



(12) **DEMANDE DE BREVET CANADIEN**
CANADIAN PATENT APPLICATION

(13) **A1**

(22) Date de dépôt/Filing Date: 2021/08/23

(41) Mise à la disp. pub./Open to Public Insp.: 2022/02/24

(30) Priorité/Priority: 2020/08/24 (IN202011036380)

(51) Cl.Int./Int.Cl. *B61L 23/34* (2006.01)

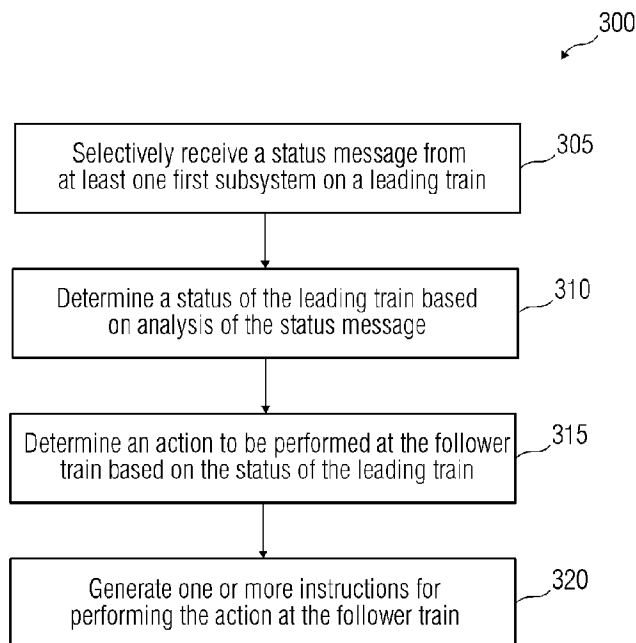
(71) Demandeur/Applicant:
SIEMENS MOBILITY, INC., US

(72) Inventeur/Inventor:
PIPARSANIYA, HARSH, IN

(74) Agent: SMART & BIGGAR LLP

(54) Titre : PREVENTION DES COLLISIONS ENTRE LES TRAINS

(54) Title: PREVENTION OF COLLISION BETWEEN TRAINS



(57) **Abrégé/Abstract:**

A system and method for preventing collision between a first train and a second train is disclosed herein. The system comprises at least one first subsystem installed on a first train. The at least one first subsystem is configured to broadcast broadcast messages indicative of a status of the first train. The system further comprises at least one second subsystem installed on a second train configured to selectively receive the broadcast message from the at least one first subsystem on the first train. The second subsystem determines the status of the first train by analysing the broadcast message. Further, an action to be performed at the second train for preventing a collision between the first train and the second train, based on the status of the first train is determined. Furthermore, one or more instructions are generated for performing the action at the second train.



Abstract

PREVENTION OF COLLISION BETWEEN TRAINS

A system and method for preventing collision between a first train and a second train is disclosed herein. The system comprises at least one first subsystem installed on a first train. The at least one first subsystem is configured to broadcast broadcast messages indicative of a status of the first train. The system further comprises at least one second subsystem installed on a second train configured to selectively receive the broadcast message from the at least one first subsystem on the first train. The second subsystem determines the status of the first train by analysing the broadcast message. Further, an action to be performed at the second train for preventing a collision between the first train and the second train, based on the status of the first train is determined. Furthermore, one or more instructions are generated for performing the action at the second train.

[To be published with **FIG. 3**]

PREVENTION OF COLLISION BETWEEN TRAINS

BACKGROUND

FIELD OF INVENTION

[001] The present invention relates to managing operation of trains and more particularly relates to a system and method for preventing collision between trains.

DESCRIPTION OF RELATED ART

[002] Rail transportation is one of the most popular modes of transportation for movement of goods and passengers. Rail vehicles operating on a common route are managed typically through signalling systems. Such signalling systems are intended to prevent head-on collisions and to maintain a safe headway between rail vehicles running in the same direction. Block signalling systems such as moving block systems and fixed block systems are used for preventing collision between trains operating on a common route, by maintaining a safe distance between the trains. For example, in moving block system, the train position and its braking curve is continuously calculated by the trains and communicated to wayside equipment. Based on the train position and the braking curve, the wayside equipment further establishes a Movement Authority for the trains. The Movement Authority indicates a permission for a train to move to a specific location within the constraints of the infrastructure with supervision of speed. Such block signalling systems may also employ track circuits, communicatively coupled to the wayside equipment, to determine the train positions. However, communication failures associated with the wayside equipment or the track circuit lead to signalling errors in the block signalling system. On manually driven trains, the driver of the train manages the operation of the train based on visual information pertaining to the Movement Authority received from the wayside

equipment. However, it is possible that the driver may fail to pay attention to the visual information, thus leading to violation of the Movement Authority. Such human errors or signalling errors may lead to catastrophic events such as a head-on collision, a near-head on collision or a rear-end collision between trains.

[003] In light of the above, there exists a need for a fail-safe mechanism for preventing collisions between trains.

BRIEF DESCRIPTION OF THE INVENTION

[004] A system and method for preventing collision between a first train and a second train is disclosed. In one aspect, the system comprises at least one first subsystem installed on the first train, wherein the at least one first subsystem is configured to generate broadcast messages indicative of a status of the first train, and at least one second subsystem installed on the second train. The at least one second subsystem is configured via executable instructions to selectively receive the broadcast message from the at least one first subsystem on the first train. The at least one second subsystem is further configured to determine the status of the first train by analysing the broadcast message. The at least one second subsystem is further configured to determine an action to be performed at the second train based on the status of the first train, wherein the action is associated with preventing a collision between the first train and the second train. Furthermore, the at least one second subsystem is configured to generate one or more instructions for performing the action at the second train.

[005] In another aspect, the method comprises selectively receiving a broadcast message from at least one first subsystem on a first train, by at least one second subsystem installed on a second train. The method further comprises determining a status of the first train, by

the at least one second subsystem, based on analysis of the broadcast message. The method further comprises determining an action to be performed at the second train, by the at least one second subsystem, based on the status of the first train, wherein the action is associated with preventing a collision between the first train and the second train. The method further comprises generating one or more instructions, by the at least one second subsystem, for performing the action at the second train.

BRIEF DESCRIPTION OF THE DRAWINGS

[006] **FIG. 1** illustrates a block diagram of a first subsystem for generating a broadcast message indicating a status of a train, in accordance with an embodiment of the present invention;

[007] **FIG. 2** illustrates a block diagram of a second subsystem configured for processing broadcast messages from the first subsystem, in accordance with an embodiment of the present invention;

[008] **FIG. 3** depicts a flowchart of a method for preventing collision between the first train and the second train, in accordance with another embodiment of the present invention;

[009] **FIG. 4A** illustrates an environment of a system for preventing collision between a first train and a second train when running on the same track, in accordance with an exemplary embodiment of the present invention; and

[0010] **FIG. 4B** illustrates an environment of the system for preventing collision between the first train and the second train when running on parallel tracks, in accordance with another exemplary embodiment of the present invention.

DETAILED DESCRIPTION

[0011] Various embodiments of the present invention are described with reference to the drawings, where like reference numerals are used in reference to the drawings. Like reference numerals are used to refer to like elements throughout. In the following description, numerous specific details are set forth in order to provide a thorough understanding of embodiments. These specific details need not be employed to practice embodiments. In other instances, well known materials or methods have not been described in detail in order to avoid unnecessarily obscuring embodiments. While the disclosure is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. There is no intent to limit the disclosure to the particular forms disclosed. Instead, the disclosure is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention.

[0012] **FIG. 1** illustrates a block diagram of a first subsystem **100** for generating a broadcast message indicating a status of a train (not shown), in accordance with an embodiment of the present invention. The first subsystem **100** comprises a message generation unit **105**, a digital to analog converter (DAC) **110**, a modulation circuit **115** and a first transceiver unit **120**. The message generation unit **105** is communicatively coupled to one or more sensing units **125**. The one or more sensing units **125** are configured to sense various parameters associated the train.

[0013] In one embodiment, the one or more sensing units **125** are configured to sense at least one parameter associated with an integrity of the train. For example, the one or more sensing units **125** may include tilt sensors installed on one or more rail cars of the train to detect

derailment of the rail cars. The one or more sensing units **125** may also include other sensors such as proximity sensors, installed between the rail cars, to detect accidental decoupling of the rail cars.

[0014] In another embodiment, the one or more sensing units **125** are configured to detect a real-time location of the train. For example, the one or more sensing units **125** may include a Global Positioning System (GPS) to detect the real-time location. In yet another aspect, the one or more sensing units **125** are configured to measure a real-time speed of the train. For example, the real-time speed is measured using a wheel speed sensor positioned on a wheel of the train. The wheel speed sensor is a specially adapted tachometer that measures a wheel speed of the train. In yet another embodiment, the real-time speed is measured using an accelerometer mounted on the train.

[0015] In yet another embodiment, the one or more sensing units **125** are configured to detect a braking status associated with the train. For example, the one or more sensing units **125** include a brake pipe sensing hose attached to a glad-hand coupler on a brake pipe of the train. The brake pipe sensing hose is configured to detect the braking status based on an air pressure within the brake pipe.

[0016] In yet another embodiment, the one or more sensing units **125** comprises at least one transmitting antenna and at least one receiving antenna located at the extremities of the train. For example, the transmitting antenna may be located near an end of the train and the receiving antenna may be located near a head of the train. The transmitting antenna may continuously emit radio-frequency signals of a predefined strength, and the receiving antenna measures a received signal strength (RSS) associated with the radio-frequency signals. Based on the RSS, a length of the train is computed in real-time. Advantageously,

the measurement of the length of the train based on the RSS helps in determining an integrity of the train. For example, the RSS reduces in case of a derailment or accidental decoupling of rail cars on the train, thereby indicating that the integrity of the train is compromised. In an alternate embodiment, the length of the train may also be determined based on GPS sensors located at the extremities of the train. In yet another embodiment, the length of the train may also be determined with the help of track circuits such as axle counters.

[0017] Further, sensor data or outputs from each of the one or more sensing units **125** are provided to the message generation unit **105**, via a data acquisition unit (not shown). In an embodiment, the message generation unit **105** comprises a first processing unit **130** and a first memory **135**. The term ‘first processing unit’ **130**, as used herein, means any type of computational circuit, such as, but not limited to, a microprocessor, microcontroller, complex instruction set computing microprocessor, reduced instruction set computing microprocessor, very long instruction word microprocessor, explicitly parallel instruction computing microprocessor, graphics processor, digital signal processor, or any other type of processing circuit. The first processing unit **130** may also include embedded controllers, such as generic or programmable logic devices or arrays, application specific integrated circuits, single-chip computers, and the like. The first memory **135** may be non-transitory volatile memory and non-volatile memory. The first memory **135** may be coupled for communication with the first processing unit **130**, such as being a computer-readable storage medium. The first processing unit **130** may execute instructions and/or code stored in the first memory **135** to generate broadcast messages based on the sensor data. More specifically, the message generation unit **105** is configured to process the sensor data to identify a current status corresponding to at least one parameter associated with the train. For example, the parameter may correspond to at least one of train integrity, braking status

and a geographical location. Based on the current status of the parameter, the broadcast message is generated. A variety of computer-readable instructions may be stored in and accessed from the first memory 135. The first memory 135 may include any suitable element for storing data and machine-readable instructions, such as read only memory, random access memory, erasable programmable read only memory, electrically erasable programmable read only memory, a hard drive, a removable media drive for handling compact disks, diskettes, magnetic tape cartridges, memory cards, and the like.

[0018] In the present embodiment, broadcast messages corresponding to a train integrity status, a braking status and a location status are generated. However, it must be understood by a person skilled in the art that it is possible to generate other types of broadcast messages that may be used to indicate various operational statuses of the train to another train.

[0019] Each of the broadcast messages are generated in the form of data packets. Each of the data packets comprise a header section, a payload section and a trailer section. In an embodiment, the header section may comprise a sequence number, a device identification number and a broadcast type identifier. The sequence number is used for reordering of the data packets to retrieve the broadcast message at a second subsystem that receives the data packets. The device identification number is used to uniquely identify the first subsystem or the train. The broadcast type identifier may indicate a type of the broadcast message. The broadcast type identifier may be indicated by alphabets, numbers or an alphanumeric series. For example, the broadcast type identifier '00' may correspond to train integrity status, the broadcast type identifier '01' may correspond to location status and the broadcast type identifier '10' may correspond to braking status. The trailer section comprises fields such as checksum or a secure key string, that are used for validating integrity of the broadcast message. The payload section is configured based on the type of the broadcast message.

[0020] In an example, if the broadcast message corresponds to train integrity status, the payload section comprises a length of the train, a geographical location of the train and a failure time of the train. The length of the train may be determined in real-time based on RSS measured at a receiving antenna as explained earlier. The geographical location of the train is a real-time geographical position of the train obtained from the GPS sensors. The failure time of the train is a timestamp corresponding to time at which the failure of the train is detected, for example, by the one or more sensing units **125**. For example, the time stamp may correspond to 5th December, 2019, 10:10 am. The failure may be one of derailment, accidental decoupling of rail cars or loss of communication with the driver's cab. The broadcast type identifier in the header section is set to '00'.

[0021] If the broadcast message corresponds to location status, the payload section comprises the length of the train, the geographical location of the train and a speed of the train. The speed of the train is obtained from the one or more sensing units **125** on the train. The broadcast type identifier in the header section is set to '01'.

[0022] If the broadcast message corresponds to braking status, the payload section comprises the length of the train, the geographical location of the train and a braking time. The braking time indicates a time duration associated with effecting an emergency brake. In general, the braking time is computed based on a braking curve associated with the train. The payload section further comprises a timestamp associated with application of emergency brakes on the train. For example, if a driver of the train applies the emergency brake at time 3:15 pm and the train attains zero speed at 3:16 pm, the braking time is 1 minute, whereas the timestamp corresponds to 3:15 pm. The broadcast type identifier in the header section is set to '10'.

[0023] The broadcast message is further converted to an analog signal using the DAC **110**. The modulation circuit **115** further modulates a carrier signal based on the analog signal using a modulation technique. The frequency of the carrier signal may be a radio frequency specific to communications in a railway network of a region. For example, in the United States, the radio frequency of 457 MHz may be used. However, it must be understood by a person skilled in the art that any suitable frequency may be selected for the purpose of sending such broadcast messages. Non-limiting examples of modulation techniques include amplitude modulation, frequency modulation, phase modulation, phase shift keying and pulse code modulation. Similar to the radio frequency, any modulation technique may be used based on the specifications or requirements of railway networks in a region. For example, certain regions may specify the use of Frequency Shift Keying (FSK). The modulated carrier signal is further amplified by the power amplifier (not shown) and broadcasted through the first transceiver unit **120**. The first transceiver unit **120** may transmit the modulated carrier signal based on a suitable broadcasting technology. In an example, the broadcasting technology may be based on Wi-Fi communication.

[0024] **FIG. 2** illustrates a block diagram of a second subsystem **200** configured for processing broadcast messages from a first subsystem (similar to the first subsystem **100**), in accordance with an embodiment of the present invention. The second subsystem **200** comprises a second transceiver unit **205**, a demodulation circuit **210**, an analog to digital converter (ADC) **215** and a train management unit **217**.

[0025] The second transceiver unit **205** is configured to receive a broadcast message in the form of a modulated carrier signal from a first subsystem. Further, the demodulation circuit **210** demodulates the modulated carrier signal to generate an analog signal. The analog signal is further processed by the ADC **215**. The ADC **215** may employ any known RF sampling

technique to generate the broadcast message in digital format from the analog signal. Further, the broadcast message in digital format is provided as input to the train management unit **217**. The train management unit **217** further comprises a second processing unit **220** and a second memory **225**.

[0026] The second processing unit **220** executes machine-readable instructions stored in the second memory **225** for preventing collision between a first train wherein the first subsystem is installed and a second train wherein the second subsystem is installed, in accordance with method **300** described below. More specifically, the second processing unit **220** generates one or more instructions for implementing an action for preventing collision between the first train and the second train. The one or more instructions are transmitted to other equipment on the second train through the second transceiver unit **205**. In an example, the equipment may include a braking system associated with the second train and the one or more instructions may be associated with application of brakes for slowing down or stopping the second train. In another example, the equipment may include a display device and the one or more instructions may be associated with displaying an information to a driver of the train. The equipment further executes the one or more instructions to prevent the collision between the first train and the second train. It must be understood that the equipment may also refer to another second subsystem located on the second train.

[0027] The term ‘second processing unit’ **220**, as used herein, means any type of computational circuit, such as, but not limited to, a microprocessor, microcontroller, complex instruction set computing microprocessor, reduced instruction set computing microprocessor, very long instruction word microprocessor, explicitly parallel instruction computing microprocessor, graphics processor, digital signal processor, or any other type of processing circuit. The second processing unit **220** may also include embedded controllers,

such as generic or programmable logic devices or arrays, application specific integrated circuits, single-chip computers, and the like.

[0028] The second memory **225** may be non-transitory volatile memory and non-volatile memory. The second memory **225** may be coupled for communication with the second processing unit **220**, such as being a computer-readable storage medium. The second processing unit **220** may execute instructions and/or code stored in the second memory **225**. A variety of computer-readable instructions may be stored in and accessed from the memory **225**. The second memory **225** may include any suitable elements for storing data and machine-readable instructions, such as read only memory, random access memory, erasable programmable read only memory, electrically erasable programmable read only memory, a hard drive, a removable media drive for handling compact disks, diskettes, magnetic tape cartridges, memory cards, and the like.

[0029] **FIG. 3**, in conjunction with **FIG. 2**, depicts a flowchart of a method **300** for preventing collision between a first train and a second train, in accordance with an embodiment of the present invention. The method comprises steps **305** to **320** may be implemented at the second subsystem **200** installed on the second train.

[0030] At step **305**, a broadcast message from at least one first subsystem (similar to the first subsystem **100**) on a first train is selectively received by at least one second subsystem installed on a second train. At first, the second subsystem identifies whether the first subsystem is installed on the same train as the second subsystem, based on the device identification number present in the broadcast message. If yes, the broadcast message is discarded. Otherwise, the second subsystem determines whether the geographical location in the broadcast message corresponds to a parallel track or the same track as the second train.

If the first train and the second train are on parallel tracks, the second subsystem may discard the broadcast message. Otherwise, the second subsystem receives the broadcast message based on the corresponding broadcast type identifier. For example, the second subsystem is configured to receive only broadcast messages with broadcast type identifier '00'. In another example, the second subsystem is configured to receive only broadcast messages with the broadcast type identifier '01' or '10'. In one embodiment, the train management unit **217** instructs the second transceiver unit **205** to retransmit the received broadcast message to another subsystem based on the broadcast type identifier. For example, if the second subsystem is configured to receive broadcast messages with broadcast type identifier '01' or '10', broadcast messages with broadcast type identifier '00' may be retransmitted to another second subsystem on the second train for processing.

[0031] At step **310**, a status of the first train is determined, by the at least one second subsystem, based on analysis of the broadcast message. For example, if the broadcast message is associated with train integrity, the second subsystem derives a length of the first train, a geographical location of the first train and a failure time associated with the first train from the broadcast message.

[0032] At step **315**, an action to be performed at the second train is determined, by the at least one second subsystem, based on the status of the first train. The action is associated with preventing a collision between the first train and the second train. For example, the one or more instructions may be associated with application of emergency brakes, controlling a speed of the second train, initiating communication with a central server or warning a driver of the second train.

[0033] In one example, if the broadcast message corresponds to train integrity, a failure time

of the first train is determined from the broadcast message. Further, a headway or distance between the first train and the second train is calculated in real-time based on the geographical location of the first train and the failure time. Based on the headway and a speed of the second train, an estimated time of arrival (ETA) at the geographical location of the first train is computed. Based on the ETA, a new speed for the second train is computed using a predefined mathematical relation. The ETA is continuously computed based on broadcast messages that are continuously received from the first train. Consequently, when the ETA approaches a threshold time-limit, of say 2 minutes, the second subsystem may compute the new speed for the second train as zero. The new speed of zero indicates application of emergency brakes at the second train.

[0034] Similarly, if the broadcast message corresponds to braking status, a braking time of the first train is determined from the broadcast message along with a timestamp associated with the braking. Further, an ETA at the geographical location of the first train is computed based on the braking time and the timestamp associated with the braking. Based on the ETA computed, the second subsystem determines the action to be performed similar to the case of integrity status.

[0035] In another example, if the broadcast message corresponds to a location status of the first train, the second subsystem determines the headway between the first train and the second train in real-time based on the geographical location of the first train. Further, a probability of collision between the first train and the second train is estimated. For example, predefined mathematical relationships are used to estimate the probability of collision from the headway. Based on a value of the probability of collision, the second subsystem determines the action to be performed. For example, if the probability of collision is greater than a predefined value of say 0.7 the action is determined as application of emergency

brakes. Otherwise, the second subsystem may determine a new speed of the second train based on predefined rules. In an implementation, the speed may be calibrated based on the probability of collision and stored in the form of a calibration curve in a memory of the second subsystem. Further, the action is determined as reducing the speed of the second train to the new speed.

[0036] At step **320**, one or more instructions are generated, by the at least one second subsystem, for performing the action at the second train. The one or more instructions are associated with for example, actuating signals for application of the emergency brakes. In another example, the one or more instructions are associated with actuating signals for application of brakes on the second train such that the speed is controlled. In yet another example, the one or more instructions are associated with sending a message indicating the status of the first train to the central server.

[0037] **FIG. 4A** illustrates an environment of a system **400** for preventing collision between a first train **405** and a second train **410** following the first train **405** on the same track, in accordance with an exemplary embodiment of the present invention. Each of the first train **405** and the second train **410** include an End of Train Telemetry (EOTT) system.

[0038] In the present embodiment, the EOTT system on the first train **405** comprises a first Head-of-Train unit (HOT) **415** installed in a cab of the first train **405** and a first End-of-Train unit (EOT) **420** installed at a rear end of the first train **405**, communicatively coupled to each other over a telemetry link. Further, the first EOT **420** may provide a train integrity status associated with the first train **405** to the first HOT **415** over the telemetry link. The first HOT **415** comprises a Cab Display Unit (CDU) (not shown). The CDU may indicate the train integrity status associated with the first train **405** on a display based on data received from

the first EOT **420**. The first EOT **420** comprises a High Visibility Marker (HVM) (not shown) and a Sensing and Braking Unit (SBU) (not shown). The HVM marker may include high intensity LED arrays that provides a visible indication of the presence of the first train **405** to the second train **410**. The SBU includes a brake pipe sensing hose and an air braking system.

[0039] The first EOT **420** further includes a first subsystem configured to transmit broadcast messages corresponding to train integrity status, braking status and location status, as explained earlier using **FIG. 1**. Therefore, the terms first EOT **420** and the first subsystem may be hereinafter used interchangeably. In the present embodiment, the broadcast message for train integrity status is generated only when a failure is detected with respect to the first train **405**. Similarly, the broadcast message for braking status is generated only when emergency brakes on the first train **405** are applied. The broadcast message for location status associated with the first train **405** is generated continuously or over predefined intervals of time irrespective of train integrity and braking status.

[0040] The EOTT system on the second train **410** comprises a second HOT **425** installed in a cab of the second train **410** and a second EOT **430** installed at a rear end of the second train, communicatively coupled to each other over a telemetry link.

[0041] In the present embodiment, both the second EOT **430** and the second HOT **425** may include separate second subsystems each configured to process different types of broadcast messages. For example, the second subsystem on the second HOT **425** may be configured to process broadcast messages associated with train integrity status and braking status, while the second subsystem on the second EOT **430** may be configured to process broadcast messages associated with location status. Hereinafter, the terms second HOT **425** and the

second EOT **430** are used to refer to the respective second subsystems. In the present embodiment, when a train integrity status or a braking status associated with the first train **405** is received, the second HOT **425** compute an ETA at a geographical location of the first train **405**. Further, if the ETA is less than a threshold time-limit, the second HOT **425** generates instructions for the second EOT **430** to communicate the status of the first train **405** to a central server. Simultaneously, the second HOT **425** also generates instructions for actuating an emergency braking system of the second train **410**. In an embodiment, the second HOT **425** may also generate instructions for displaying a warning message for the driver of the second train **410** on a CDU. The warning message may instruct the driver to manually reduce the speed of the second train **410**.

[0042] The second EOT **430** may compute the probability of collision between the first train **405** and the second train **410**. Based on the probability of collision computed, the second EOT **430** may compute a new speed for the second train **410**. Further, the second EOT **430** generates instructions for controlling the speed of the second train **410**. The generated instructions are further transmitted to the second HOT **425** in order to control the brake line pressure, in a coordinated manner. Further, the second HOT **425** is configured to identify broadcast messages intended for the second EOT **430**, based on the broadcast type identifier and to retransmit the broadcast message to the second EOT **430**. Advantageously, if a transmission radius associated with the first EOT **420** does not reach the second EOT **430**, the second HOT **425** receives and retransmits the broadcast message intended for the second EOT **430**.

[0043] In another embodiment, the system **400** comprises a single second subsystem included in the second HOT **425** for processing broadcast messages as explained earlier using **FIG. 2**. For example, when a location status of the first train **405** is received, the second

HOT **425** computes a probability of collision. Further, the second HOT **425** computes a new speed of the second train **410** such that the probability of collision between the first train **405** and the second train **410** is minimised or eliminated. Further, the second HOT **425** generates instructions to reduce the speed of the second train **410** to the new speed. The instructions are further provided to the second EOT **430** through an arming operation. The second EOT **430** further coordinates with the second HOT **425** to control a brake line pressure associated with a braking system of the second train **410**, in order to bring down the speed of the second train **410** to the new speed. In another example, when a train integrity status or a braking status associated with the first train **405** is received, the second HOT **425** may compute an ETA at a geographical location of the first train **405**. Further, if the ETA is less than a threshold time-limit, the second HOT **425** generates instructions for the second EOT **430** to communicate the status of the first train **405** to a central server. Simultaneously, the second HOT **425** also generates instructions for actuating an emergency braking system (not shown) of the second train **410**. For example, the instructions may include actuating signals for actuating the emergency braking system. The second HOT **425** may also generate instructions for displaying a warning message for the driver of the second train **410** on a CDU. The warning message may instruct the driver to manually reduce the speed of the second train **410**. It must be understood by a person skilled in the art that a train may include both the first subsystem and the second subsystem, to prevent collision with other trains.

[0044] In another instance, the first train **405** and the second train **410** may run on the same track while heading towards each other. In this case, head-on collisions are prevented in a manner similar to prevention of rear-end collision as described above.

[0045] **FIG. 4B** illustrates an environment of the system **400** for preventing collision between the first train **405** and the second train **410** when running on parallel tracks, in

accordance with another exemplary embodiment of the present invention. In the present example, the first train **405** and the second train **410** run on parallel tracks A and B respectively. The second subsystems on each of the first train **405** and the second train **410** generate broadcast messages corresponding to their respective geographical locations. Based on the geographical location of the second train **410**, the first HOT **415** on the first train **405** determines whether both the first train **405** and the second train **410** are headed towards a common juncture, say juncture **J**, within a predefined time period of say, 10 minutes. If yes, a probability of collision between the first train **405** and the second train **410** is computed based on predetermined mathematical relations. If the probability of collision is greater than a predefined value of say 0.7, the first HOT **415** may transmit a message to the central server indicating the probability of collision. Similarly, the second HOT **425** may also compute the probability of collision and transmit another message to the central server indicating the probability of collision. Further, the central server may communicate a movement authority to each of the first train **405** and the second train **410**, for example, based on predefined rules.

[0046] Advantageously, the present invention provides a fail-safe mechanism for prevention of collision between trains. More specifically, the present invention improves redundancy in existing signalling systems by facilitating communication of statuses between trains through broadcast messages, in addition to communication through wayside signalling units.

[0047] While embodiments of the present invention have been disclosed in exemplary forms, it will be apparent to those skilled in the art that many modifications, additions, and deletions can be made therein without departing from the spirit and scope of the invention and its equivalents, as set forth in the following claims.

WE CLAIM:

1. A system (400) comprising:
 - at least one first subsystem (100) installed on a first train, wherein the at least one first subsystem (100) is configured to transmit broadcast messages indicative of a status of the first train; and
 - at least one second subsystem (200) installed on a second train configured via executable instructions to:
 - selectively receive the broadcast message from the at least one first subsystem on the first train;
 - determine the status of the first train by analysing the broadcast message;
 - determine an action to be performed at the second train based on the status of the first train, wherein the action is associated with preventing a collision between the first train and the second train; and
 - generate one or more instructions for performing the action at the second train.
2. The system (400) as claimed in claim 1, wherein the at least one first subsystem is associated with an end of train unit.
3. The system (400) as claimed in claim 1, wherein the at least one second subsystem belongs to a group of second subsystems, and wherein the group of second subsystems comprise an end of train unit and a head of train unit.
4. The system (400) as claimed in claim 1, wherein the at least one second subsystem selectively receives the broadcast message based on a type associated with the broadcast message.
5. The system (400) as claimed in claim 4, wherein the status of the first train is at least one of a location status, a braking status and a train integrity status associated with the first train.

6. The system (400) as claimed in claim 1, wherein the at least one second subsystem is further configured to transmit the one or more instructions generated to one or more equipment onboard the second train.
7. The system (400) as claimed in claim 6, wherein the one or more equipment execute the one or more instructions from the at least one second subsystem, to perform the action at the second train.
8. A method comprising:
 - selectively receiving a broadcast message from at least one first subsystem (100) on a first train, by at least one second subsystem (200) installed on a second train;
 - determining a status of the first train, by the at least one second subsystem (200), based on analysis of the broadcast message;
 - determining an action to be performed at the second train, by the at least one second subsystem (200), based on the status of the first train, wherein the action is associated with preventing a collision between the first train and the second train; and
 - generating one or more instructions, by the at least one second subsystem (200), for performing the action at the second train.
9. The method as claimed in claim 8, wherein the at least one first subsystem (100) is an end-of-train unit (420).
10. The method as claimed in claim 8, wherein the at least one second subsystem (200) belongs to a group of second subsystems and wherein the group of second subsystems comprise an end-of-train unit (425) and a head-of train unit (430).
11. The method as claimed in claim 8, wherein the at least one second subsystem (200) selectively receives the broadcast message based on a type associated with the broadcast message.

12. The method as claimed in claim 11, wherein the status of the first train is at least one of a location status, a braking status and a train integrity status associated with the first train.
13. The method as claimed in claim 8, further comprising:
transmitting the one or more instructions generated, to one or more equipment onboard the second train, by the at least one second subsystem (200).
14. The method as claimed in claim 13, further comprising:
executing the one or more instructions from the at least one second subsystem (200), by the one or more equipment, to perform the action at the second train.

Fig 1

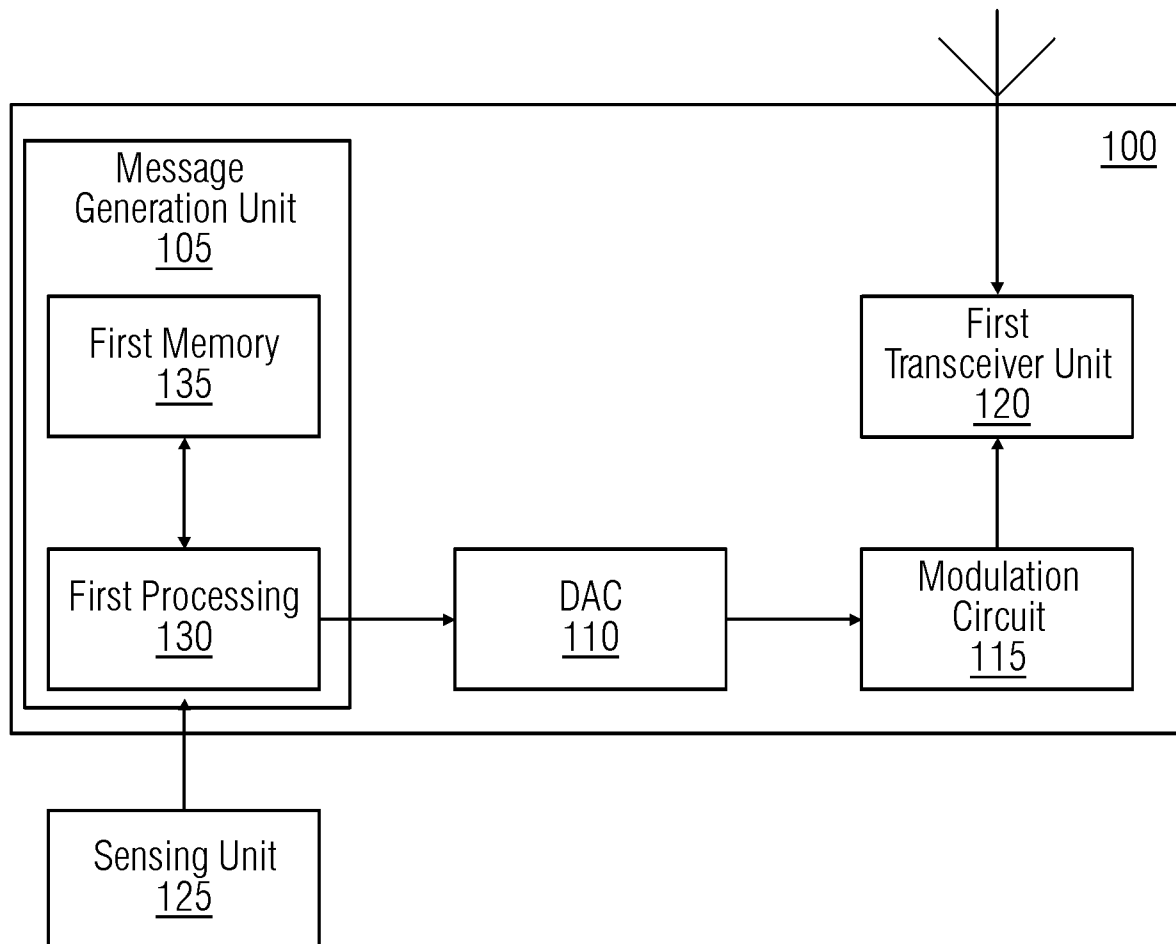


Fig 2

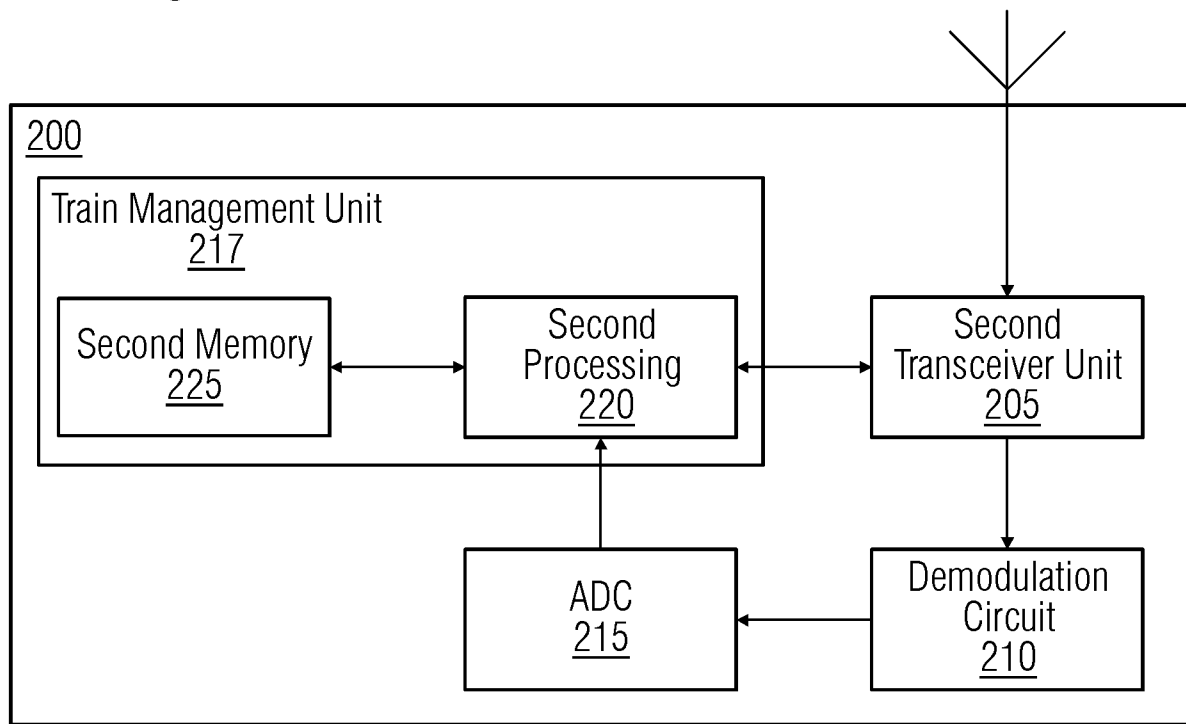


Fig 3

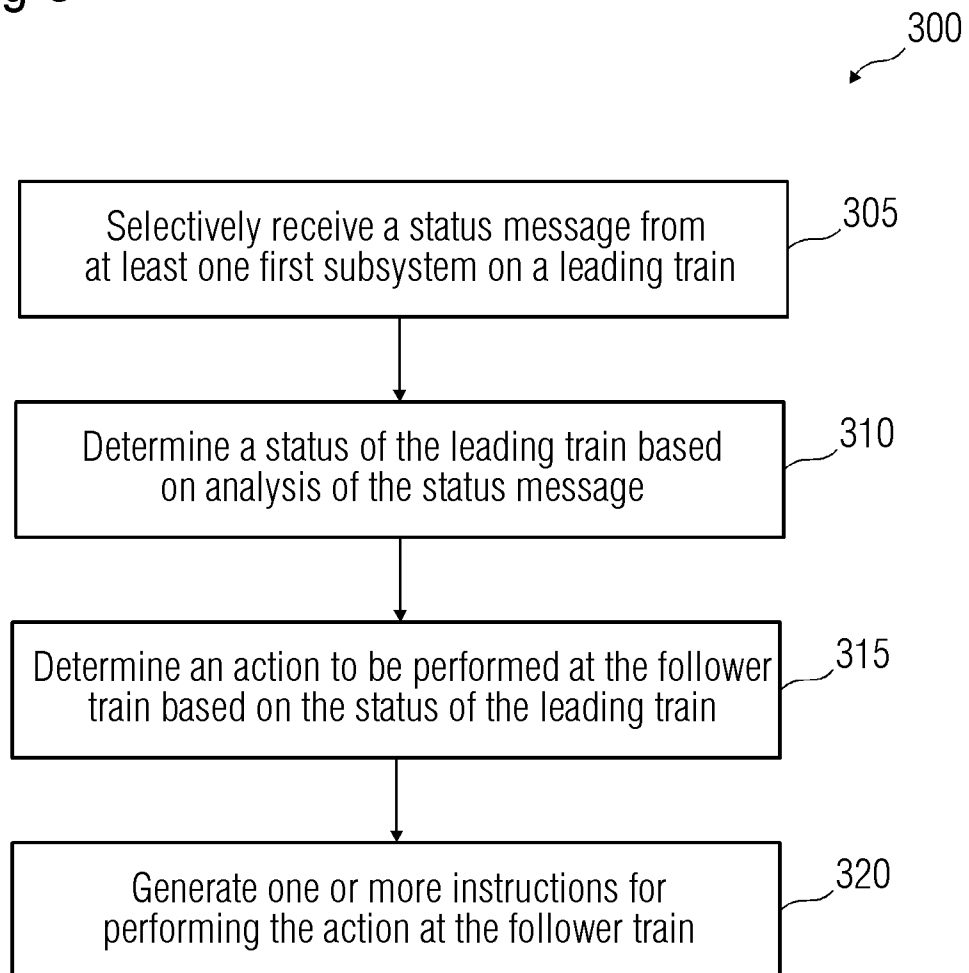
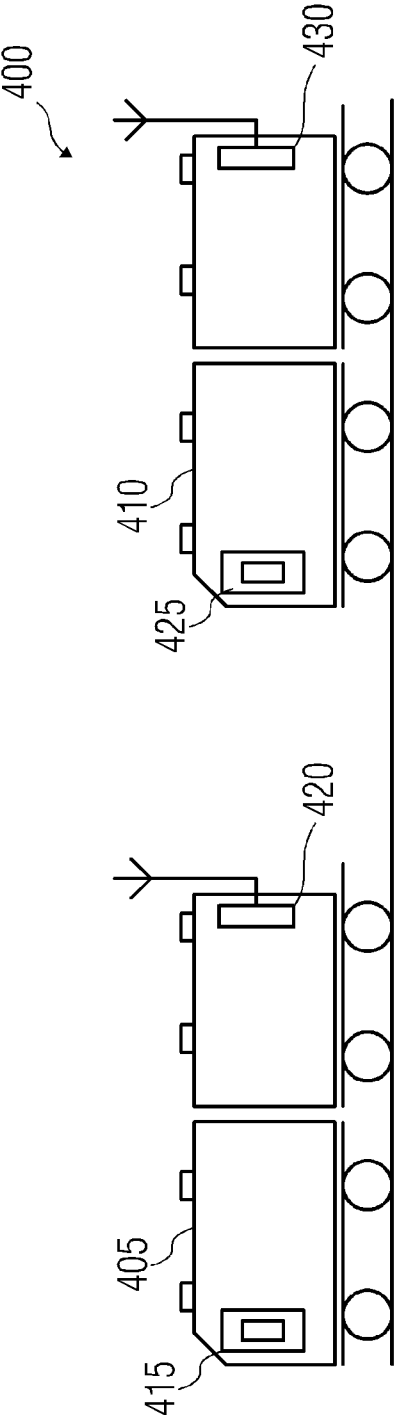
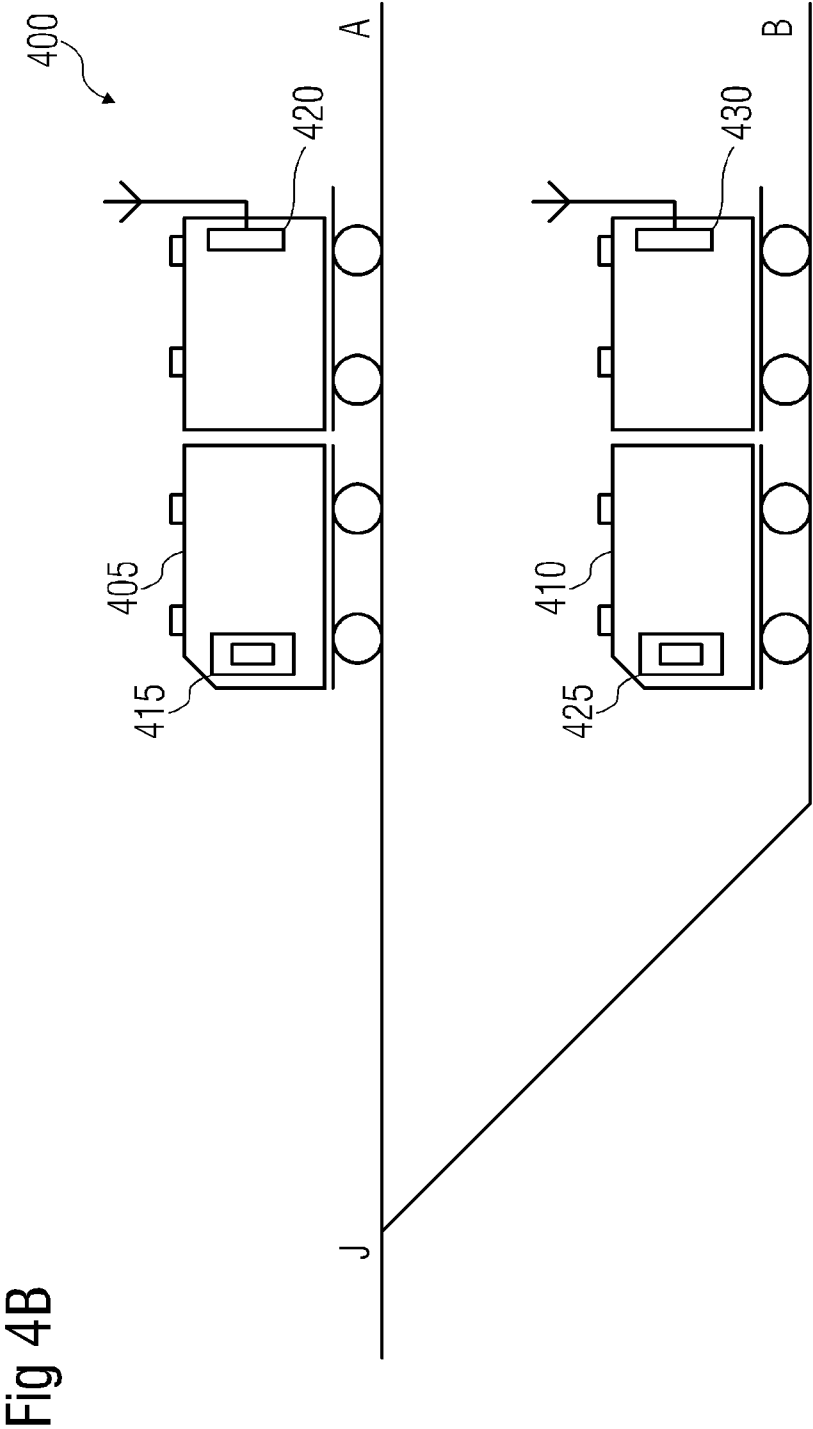


Fig 4A





300

Selectively receive a status message from
at least one first subsystem on a leading train

305

Determine a status of the leading train based
on analysis of the status message

310

Determine an action to be performed at the follower
train based on the status of the leading train

315

Generate one or more instructions for
performing the action at the follower train

320