles independently managed by distinct on-board systems, wherein the on-board system comprises said on-board devices and processing module. Two guided vehicles are independent from each other, and so-called independent guided vehicles, if their respective processing modules performing application logic that controls an on-board device or processes a signal inputted to / outputted by the on-board device are independent from each other, i.e. their respective processing modules do not exchange any information and work independently from each other. In other words, two guided vehicles, respectively a first guided vehicle and a second guided vehicle, are therefore independent guided vehicles if the application logic controlling/governing their respective on-board devices or used for processing signals inputted to, or outputted by, their respective on-board devices is performed by two independent and different processing modules, respectively a first processing module and a second processing module, wherein each processing module is specifically dedicated to and specifically cooperates with at least one on-board device of a single "independent" guided vehicle, i.e. the first processing module is installed on-board the first so-called "independent" guided vehicle and specifically cooperates with on-board devices of said first independent guided vehicle and the second processing module is installed on-board the second so-called "independent" guided vehicle and specifically cooperates with on-board devices of the second independent guided vehicle, each processing module being free of any configuration for controlling on-board devices and/or processing input/output signals of another independent guided vehicle. An independent guided vehicle is thus a guided vehicle whose on-board devices are configured for being controlled by a "single" processing module independently from an application logic controlling on-board devices of another independent guided vehicle by means of another processing module.

[0007] The installation and maintenance costs of said on-board devices or trackside devices are high, in particular because they require specialized operators that have to move to the location of the trackside device and/or in the guided vehicle for performing maintenance or installation tasks and checking their logical functions. In case of problem with processing modules, it is required to take the guided vehicle or trackside device out of service for repairing it. The Mean Time To Repair (MTTR) depends thus on the location of the guided vehicle or trackside device. In order to reduce the MTTR, redundant processing modules might be used, wherein a first processing module operates wherein a second processing module which is its duplicate does not operate and only takes the lead if the first processing module fails. Even if redundancy is a good solution for reducing MTTR, it has its limitations. Indeed, since redundant processing modules are co-located, any disaster may affect directly both co-located redundant processing modules, which come therefore at the same time out-of-service. Redundant equipment coming out-of-service may strongly impact the operation of a guided vehicle, or even block a complete guided vehicle network.

[0008] An objective of the present invention is to propose a method and system for reducing maintenance time and costs in the field of guided vehicles, as well as reducing the hardware resources needed for managing a fleet of guided vehicles.

[0009] The present invention proposes to relocate centrally in a remote location processing modules, i.e. components of trackside devices and/or on-board devices that are configured for providing logic functions to said trackside and/or on-board devices, said components performing for instance logical operations that control the trackside device or the on-board device by processing signals outputted by or inputted to said trackside and/or on-board device. According to the present invention, a trackside device of a trackside system of an independent track section and/or an on-board device of an on-board system of an independent guided vehicle (hereafter called trackside/on-board device or system for simplicity) whose working was controlled by an application logic performed by a processing module of a trackside/on-board system according to prior techniques, or which provides a signal that has to be processed by logic operations performed by said processing module, is configured, according to the present invention, for outsourcing all logical tasks related to said signal (which is actually an input or output signal, hereafter I/O signal) to a remote centralized processing system in a remote location. Advantageously, centralizing in the remote centralized processing system the processing modules, and thus the components configured for performing application logic, allows to reduce the hardware resources needed for managing/controlling guided vehicles fleets. Indeed, according to the present invention, each processing module might be in particular used for managing/controlling independent guided vehicles and independent track sections having non-overlapping operating hours, wherein said independent guided vehicles and/or track sections are preferentially located in different networks. For example, a same processing module of the remote centralized processing system

might be used for controlling/managing, by performing said application logic, a first independent guided vehicle configured for operating on a first independent track section of a first network and a second independent guided vehicle configured for operating on a second independent track section of a second network, wherein the operating hours of the first and second independent guided vehicles are free of any overlapping, for instance, the first independent guided vehicle being located in Australia, and the second independent guided vehicle being located in Europe. The present invention proposes a dynamic allocation of processing resources by sharing the processing modules of the centralized remote processing system, i.e. the resources configured for performing application logic, between several independent guided vehicles and independent track sections in order to manage/control independent guided vehicles and independent track sections having in particular non-overlapping operating hours, notably on different networks. Using the centralized remote processing system according to the invention allows thus to save the number of processing modules used for performing application logic when controlling independent guided vehicles and independent track sections compared to decentralized prior art techniques.

[0010] More precisely, the invention concerns a system for remotely controlling trackside devices of a trackside system of an independent track section and/or on-board devices of an on-board system of an independent guided vehicle, wherein each independent guided vehicle is configured for moving along a trajectory defined by at least one track of at least one independent track section, each independent track section comprising at least one of said trackside devices, the system according to the invention comprising:

- at least one, in particular each, trackside/on-board device of one of said independent track sections/guided vehicles, in particular of each of said independent track sections/guided vehicles, is connected to a communication module for exchanging an I/O signal with a remote centralized processing system, the trackside/on-board device being configured for exchanging with the communication module said input and/or an output signal, wherein the trackside/on-board device is configured for being operated/controlled by the input signal and/or for outputting the output signal, wherein the I/O signal has to be processed/controlled by an application logic performed by a processing module, the trackside/on-board device being in particular free of any component configured for / capable of performing said application logic, the trackside/on-board device comprising in particular at least one field element and/or sensor;
- the communication module configured for being connected to the trackside/on-board device and to the remote centralized processing system for allowing the exchange of said I/O signal between the trackside/on-board device and the remote centralized processing system;
- the remote centralized processing system comprising communication means for communicating with each communication module of each independent track section and/or each independent guided vehicle for exchanging said I/O signal, said remote centralized processing system comprising at least one processing module configured for performing said application logic for controlling said trackside/on-board device.

[0011] The present invention also concerns a trackside system of an independent track section, respectively an on-board system of an independent guided vehicle, the trackside/on-board system comprising:

- at least one trackside device, respectively on-board device, configured for exchanging at least one I/O signal with a communication module;
- the communication module configured for enabling an exchange of said I/O signal between the trackside, respectively on-board, device and a remote centralized processing system; characterized in that the trackside, respectively on-board, system according to the invention is free of any processing module configured for performing logical operation on said I/O signal and is configured for outsourcing any application logic that has to be performed on said I/O signal to the remote centralized processing system, wherein the output signal is a signal outputted by said trackside, respectively on-board, device and the input signal is a signal inputted to said trackside, respectively on-board, device.,

[0012] The present invention also concerns a remote centralized processing system for controlling at least one trackside device of a trackside system of at least one independent track section and/or at least one on-board device of an on-board system of at least one independent guided vehicle, the remote centralized processing system being preferentially configured for controlling each on-board/trackside device of each independent track section and/or each independent guided vehicle, each on-board device being installed on-board the independent guided vehicle and each trackside device equipping an independent track section, the remote centralized processing system comprising:

- communication means for communicating with each communication module of each trackside/on-board system of each independent track section / guided vehicle that comprises said trackside/on-board device in order to exchange at least one I/O signal with each trackside/on-board device of each of said trackside/on-board systems;
- at least one processing module configured for per-

forming an application logic on said I/O signal for controlling said trackside/on-board device, said processing module comprising therefore in particular code and rules for performing logical operation on said I/O signal in order to control the trackside/on-board device;

characterized in that the remote centralized processing system is configured for being located in a remote location compared to said independent track section and/or independent guided vehicle and is configured for performing all application logic related to/controlling the trackside/on-board device of the trackside/on-board system of each independent track section and/or independent guided vehicle, preferentially for performing the application logic controlling each trackside/on-board devices of the trackside/on-board system of each independent track section / guided vehicle wherein the trackside/on-board device of the trackside/on-board system is configured for communicating with its communication means.

[0013] The present invention finally claims a method for remotely controlling trackside devices of a trackside system of one or several independent track sections and/or on-board devices of an on-board system of one or several independent guided vehicles,, wherein each independent guided vehicle comprises at least one on-board device and is configured for moving along a trajectory defined by at least one track of at least one independent track section, said the trackside system of each independent track section being equipped with at least one of said trackside devices, the method according to the invention comprising:

- exchanging by means of a communication module an input/output signal between at least one or each trackside/on-board device and a remote centralized processing system, wherein at least one communication module is preferentially installed on-board each independent guided vehicle if said communication module is configured for communicating with an on-board device and on the track of each independent track section if it is configured for communicating with a trackside device;

characterized in that the method comprises performing an application logic on said I/O signal, i.e. performing for example logical operations/functions on said I/O signal by means of at least one processing module comprising e.g. logical components, of the remote centralized processing system, and sending back the processed I/O signal to the communication module of the trackside, resp. on-board system, of the independent track section, respectively independent guided vehicle, that initially sent said I/O signal, the processed I/O signal being in particular configured for controlling the trackside/on-board device, wherein said trackside/on-board system is free of any processing module configured for performing the application logic on the I/O signal. According to the present method, each independent track section and/or each independent guided vehicle outsources the application logic that has to be performed on its trackside devices, respectively on-board devices, to the remote centralized processing system.

[0014] Further aspects of the present invention will be better understood through the following drawings, wherein like reference numbers designate like objects:

Figure 1 schematic representation of a system for remotely controlling trackside devices and/or guided vehicle on-board devices of a network according to the invention.

Figure 2 schematic representation of a management of different networks by a system for remotely controlling trackside devices and/or on-board devices according to the invention.

[0015] Figure 1 shows a preferred embodiment of a system 1 for remotely controlling devices, i.e. trackside 21 and/or on-board devices 22, of at least one network, wherein each network comprises one or several independent guided vehicles 11 and one or several independent track sections, for example a first independent track section S1 and a second independent track section S2 that are located for example at different locations and which are configured for being independently controlled from each other. Said networks are for example railway networks. The first independent track section S1 might be a station in a first city, e.g. the railway station of Madrid, and the second independent track section S2 might be a station in a second city, e.g. the railway station of Berlin. Said independent track sections S1 and S2 are independent, because they are managed by independent trackside systems, a first trackside system comprising at least one trackside device 21 being configured for managing the first independent track section S1 so that an independent guided vehicle 11 may safely move along said first independent track section S1, and a second independent trackside system comprising at least one trackside device being configured for managing the second independent track section S2 so that an independent guided vehicle 11 may safely move along said second independent track section S2. Trackside devices 21 are devices configured for being installed along/on tracks 4 of each independent track section. The trackside devices 21 are configured for guiding the independent guided vehicle 11 along a trajectory defined in the network by said track 4 of independent track sections S1, S2, and ensuring the safe movement of the guided vehicle 11 on each independent track section. Typical trackside devices 21 according to the invention include in particular: an axle counter, a track circuit, a point machine, a switch, a check point, a light signal, a level crossings, a device configured for reinforcing the safe movement of the independent guided vehicle 11, an object detector, a control system of platform doors, an air conditioning system, a balise, a radar, a wheel sensor, a light system, a camera system,

a balise, an information panel/display, an alarm system, photoelectric sensors, a safety warning panel/display, an emergency stop plunger, an anti-flooding gate, a civil defense blast door, a roller shutter, a control center/panel, a PLC.

[0016] On-board devices 22 are devices installed on-board the independent guided vehicle 22. It is in particular devices configured for ensuring the safe displacement of the independent guided vehicle 11. A typical on-board device is for example a balise reader, a radar, a wheel sensor, a brake system, a door system, a light system, an object detector, a camera system, or an odometry system. On-board and trackside devices 21, 22 according to the invention are devices configured for exchanging data between one another, or with a control center, or for performing measurement, or providing a signal to the independent guided vehicle 11, or ensuring the safety of the independent guided vehicle 11, or of the public, etc. Such trackside/on-board devices 21, 22 may comprise sensors or fields elements.

[0017] The trackside system of an independent track section S1, S2 according to the invention comprises in particular at least one trackside device 21 configured for exchanging at least one I/O signal T with a communication module 23 installed preferentially along the track 4 of the independent track section, at proximity of the trackside device 21, wherein the communication module 23 is configured for enabling an exchange of said I/O signal T between the trackside device 21 and a remote centralized processing system 3. The trackside device 21 of trackside system of the independent track section according to the invention is in particular free of any component configured for performing application logic and/or logical operation on the I/O signal T. The I/O signal T might be a signal outputted by said trackside device 21 or a signal inputted to said trackside device 21.

[0018] The on-board system of an independent guided vehicle 11 according to the invention preferentially comprises at least one on-board device 22 configured for exchanging at least one I/O signal G with a communication module 23 preferentially installed on-board the independent guided vehicle 11. Optionally, the trackside device 21 may exchange the I/O signal T with the communication module 23 installed on-board the independent guided vehicle 11, and/or the on-board device 22 may exchange the I/O signal G with the communication module 23 installed at points along the track 4 of the independent track section. In particular, the communication module 23 installed on-board the independent guided vehicle 11 is configured for enabling the exchange of said I/O signal G between the on-board device 22 and the remote centralized processing system 3. In particular, the on-board device 22 according to the invention is free of any component configured for performing application logic and/or logical operation on the I/O signal G, wherein I/O signal G might be a signal outputted by said on-board device 22 or a signal inputted to said on-board device 22.

[0019] The trackside and on-board system of respectively the independent track section and the independent guided vehicle according to the invention are configured for outsourcing any application logic that has to be performed on the I/O signal G, T to the remote centralized processing system 3. The communication module 23 installed on-board the independent guided vehicle 11 might be connected to one or several on-board devices 22 for transmitting I/O signals G from each of said on-board devices 22 to the remote centralized processing system 3 and from the remote centralized processing system 3 to each of the on-board devices 22. The same applies mutatis mutandis to the communication module 23 configured for being installed along the track 4 of the independent track section. Optionally, the trackside device 21 or the on-board device 22 may directly comprise said communication module 23 and/or a single communication module 23 (on-board and/or installed along the track 4) might be used by several on-board/trackside devices for their communication with the remote centralized processing system 3. In particular, several on-board devices 22, respectively several trackside devices 21 might be connected to a single communication module 23 or to redundant communication modules 23. Integrating the communication module 23 directly inside the trackside device 21 or respectively inside the on-board device 22, allows to save place along the track 4 of the independent track section, or respectively on the independent guided vehicle 11. In particular, according to the present invention, the communication module 23, whether on-board or installed along the track 4, is located closer to the trackside/on-board device than the remote centralized processing system 3.

[0020] Indeed, the remote centralized processing system 3 according to the invention is configured for being located in a remote location compared to the location of the trackside/on-board devices 21, 22. The remote centralized processing system 3 comprises in particular communication means 33 for communicating with each communication module 23 of each independent track section/guided vehicle in order to exchange said I/O signals G, T with the communication module 23 on-board the independent guided vehicle 11 and/or with the communication module 23 installed at points along the track 4 of the independent track section. In particular, the remote centralized processing system 3 comprises at least one processing module PM configured for performing an application logic and/or logical operations on the I/O signal G, T for controlling said trackside/on-board device 21, 22. Preferentially said processing module PM comprises hardware resources like a processing unit/resource 32, and notably code and rules for performing said logical operation or calculation on said I/O signal. According to the present invention, a same hardware may host more than one processing module (e.g. if is powerful enough), wherein each processing module PM preferentially controls a single independent guided vehicle/track section at a time, each processing module working independently from each other. The remote centralized processing

system 3 may also further comprise a database, one or several additional processing units for further analyzing/processing the I/O signal G, T, or for encrypting the signal G, T. Preferentially, the processing module PM comprises one or several dispatchers for assigning idle processing unit resources to specific independent track sections and/or independent guided vehicles.

[0021] By performing application logic and/or logical operation on the I/O signal, it has to be understood in particular that the processing module of the remote centralized processing system according to the invention is configured for managing and providing functions ensuring the safe displacement of the independent guided vehicle and passengers by processing said I/O signal and performing said application logic and/or logical/arithmetic operations. For example, the processing module is able to perform at least one of the following processing functions: automatic guided vehicle control, automatic guided vehicle protection, automatic guided vehicle braking, automatic guided vehicle door control, automatic platform door control, balise system control, light system control, automatic switch control, interlocking, radio block center, block processor, temporary speed restriction management, positive train control, etc.

[0022] Preferentially, each processing module PM of the remote centralized processing system 3 is assigned to a different processing function: for example a first processing module is assigned to an interlocking function and controls the interlocking function of one or more independent track sections whose trackside system is connected to its communication means 33 by means of the communication module 23, a second type of processing module is assigned to an automatic guided vehicle protection function (e.g. ATP function) for one or more independent guided vehicles, a third processing module is assigned to an automatic guided vehicle operation function (e.g. ATO function) for one or more of said independent guided vehicles, and a fourth processing module is assigned to a Lineside Electronic Unit (LEU) function. Preferentially, an instance of the processing unit 32 might be assigned to each processing function for acting as a dispatcher for said processing function, i.e. for all independent track sections/guided vehicles whose trackside/on-board system comprises such a function.

[0023] Preferentially, the communication module 23 and/or even the trackside/on-board device 21, 22, and/or the processing unit 32, and/or the communication means 33, and/or the processing module PM, may comprise an encryption module for encrypting/decrypting the I/O signal in order to avoid unauthorized control of the trackside/on-board devices.

[0024] The remote centralized processing system 3 is located in a remote location compared to each of said independent track sections S1, S2 and/or independent guided vehicle, and is configured for performing all application logics of the trackside/on-board systems connected to its communication means in order to control their trackside/on-board devices by applying said application logic to said I/O signal. According to the present invention, the trackside system of an independent track section, like said first independent track section S1, or second independent track section S2, and/or the on-board system of an independent guided vehicle preferentially integrally and completely outsource all the application logics that have to be performed on each of the I/O signals of their trackside/on-board devices for controlling said trackside/on-board devices or analyzing signals coming from said on-board/trackside devices or inputted to the latter. The outsourcing of the application logic to a single remote centralized processing system 3 allows to reduce maintenance costs, to reduce installation cost, to better use hardware resources, to better use multi-core processing, to improve the scalability, and to decrease the size of on-board/trackside systems since they are free of processing modules configured for performing application logic on the I/O signal of their respective devices. The remote centralized processing system 3 is a centralized system in that a single main system (i.e. said remote centralized processing system 3) provides all application logic for one or several independent guided vehicles and/or independent track sections.

[0025] The remote centralized processing system 3 is preferentially configured for controlling all on-board/trackside devices 22, 23 of one or several trackside/on-board systems according to the invention, i.e. trackside systems of independent track sections and on-board systems of independent guided vehicles, each on-board device G_i being installed on-board each independent guided vehicle and each trackside device T_i being installed on each track 4 of said independent track section communicating/transmitting by means of the communication module 23 said I/O signal G_i, T_i, which might be encrypted, to the remote centralized processing system 3 for processing logical operations on and/or performing application logic to said I/O signal G_i, T_i, in order to control functions as previously described and which ensure a safe displacement of the independent guided vehicle 11 on each independent track section. Once the logical operation/application logic has been performed on said I/O signal G_i, T_i, then the remote centralized processing system 3 is configured for sending back the processed I/O signal G_i, T_i, to the corresponding trackside/on-board device G_i, T_i.

[0026] Figure 2 shows another preferred embodiment of the present invention which illustrates the controlling by a system according to the invention of two different networks, respectively a first network N1 and a second network N2, located for example at two different locations (e.g. in Australia and in Europe) and that are independent from one another.

[0027] The first network N1 comprises for example a first independent guided vehicle 111, a second independent guided vehicle 112 and a third independent guided vehicle 113, as well as five independent track sections, namely S1-S5. The second network N2 comprises for example a first independent guided vehicle 114 and a

second independent guided vehicle 115, as well as at least one independent track section S6.

[0028] The remote centralized processing system 3 according to the invention is in particular configured for controlling several independent track sections/guided vehicles at a time, for instance at least two trackside/on-board systems, each of a different independent track section/guided vehicle. The remote centralized processing system 3 may comprise one or several processing modules for performing application logic according to the invention, i.e. wherein each processing module is configured for collecting all I/O signals T,G (said signals being either signals that have to be inputted to a trackside/on-board device, or that have been outputted by a trackside/on-board device) of all the trackside/on-board devices it controls, applying specific application rules/calculation according to specific characteristics of the track and/or the (independent) guided vehicle, as well as according to a current status of said track and/or said (independent) guided vehicle, and providing in return processed signals to the trackside/on-board devices under its control, in order to ensure the safe displacement of the (independent) guided vehicle along the tracks of independent track sections of the network. Each processing module according to the invention is in particular configured for performing application logic for at least two trackside/on-board systems, each of a different independent track section/guided vehicle. For example, the remote centralized processing system 3 may in particular comprise twelve processing modules, namely PM1-PM12, wherein:

- PM1 is assigned to S1.
- PM2 is assigned to S2;
- PM3 is assigned to S3;
- PM4 is assigned to S4;
- PM5 is assigned to S5;
- PM6 is a spare/idle processing module or assigned to S6;
- PM7 is assigned to the independent guided vehicle 111;
- PM8 is assigned to the independent guided vehicle 112;
- PM9 is assigned to the independent guided vehicle 113;
- PM10 is a spare/idle processing module or assigned to the independent guided vehicle 114;
- PM11 is a spare/idle processing module or assigned to the independent guided vehicle 115;
- PM12 is a spare/idle processing module.

[0029] The present invention proposes in particular a dynamic allocation of processing resources, i.e. the dynamic allocation of at least one processor resource of the processing module PM between the different independent track sections and/or independent guided vehicles. Indeed, the present invention proposes preferentially to share the processing modules PM1-PM12 between the trackside systems and on-board systems that have distinct operating times/hours. For example, if the first network N1 and the second network N2 do not operate at the same time, then PM6, PM10, PM11, and PM12 might be spared (not used), since for example, when the first network N1 is not operated, the processing modules PM1-PM5 and PM7-PM9 might be assigned to the independent track sections and independent guided vehicles of the second network N2. Consequently, in this case, PM6, PM10, PM11, and PM12 might be advantageously assigned to any other independent track section or independent guided vehicle of another network if the networks N1 and N2 are free of identical operating hours.

[0030] According to the present invention, the processing module PM1 might perform for example an application logic for an interlocking function of the first network N1 and of the second network N2 if the operating time of the trackside/on-board systems of both networks is free of any overlapping.

[0031] The application logic performed by each of the processing modules PM1-PM12 according to the invention is a logic configured for ensuring the safe displacement of at least one independent guided vehicle on a single independent track section at a time. The track sections S1-S6 are independent from each other, because their respective trackside systems cannot be controlled by a same processing module at the same time: each independent track section is a track section that is controlled by a trackside system whose working is controlled by a single processing module at a time, each processing module being configured for controlling a single trackside system (or on-board system) of an independent track section (or independent guided vehicle) at a time. According to the present invention, a same processing module might in particular control a first trackside/on-board system of an independent track section/guided vehicle for a first period of time, and a second trackside/on-board system of an independent track section/guided vehicle for a second period of time, if the first and second trackside/on-board systems are free of any overlapping operating hours.

[0032] To summarize, the present invention proposes to perform, in a remote location, application logic on I/O signals of at least one or each trackside/on-board device of a trackside/on-board system of one or several independent track sections/guided vehicles, for example of at least two independent track sections and/or at least two independent guided vehicles, by means of a remote centralized processing system, wherein the I/O signal is for example transmitted from the trackside/on-board device to the remote centralized processing system 3 by means of a communication module 23, then the remote centralized processing system processes said I/O signal by performing application logic on said signal, and then send back the processed I/O signal to the trackside/on-board system that transmitted originally said I/O signal by using said communication module 23. The communication module of the trackside/on-board system accord-

ing to the invention is in particular capable to determine from the received processed I/O signal to which trackside/on-board device said processed I/O signal has to be transmitted. Indeed, the processing module according to the invention is in particular configured for providing the processed I/O signal with a data indicating the final recipient of said processed I/O signal. For each trackside/on-board device of a trackside/on-board system within an independent track section/guided vehicle, the remote centralized processing system comprises an application logic specifically configured for controlling said trackside/on-board device and/or analyzing its I/O signal.

Claims

1. Trackside/on-board system of an independent track section/guided vehicle, the trackside/on-board system comprising:

   - at least one trackside/on-board device (21, 22) configured for exchanging at least one I/O signal (T, G) with a communication module (23);
   - the communication module (23) configured for enabling an exchange of said I/O signal (T, G) between the trackside/on-board device and a remote centralized processing system (3);

   characterized in that the trackside/on-board system according to the invention is free of any processing module (PM) configured for performing logical operation on said I/O signal (T, G) and is configured for outsourcing any application logic that has to be performed on said I/O signal (T, G) to the remote centralized processing system (3).

2. Trackside/on-board system according to claim 1 comprising encryption modules for encrypting/decrypting the I/O signal (T, G).

3. Trackside/on-board system according to claim 1 or 2, wherein several trackside/on-board devices (21, 22) are connected to a single communication module (23).

4. Trackside/on-board system according to one of the claims 1 to 3, wherein the trackside device (21) is one of the following devices: an axle counter, a track circuit, a point machine, a switch, a check point, a light signal, a level crossings, a device configured for reinforcing the safe movement of the independent guided vehicle (11), an object detector, a control system of platform doors, an air conditioning system, a balise, a radar, a wheel sensor, a light system, a camera system, a balise, an information panel/display, an alarm system, photoelectric sensors, a safety warning panel/display, an emergency stop plunger, an anti-flooding gate, a civil defense blast door, a roller shutter, a control center/panel, a PLC.

5. Trackside/on-board system according to one of the claims 1 to 4, wherein the on-board device (22) is one of the following devices: a balise reader, a radar, a wheel sensor, a brake system, a traction system, a door system, a light system, an object detector, a camera system, a GPS, an inertial movement unit, train integrity system, dead man system, a laser system, an odometry system, an air conditioning system, a light system.

6. Remote centralized processing system (3) for controlling at least one trackside device (21) of a trackside system of at least one independent track section and/or respectively at least one on-board device (22) of an on-board system of at least one independent guided vehicle (11), the remote centralized processing system (3) comprising:

   - communication means (33) for communicating with each communication module (23) of each track-side/on-board system in order to exchange at least one I/O signal (G, T) with each trackside/on-board device (21, 22) of each of said trackside/on-board systems;
   - at least one processing module (PM) configured for performing an application logic on said I/O signal (T, G) for controlling said trackside/on-board device (21, 22);

   characterized in that the remote centralized processing system (3) is configured for being located in a remote location compared to the independent track section and/or independent vehicle and is configured for performing all application logics for controlling the trackside/on-board device (21, 22) of the trackside/on-board system of each independent track section/guided vehicle.

7. Remote centralized processing system (3) according to claim 6 comprising an encryption module for encrypting/decrypting the I/O signal (T, G).

8. Remote centralized processing system (3) according to claim 6 or 7 comprising a database and/or a dispatcher.

9. Remote centralized processing system (3) configured for dynamically allocating at least one processor resource of the processing module (PM) between different independent track sections and/or independent guided vehicles.

10. System (1) for remotely controlling at least one trackside device (21) of a trackside system of an independent track section (S1, S2) and/or at least one on-board device (22) of an on-board system of an

independent guided vehicle(11), wherein said independent guided vehicle (11) is configured for moving along a trajectory defined by a track (4) of at least one independent track section (S1, S2) comprising at least one of said trackside devices (21), the system (1) comprising:

- at least one trackside/on-board device according to one of the claims 1 to 5;
- a remote centralized processing system (3) according to one of the claims 6-9.

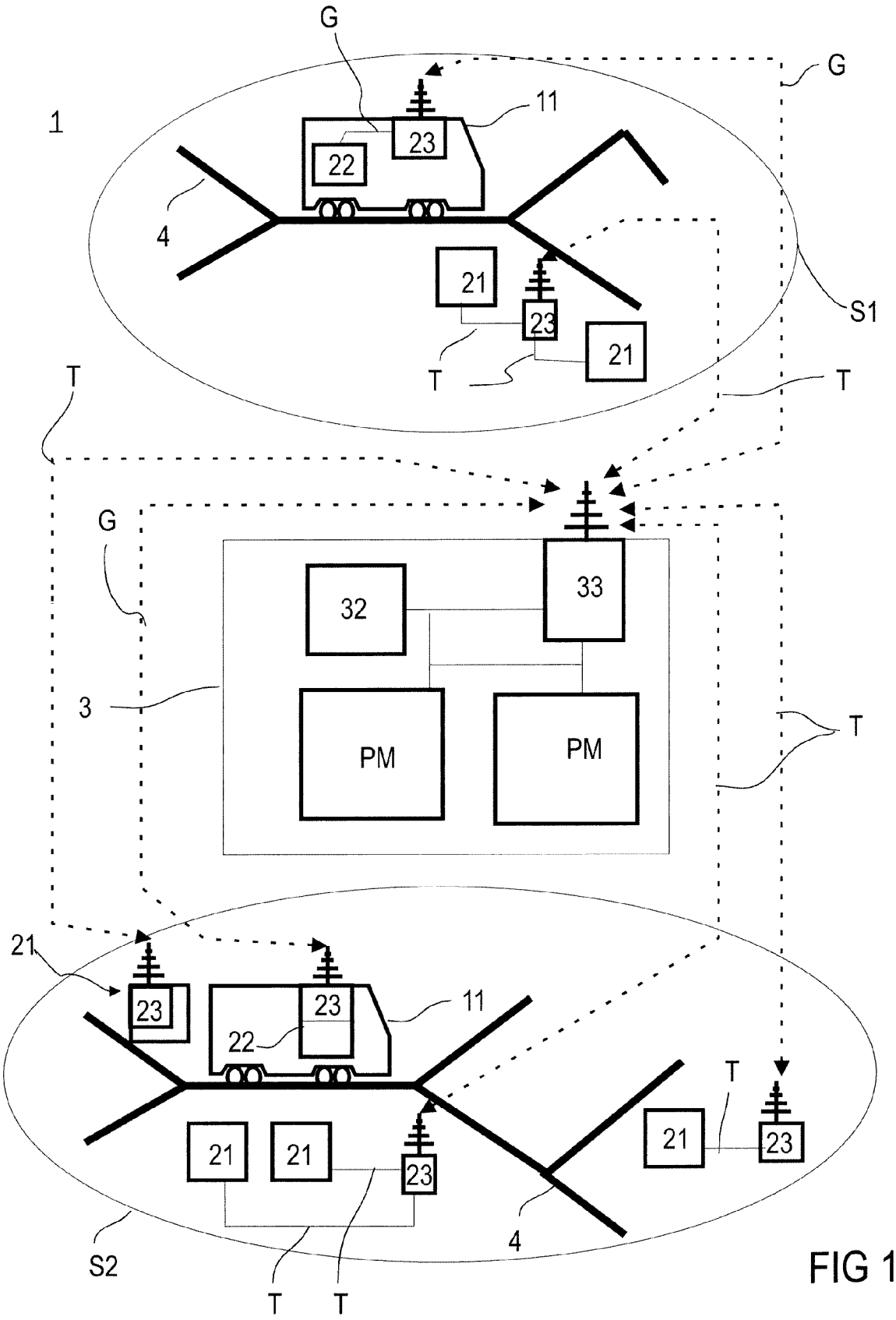
11. Method for remotely controlling a trackside device (21) of a trackside system of at least one independent track section (S1, S2) and/or an on-board device (22) of an on-board system of at least one independent guided vehicle (11), wherein said independent guided vehicle (11) is configured for moving along a trajectory defined by a track (4) of at least one independent track section, the trackside system of each independent track section being equipped with at least one of said trackside devices (21), the method comprising:

- exchanging by means of a communication module (23) an I/O signal (R,G) between at least one trackside/on-board device (21, 22) and a remote centralized processing system (3);

characterized in that the method comprises performing an application logic on said I/O signal by means of at least one processing module (PM) of the remote centralized processing system (3) and sending back the processed I/O signal (T, G) to the communication module (23) of the trackside/on-board system of the independent track section/guided vehicle from which the I/O signal originated in order to control at least one trackside/on-board device of said trackside/on-board system, said trackside/on-board system being free of any processing module (PM) configured for performing the application logic on the I/O signal (T, G).

12. Method according to claim 11, comprising encrypting/decrypting each I/O signal (G, T).

13. Method according to claim 11 or 12, comprising a dynamic allocation of at least one processor resource of the processing module (PM) between different independent track sections and/or independent guided vehicles.


G
G
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11
23
22
4
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23
21
S1
T
T
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33
3
PM
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23
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S2
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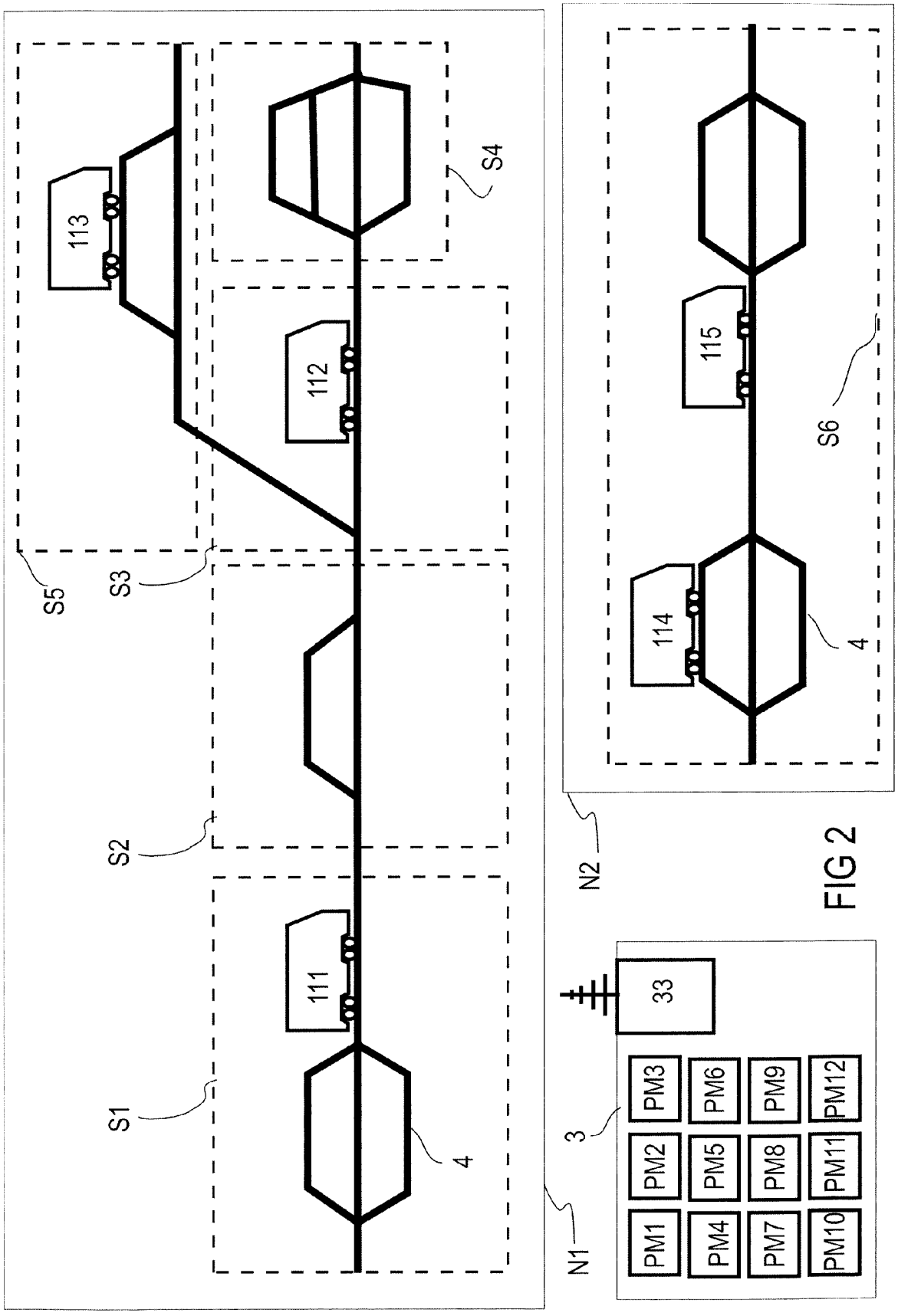
T

FIG 1


S1
S2
S3
S4
S5
S6
111
112
113
114
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N1
N2
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PM1
PM2
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PM5
PM6
PM7
PM8
PM9
PM10
PM11
PM12

FIG 2

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EUROPEAN SEARCH REPORT

Application Number
EP 14 38 0027

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Place of search	Date of completion of the search	Examiner
Munich	24 March 2015	Robinson, Victoria

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X : particularly relevant if taken alone
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