division, to realize the function safety. The control center contains an operation control device 230, an ATP ground device 232, a station control device 234 and an interlocking device 236. The respective devices are mutually connected by an exclusive-use LAN (Local Area Network) 238 to be bi-directionally communicable. The operation control device 230 controls the whole operation. The interlocking device 236 carries out the protection of traveling routes of the trains. The ATP ground device 232 prevents a collision between the trains. The station control device 234 attains the function safety of the control of the opening/closing of platform screen doors and train doors at a station.

[0004]

Each of the (group of) trains is provided with an on-board device 210. The on-board device 210 controls the operation of the train based on the control of the control center. The on-board device 210 is connected with the ATP ground device 232 by the exclusive-use LAN 250 to be bi-directionally communicable. The station is provided with a remote I/O 220. The remote I/O 220 carries out the opening/closing control of the platform screen door 240 and the control of railroad switches 250 on the railroad track based on the control of the control center. The remote I/O 220 is connected with the station control device 234 and the interlocking device 236 by an exclusive-use LAN 252 to be bi-directionally communicable.

[0005]

The operation of this conventional signaling system (the operation of a train) becomes as described below, for example.

When a departure time of an optional train comes gets closer based on the train diagram, the

operation control device 30. The center storage unit 32 is a storage unit which is exemplified by a hard disk drive, RAM (Random Access Memory) and ROM (Read Only Memory), and stores data and a software program which are used in the center control device 31, and data and a software program which are outputted from the center control device 31. The center communication device 33 is a radio LAN transmitting and receiving unit which carries out a data communication through the general-purpose LAN 60. The center communication device 33 transmits data and the software program which are outputted from the center control device 31, to the on-board device 10 and the station I/F device 20, and receives data and the software program which are transmitted from the on-board device 10 and the station I/F device 20 to output to the center control device 31.

[0036]

The general-purpose LAN 60 is provided with a plurality of base stations 61. The plurality of base stations 61 are arranged in the control center 4 and each station 3 and at a plurality of locations along the railroad track 500. The base station 61 mediates a radio communication among the operation control device 30, the plurality of the on-board devices 10 and the plurality of the station I/F devices 20 to allow data to be sent and received among them. Note that in the present embodiment, an example using the radio LAN as the communication means is shown. However, different communication means may be used if it is possible to send and receive data among them.

[0037]

The on-board device 10 of the train 2 is provided with a control device 11, a storage unit 12 and a communication device 13. The control device 11 is an information processing device which is

operation interval.

[0054]

When the train 2 is in a stop state, the station related data 132 contains data related to a current station (hereinafter, to be referred to as the station 3A) at which the train 2 is in the stop state, data related to the next station as the station 3 (hereinafter, to be referred to as the station 3B) for the train to be stopped next, data related to a previous station as the station 3 (hereinafter, to be referred to as the station 3C) for the train to have been stopped last time. When the train 2 is traveling, the station related data 132 contains data related to the previous station as the station 3 for the train 2 to have departed and data related to the next station as the station 3. The station related data 132 is updated appropriately (e.g. regularly) and is different for every train 2. The station related data 132 contains the railroad switch switching position data and the inter-station section related data. The railroad switch switching position data shows a switching position of each of the plurality of railroad switches 51 which belongs to the targeted stations 3A, 3B and 3C (the previous station, the current station, the next station), and contains the railroad switch command data (to be described later) of each railroad switch 51. Moreover, the railroad switch switching position data may contain the locked state or the unlocked state of the railroad switch 51. The inter-station section related data shows whether or not there is a failure in an inter-station section (e.g. between the station 3A and the station 3B, between the station 3A and the station 3C) among the targeted stations 3A, 3B and 3C, and whether or not a different train is not in the on-rail state between the stations (the on-rail clearance between the

signaling system according to the present embodiment. The station storage unit 22 contains station in-station related data 142 at least.

[0058]

The station in-station related data 142 contains data related to the station 3. The station in-station related data 142 is different for every station 3. The station in-station related data 142 contains railroad switch switching position data and inter-station section related data. The railroad switch switching position data shows a switching position of each of a plurality of railroad switches 51 which belong to the station 3, and contains railroad switch command data of each railroad switch 51. The railroad switch command data shows the railroad switch switching command from the train 2 to each of the plurality of railroad switches 51 which belong to the station 3. The railroad switch switching command is a command which instructs the switching of the railroad switch 51, and is related with data of a command source side train 2 and is stored. While the railroad switch switching command is retained, the railroad switch 51 maintains (locks) the switching state. When the railroad switch switching command is erased in response to a railroad switch release command from the command source side train 2, the lock state of the railroad switch 51 is released. The inter-station section related data shows whether or not there is a failure between the station 3 and a neighbor station 3. The railroad switch command data and the inter-station section related data are transmitted to the on-board device 10 and the operation control device 30, and are stored as the station related data 132 and the center station related data 152.

[0059]

FIG. 5C is a block diagram showing the configuration of the center (CTR.) storage unit 32 of the operation control device 30 of the signaling system according to the present embodiment. The center storage unit 32 contains center (CTR.) operation mode data 150, center (CTR.) train diagram data 151, center (CTR.) station related data 152, center (CTR.) train related data 153 and center (CTR.) basic data 154 at least.

[0060]

The center operation mode data 150 is the same as the operation mode data 130.

[0061]

The center train diagram data 151 contains data showing a train diagram of a railroad line and contains the train diagrams for all the trains 2. The train diagram data may be data of the operation interval.

[0062]

The center station related data 152 contains data related to all stations 3. The center station related data 152 contains the railroad switch switching position data and inter-station section related data of the station in-station related data 142 acquired from all the stations 3. The center station related data 152 are appropriately acquired from the station I/F devices 20 of all the stations 3.

[0063]

The center train related data 153 contains data related to the moving (traveling) of all the trains 2. The center train related data 153 contains the train position data, the traveling permission limit position data, the arrival scheduled platform data, traveling direction data, the traveling route data and the traveling line data of the train related data 133 acquired from all the trains 2. The center

passed through the traveling permission limit position.

[0096]

Next, the train interval protection in case of the inter-station traveling of the train 2 in the operation at the time of occurrence of the failure (the failure mode; the state of the railroad in FIG. 11) will be specifically described.

FIG. 13 is a flow chart showing the operation of the train interval protection in case of inter-station traveling of the train in the operation at the time of occurrence of the failure. The on-board device 10 of the train 2 carries out the traveling route securement and the traveling permission by the train 2 itself based on the exchange of data with the above-mentioned different devices (a plurality of different on-board devices 10, a plurality of station I/F devices 20, and the operation control device 30). Here, the attention should be paid to the on-board device 10 of the train 2A in FIG. 12.

[0097]

The station I/F device 20 of the station 3A (or the station 3B) recognizes that the failure has occurred between the station 3A and the station 3B (failure section 190) by an input of the user or a detection of a sensor, and transmits it to the operation control device 30 of the control center 4 as the station related data (the inter-station section related data (Step S50).

[0098]

The operation control device 30 changes the operation mode from the normal mode to the failure mode (failure section 190). Then, the operation control device 30 transmits the changed operation mode (the failure mode: the failure section 190) to the station I/F devices 20 of all the stations 3

determining the traveling of the moving vehicle on the secured traveling route based on the different moving vehicle related data.

7. The control method of the moving vehicle according to claim 6, wherein the securing the traveling route comprises:

inquiring the different moving vehicle related data to the different moving vehicle by the on-board device; and

inquiring the station related data to the station to which the branch belongs, by the on-board device.

8. The control method of the moving vehicle according to claim 6 or 7, wherein the different moving vehicle related data comprises traveling permission limit position data indicating a range where the moving vehicle succeeding to the different moving vehicle is permitted to travel, and

wherein the determining the traveling comprises:

determining the traveling of the moving vehicle in the range where the traveling of the moving vehicle is permitted, by the on-board vehicle, based on the traveling permission limit position data.

9. The control method of the moving vehicle according to any one of claims 6 to 8, further comprising:

acquiring the moving vehicle related data and the station related data through a radio LAN by the on-board device.

10. A non-transitory recording medium which stores a program to make a computer execute a control

method of a moving vehicle according to any one of claims 6 to 9.

division, to realize the function safety. The control center contains an operation control device 230, an ATP ground device 232, a station control device 234 and an interlocking device 236. The respective devices are mutually connected by an exclusive-use LAN (Local Area Network) 238 to be bi-directionally communicable. The operation control device 230 controls the whole operation. The interlocking device 236 carries out the protection of traveling routes of the trains. The ATP ground device 232 prevents a collision between the trains. The station control device 234 attains the function safety of the control of the opening/closing of platform screen doors and train doors at a station.

[0004]

Each of the (group of) trains is provided with an on-board device 210. The on-board device 210 controls the operation of the train based on the control of the control center. The on-board device 210 is connected with the ATP ground device 232 by the exclusive-use LAN 238 to be bi-directionally communicable. The station is provided with a remote I/O 220. The remote I/O 220 carries out the opening/closing control of the platform screen door 240 and the control of railroad switches 250 on the railroad track based on the control of the control center. The remote I/O 220 is connected with the station control device 234 and the interlocking device 236 by an exclusive-use LAN to be bi-directionally communicable.

[0005]

The operation of this conventional signaling system (the operation of a train) becomes as described below, for example.

When a departure time of an optional train comes gets closer based on the train diagram, the

operation control device 30. The center storage unit 32 is a storage unit which is exemplified by a hard disk drive, RAM (Random Access Memory) and ROM (Read Only Memory), and stores data and a software program which are used in the center control device 31, and data and a software program which are outputted from the center control device 31. The center communication device 33 is a radio LAN transmitting and receiving unit which carries out a data communication through the general-purpose LAN 60. The center communication device 33 transmits data and the software program which are outputted from the center control device 31, to the on-board device 10 and the station I/F device 20, and receives data and the software program which are transmitted from the on-board device 10 and the station I/F device 20 to output to the center control device 31.

[0036]

The general-purpose LAN 60 is provided with a plurality of base stations 61. The plurality of base stations 61 are arranged in the control center 4 and each station 3 and at a plurality of locations along the railroad track 50. The base station 61 mediates a radio communication among the operation control device 30, the plurality of the on-board devices 10 and the plurality of the station I/F devices 20 to allow data to be sent and received among them. Note that in the present embodiment, an example using the radio LAN as the communication means is shown. However, different communication means may be used if it is possible to send and receive data among them.

[0037]

The on-board device 10 of the train 2 is provided with a control device 11, a storage unit 12 and a communication device 13. The control device 11 is an information processing device which is

operation interval.

[0054]

When the train 2 is in a stop state, the station related data 132 contains data related to a current station (hereinafter, to be referred to as the station 3A) at which the train 2 is in the stop state, data related to the next station as the station 3 (hereinafter, to be referred to as the station 3B) for the train to be stopped next, data related to a previous station as the station 3 (hereinafter, to be referred to as the station 3C) for the train to have been stopped last time. When the train 2 is traveling, the station related data 132 contains data related to the previous station as the station 3 for the train 2 to have departed and data related to the next station as the station 3. The station related data 132 is updated appropriately (e.g. regularly) and is different for every train 2. The station related data 132 contains the railroad switch switching position data and the inter-station section state data. The railroad switch switching position data shows a switching position of each of the plurality of railroad switches 51 which belongs to the targeted stations 3A, 3B and 3C (the previous station, the current station, the next station), and contains the railroad switch command data (to be described later) of each railroad switch 51. Moreover, the railroad switch switching position data may contain the locked state or the unlocked state of the railroad switch 51. The inter-station section state data shows whether or not there is a failure in an inter-station section (e.g. between the station 3A and the station 3B, between the station 3A and the station 3C) among the targeted stations 3A, 3B and 3C, and whether or not a different train is not in the on-rail state between the stations (the on-rail clearance between the

signaling system according to the present embodiment. The station storage unit 22 contains station in-station related data 142 at least.

[0058]

The station in-station related data 142 contains data related to the station 3. The station in-station related data 142 is different for every station 3. The station in-station related data 142 contains railroad switch switching position data and inter-station section state data. The railroad switch switching position data shows a switching position of each of a plurality of railroad switches 51 which belong to the station 3, and contains railroad switch command data of each railroad switch 51. The railroad switch command data shows the railroad switch switching command from the train 2 to each of the plurality of railroad switches 51 which belong to the station 3. The railroad switch switching command is a command which instructs the switching of the railroad switch 51, and is related with data of a command source side train 2 and is stored. While the railroad switch switching command is retained, the railroad switch 51 maintains (locks) the switching state. When the railroad switch switching command is erased in response to a railroad switch release command from the command source side train 2, the lock state of the railroad switch 51 is released. The inter-station section state data shows whether or not there is a failure between the station 3 and a neighbor station 3. The railroad switch command data and the inter-station section state data are transmitted to the on-board device 10 and the operation control device 30, and are stored as the station related data 132 and the center station related data 152.

[0059]

FIG. 5C is a block diagram showing the configuration of the center (CTR.) storage unit 32 of the operation control device 30 of the signaling system according to the present embodiment. The center storage unit 32 contains center (CTR.) operation mode data 150, center (CTR.) train diagram data 151, center (CTR.) station related data 152, center (CTR.) train related data 153 and center (CTR.) basic data 154 at least.

[0060]

The center operation mode data 150 is the same as the operation mode data 130.

[0061]

The center train diagram data 151 contains data showing a train diagram of a railroad line and contains the train diagrams for all the trains 2. The train diagram data may be data of the operation interval.

[0062]

The center station related data 152 contains data related to all stations 3. The center station related data 152 contains the railroad switch switching position data and inter-station section state data of the station in-station related data 142 acquired from all the stations 3. The center station related data 152 are appropriately acquired from the station I/F devices 20 of all the stations 3.

[0063]

The center train related data 153 contains data related to the moving (traveling) of all the trains 2. The center train related data 153 contains the train position data, the traveling permission limit position data, the arrival scheduled platform data, traveling direction data, the traveling route data and the traveling line data of the train related data 133 acquired from all the trains 2. The center

passed through the traveling permission limit position.

[0096]

Next, the train interval protection in case of the inter-station traveling of the train 2 in the operation at the time of occurrence of the failure (the failure mode; the state of the railroad in FIG. 11) will be specifically described.

FIG. 13 is a flow chart showing the operation of the train interval protection in case of inter-station traveling of the train in the operation at the time of occurrence of the failure. The on-board device 10 of the train 2 carries out the traveling route securement and the traveling permission by the train 2 itself based on the exchange of data with the above-mentioned different devices (a plurality of different on-board devices 10, a plurality of station I/F devices 20, and the operation control device 30). Here, the attention should be paid to the on-board device 10 of the train 2A in FIG. 12.

[0097]

The station I/F device 20 of the station 3A (or the station 3B) recognizes that the failure has occurred between the station 3A and the station 3B (failure section 190) by an input of the user or a detection of a sensor, and transmits it to the operation control device 30 of the control center 4 as the station related data (the inter-station section state data (Step S50).

[0098]

The operation control device 30 changes the operation mode from the normal mode to the failure mode (failure section 190). Then, the operation control device 30 transmits the changed operation mode (the failure mode: the failure section 190) to the station I/F devices 20 of all the stations 3

determining the traveling of the moving vehicle on the secured traveling route based on the different moving vehicle related data.

7. The control method of the moving vehicle according to claim 6, wherein the securing the traveling route comprises:

inquiring the different moving vehicle related data to the different moving vehicle by the on-board device; and

inquiring the station related data to the station to which the branch belongs, by the on-board device.

8. The control method of the moving vehicle according to claim 6 or 7, wherein the different moving vehicle related data comprises traveling permission limit position data indicating a range where the moving vehicle succeeding to the different moving vehicle is permitted to travel, and

wherein the determining the traveling comprises:

determining the traveling of the moving vehicle in the range where the traveling of the moving vehicle is permitted, by the on-board vehicle, based on the traveling permission limit position data.

9. The control method of the moving vehicle according to any one of claims 6 to 8, further comprising:

acquiring the moving vehicle related data and the station related data through a radio LAN by the on-board device.