Description

System and method for determining a position of a guided vehicle

Technical Field

The present invention generally concerns the safety of guided vehicles. By “guided vehicle”, it has to be understood any rail transport means configured for moving on tracks of a railway network, said guided vehicle typically running on at least one rail configured for supporting one or several wheels of said guided vehicle or using at least one rail as a guiding means for guiding the guided vehicle along a trajectory defined by said rail. Said rail transport means are for instance public transport means like 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. In particular, knowing the position of the guided vehicle on the railway network at any time as well as its integrity, i.e. whether a guided vehicle comprising several cars at a time T still comprises all said several cars at a time T + ΔT, is of crucial importance for enabling safe motion of a fleet of guided vehicles on said railway network. The present invention proposes notably a system and a method capable of improving the safety of a guided vehicle, notably by determining its position and/or its integrity.

Background Art

Two main systems have been commonly used for tracking and locating guided vehicles on a railway network: the track circuit and the axle counter. However, these systems are complex to install, depend on specifications of the track or guided vehicle, require regular maintenance, and are consequently expensive systems. Due to these disadvantages, they are usually only used on mainlines, while manual tracking and location of guided vehicles is used for “secondary” lines, like lines serving a depot, a port, a mine, or any other location with little traffic. There is therefore a need for a simple system which would enable to locate and track guided vehicles on tracks of a railway network. Solutions based on a use of beacons for tracking guided vehicles, as described for instance in the document GB 2596890 A, have been proposed. However, the use of beacons for tracking guided vehicles is challenging, notably due to the fluctuations of beacons signals in the railway environment. Improved solutions are therefore needed.

Summary of Invention

An objective of the present invention is to propose a method and a system for improving guided vehicle safety, notably by precisely locating a guided vehicle on a track of a railway network and/or checking its integrity, wherein said method and system are simple, easy to implement or install, and offer flexibility, reliability and safety with respect to guided vehicle or track configurations.

This objective is achieved by the measures taken in accordance with the independent claims. Further advantageous embodiments are proposed by the dependent claims.

More precisely, the present invention concerns a system for locating one or several guided vehicles on a track of a railway network and/or checking the integrity of said one or several guided vehicles by determining for instance for each guided vehicle at least two positions, each for a different car of the guided vehicle, e.g. a position for the first car and a position for the last car, said system comprising:

- a control subsystem configured for locating each of said one or several guided vehicles;
- Bluetooth Low Energy (BLE) devices of two types, namely a BLE device of a first type, called hereafter BLET1, and a BLE device of a second type, called hereafter BLET2, wherein BLET1 is either a BLE gateway or a BLE beacon, wherein if BLET1 is a BLE gateway, then BLET2 is a BLE beacon, and, inversely, if BLET1 is a BLE beacon, then BLET2 is a BLE gateway, wherein each BLE beacon is configured for broadcasting a signal encoding information data comprising at least a unique identifier and optionally a power level data, wherein the unique identifier is configured for identifying the BLE beacon broadcasting said signal and the power level data is configured for encoding the power level used for transmitting said signal, and wherein each BLE gateway is assigned a unique identifier and is configured for acquiring said signal;
- for each guided vehicle, a set of one or several BLET1 configured for being installed on-board the guided vehicle, wherein each BLET1 of said set of BLET1 is configured for being installed at a predefined position on-board said guided vehicle. If several BLET1 are installed on-board, then their respective predefined positions are different. According to the present invention, each guided vehicle receives thus a set of BLET1, each guided vehicle being thus equipped with at least one BLET1;
- a set of BLET2, wherein each BLET2 of said set is configured for being installed each at a predefined position along said track, the predefined position of a BLET2 of said set being different from the predefined position of any other BLET2 of said set, each

BLET2 being thus installed at a different predefined position with respect to the other BLET2 of said set;

- wherein, upon reception of a signal broadcasted by a BLE beacon, each BLE gateway is configured for measuring an intensity of the received signal, and for transmitting in real time to the control subsystem a set of data comprising the intensity value measured for said received signal, a time of measurement of said intensity value or of reception of said received signal (according to the present invention, the time at which the measure was performed is considered to be substantially the same as the time at which the signal was received), its unique identifier, and said information data comprised in the received signal, i.e. the unique identifier of the BLE beacon that broadcasted said received signal and, optionally, the power level data that is thus associated to said measured intensity value. Each set of data is thus associated or related to a couple of BLE devices BLET1 and BLET2 comprising the BLE gateway that measured the intensity value comprised in the set of data and the BLE beacon that broadcasted the signal for which said measured intensity value comprised in the set of data has been measured, said couple of BLE devices being also called hereafter “BLE devices couple” or “couple BLE beacon – BLE gateway”. Each set of data is thus specific to one couple of BLE devices (i.e. it characterized a communication relation of a single couple of BLE devices BLET1 – BLET2 at the time of measurement of said intensity value), comprising information about the intensity value measured by the BLE gateway of the couple when receiving the signal broadcasted by the BLE beacon of said couple;
- the control subsystem is configured for receiving each set of data, for associating to each set of data a single one of said one or several guided vehicles by identifying the guided vehicle to be associated from at least one unique identifier comprised in said received set of data (i.e. from the unique identifier of the BLE device(s) installed on board the guided vehicle), and for automatically determining a position of each identified guided vehicle on the track of the railway network;

the system according to the invention being characterized in that

- said system, preferably the control subsystem, is in particular configured for storing each predefined position of each BLET1 and of each BLET2. For instance, the control subsystem may store said predefined positions in a memory or in a database; and
- for each identified guided vehicle, the control subsystem is configured for determining said position from at least one set of data that has been received in connection with the identified guided vehicle, wherein for each set of data, the measured intensity value comprised in the set of data, the predefined position of the BLET1 and the predefined position of the BLET2 which are associated to the concerned set of data,

and optionally the power level data associated to said measured intensity value (i.e. the power level that was used by the BLE beacon for broadcasting the signal for which said intensity value has been measured) are used by the control subsystem for determining said position of the guided vehicle. Preferentially, at least two sets of data are used by the control subsystem for determining the position of the guided vehicle.

The present invention concerns also a method for locating one or several guided vehicles on a track of a railway network and/or checking an integrity of said one or several guided vehicles by means of a system comprising a control subsystem and BLE devices of two types, namely BLET1 and BLET2 as previously explained, wherein at least one BLET1 is installed at a predefined position on-board each guided vehicle, and wherein each BLET2 of a set of several BLET2 is installed at a predefined position along said track, the method comprising:

- receiving by at least one BLE gateway a signal broadcasted by a BLE beacon and measuring by each BLE gateway having received such a broadcasted signal an intensity of the received signal;
- transmitting in real time, by each BLE gateway having received a broadcasted signal and to the control subsystem, a set of data comprising the intensity value measured for said received signal, a time of measurement of said intensity value, the unique identifier of the BLE beacon that broadcasted said received signal, its unique identifier, and optionally, the power level data comprised in the received signal and thus associated to said measured intensity value, each set of data being thus associated to a couple of BLET1 and BLET2 comprising the BLE gateway that measured said intensity value comprised in the set of data and the BLE beacon that broadcasted the signal for which said measured intensity value comprised in the set of data has been measured by the BLE gateway;
- receiving by the control subsystem each set of data transmitted by the BLE gateway(s);
- associating, by the control subsystem, a single one of said one or several guided vehicles to each set of data by identifying the guided vehicle to be associated from at least one unique identifier comprised in said received set of data;
- automatically determining, by the control subsystem, a position of each identified guided vehicle on the track of the railway network

the method being characterized in that it comprises:

- optionally, storing each predefined position of each BLET1 and of each BLET2. Alternatively, or additionally, said predefined positions might be encoded in a computer program used for determining the position of each identified guided vehicle;
- for each identified vehicle, determining said position from at least one set of data that has been received in connection with the identified guided vehicle, wherein, for each set

of data, the measured intensity value comprised in the set of data, the predefined position of the BLET1 and the predefined position of the BLET2 which were associated to the concerned set of data are used by the control subsystem (103) for determining said position of the identified guided vehicle.

Description of Embodiments

According to the present invention, the position in function of the time of an identified guided vehicle might be determined from one or several sets of data. As explained hereafter, sets of data that comprise an intensity value measured at a same time, or sets of data comprising each intensity value measured at a different time might be used for determining and/or improving the position of the guided vehicle. Each set of data enables to determine a position of the guided vehicle. Basically, said position of the guided vehicle is determined from the position of one or several, preferably of each, BLET1 of the guided vehicle, and in other words, from the set(s) of data to which said one or several, preferably each, BLET1, is associated. Each of said BLET1 is thus associated to one or several sets of data (each set of data associating said BLET1 to a BLET2), wherein each set of data comprises a measured intensity value that is used by the control subsystem for calculating a (relative) distance separating the BLET1 from the BLET2 at the time of measurement of said intensity value. Therefore, for a BLET1, notably for each BLET1, one or several distances separating, at a given time, said BLET1 from one or several BLET2 might be obtained from respective sets of data and used for precisely locating the BLET1, said given time being the time of measurement of the intensity value within said respective sets of data, which is considered in this case to be identical in said respective sets of data. Also, additionally or alternatively, several distances separating, each at a different given time, said BLET1 from one or several BLET2 might be obtained from respective sets of data and used for precisely locating the BLET1, said different given times being each a time of measurement of the intensity value in one of said respective sets of data. For each calculated distance between a BLET1 and a BLET2, the control subsystem may determine a position of the BLET1 with respect to the BLET2. If several distances are calculated for a same BLET1, then the control subsystem may use known in the art techniques for improving the position of the BLET1 with respect to the BLET2 for which said distances have been calculated, like determining an average distance or using triangulation techniques, or weighted techniques, etc. In particular, if the identified guided vehicle comprises several BLET1 and for each BLET1, one or several distances have been calculated with respect to one or several BLET2, then the control subsystem may assign to the guided vehicle a position (called hereafter the final

position) that is an average position with respect to the position determined for each of the BLET1 or that minimizes a value that is a sum of positional differences, wherein each positional difference in said sum is a difference obtained for one of the BLET1 between the position of said BLET1 determined from the distance separating it from BLET2 (as usual, BLET2 and BLET1 form a couple of BLE devices for which said distance has been calculated from the set of data associated to it) and the position of the BLET1 when assigning to the guided vehicle said final position. An iterative process might be used for minimizing said value.

As explained above, the control subsystem is configured for using the measured intensity value for determining a distance separating the BLE gateway having measured said measured intensity value at said time of measurement from the BLE beacon having broadcasted the signal for which said intensity value has been measured. The position of the guided vehicle is then inferred from said distance when taking into account the predefined position of the BLET2 and the predefined position of the BLET1, wherein the predefined position of the BLET1, i.e. of the BLE device, among said BLE beacon and the BLE gateway, that is installed on-board, is used by the control subsystem as a positional constraint for determining a position of the BLET1 at said distance from the BLET2 at said time of measurement and which is comprised on a real trajectory followed by said BLET1, said real trajectory being typically inferred by the control subsystem from the guided vehicle trajectory defined by the track of the railway network. The knowledge of the position of the BLET1 enables then to determine the position of any part of the guided vehicle, e.g. the front end or rear end of the guided vehicle, and thus of the guided vehicle in general. The present invention proposes to take advantage of the fact that for a given predefined position of a BLET1, there is only a single trajectory (i.e. said real trajectory) that is possible when the guided vehicle is moving on a track of the railway network, and the position of the BLET1 determined from the distance calculated from the measured intensity value shall be on said trajectory. This imposes a constraint, said positional constraint, with respect to the position of the BLET1 at a given distance from a BLET2. In particular, the real trajectory followed by the BLET1 might be determined or derived by the control subsystem from a map of the railway network which comprises the predefined positions of the BLET2 and the position of the track followed by the guided vehicle. In other words, said map is configured for mapping the tracks of the railway network and the predefined position of the BLET2. Said map might be for instance a 2D map or a 3D map depending on the configuration of the system BLET1 – BLET2, i.e. the position of the BLET1 with respect to the BLET2. For instance, if the BLET1 and BLET2 are installed within a same plane parallel to the tracks, then said map might be a 2D map. In particular, LIDAR techniques might be used for creating said map. Typically, said map might be stored in a memory of the control subsystem or in a database accessible by the latter. Said map enables to determine a position of the BLET1 lying in the trajectory followed by the BLET1 when

the identified guided vehicle is running on the track of the railway network, by taking into account the predefined position of the BLET1 with respect to the guided vehicle (i.e. where it is installed on or in said guided vehicle). Indeed, when the guided vehicle is moving on said track, it is typically guided by one or several rails of said track, and thus each element or component of the guided vehicle, in particular the BLET1, follows a predefined trajectory that is parallel to the trajectory imposed by the rail(s) of the track. Of course, other alternatives might be envisaged by the skilled person, wherein the predefined position of the BLET1 is used as a positional constraint with respect to the real trajectory followed by the BLET1. For instance, instead of using a map of the railway network the system according to the invention might store for each predefined position of a BLET1, a predefined trajectory that is defined in function of the predefined positions of the BLET2.

According to this technique, it is possible to improve the position determination of the guided vehicle by increasing the number of BLET1, e.g. typically two BLET1 each at one extremity of the guided vehicle, wherein each BLET1 follows a different trajectory. This enables to improve the precision of the position determined by the control subsystem for the guided vehicle, notably by further taking into account a distance separating the two BLET1. In particular, the control subsystem might be configured for minimizing said value that is a sum of positional differences, wherein each positional difference in said sum is a difference obtained for one of the BLET1 between the position of said BLET1 determined from the distance separating it from BLET2 (as usual, BLET2 and BLET1 form a couple of BLE devices for which said distance has been calculated from the set of data associated to it) and the position of the BLET1 on its real trajectory when assigning to the guided vehicle the so-called final position.

Preferentially, for increasing the precision of the position determination of the identified guided vehicle, each set of data may comprise said power level data associated to the measured intensity value, and the control subsystem is configured for calculating, from the value of a difference between i) a power level Pw (usually expressed in dBm or Watt) encoded in the power level data associated to the measured intensity value Int, and, ii) said measured intensity value Int (usually expressed in dBm or Watt), said distance D separating the BLE gateway having measured said intensity value from the BLE beacon having broadcasted the signal for which the BLE gateway measured said intensity value, inferring then the position of the identified guided vehicle from the distance D obtained in connection with or for each set of data associated to the identified guided vehicle, together with their respective predefined position of the BLET1 and predefined position of the BLET2.

For each set of data comprising a measured intensity value Int and its associated power level data, the distance D determined might thus be expressed as a function of Pw and Int. In particular, the distance D might be given by:

$$D = 10^{\frac{(Pw-Int)}{10 \cdot n}}$$

wherein n is the path loss exponent when considering the path followed by the broadcasted signal from the BLE beacon to the BLE gateway, n having typically a value of 2 in free space, Pw is the power level, i.e. the power used by the BLE beacon for transmitting the signal, and Int is the signal intensity measured by the BLE gateway at the reception of the transmitted signal. For each set of data, the control subsystem might use said distance D, the predefined position of the BLE gateway and of the BLE beacon for inferring the position of the guided vehicle, wherein the predefined position of the BLET1 is used as said positional constraint during the determination of the guided vehicle position.

Preferentially, the position of an identified guided vehicle is determined by the control subsystem from at least two sets of data that have been associated to said identified guided vehicle, wherein the two measured intensity values comprised each in one of said two sets of data are used for determining the position of the identified guided vehicle. Preferentially, said two intensity values are intensity values that have been measured by a same BLE gateway at different times within a predefined temporal window for a signal broadcasted by a same BLE beacon. In particular, a guided vehicle average speed (i.e. the average speed of the identified guided vehicle) measured during said predefined temporal window and/or a third intensity value measured by said same BLE gateway for said signal broadcasted by said same BLE beacon are further used for determining or improving the position of the guided vehicle. Notably, said third intensity value is measured at a time of measurement different from the respective measurement times of said two intensity values and takes place within said predefined temporal window.

Preferentially, the set of data further comprises an angle of arrival and/or an angle of departure, wherein the control subsystem is further configured for using said angle of arrival and/or angle of departure for improving the precision of the position of the identified guided vehicle, wherein said angle of departure is a data comprised in the signal broadcasted by the BLE beacon and characterizing an angle of transmission of the broadcasted signal, and the angle of arrival is a data measured by the BLE gateway capturing said broadcasted signal and configured for defining an angle of reception of the broadcasted signal.

According to another preferred embodiment, the position of an identified guided vehicle is determined by the control subsystem from at least two sets of data that have been associated to said identified guided vehicle, wherein the two measured intensities values comprised each in one of said two sets of data are a first intensity value measured by a first BLE gateway for a signal broadcasted by a first BLE beacon and a second intensity value measured by said first BLE gateway for a signal broadcasted by a second BLE beacon located at a predefined position different from the position of the first BLE beacon, wherein the first intensity values and the second intensity values have been preferentially acquired at a same time. In particular, the control subsystem is configured for determining said position of the guided vehicle from three intensity values, namely said first intensity value, said second intensity value, and a third intensity value, all preferentially acquired at a same time, wherein the third intensity value is measured by said first BLE gateway for a signal broadcasted by a third BLE beacon located at a predefined position different from the predefined position of the first BLE beacon and second BLE beacon, the control subsystem being configured for using said third intensity value for improving the position of the guided vehicle. In the above-mentioned case, the BLET2 are preferentially said BLE beacons.

According to another preferred embodiment, the position of an identified guided vehicle is determined by the control subsystem from at least two sets of data that have been associated to said identified guided vehicle, wherein the two intensities values comprised each in one of said two sets of data are a first intensity value measured by a first BLE gateway for a signal broadcasted by a first BLE beacon and a second intensity value measured by a second BLE gateway for a signal broadcasted by said first BLE beacon, wherein the first BLE gateway is located at a predefined position different from the position of the second BLE gateway, wherein the first intensity values and the second intensity values have been preferentially acquired at a same time. In particular, the control subsystem is configured for determining said position from three intensity values, namely said first intensity value, said second intensity value, and a third intensity value, all preferentially acquired at a same time, wherein the third intensity value is measured by a third BLE gateway for the signal broadcasted by said first BLE beacon, wherein the third BLE gateway is located at a predefined position different from the predefined position of the first BLE gateway and second BLE gateway, the control subsystem being configured for using said third intensity value for improving the position of the guided vehicle. In the above-mentioned case, the BLET2 are preferentially said BLE gateways.

Preferentially, the signal broadcasted by each BLE beacon further comprises a first broadcasted channel and a second broadcasted channel, wherein the first broadcasted channel is configured for encoding said information data in a first format (typically in TRUE format) and the second

broadcasted channel is configured for encoding said information data in a second format (typically COMPLEMENT format) different from the first format, in addition each of said channels includes a CRC code over said information data for avoiding corruption, and wherein the control subsystem is configured for automatically checking the CRC codes and then comparing the information data comprised in said channels and for implementing integrity and/or coherence checking based on said comparison and check. In particular, if the information data encoded in the first format is different from the information data encoded in the second format, then the control subsystem is configured for automatically discarding said information data and the measured intensity for the signal received by the BLE gateway, and starts a determination of a new position for the guided vehicle based on another, e.g. a next, set of data it received from the same BLE gateway and/or from another BLE gateway.

The present invention further enables to check the integrity of the guided vehicle. For instance, two BLET1 might be configured for being installed on-board the guided vehicle, each at a different extremity of said guided vehicle, and the control subsystem is configured for checking the integrity of the guided vehicle from a calculation of a distance separating the respective position of said two BLET1 at a given time. According to another example, at least one additional BLET2 is configured for being installed on-board the guided vehicle, wherein at least one BLET1 of said set of one or several BLET1 and the additional BLET2 are configured for being installed each at a different extremity of said guided vehicle, and the control subsystem is configured for checking the integrity of the guided vehicle from a calculation of a distance separating the position of BLET1 from the position of the additional BLET2.

Brief Description of the Drawing

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

Fig. 1 schematic illustration of a first preferred embodiment of a system according to the invention.

Fig. 2 schematic illustration of a second preferred embodiment of a system according to the invention.

Fig. 3 schematic illustration of a third preferred embodiment of a system according to the invention.

Fig. 4 flowchart of a preferred embodiment of a method according to the invention.

Description of Examples

A preferred embodiment of a system 100 according to the invention is illustrated in Figure 1. Said system 100 comprises a set of one or several BLE devices of a first type, namely said BLET1 101, and a set of several BLE devices of a second type, namely said BLET2 102, and a control subsystem 103. The latter is configured for determining the position of one or several guided vehicles 1 that are configured for moving on tracks 2 of a railway network.

According to the present invention, said one or several BLET1 101 of said set of BLET1 might be either all BLE gateways, which are schematically represented by a black rectangle in the Figures 1-3 or all BLE beacons, which are schematically represented by a triangle in the Figures 1-3. In other words, all BLET1 of said set of BLET1 are either BLE gateways, or BLE beacons. If said one or several BLET1 of said set are BLE gateways, then all BLET2 of the set of BLET2 are BLE beacons, and inversely if all BLET1 of the set of BLET1 are BLE beacons, then all BLET2 of the set of BLET2 are BLE gateways. According to the present invention, a set of BLET1 comprising at least one BLET1 101 is installed on-board each guided vehicle 1 whose position has to be determined by the system 100 (i.e. each guided vehicle comprising thus at least one of BLET1 installed on-board), and said several BLET2 102 of said set of BLET2 are installed each at a predefined position along the track 2. All BLET2 of the set have a different predefined position, and all BLET1 installed on-board a same guided vehicle have also a different predefined position, that is the predefined position of a BLET2 of said set is always different from the predefined position of another BLET2 of said set, and likewise, the predefined position of a BLET1 of a set of BLET1 installed on-board a guided vehicle is always different from the predefined position of another BLET1 of said set of BLET1 installed on-board said guided vehicle. Preferentially, each or some of the BLE beacons comprises a motion sensor used for adapting the frequency at which its signal is broadcasted in function of a guided vehicle motion detection. The motion sensor of a beacon installed along the track is configured for detecting an arrival of the guided vehicle within a detection zone of the BLE beacon and a departure of said guided vehicle from said detection zone. The motion sensor of a beacon installed on-board a guided vehicle is configured for detecting a start and an end of the motion of said guided vehicle. Upon detection of a guided vehicle motion via its motion sensor, the BLE beacon is configured for increasing the frequency its signal is broadcasted (e.g. upon detection of the arrival of a guided vehicle in the detection zone of a BLE beacon installed along the track, or upon detection of a start of the motion of the guided vehicle carrying the BLE beacon comprising such motion sensor), and for decreasing said frequency at which said signal is broadcasted when no guided vehicle motion is detected (e.g. said frequency is decreased once the BLE beacon detects via its motion sensor that the guided vehicle whose arrival has been

previously detected has left the detection zone, or said frequency is decreased when the on-board BLE beacon detects no motion of the guided vehicle carrying it). In particular, if no motion is detected, then the BLE beacon may stop broadcasting its signal, or, preferentially and for safety reason, may keep broadcasting said signal, but at a lower frequency compared to the frequency used when a guided vehicle motion is detected. By this way, the battery life of each BLE beacon might be increased. The system might thus save energy by providing a smart use of the BLE beacons, resulting in a reduction of maintenance activities, as well as a cost reduction.

As shown in Fig. 1-3, different configurations are thus considered by the present invention. For instance, according to Fig. 1, each BLET1 of the set of BLET1 installed on-board the guided vehicle is a BLE gateway, while each BLET2 of the set of BLET2 is a BLE beacon. According to Fig. 2, each BLET1 of the set of BLET1 installed on-board the guided vehicle is a BLE beacon, and each of said BLET2 of the set of BLET2 installed along the track 2 is a BLE gateway. Of course, other embodiments are covered by the present invention as illustrated in Fig. 3, wherein in addition to the BLET1 of said set of BLET1 installed on-board the guided vehicle 1 and the set of BLET2 installed along the track 2, the system 100 comprises at least one additional BLET2 102' also installed on-board said guided vehicle. This means, that the system comprises a BLE beacon and a BLE gateway both installed on-board the guided vehicle, preferentially each at a different extremity of the guided vehicle according to the length of the latter. Similarly, in addition to the set of BLET2 102 installed along the track 2, and apart from the set of one or several BLET1 101 installed on-board, one or several additional BLET1 101' might also be installed along said track 2, so that the system comprises BLE beacons and BLE gateways installed along tracks of the railway network.

As illustrated in Fig. 1-3, the BLET1 of the set of BLET1 101 are installed on-board the guided vehicle 1 and thus moving with it according to a direction F of displacement with respect to the track 2. As the guided vehicle 1 is moving on the track 2, each BLET1 of said set of BLET1 installed on-board will successively approach, cross, and move away from each of the BLET2 installed along the track, enabling each time it approaches, crosses and moves away an interaction with a different BLET2, wherein the signal broadcasted by the BLE beacon is captured by the BLE gateway. The interaction zone between a BLET1 installed on-board and a BLET2 installed along the track, i.e. between a BLE beacon and a BLE gateway, will notably depend on the broadcasted signal strength. Preferentially, an interaction zone between a BLET1 and a BLET2 (i.e. the zone in which a BLE gateway is able to receive a BLE beacon broadcasted signal) may cover the interaction zone of said BLET1 with another BLET2.

According to the present invention, each BLE beacon is configured for broadcasting a signal encoding information data comprising at least a unique identifier and optionally a power level data. The unique identifier enables the system according to the invention to identify the BLE beacon broadcasting said signal and the optional power level data is configured for encoding the power level used for transmitting said signal. Typically, the control subsystem 103 is able to determine, from an intensity value measured by said BLE gateway when receiving the signal broadcasted by a BLE beacon and optionally said power level data characterizing the power level at which the broadcasted signal has been transmitted, a (relative) distance separating at a time Ti (which corresponds to the time at which the broadcasted signal was received or its intensity value measured by the BLE gateway) the position of the BLE gateway that received said signal from the position of the BLE beacon which broadcasted said signal. This "distance determination" enabled by each couple BLE beacon-BLE gateway may provide a rough determination of the position of the identified guided vehicle. In order to ensure a safe determination of the position of the guided vehicle, the present invention proposes to take account of the predefined position of each BLET1 when determining said position of the guided vehicle, wherein said predefined position of each BLET1 is preferably used as a positional constraint when determining the position of the BLET1 with respect to the BLET2, and thus of the guided vehicle. According to the present invention, the control subsystem 103 is preferentially configured for storing each predefined position BLET1 and BLET2 that are used when determining the position of the guided vehicle in a memory or database of the system. Preferentially, the control subsystem 103 is further configured for using a map of the railway network for imposing, from the predefined position of the BLET1, said positional constraint on the position of the BLET1 with respect to the predefined position of the BLET2 on said map, and therefore for applying said positional constraint to the guided vehicle when assessing or determining its position.

Typically, said map comprises the predefined positions of the BLET2, and the track position or a representation of the real trajectory followed by the BLET1. Indeed, to each BLET1 installed on-board a guided vehicle, the control subsystem may assign, notably from said map, a real trajectory which defines the position of the BLET1 with respect to the predefined positions of the BLET2 along the track, wherein, when calculating said distance separating a BLET1 from a BLET2, the control subsystem is configured for assigning to the BLET1 a position on its real trajectory that is at said calculated distance from the BLET2. Said position on the real trajectory might be improved by using the angle of arrival and/or angle of departure, which might be transmitted in said set of data to the control subsystem. Using said angles for improving the precision of a position is known in the art and does not need further explanations here. Alternatively, or additionally, a distance separating said BLET1 from a second BLET2 might be

used for improving the precision of said position on the real trajectory. According to the present invention, each BLE gateway is assigned a unique identifier and is configured for acquiring or receiving the signal broadcasted by any BLE beacon according to the invention, once the latter is sufficiently close for the broadcasted signal to be detected by the BLE gateway (i.e. once they are in said interaction zone).

In connection with Figure 4, the principles of the present invention for safely determining the position of a guided vehicle will be described in more detail hereafter.

At step 401, at least one BLE gateway receives a signal broadcasted by a BLE beacon. In the example of Fig. 1, a BLE gateway installed on-board may receive a signal broadcasted by a BLE beacon located along the track. In the example of Fig. 2, a BLE gateway located along the track may receive a signal broadcasted by a BLE beacon installed on-board. According to Fig. 3, the two previous configurations might be merged together. In any case, each BLE gateway receiving such a broadcasted signal from a BLE beacon, wherein said BLE gateway and said BLE beacon are notably in relative motion with respect to one another, is configured for measuring an intensity of the received signal.

At step 402, the BLE gateway having received said broadcasted signal and measured its intensity value transmits to the control subsystem 103 a set of data comprising:

- the intensity value measured for said received signal;
- optionally, the power level data comprised in the received signal and thus associated to said measured intensity value;
- a time of measurement of said intensity value (i.e. the time at which said measurement was made or the time at which said broadcasted signal was received);
- the unique identifier of the BLE beacon that broadcasted said received signal;
- its own unique identifier (i.e. the unique identifier of the BLE gateway having performed said measurement of the intensity value);
- optionally, an angle of departure and/or an angle of arrival.

In other words, the BLE gateway preferentially sends to the control subsystem 103, using for instance radio communication, a set of data comprising the information data (forwarding thus the latter to the control subsystem, wherein said information data may comprise the angle of departure) associated to the measured intensity value of the received signal, the time at which the signal was measured or received, its identifier, and optionally the angle of arrival.

At step 403, the control subsystem 103 receives the set of data transmitted by the BLE gateway. The control subsystem 103 centrally receives thus all sets of data that are transmitted

by all BLE gateways of the system 100. Depending on the size of the railway network and the number of guided vehicles, it may receive several of said sets at the same time and/or consecutively different sets of said data.

At step 404, the control subsystem 103 associates, to each set of data it received, a single one of said guided vehicles. For identifying the guided vehicle to be associated to a received set of data, the control subsystem 103 might store in a memory or database a list configured for identifying each guided vehicle from the unique identifier of at least one of the BLE devices installed on-board the concerned guided vehicle 1, e.g. from the unique identifier of one of the BLE gateways installed on board the guided vehicle 1 of Fig. 1, or from the unique identifier of at least one of the BLE beacons installed on board the guided vehicle 1 of Fig. 2. Consequently, the control subsystem 103 is able to identify to which guided vehicle the received set of data corresponds to by identifying at least one of the BLET1 installed on-board the guided vehicle.

At step 405, the control subsystem 103 automatically determines a position of each identified guided vehicle on the track 2 of the railway network from at least one set of data that has been received for the identified guided vehicle, wherein for each set of data received for the guided vehicle, the control subsystem 103 uses data comprised in said set of data together with the predefined position of the BLET1 and of the BLET2 that are associated to said set of data for inferring the position of the guided vehicle, wherein the predefined position of the BLET1 is in particular used for applying a positional constraint to the position of the guided vehicle when inferring its position.

Indeed, and preferably, for an identified guided vehicle, the control subsystem 103 is configured for using the data comprised in each set of data associated to the identified guided vehicle for inferring its position. In particular, the control subsystem may use one or several sets of data for inferring the position of the guided vehicle, notably at least two sets of data comprising intensity values that have been measured at a same time, and/or at least two sets of data comprising each an intensity value that has been measured at a different time. For each set of data, the distance separating the position of the BLET1 from the position of the BLET2 that are associated to said set of data might be determined, and said distance, or said distances if they are determined for several sets of data, like said two sets of data, are used by the control subsystem, together with the predefined position of the BLET1, for determining the position of the guided vehicle. Preferentially, the control subsystem may use a map configured for mapping the tracks of the railway network and for representing the predefined position of the BLET2 (e.g. comprising coordinates of each BLET2 and coordinates of the track) for determining, from said predefined position of the BLET1, a positional constraint for the position of the BLET1 with

respect to the BLET2 when determining a position of the BLET1 from the distance separating the BLET1 from the BLET2.

Preferentially, the control subsystem 103 may infer the position of the guided vehicle from at least two of said measured intensity values and, optionally, their respectively associated power level data that have been received in connection with the identified guided vehicle. Preferentially, said two measured intensity values have been acquired within a predefined temporal window, i.e. a first measurement taking place at time T1 and a second measurement taking place at a time T2, wherein T1, T2 belong to said predefined temporal window, wherein broadcasted signal intensity value measurements take place within each predefined temporal window. According to the invention, predefined temporal windows might succeed each other according to a predefined pattern, and preferentially, the broadcasted signal might be repeatedly acquired within each predefined temporal window, so that during each of said predefined temporal windows at least two measurements of the intensity of the broadcasted signal take place.

Basically, the control subsystem is configured for using the predefined position of the BLET1 and of the BLET2 for determining the position of the guided vehicle, for instance of the front end of the guided vehicle and/or of the rear end of the guided vehicle. The predefined position of each BLET1 installed on-board a guided vehicle is defined with respect to the guided vehicle taken as reference frame, i.e. with respect to the guided vehicle reference frame. The predefined position of each BLET2 is defined with respect to the track of the railway network taken as reference frame, called hereafter the track reference frame. Thus, the control subsystem will typically determine the relative position of a BLET1 with respect to a BLET2, assigning to the BLET1 a determined location at a time Ti, wherein said determined location at time Ti is defined in the track reference frame, enabling thus to locate the BLET1 in said track reference frame at time Ti, preferentially on a real trajectory that is assigned to the BLET1 from a knowledge of its predefined position with respect to the guided vehicle and the knowledge of the guided vehicle trajectory defined by the tracks. Said determined location at time Ti might be then associated to the position of the guided vehicle at time Ti in said track reference frame. Optionally, for more precision, the control subsystem may further calculate the position of a relevant part of the guided vehicle, e.g. the position of its front end and/or rear end, from the determined location of the BLET1 at said time Ti and a distance separating the predefined position of the BLET1 which was located at said determined location at time Ti from said relevant part. By this way, the control subsystem may determine the position of the front end and/or rear end of a guided vehicle at a time Ti with respect to said track reference frame.

For instance, the control subsystem 103 might be configured for using two measured intensity values acquired by a same BLE gateway for a signal broadcasted by a same BLE beacon for determining the position of the BLE gateway with respect to the BLE beacon. For instance, the signal broadcasted by the BLE beacon (which can be either installed on-board, or along the track) is acquired at two different successive times T1 and T2 (with T2>T1) by the same BLE gateway (which would then be located either along the track or on-board respectively) giving rise to two different intensity values M1 and M2. From M1 and optionally the power level data, the control subsystem is able to determine a distance D1 separating the BLE beacon from the BLE gateway at the time T1. From M2 the control subsystem is able to determine a distance D2 separating the BLE beacon from the BLE gateway at the time T2. However, the position is not yet precisely defined. For instance, for a guided vehicle approaching the BLE beacon installed along a track, one does not know yet if the guided vehicle already crossed the BLE beacon and is located downstream the latter at time T2 or if it is located upstream the latter at said time T2. In order to solve this issue and improve the precision, the control subsystem 103 might be configured for implementing different solutions, which can be combined with each other for improving the safety of the determination of the position of the guided vehicle.

According to a first solution, the control subsystem might be configured for acquiring, at least during said predefined temporal window, in real time and in function of the time, the speed of the guided vehicle whose position has to be determined. From said speed of the guided vehicle versus time, the control subsystem is configured for automatically calculating an average speed of the guided vehicle during said predefined temporal window, and to automatically determine whether, at said time T2, the BLE device installed on-board already passed or crossed the BLE device installed along the track from the knowledge of said average speed and notably by using the latter for determining a maximal distance that can be travelled by the guided vehicle during the lapse of time separating T2 from T1, and automatically determining, according to said maximal distance, whether the BLE device installed along the track has already been crossed or not at time T2 by the BLE device installed on-board, determining thus whether the BLE device installed on-board is located upstream or downstream the BLE device located along the track.

According to a second solution, the intensity of the signal broadcasted by said BLE beacon is continuously measured in function of the time, during said predefined temporal window, between the time T1 and the time T2, storing the values of said intensity in function of the time during a time interval [T1,T2], the control subsystem being further configured for automatically searching, within said time interval, a maximum value M3 of the measured intensity between the time T1 and the time T2. If such a maximum value M3 exists, then the distance separating the

BLE gateway from the BLE beacon reached a minimum, meaning that at time T1, the BLE device installed on-board the guided vehicle was upstream (with respect to the motion of the guided vehicle) the BLE device installed along the track, and at time T2, the BLE device installed on-board was then downstream the BLE device installed along the track Otherwise, it was always upstream if M1<M2, or downstream if M1>M2 (with the assumption that the measurement at T1 takes place before the measurement at T2). By this way, the control subsystem might rapidly determine whether the BLE device installed on board and the BLE device installed along the track crossed each other or not, enabling thus to precisely determine the position of the guided vehicle.

According to a third solution, the encoded information data comprised within the signal broadcasted by the BLE beacon further comprise an angle of departure that geometrically characterizes the transmission direction (i.e. the angle of transmission) of the signal broadcasted by the BLE beacon. The BLE gateway might then be configured for automatically measuring an angle of arrival of the signal broadcasted by the BLE beacon, i.e. the angle according to which the broadcasted signal is received by the BLE gateway (using typically phase differences with respect to the reception of said broadcasted signal by different antennas of an antenna array of the BLE gateway). According to said third solution, the angle of departure and/or the angle of arrival are automatically transmitted by the BLE gateway to the control subsystem 103. The latter acquires thus for a couple comprising a transmitter, i.e. the BLE beacon, and a receiver, i.e. said BLE gateway, an angle of departure and/or arrival of the signal broadcasted by the BLE beacon and its intensity value measured at time T1, and an angle of departure and/or arrival of the broadcasted signal and its intensity value measured at time T2, improving the determination of the position of the BLE gateway with respect to the position of the BLE beacon by taking into account at least one of said angles of arrival and/or departure, notably for each of said measured intensity values at time T1 and T2. This enables to improve the determination of the position of the guided vehicle.

Alternatively, a same BLE gateway may measure at a same time the intensity values of two or more broadcasted signals, each of said broadcasted signals being broadcasted by a different BLE beacon, which are in this case located along the track. By determining the distance separating at said time the BLE gateway from each of said different BLE beacons whose broadcasted signal intensity has been measured by said BLE gateway at said same time and then transmitted to the control subsystem, the latter may precisely determine the position of the BLE gateway with respect to said BLE beacons, using for instance triangulation techniques, and notably the previously explained positional constraint. This enables the control subsystem to determine the location of the BLE gateway in the track reference, and thus the position of the

guided vehicle or any relevant part of the latter as explained earlier. The same applies mutatis mutandis when considering several BLE gateways installed along the track and acquiring at a same time the signal broadcasted by a same or single BLE beacon installed on-board the guided vehicle. The control subsystem may again determine for each BLE gateway a distance separating the BLE gateway from the single BLE beacon at said same time, and by using triangulation technique, determine the position of the BLE beacon with respect to the BLE gateways. Once the position of the BLE device installed on-board the guided vehicle known with respect to the position of the BLE device installed along the track, the position of any relevant part of the guided vehicle (e.g. front end) might be determined by the control subsystem from knowledge of the predefined position of said BLE device installed on-board and a distance (measured for instance along the length of the guided vehicle) separating the on-board BLE device from said relevant part. Of course, the previously mentioned ways of determining the position of a BLE gateway with respect to a BLE beacon might be combined for improving the determination of the position of the guided vehicle.

Preferentially, apart from the set of BLET2 installed along the track 2, at least one additional BLET2 102' is installed on-board the guided vehicle 1 as shown in Fig. 3. In this case, the system according to the invention comprises at least one BLE gateway installed on-board and at least one BLE beacon installed on-board. Preferentially, the BLE gateway installed at one extremity of the guided vehicle according to its length and the BLE beacon is installed at the other one extremity. For instance, the BLE beacon might be installed on the last car of a guided vehicle comprising multiple cars and the BLE gateway might be installed on the first car, or inversely. According to the present invention, the BLE gateway installed on-board is configured for measuring the intensity of the signal broadcasted by said BLE beacon installed on-board and for sending to the control subsystem said set of data which comprises then a measured value M4 of said intensity of the signal broadcasted by the BLE beacon installed on-board, optionally its power level data, the unique identifier of said BLE beacon, a time of measurement, and its own unique identifier if not already part of the set of data. The control subsystem is configured for automatically calculating, from said intensity value M4 and, optionally, the power level data, a distance separating the BLE beacon from the BLE gateway. Said distance is then compared to a reference distance by the control subsystem in order to verify the integrity of the guided vehicle. For instance, if said distance is outside of a range of distances defined from the reference distance, then the control subsystem may automatically generate an alert. Alternatively or additionally, the control subsystem 103 might be further configured for determining the integrity of the guided vehicle by calculating the distance separating the determined location of two BLE gateways installed on board, each at a different extremity of the guided vehicle (e.g. one on the first car and the other one on the last car), or separating the

determined location of two BLE beacons installed on board, each at a different extremity of the guided vehicle (e.g. one on the first car and the other one on the last car), and by comparing, as explained earlier, said calculated distance to the reference distance. Preferentially, if a divergence greater than a predefined divergence value occurs, then an alert might be automatically triggered by the control subsystem. In other words, the control subsystem might be configured for calculating the distance separating the position of two BLET1 installed each at a different extremity of the guided vehicle for checking the integrity of the guided vehicle, wherein the position of each of said BLET1 is determined by the control subsystem from an intensity value measured by the BLE gateway of the couple of BLE devices comprising the concerned BLET1 and a BLET2 (called hereafter its associated BLET2), the control subsystem calculating from said measured intensity value the distance separating the concerned BLET1 from its associated BLET2, using the predefined position of the BLET1 for applying a positional constraint to the position of the BLET1, notably with respect to the track position, for instance by constraining the position or location of the BLET1 on a real trajectory that is defined in function of the track trajectory, and using the position of both BLET1 for determining the distance separating them.

It has to be finally pointed out that, for each couple of BLET1 and BLET2, the control subsystem is able to determine from a temporal evolution of the value of the measured intensity a parameter indicating whether the guided vehicle is approaching the BLET2 or moving away from it, i.e. said parameter being typically a moving direction, said parameter being preferentially used by the control subsystem when determining the position of a BLET1 with respect to a BLET2 notably on said real trajectory, and preferentially together with a use of said angle of departure and angle of arrival for determining said position of the BLET1. This enables to infer a very precise position for the guided vehicle, by notably locating on said real trajectory a position for the BLET1 at the calculated distance from the BLET2 that matches the guided vehicle approaching the BLET2 or moving away from it.

To conclude, the present invention proposes a new way of locating a guided vehicle within track of a railway network, based on the use of BLE beacons and BLE gateways, that is easy to implement, very flexible in that it can be adapted to any configuration of the railway network and guided vehicle. According to the present invention, tracks of a railway network might be equipped by said set of BLET2 and each guided vehicle configured for moving on said tracks of the railway network might be equipped with said set of BLET1, wherein all BLET1 of all sets of BLET1 are either BLE beacons or BLE gateways, and all BLET2 of the set of BLET2 are BLE beacons if the BLET1 of all sets of BLET1 are BLE gateways, and BLE gateways if the BLET1 of all sets of BLET1 are BLE beacons. Finally, the present invention concerns also such a

railway network comprising tracks and guided vehicles configured for moving on said tracks, wherein said railway network comprises the system according to the invention.

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Claims

1. System (100) for locating one or several guided vehicles (1) on a track (2) of a railway network, said system (100) comprising:
   - a control subsystem (103) configured for locating each of said one or several guided vehicles (1);
   - BLE devices of two types, namely a BLE device of a first type, called hereafter BLET1 (101), and a BLE device of a second type, called hereafter BLET2 (102), wherein BLET1 (101) is either a BLE gateway or a BLE beacon, wherein if BLET1 (101) is a BLE gateway, then BLET2 (102) is a BLE beacon, and if BLET1 (101) is a BLE beacon, then BLET2 (102) is a BLE gateway, wherein each BLE beacon is configured for broadcasting a signal encoding information data comprising at least a unique identifier, wherein the unique identifier is configured for identifying the BLE beacon broadcasting said signal, and wherein each BLE gateway is assigned a unique identifier and is configured for acquiring said signal;
   - for each guided vehicle (1), a set of one or several BLET1 (101), each BLET1 (101) of said set being configured for being installed at a predefined position on-board the guided vehicle (1);
   - a set of BLET2 (102), wherein each BLET2 (102) of said set is configured for being installed at a predefined position along said track (2);
   - wherein, upon reception of a signal broadcasted by a BLE beacon, each BLE gateway is configured for measuring an intensity of the received signal, and for transmitting in real time to the control subsystem(103) a set of data comprising the intensity value measured for said received signal, a time of measurement of said intensity value, the unique identifier of the BLE beacon that broadcasted said received signal, and its unique identifier, each set of data being thus associated to a couple of BLET1 and BLET2 comprising the BLE gateway that measured said intensity value comprised in the set of data and the BLE beacon that broadcasted the signal for which said measured intensity value comprised in the set of data has been measured;
   - the control subsystem (103) is configured for receiving each set of data, for associating to each set of data a single one of said one or several guided vehicles (1) by identifying the guided vehicle (1) to be associated from at least one unique identifier comprised in said received set of data, and for automatically determining a position of each identified guided vehicle (1) on the track (2) of the railway network;

characterized in that for each identified guided vehicle, the control subsystem (103) is configured for determining said position from at least one set of data s that has been received in connection with the identified guided vehicle, wherein for each set of data, the measured intensity value comprised in the set of data, the predefined position of the BLET1 and of the BLET2 which are associated to the concerned set of data are used by the control subsystem (103) for determining said position of the guided vehicle.

2. System (100) according to claim 1, wherein the measured intensity value is used for determining a distance separating the BLE beacon from the BLE gateway at said time of measurement, the position of the guided vehicle being inferred from said distance, taking into account the predefined position of the BLET2 and the predefined position of the BLET1, wherein the predefined position of the BLET1 is used by the control subsystem (103) as a positional constraint for determining a position of the BLET1 at said distance from the BLET2 at said time of measurement and which is comprised on a real trajectory followed by said BLET1.

3. System (100) according to claim 1 or 2, wherein each or some of the BLE beacons comprises a motion sensor used for adapting the frequency at which its signal is broadcasted in function of a guided vehicle motion detection.

4. System (100) according to one of the claims 1 to 3, wherein the control subsystem (103) is configured for determining said position from at least two sets of data that have been associated to the identified guided vehicle, wherein the two intensity values comprised each in one of said two sets of data have been measured by a same BLE gateway at different times within a predefined temporal window for a signal broadcasted by a same BLE beacon, and wherein a guided vehicle average speed during said predefined temporal window and/or a third intensity value measured by said same BLE gateway for said signal broadcasted by said same BLE beacon are further used for determining or improving said position.

5. System (100) according to one of the claims 1 to 3, wherein the control subsystem (103) is configured for determining said position from at least two sets of data that have been associated to the identified guided vehicle, wherein the two intensities values comprised each in one of said two sets of data are a first intensity value measured by a first BLE gateway for a signal broadcasted by a first BLE beacon and a second intensity value

measured respectively either by said first BLE gateway for a signal broadcasted by a second BLE beacon located at a predefined position different from the predefined position of the first BLE beacon or by a second BLE gateway for the signal broadcasted by said first BLE beacon, wherein said second BLE gateway is located at a predefined position different from the first BLE gateway, wherein the first intensity values and the second intensity values have been preferentially acquired at a same time.

6. System (100) according to claim 5, wherein the control subsystem (103) is configured for determining said position of the identified guided vehicle from three intensity values, namely said first intensity value, said second intensity value, and a third intensity value, wherein the third intensity value is measured respectively either by said first BLE gateway for a signal broadcasted by a third BLE beacon located at a predefined position different from the predefined position of the first BLE beacon and second BLE beacon, or by a third BLE gateway for the signal broadcasted by said first BLE beacon, wherein said third BLE gateway is located at a predefined position different from the predefined position of the first and second BLE gateways, the control subsystem (103) being configured for using said third intensity value for improving the position of the identified guided vehicle.

7. System (100) according to one of the claims 1 to 6, wherein said signal broadcasted by each BLE beacon further comprises a first broadcasted channel and a second broadcasted channel, wherein the first broadcasted channel is configured for encoding said information data in a first format and the second broadcasted channel is configured for encoding said information data in a second format different from the first format, each of said channels including a CRC code over the sent information data for avoiding corruption, and wherein the control subsystem (103) is configured for automatically checking said CRC codes, and for comparing the information data comprised in said channels and for implementing integrity and/or coherence checking based on said comparison and check.

8. System (100) according to one of the claims 1 to 7, wherein two BLET1 (101) are configured for being installed on-board the guided vehicle (1), each at a different extremity of said guided vehicle (1), and the control subsystem is configured for checking an integrity of the guided vehicle from a calculation of a distance separating the respective position of said two BLET1 (101) at a given time.

9. System (100) according to one of the claims 1 to 8, wherein at least one additional BLET2 (102') is configured for being installed on-board the guided vehicle, wherein at least one BLET1 (101) of the set of BLET1 and said at least one additional BLET2 (102') are configured for being installed each at a different extremity of said guided vehicle (1), and the control subsystem (103) is configured for checking an integrity of the guided vehicle (1) from a calculation of a distance separating the position of said at least one BLET1 (101) from the position of the additional BLET2 (102').

10. Method for locating guided vehicles (1) on a track (2) of a railway network by means of a system (100) comprising a control subsystem (103) and BLE devices of two types, namely a BLE device of a first type, called hereafter BLET1 (101), and a BLE device of a second type, called hereafter BLET2 (102), wherein BLET1 (101) is either a BLE gateway or a BLE beacon, wherein if BLET1 (101) is a BLE gateway, then BLET2 (102) is a BLE beacon, and if BLET1 (101) is a BLE beacon, then BLET2 (102) is a BLE gateway, wherein each BLE beacon is configured for broadcasting a signal encoding information data comprising at least a unique identifier, wherein the unique identifier is configured for identifying the BLE beacon broadcasting said signal, and wherein each BLE gateway is assigned a unique identifier and is configured for acquiring said signal, wherein a set of one or several BLET1 (101) is installed on-board each guided vehicle, each BLET1 (101) at a predefined position on-board the guided vehicle whose location has to be determined, and wherein each BLET2 (102) of a set of BLET2 (102) is installed at a predefined position along said track (2), the method comprising:
    - receiving (401) by at least one BLE gateway a signal broadcasted by a BLE beacon and measuring by each BLE gateway having received such a broadcasted signal an intensity of the received signal;
    - transmitting (402) in real time, by each BLE gateway having received a broadcasted signal and to the control subsystem (103), a set of data comprising the intensity value measured for said received signal, a time of measurement of said intensity value, the unique identifier of the BLE beacon that broadcasted said received signal, and its unique identifier, each set of data being thus associated to a couple of BLET1 and BLET2 comprising the BLE gateway that measured said intensity value comprised in the set of data and the BLE beacon that broadcasted the signal for which said measured intensity value comprised in the set of data has been measured by the BLE gateway;
    - receiving (403) by the control subsystem (103) each set of data transmitted by the BLE gateway(s);

- associating (404), by the control subsystem (103), a single one of said guided vehicles to each set of data by identifying the guided vehicle to be associated from at least one unique identifier comprised in said received set of data;
- automatically determining (405), by the control subsystem (103), a position of each identified guided vehicle (1) on the track (2) of the railway network;

the method being characterized in that it comprises

- for each identified vehicle (1), determining said position from at least one set of data that has been received in connection with the identified guided vehicle, wherein, for each set of data, the measured intensity value comprised in the set of data, the predefined position of the BLET1 and the predefined position of the BLET2 which were associated to the concerned set of data are used by the control subsystem (103) for determining said position of the identified guided vehicle.

11. Method according to claim 10, wherein said position is determined from at least two sets of data that have been associated to the identified guided vehicle, wherein the two intensity values comprised each in one of said two sets of data have been measured by a same BLE gateway at different times within a predefined temporal window for a signal broadcasted by a same BLE beacon, and wherein an average speed of the identified guided vehicle during said predefined temporal window and/or a third intensity value measured by said same BLE gateway for said signal broadcasted by said same BLE beacon are further used for determining or improving said position.

12. Method according to claim 10 or 11, wherein the set of data further comprises an angle of arrival and/or an angle of departure, the method comprising using, by the control subsystem (103), said angle of arrival and/or angle of departure for improving the precision of the position of the identified guided vehicle, wherein said angle of departure is a data comprised in the signal broadcasted by the BLE beacon and characterizing an angle of transmission of the broadcasted signal, and the angle of arrival is a data measured by the BLE gateway capturing said broadcasted signal and configured for defining an angle of reception of the broadcasted signal.

13. Method according to claim 10, wherein said position is determined from at least two sets of data that have been associated to the identified guided vehicle, wherein the two intensities values comprised each in one of said two sets of data are a first intensity value measured by a first BLE gateway for a signal broadcasted by a first BLE beacon and a second intensity value measured by said first BLE gateway for a signal

broadcasted by a second BLE beacon located at a different position from the position of the first BLE beacon, wherein the first intensity values and the second intensity values have been preferentially acquired at a same time.

14. Method according to claim 13, comprising determining, by the control subsystem (103), said position from three intensity values, namely said first intensity value, said second intensity value, and a third intensity value, wherein the third intensity value is measured by said first BLE gateway for a signal broadcasted by a third BLE beacon located at a different position from the position of the first BLE beacon and second BLE beacon, the method comprising using said third intensity value for improving the position of the identified guided vehicle.

15. Method according to one of the claims 10 to 14, wherein said signal broadcasted by each BLE beacon further comprises a first broadcasted channel and a second broadcasted channel, the method comprising using the first broadcasted channel for encoding said information data in a first format and using the second broadcasted channel for encoding said information data in a second format different from the first format, and automatically comparing, by the control subsystem (103), the information data comprised in said channels and implementing, based on said comparison, an integrity and/or coherence checking.

16. Method according to one of the claims 10 to 15, comprising checking an integrity of the guided vehicle from a calculation of a distance separating at a given time the respective position of two BLET1 (101) installed on-board the guided vehicle, each at a different extremity of said guided vehicle, and/or the position of the BLET1 (101) from the position of an additional BLET2 (102') installed on-board the guided vehicle (1), wherein the BLET1 (101) and the additional BLET2 (102') are installed each at a different extremity of said guided vehicle (1).