



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.01.2016 Bulletin 2016/03

(51) Int Cl.:
B61L 27/00 (2006.01)

(21) Application number: **14177525.4**

(22) Date of filing: **17.07.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Hitachi, Ltd.**
Chiyoda-ku
Tokyo 100-8280 (JP)

(72) Inventor: **Li, Dong**
London, Greater London EC1N 2PB (GB)

(74) Representative: **Gill, Stephen Charles et al**
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

(54) **Train management system**

(57) A train management system includes: an on-board server unit of a given train; and a railway operating centre. The railway operating centre includes: (i) a track monitoring unit which monitors locations of trains and statuses of trackside signalling equipment, and creates signalling settings to be enacted by the signalling equipment based on the current train locations and the current statuses of the trackside signalling equipment; and (ii) a timetable updating unit which updates timetables for the

trains based on the current train locations. The train management system further includes a calculation module which, while the given train is running, repeatedly calculates a recommended speed profile for the given train compatible with the latest updated timetable for the given train and latest updated signals from the signalling settings. The on-board server unit displays the latest recommended speed profile as advice for the driver of the train.

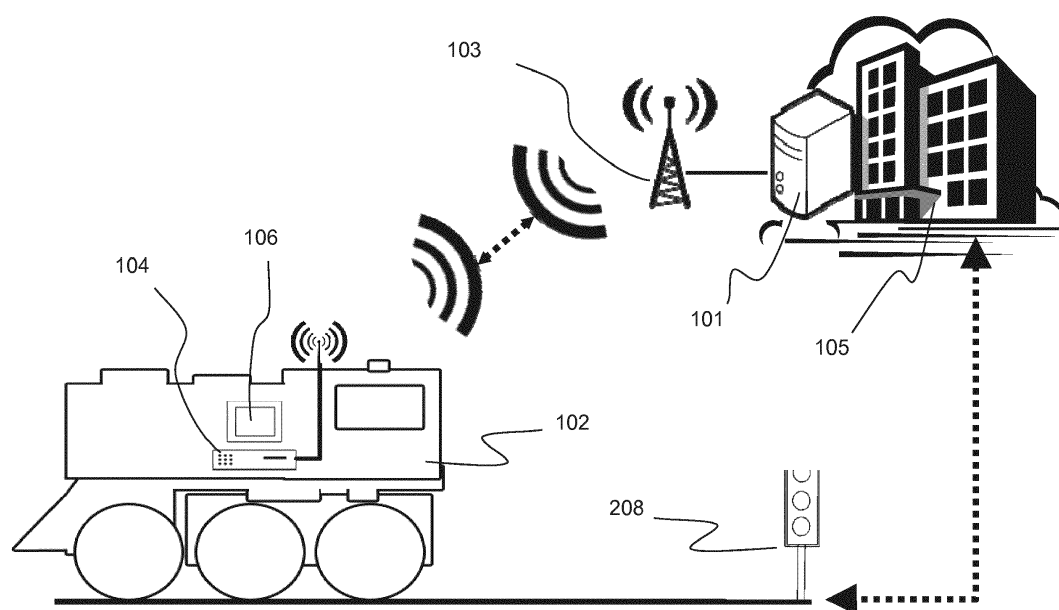


Fig. 1

Description

Field of the Invention

[0001] The present invention relates to a train management system, and in particular, but not exclusively, to such a system that makes use of a driver advisory system of a railway vehicle.

Background of the Invention

[0002] A Driver Advisory System (DAS) can calculate an optimized driving speed profile for a given train based on the train location, track information, the train route and the train timetable. The DAS can then present driving advice to the train driver based on the calculation. Such systems are becoming increasingly important for environmental and cost-saving reasons because of the potential, if a driver follows the advice, for improvements in safety and punctuality, and reductions in energy consumption and brake maintenance costs.

Summary of the Invention

[0003] A problem can arise when advice given by a DAS is inconsistent with signal settings in front of the train. In this situation, the driver should drive the train based on the signal settings, but the incorrect advice may distract or disturb the driver. Thus for safety, the advice given by the DAS should be consistent with signalling. In addition, incorrect or sub-optimal advice can reduce or eliminate energy efficiency improvements e.g. due to sudden braking when advice is inconsistent with signal settings. It would also be desirable to improve ride comfort and reduce brake wear.

[0004] Accordingly, the present invention provides a train management system including:

an on-board server unit of a given train; and
a railway operating centre which includes: (i) a track monitoring unit which monitors locations of trains and statuses of trackside signalling equipment, and creates signalling settings to be enacted by the signalling equipment based on the current train locations and the current statuses of the trackside signalling equipment; and (ii) a timetable updating unit which updates timetables for the trains based on the current train locations;
wherein the train management system further includes a calculation module which, while the given train is running, repeatedly calculates a recommended speed profile for the given train compatible with the latest updated timetable for the given train and latest updated signals from the signalling settings; and
wherein the on-board server unit displays the latest recommended speed profile as advice for the driver of the train.

[0005] Thus, advantageously, the driver can be presented with real-time speed profile advice that not only takes into account the latest signal settings, but also takes into account the latest timetable for the train. In this way, inconsistencies between the advice and the signals can be reduced or eliminated, improving train safety. However, in addition, the train can be driven at a speed which is optimised in terms of ride comfort, reduced mechanical wear and tear, and overall network utilisation.

[0006] Optional features of the invention will now be set out. These are applicable singly or in any combination with any aspect of the invention.

[0007] The calculation module can be a part of the on-board server unit. In this case, the railway operating centre may further include an interface unit which, while the given train is running, sends the latest updated timetable and the latest updated signals to the on-board server unit. The interface unit may further include a signalling management module which checks if the signalling settings in front of the given train have changed, the interface unit sending the updated signals to the on-board server unit only when the signalling settings in front of the train have changed.

[0008] Another option, however, is for the railway operating centre to further include an interface unit, and for the calculation module to be a part of that interface unit, which sends the recommended speed profile to the on-board server unit. In this case, the interface unit can also send the latest updated timetable and the latest updated signals to the on-board server unit.

[0009] The on-board server unit may also display the latest updated timetable and the latest updated signals as advice for the driver of the train.

[0010] The railway operating centre may further include a track description database which contains information on maximum track speeds. The calculation module can then calculate the recommended speed profile for the given train compatible with the latest updated timetable and the latest updated signals but not exceeding the maximum speeds. When the calculation module is a part of the on-board server unit, the interface unit can send the information on maximum speeds to the on-board server unit. The track description database typically also contains information on track gradients and curves. The recommended speed profile can be calculated to be compatible with this information as well.

Brief Description of the Drawings

[0011] Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows an operational background of the invention;

Figure 2 shows system architecture inside a railway operating centre;

Figure 3 shows on-board components of a DAS;

Figure 4 shows functional modules of an interface unit;

Figure 5 shows a flow chart of a signal management module;

Figure 6 shows a flow chart of comparing function;

Figure 7 shows a sequence diagram illustrating a signal update process;

Figure 8 shows a flow chart of a timetable management module;

Figure 9 shows an example of a Driver Machine Interface (DMI) display;

Figure 10 shows the DMI display with signalling light changes;

Figure 11 shows the DMI display with further signalling light changes;

Figure 12 shows of the DMI display with a the timetable change;

Figure 13 shows a sequence diagram illustrating an initialisation process of track data;

Figure 14 shows a sequence diagram illustrating an update process of the track data; and

Figure 15 shows a sequence diagram illustrating a process of searching for train-related signals;

Detailed Description and Further Optional Features of the Invention

[0012] Figure 1 shows an operational background of the invention. In particular, Figure 1 shows trackside equipment (208), an interface unit (101), a train (102), a communication antenna (103), and an on-board server unit (104) which includes a driver-machine interface (106) (i.e. a display).

[0013] The trackside equipment (208) typically include, for example, signals, points, train detection equipment, and train protection equipment. Based on timetables and the train locations detected by the train detection equipment, signalling settings to be enacted by the signals of the trackside equipment are decided.

[0014] A railway operating centre (105) collects the signalling settings and the running statuses of all the trains in a pre-defined geographical region, which can contain one or multiple railway routes.

[0015] The interface unit (101) provides a communications link using the communication antenna (103) be-

tween the on-board server unit (104) and a railway Traffic Management System (TMS) in the rail operating centre (105).

[0016] According to a first embodiment, the on-board server unit (104) has a calculation module which processes data obtained from the interface unit (101) and optionally also processes data obtained from other train-borne devices. In particular, the on-board server unit (104) calculates driving advice for the train driver according to the obtained data, and displays the advice on the driver-machine interface (106). According to a second embodiment, the calculation of the driving advice is performed by a calculation module of the interface unit (101), which then sends the advice for display by the driver-machine interface (106) of the on-board server unit (104).

[0017] The present invention enables the creation and display of such driving advice while the train is being run. In this way, the advice available to the driver can be continuously refreshed.

[0018] Optionally, the interface unit (101) can receive information from the on-board server unit (104) so that the TMS is informed of train statuses. This information can be used to improve management decisions by the TMS.

[0019] Figure 2 illustrates the system architecture inside the railway operating centre (105). In particular, the railway operating centre (105) includes a timetable planning unit (209), a track description database (206) and the TMS (201).

[0020] A track monitoring unit (207) within the TMS has two main functions. Firstly it automatically monitors real-time train locations and statuses of trackside equipment (208) by monitoring an interlocking unit (not shown) that controls the trackside equipment (208). Secondly the track monitoring unit sets routes for each train and creates signalling settings for the signals to avoid route conflicts based on the real-time train locations and trackside equipment statuses. The track monitoring unit sends the train routes and signalling settings to the interlocking unit.

[0021] A timetable updating unit (202) within the TMS (201) updates the train running timetable, which is originally prepared by the timetable planning unit (209). The train running timetable created by the timetable planning unit (209) includes departure and arrival times of trains from timing points, including train stations. Under undisrupted running situations, trains run according to the planned timetable. Under disruption, the timetable updating unit (202) predicts feasible arrival and departure times and automatically creates an updated timetable. The timetable updating unit (202) can include a human interface having a display unit and an input unit. A human operator can then view the updated timetable on the display unit, and can adjust the timetable via the input unit if necessary. In this way, a finally updated timetable is created in the timetable updating unit (202).

[0022] Track description database (206) stores and manages data about the railway lines. the track description database may be located in the railway operating

centre (105). The railway line data can include starting and ending points of track sections, lengths of track sections, connectivities of track sections, locations of points, locations of timing points, locations of signal lights, maximum line speeds of track sections, temporary speed restrictions, track gradients, starting and ending points of track gradients, track curves, starting and ending points of track curves.

[0023] The timetable updating unit (202) receives track description data from the track description database (206), and uses the data for creating the updated timetable.

[0024] The interface unit (101) receives the updated timetable from the timetable updating unit (202) and signal updates from the track monitoring unit (207). The interface unit (101) can also receive track description data from the track description database server (206).

[0025] The interface unit (101) can connect to the train through GSM-R, the international wireless communications standard for railway operations.

[0026] Figure 3 shows on-board components of a driver advisory system (DAS). A Driver Machine Interface (DMI) (106) is placed inside the driver's cab. It provides the driver (110) with advice about optimal driving speeds and other relevant information. The DMI can also display upcoming real-time signaling settings received via the train interface unit (101), updated timetables, track speed limits, track gradients, other trains' locations, etc. in order to provide the driver with assistive information.

[0027] The on-board server unit (104) receives input from the interface unit (101). The on-board server unit (104) also receives input such as instantaneous train speed and GPS location from other on-board equipment (107). According to the first embodiment, the on-board server unit (104) calculates a recommended speed and a recommended speed profile (303). According to the second embodiment, the interface unit (101) calculates a recommended speed and a recommended speed profile which are sent to the on-board server unit (104). Either way, the calculation results are displayed by the DMI (106).

[0028] Figure 9 illustrates an example of display contents shown by the DMI. The rectangular bar on the left is a speed indicator. The line speed limit is represented by the height of a white bar (312). The exact value of the speed limit (306) is displayed at the top of the white bar. The displayed line speed limit is dynamic, depending on the section of track the train is travelling on. The speed limit (306) can be sent from the track description database (206) via the interface unit (101).

[0029] The current speed (311) is represented by the height of a shaded bar (311) overlayed on the white bar (312). The exact value of the current speed (307) can be displayed at the top of the shaded bar. The current speed (311) can be sent from the on-board equipment (107).

[0030] The recommended speed (305) is indicated by an arrow, and the exact value of the recommended speed is displayed by the side of the arrow.

[0031] A horizontal current location line (308) indicates the current location of the train (102) against a vertical journey line indicating upcoming track sections. The markers on the horizontal line are speed markers. The recorded speed profile (301) is indicated by a bold line below the current location line (308). The recommended speed profile (303) is indicated by a bold line above the current location line. The recorded speed profile is dependent historical record of the actual speed of the train. The recommended speed profile is calculated by the on-board server unit (104) or the interface unit (101), depending on the updated timetable, the track description data, the signal updates, and optionally train conditions.

[0032] Timing point locations (TIPLOC) (304) are indicated by small triangles on the vertical line indicating upcoming track sections. The name (313) and scheduled time (310) for each TIPLOC is displayed next to the TIPLOC symbol. Names of the TIPLOCs can be extracted from the updated timetable. Although often abbreviated, TIPLOC names are familiar to qualified drivers.

[0033] The current time (302) is displayed to the right of the current location line (308).

[0034] Indicators (309) for upcoming signalling lights are displayed along the vertical journey line at appropriate positions. The updated signals can be displayed on the signal indicators in the display. In this way, real-time signal changes can be reflected in real-time changes on the DMI display. Driving advice, such as new recommended speed profiles, new recommended speeds and updated signals, are re-calculated by the on-board server unit (104) or the the interface unit (101) when the timetable is updated and/or any signalling settings change.

[0035] Figure 4 illustrates the architecture of functional modules of the interface unit (101).

[0036] A communication and control module (113) handles all internal communications between functional modules, and all external communications with other units.

[0037] The main incoming data from the railway operating centre (105) are track descriptions from the track description database server (206), planned and updated timetables (211) from the timetable updating unit (202), and an interlocking data file (212) from the track monitoring unit (207).

[0038] A signal management module (114) receives and processes the real-time signalling settings (212). Updated signals are extracted from the signalling settings and sent to relevant trains.

[0039] A timetable management module (115) receives and processes the updated timetable (211). Relevant timetables are extracted from all the updated timetables and send to relevant trains.

[0040] A train register module (116) keeps a list of train IDs of those trains in the TMS controlled area.

[0041] A track data management module (117) manages track data of the controlled area. For example, the module can keep a copy of the track data. When any track data are changed, the update is sent to the module

(117) from the track description database (206).

[0042] A train running management module (118) keeps train running statuses, including latest received locations, speeds and predicted arrival times.

[0043] A time synchronisation module (119) adjusts the system time when the interface unit application is started.

[0044] A communication and control module (113) manages incoming and outgoing messages with the trains that are in the control area. It also manages internal communications between the above-mentioned functional modules (114-119).

[0045] Figure 5 shows the working arrangement of the signal management module (114). The track monitoring unit (207) in the TMS sends the interlocking data file (212) to the communication and control module (113), which sends it to the signal management module (114). The signal management module (114) then returns an acknowledgement to the track monitoring unit (207). Upon receiving the interlocking data, a comparison function (121) within the the signal management module compares the incoming interlocking data with the last received interlocking data. If there is no change, the signal management module waits for another regular interlocking data update.

[0046] If there is change with the interlocking data, the signal management module (114) calls the train register module (116) to obtain a copy of the list of trains that are currently in the control area. The signal management module (114) then loops over each train in the control area to check if the signals in front of this train have changed using a comparing function (123). If the signals have changed for the train being considered, relevant signal updates are prepared by the output function (122) to be sent to the train via the communication and control module (113). The same process continues to other trains in the current list until all the trains in the control area have been tested.

[0047] After each train is tested, the signal management module waits for another interlocking data update.

[0048] Figure 6 shows how the comparing function (123) identifies whether the signals in front of a given train have changed. The function first calls train running module (118), which returns the GPS location of the train to the function. The function then calls the track management module (117) with the GPS location as argument. The track management module returns the signal IDs in front of the given location. The comparing function then compares the signals' settings.

[0049] Figure 7 shows a sequence diagram illustrating a signal update process. When the train drives along the track, the on-board server unit (104) may request signal updates from the interface unit (101). When such a request is received by the communication and control module (113), the module (113) forwards the request to the signal management module (114). The signal management module search function (124) searches for the requested signal and returns the relevant data to the on-

board server unit (104) via the communication and control module (113).

[0050] Figure 8 shows the working arrangement of the timetable management module (115). The timetable updating unit (202) in the TMS prepares and sends updated timetables (211) to the communication and control module (113), which send them to the timetable management module (115). The timetable management module (115) then returns an acknowledgement to the timetable updating unit (202). An updated timetable (211) does not have to be a full timetable. It may only relate to trains whose timetables are changed. Upon receiving the timetable data, the timetable management module (115) loops over each train that is specified in the updated timetable. The timetable processing function (131) prepares data for each affected train. The data is output to the communication and control module (113), which sends it to corresponding trains.

[0051] The updated timetable and the updated signals are displayed by the DMI, and are also used to calculate a recommended speed profile which is displayed by the DMI.

[0052] Thus, as mentioned previously, in Figure 9 the signal indicators (309) shown by the DMI can show not only the upcoming signal positions but also updated signal settings. For example, a vertical line on a given signal can indicate a green signal, a tilted line an amber signal and a horizontal line a red signal. If the DMI has colour display, the updated signal colours can be indicated directly by the colour of the signal indicator circle.

[0053] As also mentioned previously, according to a first embodiment, the recommended speed profile (303) can be calculated by a module of the on-board server unit (104), depending on the updated timetable, the track description data, the signalling updates and optionally locomotive conditions. For example, the on-board server unit (104) extracts the scheduled time of each TIPLOC (SHPY and BAILDON) from the updated timetable. The on-board server unit (104) also extracts the line speed limit (312) from the track description database, and the updated signalling setting of each signal indicator in front of the train. Based on this information, the recommended speed profile (303) is calculated so that the train arrives at each TIPLOC on time, the train speed does not exceed the line speed limit (312), and the signals are obeyed. Optionally, the recommended speed profile (303) can be calculated so that the train can avoid unnecessary acceleration and braking, thereby improving ride comfort and reducing energy consumption.

[0054] Figure 10 illustrates the display contents shown by the DMI when the signal settings change without a timetable change. The setting changes are reflected by the signal indicators (309), and the recommended speed profile (303) is adjusted to reflect the changed signal settings.

[0055] More particularly, the middle signal indicator (309) shows amber, changed from green, and the upper signal indicator shows red, changed from green. The rec-

ommended speed profile (303) is adjusted to a slower speed profile, because the amber signal could change to red. Without this updated signalling information, the DMI would continue to display the original recommended speed profile (323). Then, if a driver drove according to the original recommended speed profile (323) and did not observe the amber signal, a safety system may have to be actuated to force a stop to avoid running through a red signal. This is undesirable, not only from a compromised safety viewpoint, but also because it reduces ride comfort, wastes energy and increases brake wear and tear.

[0056] Figure 11 illustrates the display contents shown by the DMI when the upper and middle signal indicators (309) display red signals, changed from green, and the lower signal indicator shows amber, changed from green. The recommended speed profile (303) is now adjusted to even slower speeds and advises a stop at the middle signal. Again, without the updated signalling information, the DMI would mislead the driver.

[0057] Figure 12 illustrates the display contents shown by the DMI when there is a timetable update. The DMI displays the updated timetable using the scheduled time indicator (310), and the on-board server unit (104) recalculates and adjusts the recommended speed profile (303) which is also displayed on the DMI. In this case, the updated timetable changes the scheduled time (310) of TIPLOC SHPY (304), from 08:18 to 08:26. Accordingly, the recommended speed profile (303) is changed to a slower speed compatible with the later scheduled time, and thereby reduces energy consumption. Additionally, because the train is slower, it stops at TIPLOC SHPY for a relatively short time. This reduced stop time increases the possibilities for other train to maneuver using the available track and recover faster from disruption, hence the overall reliability of the railway network can be improved.

[0058] Without the updated timetable, the DMI would still display the original timetable and the original speed profile (323) based on the original timetable. If the driver drove according to the original advice, the train would accelerate to a higher speed compatible with the original timetable (08:18). The train would then stop at SHPY until the updated timetable time (08:26) was reached. Therefore, the train would reach to SHPY too early and waste energy.

[0059] In the second embodiment, the DMI shows the same display as described above in relation to Figures 9 to 12. However, instead of the on-board server unit (104) calculating the recommended speed profile, this calculation can be performed for each train by a further module of the interface unit (101). The recommended speed profile can then be transmitted to each train, along with the relevant updated timetable, updated signals and track description data, via the communication and control module (113).

[0060] Figure 13 is a sequence diagram showing an initialisation process of the track data. When the DAS

interface system starts up, the communication and control module (113) sends a request to the railway operating centre (105). Upon receiving the request, the railway operating centre (105) sends the full track data from the track description database (206) to the communication and control module (113), which forwards the data to the track data management module (117). The track data management module (117) processes the track data and prepares for each train in the control area the relevant track data. The relevant data is forwarded to the individual on-board server unit (104) via the communication and control module (113).

[0061] Figure 14 is a sequence diagram showing an update process of the track data. When there is any update of the track data, especially temporary speed restrictions or emergency speed restrictions, such updates are sent to the track data management module (117) via the communication and control module (113). The track data management module (117) processes the updated track data and prepares for each train in the control area affected by the track data update the relevant track data. The relevant data is forwarded to the individual on-board server unit (104) via the communication and control module (113).

[0062] The track data management module (117) stores the links between GPS coordinates and positions on track sections. If GPS coordinates are input to the module (117), the module returns the upcoming signals and track data. Figure 15 is a sequence diagram showing the process of searching for train-related signals. When the signalling management module (114) sends the train GPS position to the track data management module (117) via the communication and control module (113), the track data management module (117) searches the relevant track section and returns to the signalling management module the relevant track data, including signal and upcoming track details.

[0063] A more integrated option is for the track data management module (117) to make a query to the track description database (206) when necessary, but not to store track data itself.

[0064] The train register module (116) maintains a list of train IDs of those trains in the TMS controlled area. The train register module (116) can store a copy of the train list from the TMS. Another option is for the train register module (116) to monitor the boundary of the controlled area. The module can then add a train ID to the list when a train arrives at the boundary, and remove a train ID from the list when a train leaves the controlled area from the boundary. In addition, the train register module can maintain a record of the on-board server unit (104) connection details for each currently registered trains.

[0065] The on-board server unit (104) can send the current location of the train to the interface unit (101). The communication and control module (113) forwards such data to the train running module (118). When the signalling management module (114) checks whether

the signal settings are changed for the train in question, it first calls the train running management module (118) to get the location of the train. When contacted, the train running management module (118) returns the GPS location of train to the signalling management module.

[0066] The on-board server unit (104) or the interface unit (101) can predict the running time of train, based on the recommended speed profile. The predicted running time may be sent to the train running module (118). The module can then forward such information to the TMS. Optionally, the on-board server unit (104) or the interface unit (101) can send to the train running module (118) a message to indicate whether the timetable can be achieved by the train. The train running module can also forward such information to the TMS.

[0067] While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention

Claims

1. A train management system including:

an on-board server unit of a given train; and
a railway operating centre which includes: (i) a track monitoring unit which monitors locations of trains and statuses of trackside signalling equipment, and creates signalling settings to be enacted by the signalling equipment based on the current train locations and the current statuses of the trackside signalling equipment; and
(ii) a timetable updating unit which updates timetables for the trains based on the current train locations;

wherein the train management system further includes a calculation module which, while the given train is running, repeatedly calculates a recommended speed profile for the given train compatible with the latest updated timetable for the given train and latest updated signals from the signalling settings; and

wherein the on-board server unit displays the latest recommended speed profile as advice for the driver of the train.

2. A train management system according to claim 1, wherein the railway operating centre further includes an interface unit which, while the given train is running, sends the latest updated timetable and the latest updated signals to the on-board server unit; and wherein the calculation module is a part of the on-

board server unit.

3. A train management system according to claim 2, wherein the interface unit further includes a signalling management module which checks if the signalling settings in front of the given train have changed, the interface unit sending the updated signals to the on-board server unit only when the signalling settings in front of the train have changed.

4. A train management system according to claim 1, wherein the railway operating centre further includes an interface unit; and wherein the calculation module is a part of the interface unit, which sends the recommended speed profile to the on-board server unit.

5. A train management system according to any one of the previous claims, wherein the on-board server unit also displays the latest updated timetable and the latest updated signals as advice for the driver of the train.

6. A train management system according to any one of the previous claims, wherein the railway operating centre further includes a track description database which contains information on maximum track speeds, and the calculation module calculates the recommended speed profile for the given train compatible with the latest updated timetable and the latest updated signals but not exceeding the maximum speeds.

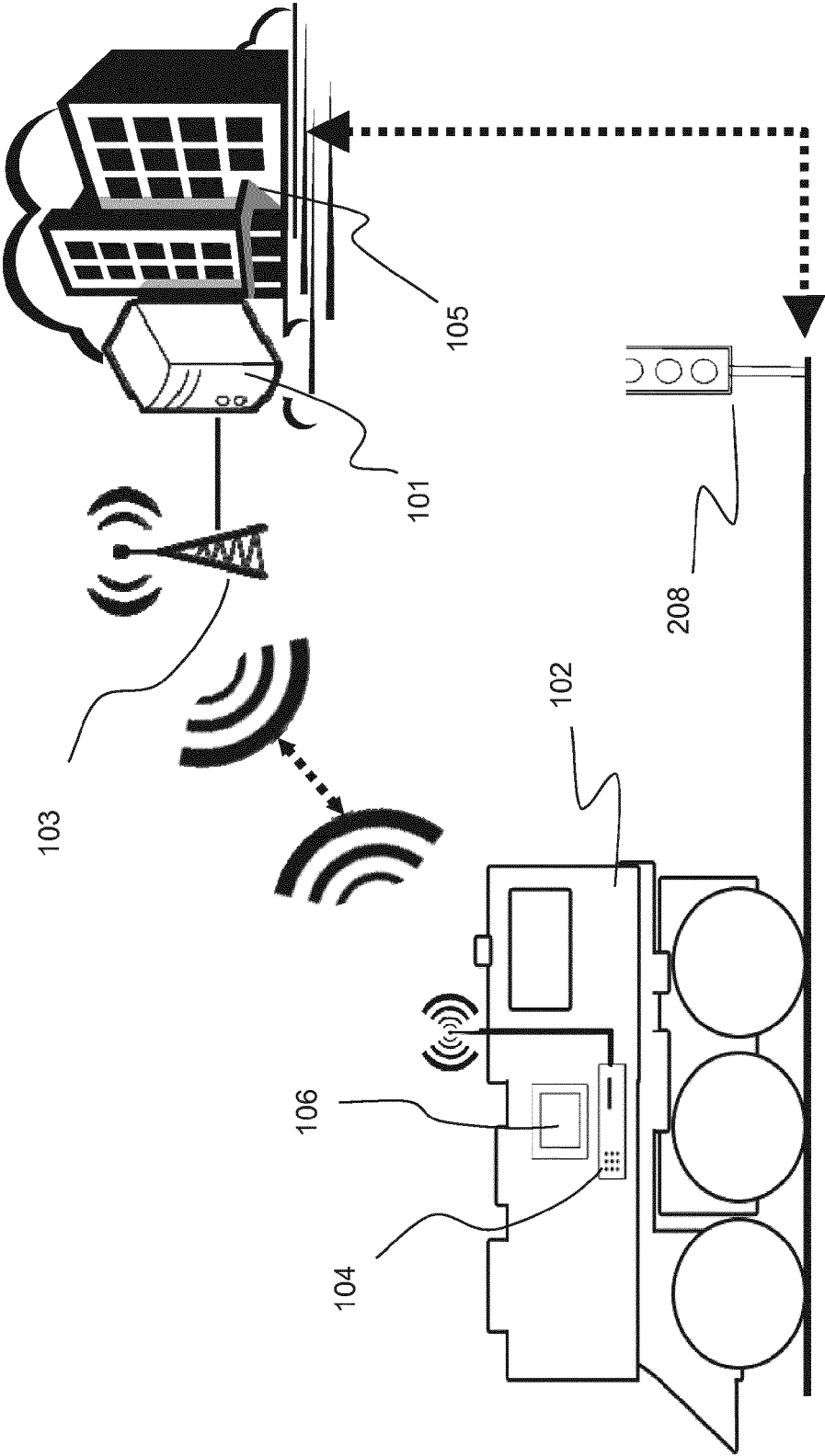


Fig. 1

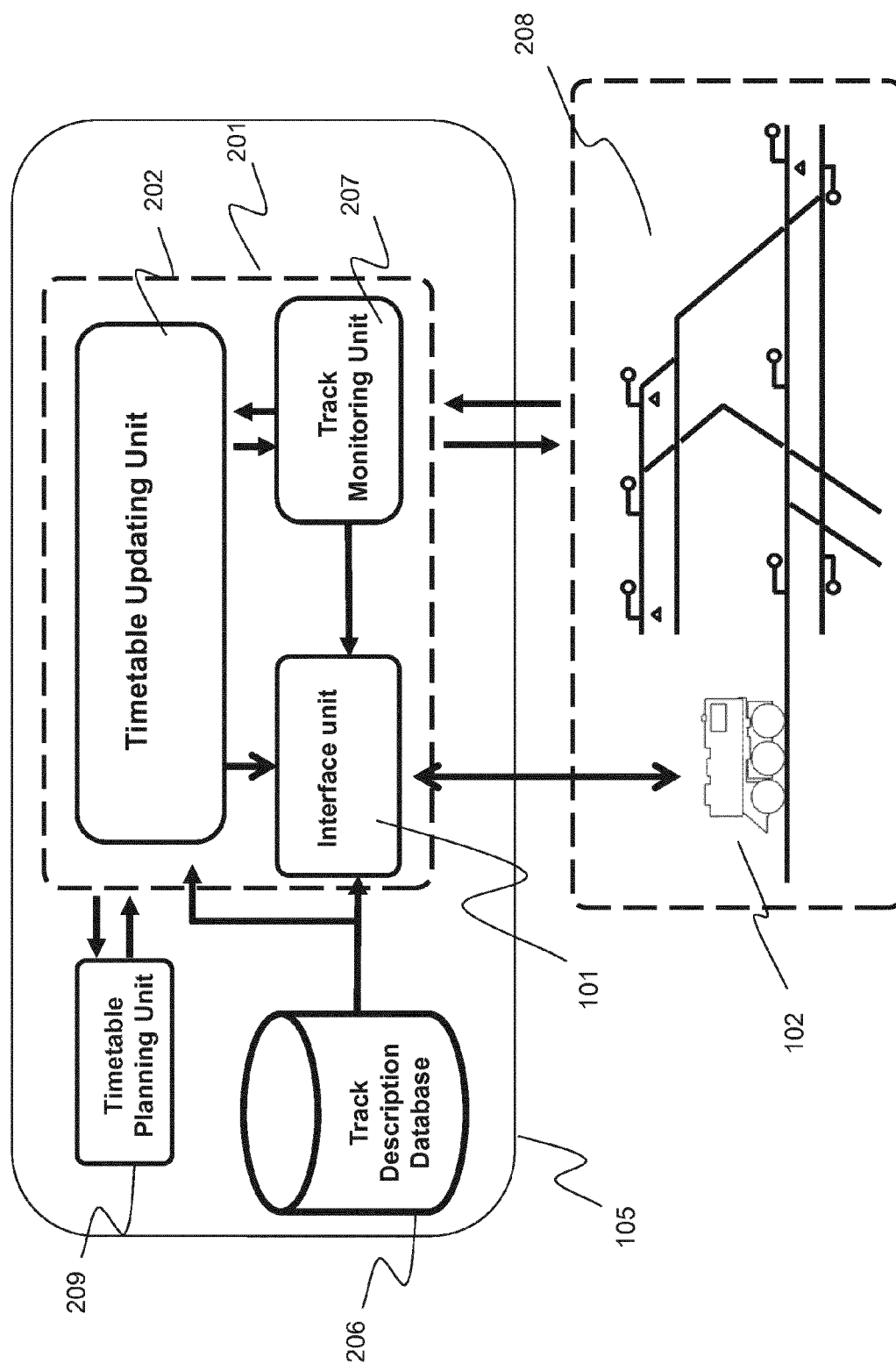


Fig. 2

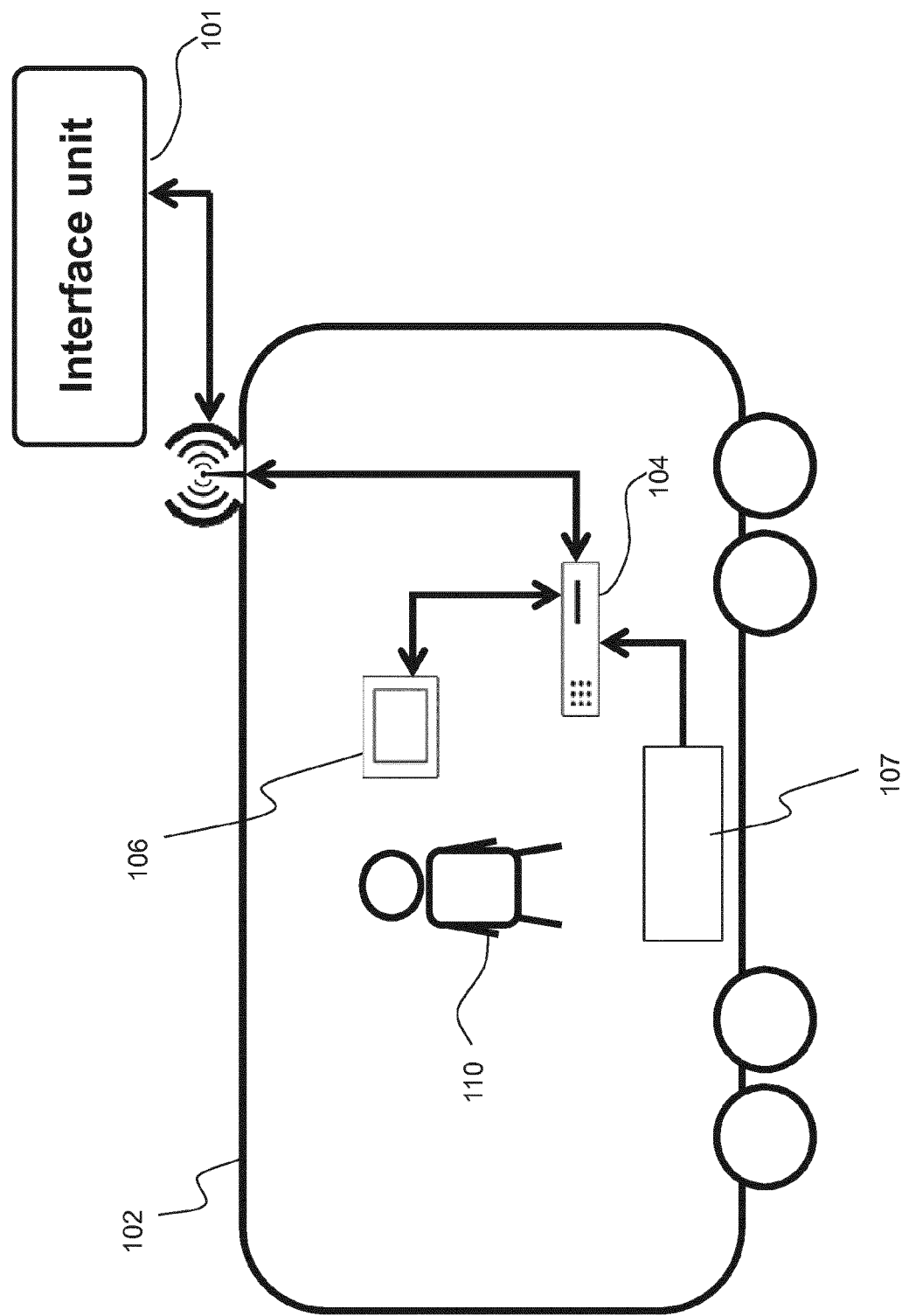


Fig. 3

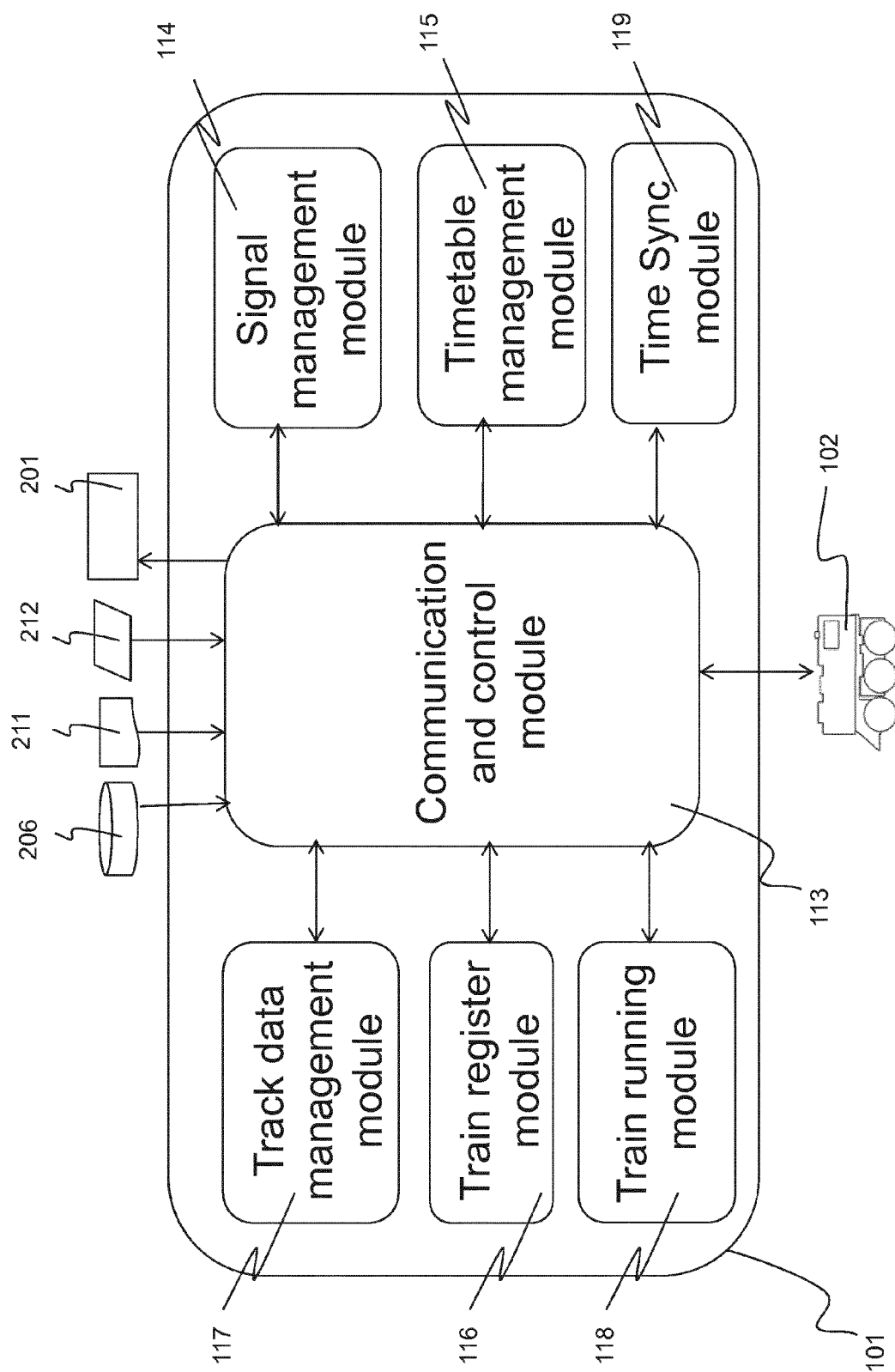


Fig. 4

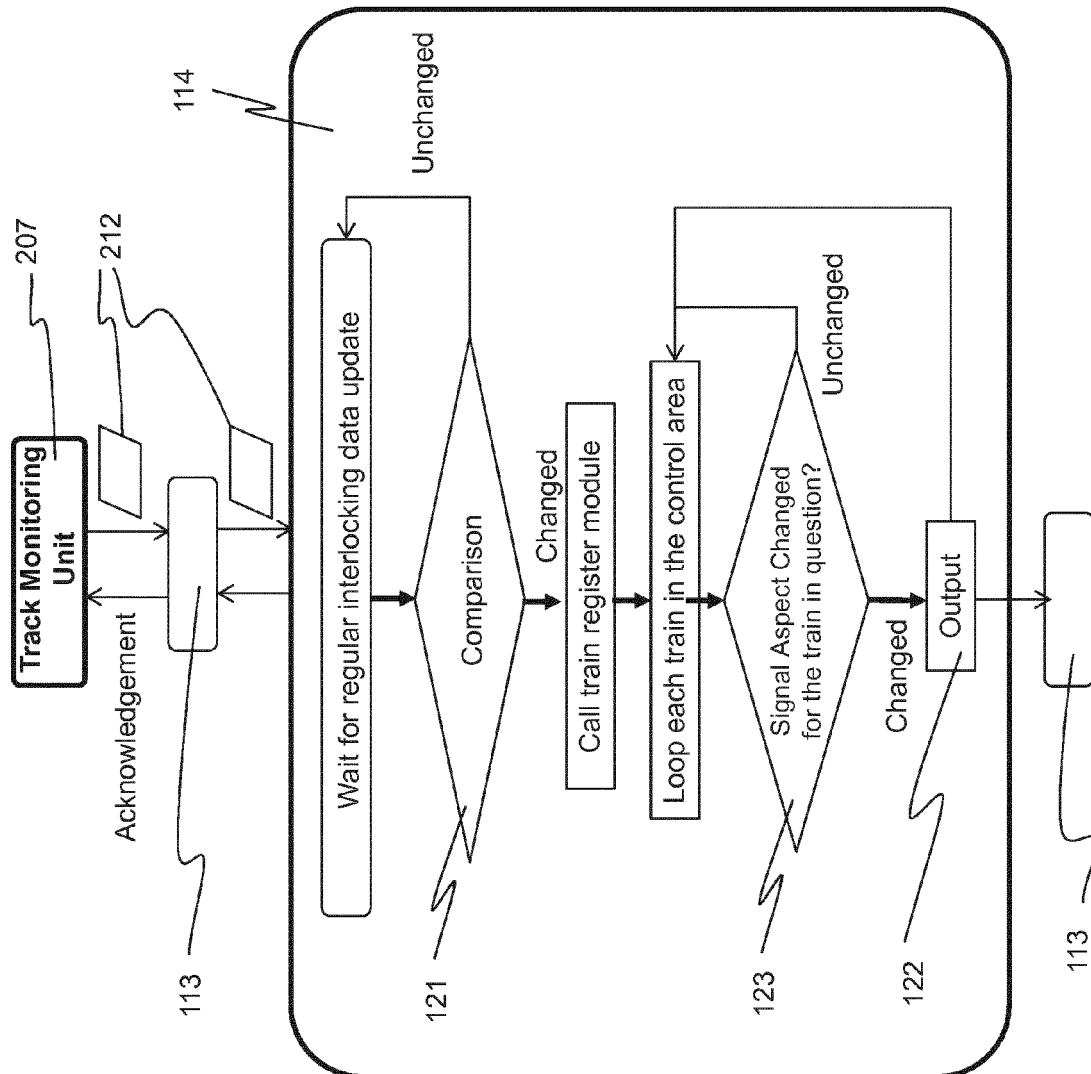


Fig. 5

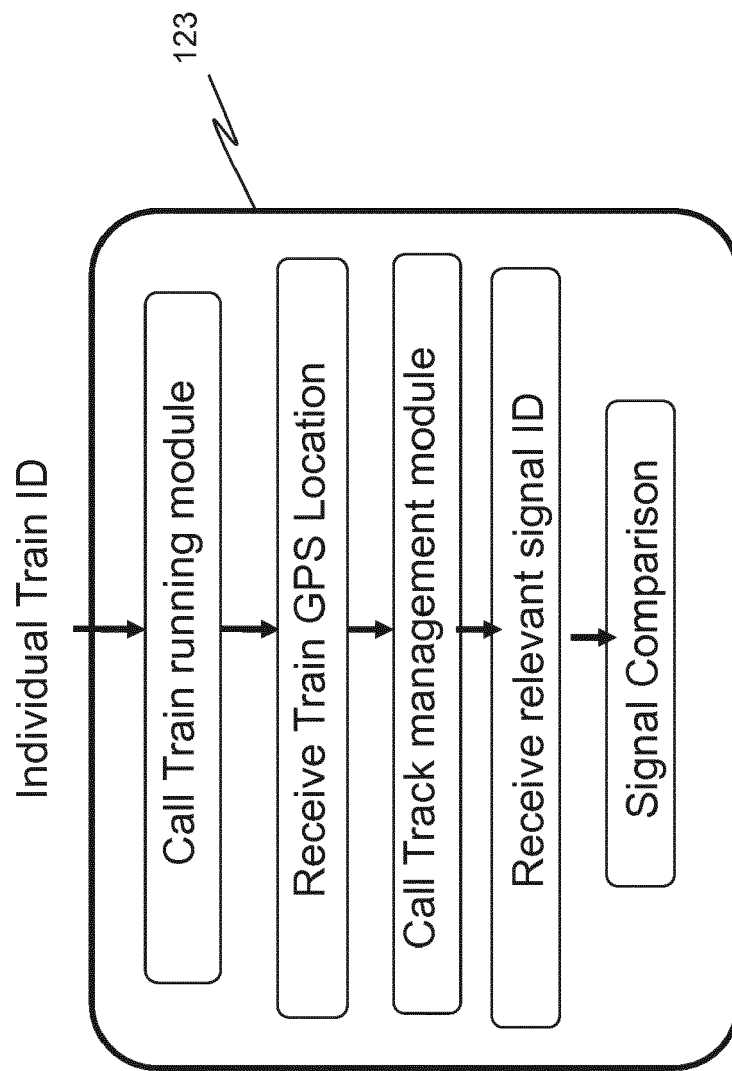


Fig. 6

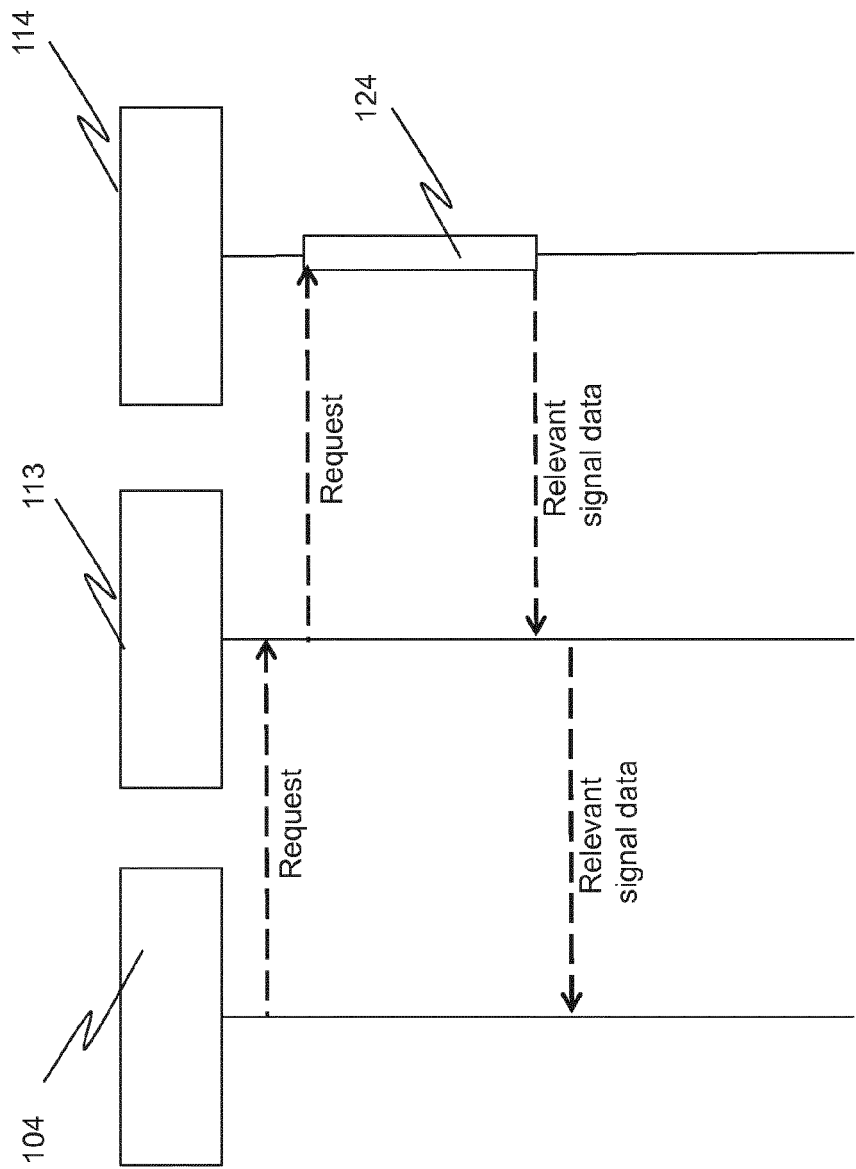


Fig. 7

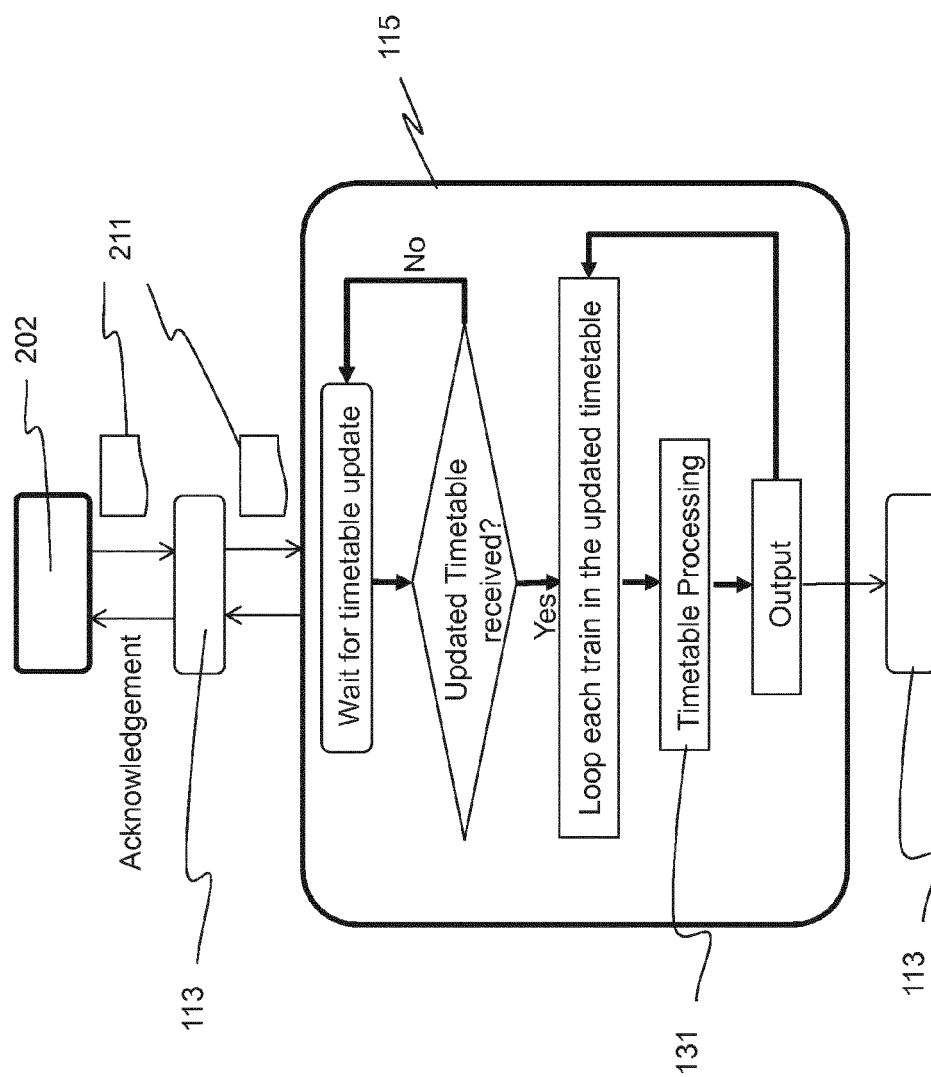
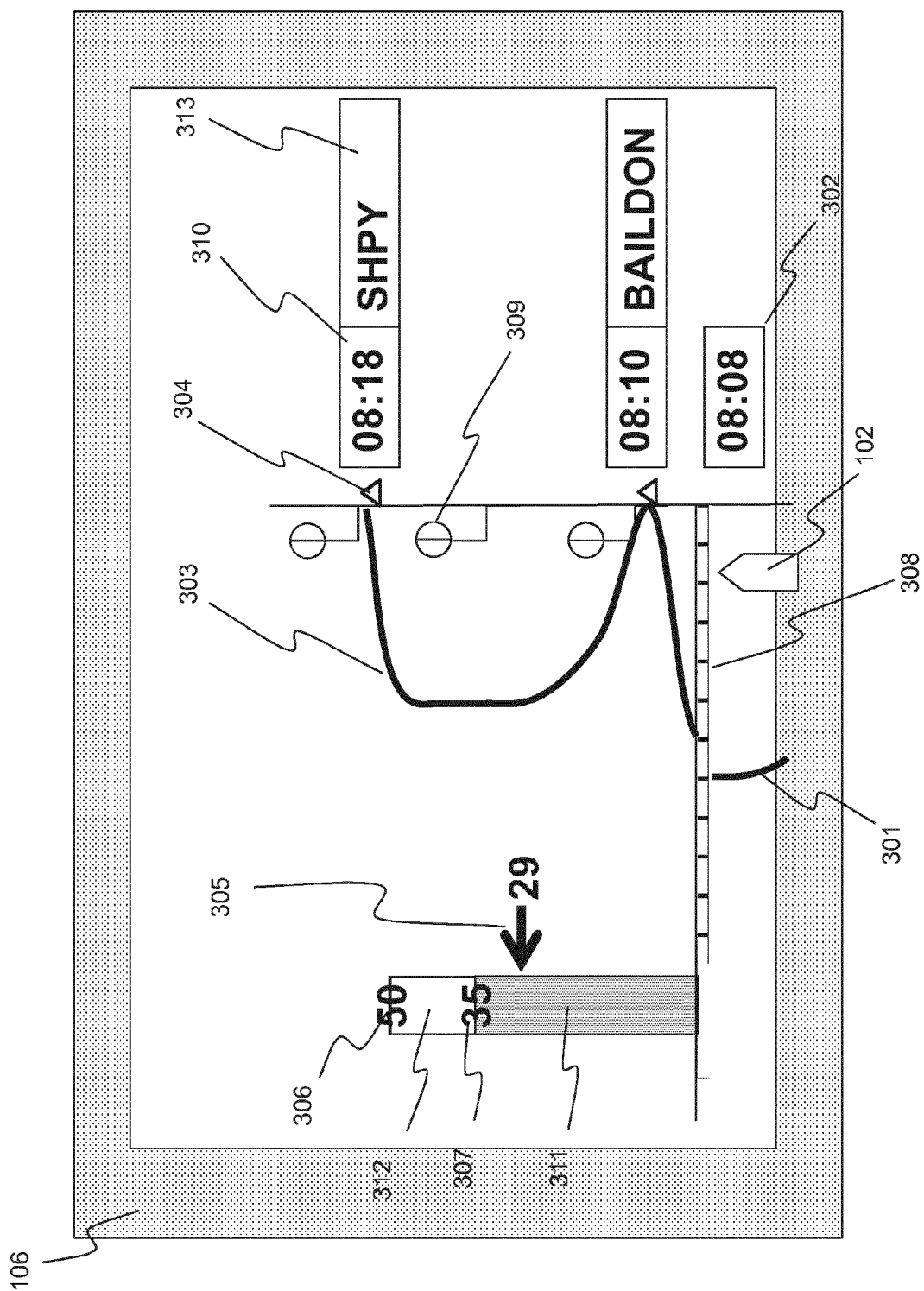


Fig. 8



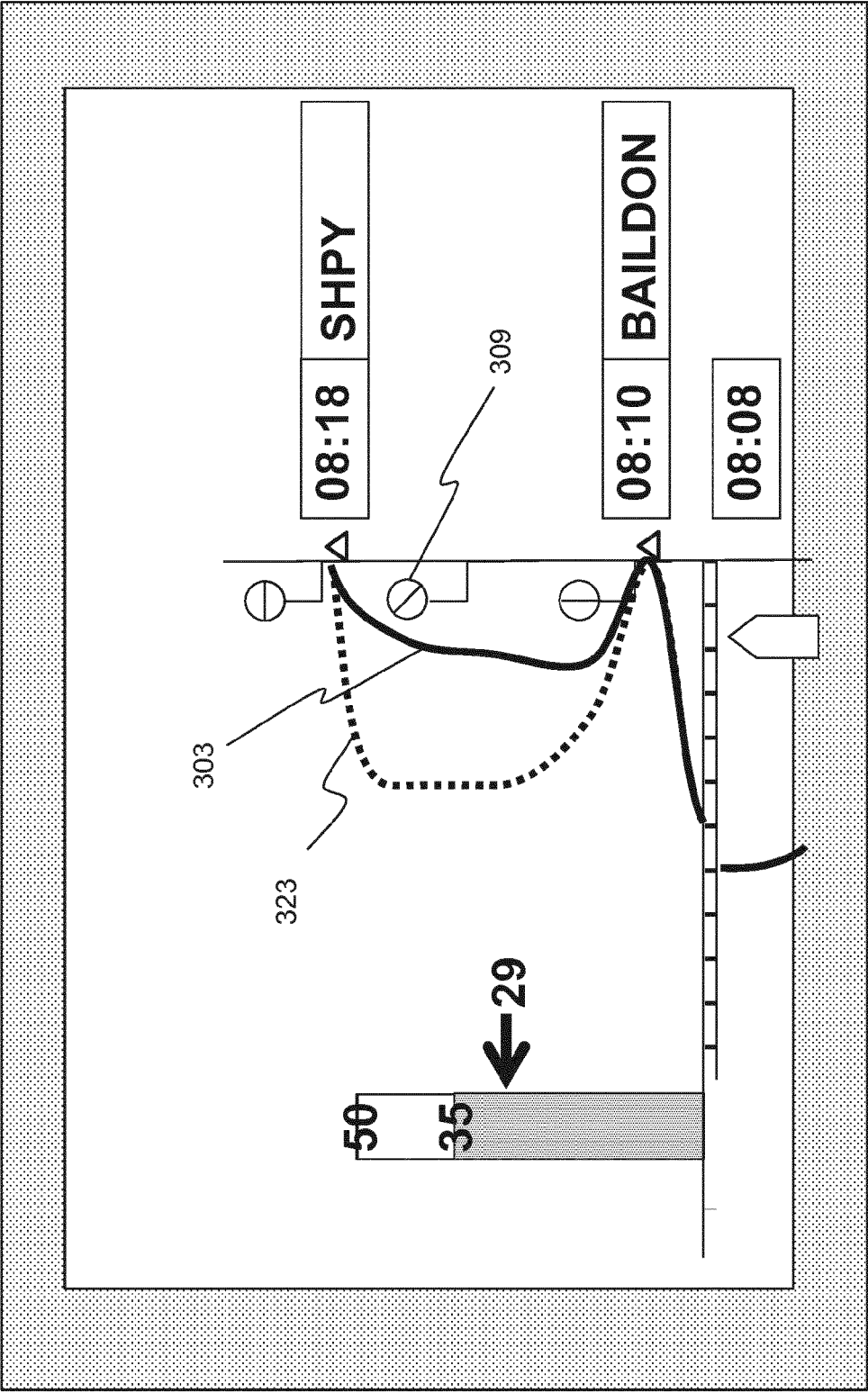


Fig. 10

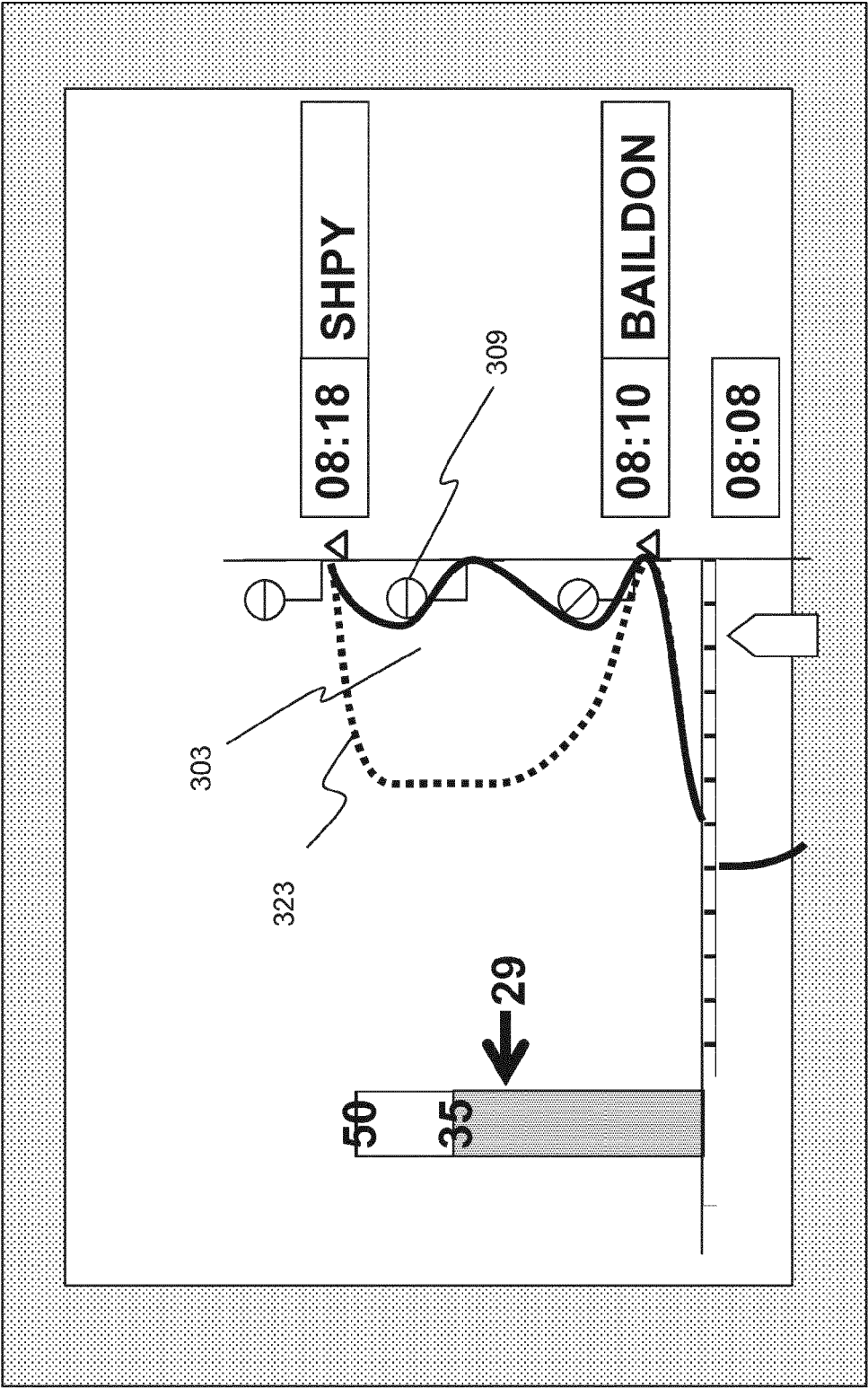


Fig. 11

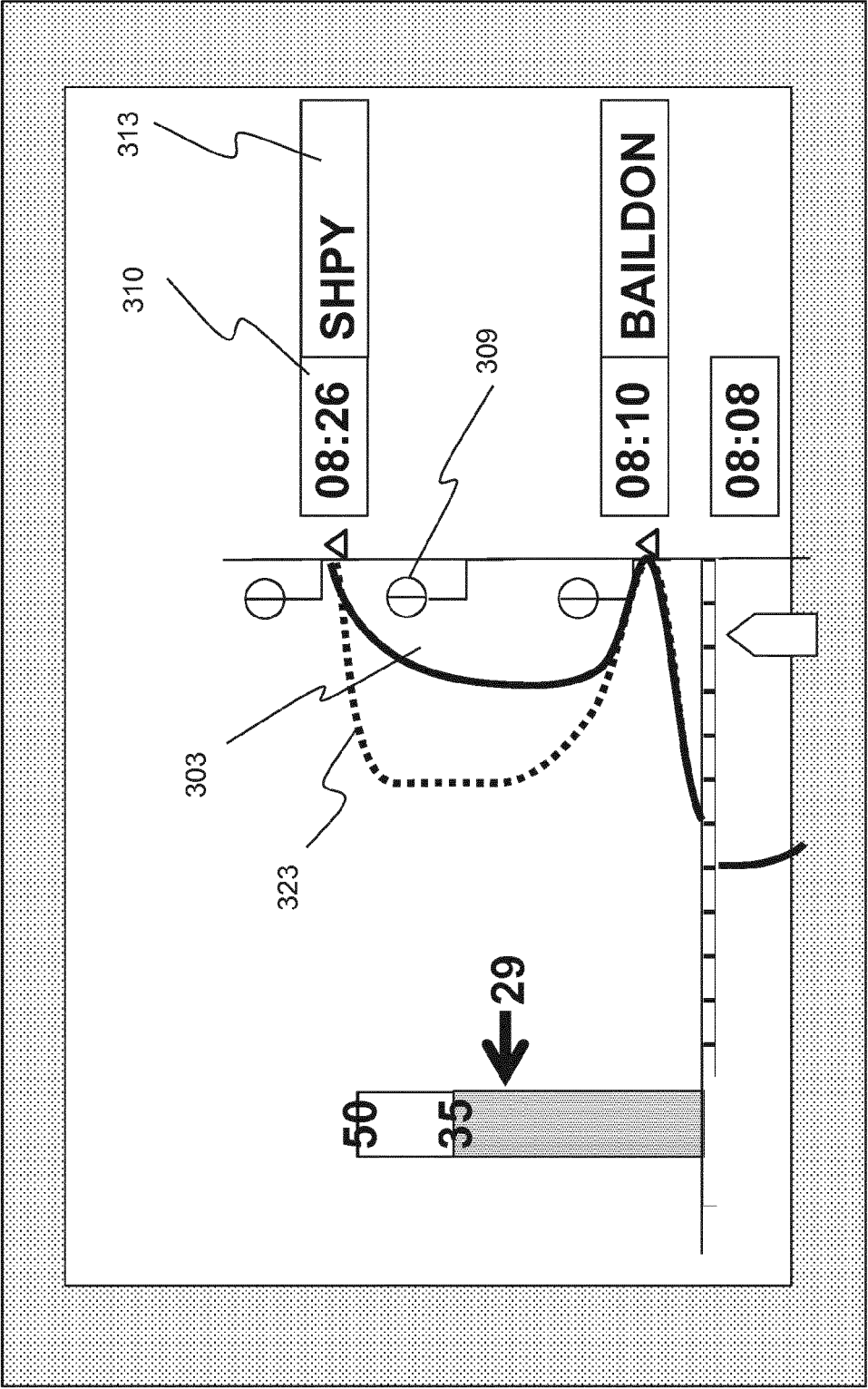


Fig. 12

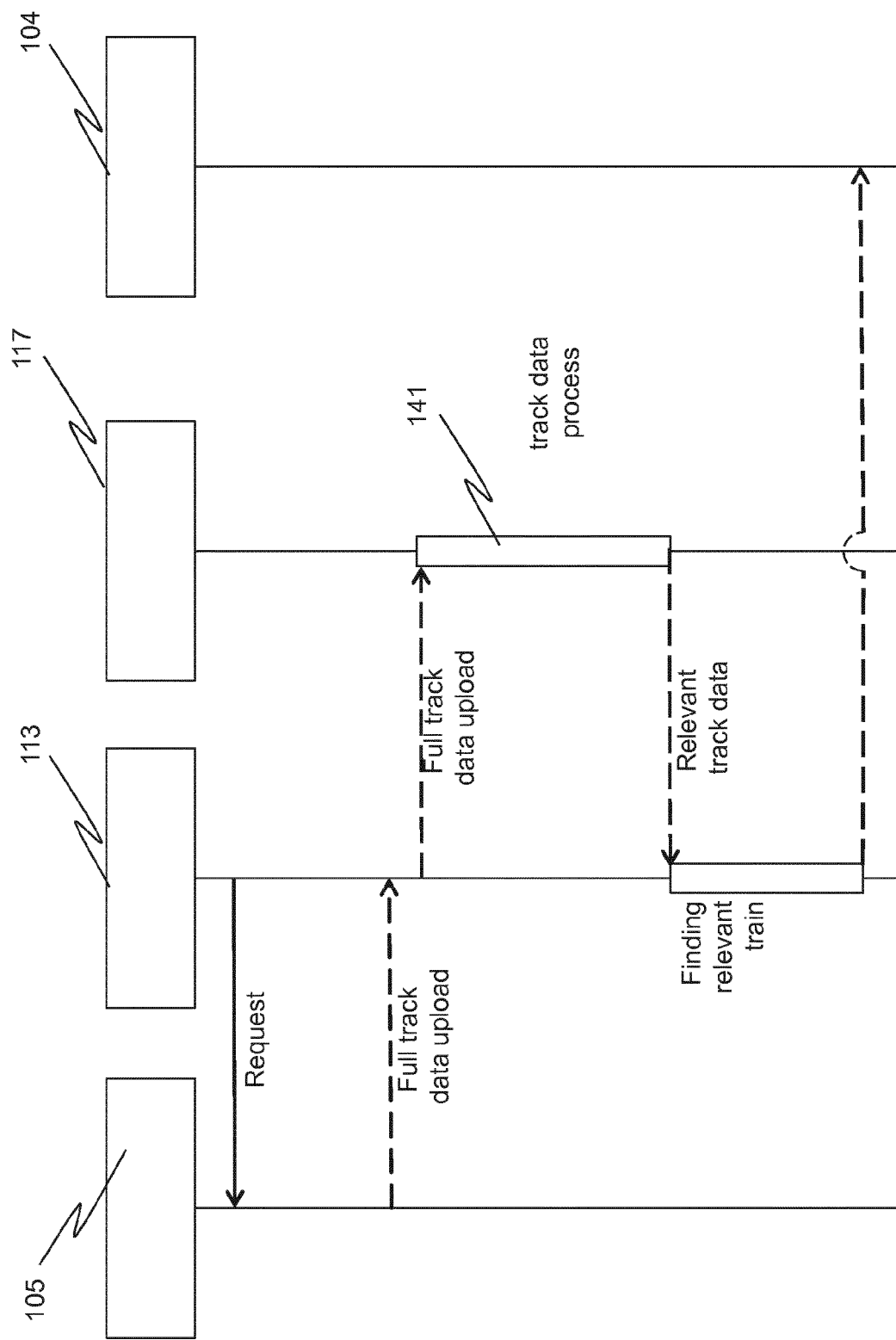


Fig. 13

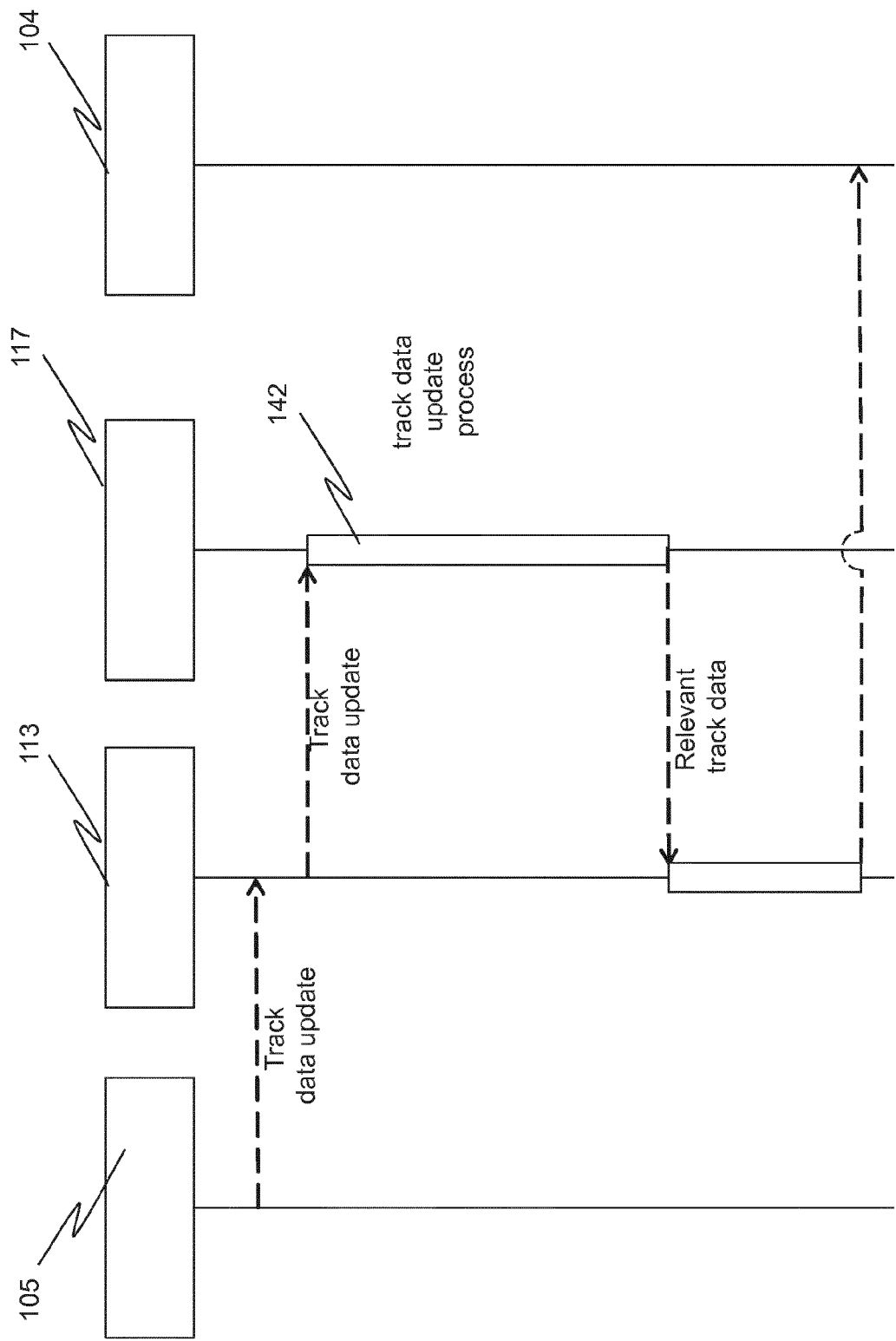


Fig. 14

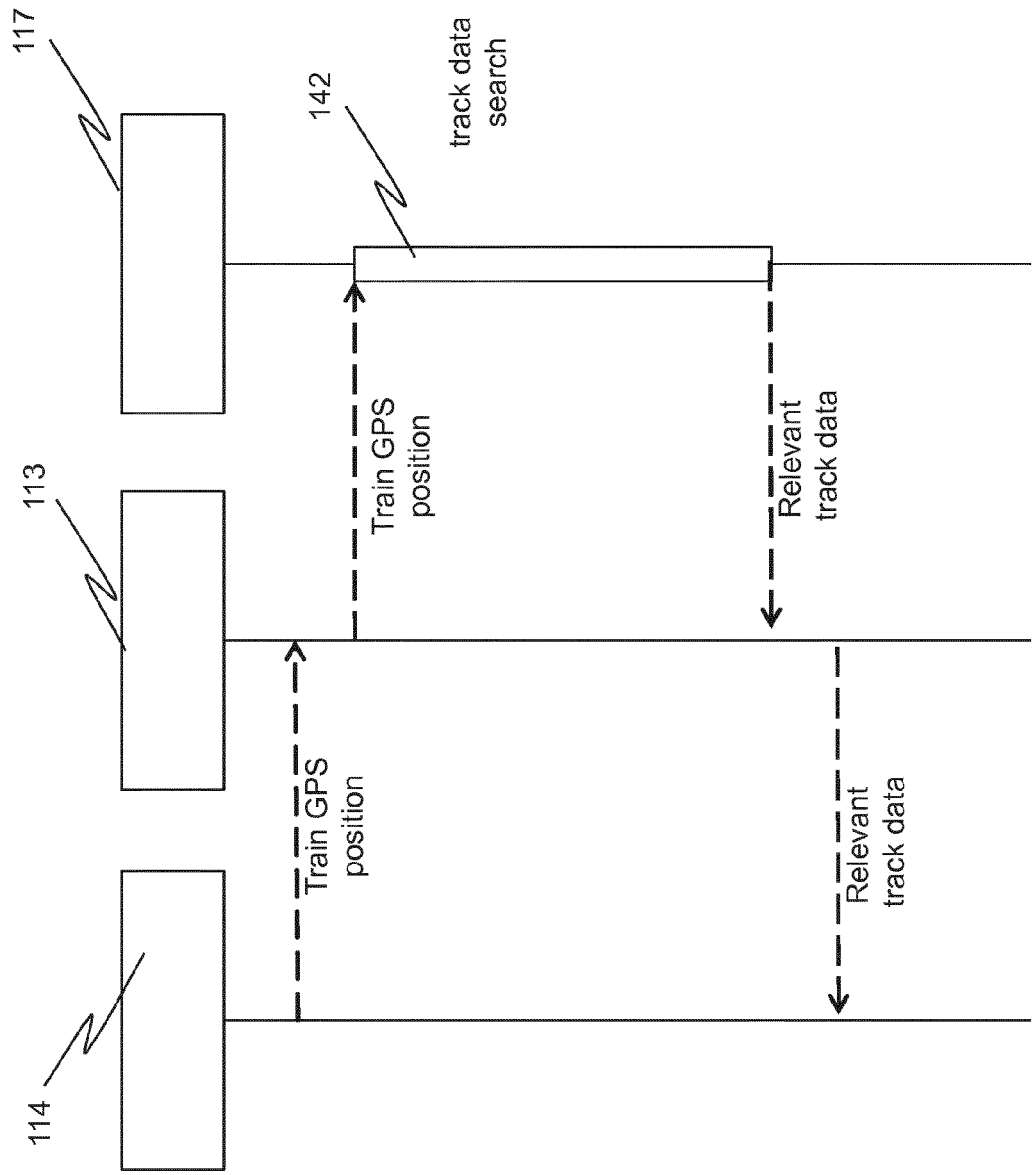


Fig. 15



EUROPEAN SEARCH REPORT

Application Number
EP 14 17 7525

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 98/30426 A1 (SIEMENS AG [DE]; MUECKE WOLFGANG [DE]) 16 July 1998 (1998-07-16) * page 1, line 5 - page 2, line 12; page 4, line 22 - page 5, line 31; figures 1,2 *	1-6	INV. B61L27/00
A	WO 2010/149715 A2 (KNORR BREMSE SYSTEME [DE]; NOCK MARCO [DE]; SCHMOELZ DOMINIK [DE]) 29 December 2010 (2010-12-29) * page 3, line 20 - page 8, line 17; figure 1 *	1-6	
A	JP 2000 344107 A (KYOSAN ELECTRIC MFG) 12 December 2000 (2000-12-12) * abstract; figures 1,2 *	1-6	
			TECHNICAL FIELDS SEARCHED (IPC)
			B61L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 January 2015	Examiner Plützer, Stefan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 17 7525

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-01-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9830426 A1	16-07-1998	DE 19701947 A1	16-07-1998
		EP 0951415 A1	27-10-1999
		WO 9830426 A1	16-07-1998

WO 2010149715 A2	29-12-2010	DE 102010024800 A1	13-01-2011
		WO 2010149715 A2	29-12-2010

JP 2000344107 A	12-12-2000	JP 3089240 B1	18-09-2000
		JP 2000344107 A	12-12-2000
