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(54) TRAIN FORMATION MANAGEMENT METHOD AND APPARATUS, DEVICE, AND MEDIUM

(57) The present invention relates to a marshalled train management method, apparatus, device and medium, the method including: S1: identifying, by a vehicle-mounted VOBC, train marshalling information; S2: identifying, by a trackside ZC, coupling marshalling information; S3: when the coupling marshalling information or the train marshalling information is valid, calculating, by the trackside ZC, a valid movement authorization for the marshalled train; S4: checking, by the vehicle-mounted VOBC, a currently applied marshalled train parameter state thereof; if the coupling marshalling information or the train marshalling information is valid, setting the fromed train parameter state to be available; and if the state is available and the valid movement authorization is received, safely controlling the train to run; S5: verifying, by the vehicle-mounted VOBC, an availability state of the marshalled train parameter state in real time according to the coupling marshalling information or the train marshalling information; and S6: when the coupling state of the marshalled train changes during online coupling or dis-marshalling, re-performing the calculation and verification steps of the vehicle-mounted VOBC and the trackside ZC. Compared with the prior art, the present invention has advantages of high safety, high reliability, high availability, etc.

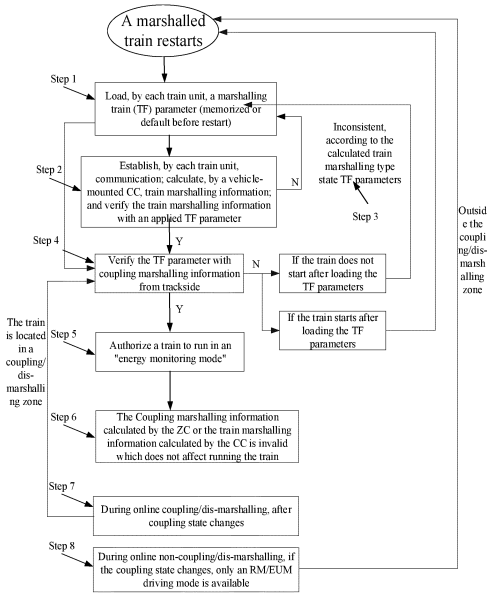

FIG. 1

EP 4 417 487 A1

Description

FIELD OF TECHNOLOGY

[0001] The present invention relates to a train signal control system, in particular to a marshalled train management method, apparatus, device and medium based on flexible marshalling for operation.

BACKGROUND

[0002] The time distribution characteristics of daily passenger flows on different lines of urban rail transit are quite different, especially on suburban lines, wherein tidal changes of passenger flows are particularly obvious. The fixed marshalling mode can not solve problems that train capacity is waste during off-peak hours and it is crowded in the trains during peak hours.

[0003] In view of the passenger flow difference characteristics of different time periods or different sections throughout a day, under a condition of ensuring a better train service frequency in each period, the flexible marshalling for operation realizes the optimal cooperative transportation organization between passenger flow demand and capacity by changing the number of marshalled trains online, and reasonably optimizes a full load ratio of trains in each period, which solves the problem of transport capacity waste caused by unbalanced time distribution and can improve operation economy of a rail transit system while ensuring a service level.

[0004] The flexible marshalling requires online coupling/dis-marshalling of trains on the lines, and different marshalled trains run in a mixed manner. A Communication Based Train Control (CBTC) needs to identify the number and type of marshalled trains in its management zone in real time, and safely control automatic run of the trains after the identified type of marshalled trains thereby is consistent with the train parameter used for train control thereby.

[0005] However, how to effectively manage the flexible marshalled trains so as to improve the operation efficiency under a premise of ensuring train safety has become a technical problem to be solved.

SUMMARY

[0006] The purpose of the present invention is to provide a marshalled train management method, apparatus, device and medium with high safety, high reliability, high availability in order to overcome the defects existing in the prior art.

[0007] The purpose of the present invention can be realized by the following technical solutions:

According to a first aspect of the present invention, provided is a marshalled train management method, wherein a CBTC system automatically identifies and manages a marshalled train after the marshalled train restarts or a marshalling state changes, and the method specifically comprises the following steps:

step S1: identifying, by a vehicle-mounted VOBC, train marshalling information and transmitting the train marshalling information to a trackside ZC;

step S2: identifying, by the trackside ZC, coupling marshalling information and transmitting the connecting marshalling information to a vehicle-mounted CC;

step S3: when the coupling marshalling information or the train marshalling information is valid, calculating, by the trackside ZC, a valid movement authorization for the marshalled train;

step S4: checking, by the vehicle-mounted VOBC, a currently applied marshalled train parameter state thereof; if the coupling marshalling information or the train marshalling information is valid, setting the marshalled train parameter state to be available, and if the state is available and the valid movement authorization is received, safely controlling the train to run;

step S5: verifying, by the vehicle-mounted VOBC, an availability state of the marshalled train parameter state in real time according to the coupling marshalling information or the train marshalling information; and

step S6: when a coupling state of the marshalled train changes during online coupling or dis-marshalling, returning to step S1) to re-perform the calculation and verification steps of the vehicle-mounted VOBC and the trackside ZC.

[0008] As a preferred technical solution, the step S1 is specifically as follows:

obtaining, by the vehicle-mounted VOBC, identification number VIDs of other train units in the marshalled train and a coupling state of a Cab terminal by means of communication between train units, calculating and transmitting the train marshalling information to the trackside ZC.

[0009] As a preferred technical solution, the step S2 is specifically as follows:

according to train marshalling information from each train unit and an envelope order of each train unit, constructing and transmitting, by the trackside ZC, coupling marshalling information to the vehicle-mounted CC.

[0010] As a preferred technical solution, the train marshalling information of each train unit comprises an identification number of each train unit and coupling state information of each terminal.

[0011] As a preferred technical solution, wherein checking a currently applied marshalled train parameter state thereof in the step S4 is specifically as follows:

checking, by the vehicle-mounted VOBC, the currently applied marshalled train parameter state thereof accord-

ing to the train marshalling information calculated thereby or the coupling marshalling information from the ZC.

[0012] As a preferred technical solution, when the marshalled train is restarted, the vehicle-mounted VOBC verifies that a marshalled train parameter applied thereby is consistent with the coupling marshalling information from the trackside ZC or the calculated train marshalling information, and then authorizes the train to run in an energy monitoring mode.

[0013] As a preferred technical solution, the step S5 is specifically as follows:

after the vehicle-mounted VOBC is restarted and initialized, and after the marshalled train parameter applied thereby is verified to be correct according to the coupling marshalling information from the trackside ZC, setting the marshalled train parameter state to be available; and

after the train marshalling information calculated by the vehicle-mounted VOBC or the coupling marshalling information from the trackside ZC is consistent with the marshalled train parameter applied thereby, when any one subsystem is degraded and cannot figure out valid, trusting and applying the information from the other party to safely control the train to run.

[0014] As a preferred technical solution, after the verification in the step S5 is passed, the train marshalling information calculated by the vehicle-mounted VOBC and the coupling marshalling information calculated by the trackside ZC are trustable.

[0015] As a preferred technical solution, in the step S6, when the marshalled train coupling state changes, the vehicle-mounted VOBC and the trackside ZC automatically recalculate and verify a marshalled train parameter.

[0016] According to a second aspect of the present invention, provided is a marshalled train management apparatus, comprising:

a train marshalling information module, for a vehicle-mounted VOBC to identify a marshalled train;

a coupling marshalling information module, for a trackside ZC to identify the marshalled train;

a movement authorization calculation module, for the trackside ZC to calculate a valid movement authorization for the marshalled train when a marshalled train parameter state is available, and feed back coupling marshalling information to an associated vehicle-mounted VOBC;

a check module, for the vehicle-mounted VOBC to check a currently applied marshalled train parameter state thereof, and safely control the train to run if the state is available and the valid movement authorization is received;

a verification module, for the vehicle-mounted VOBC to verify the marshalled train parameter state according to the train marshalling information or the coupling marshalling information from the ZC; and

a state detection module, for re-performing the calculation and verification process of the vehicle-mounted VOBC and the trackside ZC when a coupling state of the marshalled train changes during online coupling or dis-marshalling.

[0017] According to a third aspect of the present invention, provided is an electronic device, comprising a processor and a memory in which a computer program is stored, wherein the processor, when executing the program, implements the above-mentioned methods.

[0018] According to a fourth aspect of the present invention, provided is a computer readable storage medium in which a computer program is stored, wherein the program, when being executed by a processor, implements the above-mentioned methods.

[0019] Compared with the prior art, the present invention has the following advantages:

(1) in the present invention, the train identification number VIDs and the coupling states of Cab ends of other train units are obtained through the communication among the train units of the marshalled train, and each train unit independently calculates the train marshalling information and transmits it to the trackside ZC to improve the safety of the system;

(2) in the present invention, the trackside ZC constructs the coupling marshalling information according to the train marshalling information of each train unit (including the identification number of each train unit, the coupling marshalling state of each end) and the safety envelope order of each train unit, which ensures the correctness and safety of the identification of the marshalled train;

(3) in the present invention, after the marshalled train restarts, after the vehicle-mounted VOBC verify that the marshalled train parameter applied thereby is consistent with the coupling marshalling information from the trackside ZC, it authorizes the train to run in the energy monitoring mode to ensure the safety of the marshalled train operation;

(4) in the present invention, after the verification is successful, the train marshalling information calculated by the vehicle-mounted VOBC and the coupling marshalling information calculated by the trackside ZC are trustable, which improves the availability of flexible marshalling for operation; and

(5) in the present invention, when the train coupling marshalling state changes, the vehicle-mounted

VOBC and the trackside ZC automatically recalculate and verify the marshalled train parameter applied thereby, which improves automation of flexible marshalling for operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a working flow chart of a specific embodiment of the present invention;

FIG. 2 is a vehicle-mounted architecture diagram of a multi-marshalling train in a specific embodiment of the present invention; and

FIG. 3 is a schematic diagram of a multi-marshalling train inserted from a non-CBTC zone to a CBTC zone in a specific embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0021] The following is a clear and complete description of the technical solutions in the embodiments of the present invention in combination with accompanying drawings attached to the embodiments of the present invention. Obviously, the embodiments described are a part of the embodiments of the present invention, but not the whole embodiments. Based on the embodiments of the present invention, all other embodiments obtained by a person skilled in the art without creative labor shall fall within the protection scope of the present invention.

[0022] The present invention provides an effective method for identification and management of a marshalled train for a Communication-Based Train Control (CBTC) signal system, especially for dynamic management of the marshalled trains of different marshalling combinations in flexible marshalling for operation of urban rail transit.

[0023] As shown in FIG. 1, the embodiment of the present invention provides a marshalled train identification and management method for flexible marshalling for operation. All train units in a multi-marshalling train maintain communication with a trackside ZC, and identify and maintain marshalled train parameters through joint calculation and mutual verification by a vehicle-mounted VOBC and the trackside ZC. The method specifically comprises the following steps:

step 1: after the marshalled train restarts, loading, by each train unit, the marshalled train (TF) parameter according to the type of marshalling train memorized before the restart; and if the memorized information is unavailable, loading, by each train unit, a default Train marshalling (TF) parameter;

step 2: after the communication of each train unit is established, checking, by the vehicle-mounted VOBC, legality of the marshalled train according to the VIDs of other train units and Cab coupling states of the other train units; and if an effective marshalling train can be formed (data definition), calculating the valid train marshalling information;

step 3: verifying, by the vehicle-mounted VOBC, consistency between the calculated valid train marshalling information and its applied TF parameter; when they are not consistent, if the train does not start after restart, reloading, by the vehicle-mounted VOBC, the TF parameter according to the type of marshalling train corresponding to the calculated train marshalling information, and if the train has started after restart, restarting each train unit manually in order to reload the TF parameter; and

step 4: or according to the consistency of the valid coupling marshalling information from the ZC and its applied TF parameter, if they are inconsistent and the train does not start after restart, reloading the TF parameter according to the valid coupling marshalling information from the ZC;
this step takes precedence over the step 3; for example, after online coupling/dis-marshalling and before communication of VOBC-VOBC is established, if the ZC receives valid coupling marshalling information, the vehicle-mounted VOBC automatically loads the corresponding TF parameter according to the information; after being successful loaded, the TF parameter state is set to be valid, which greatly reduces time for system reconfiguration;

step 5: after the vehicle-mounted VOBC verifies the newly loaded train marshalling (TF) parameter as available according to the coupling marshalling information from the ZC, authorizing the train to run in an "energy monitoring" driving mode;

step 6: in the process of multi-marshalling train operation, in a case of degradation, as long as the VOBC can calculate the valid train marshalling information or the ZC can calculate the valid coupling marshalling information, running, by the multi-marshalled trains, in the "energy monitoring" driving mode;

step 7: when the coupling state of the train unit changes during the online coupling/dis-marshalling operation, automatically loading the newly identified TF parameter according to the valid coupling marshalling information from the ZC; and

step 8: during the non-coupling/dis-marshalling operation, if the coupling state of the train unit changes, automatically loading, by the marshalled train, no newly identified TF parameter; and only authorizing the train to run in an RM or EUM driving mode; only

after restarting the vehicle-mounted VOBC of each train unit, setting the TF parameter state to be available after the TF parameter is reloaded and verified.

[0024] As shown in FIG. 2, the method of the present invention comprises the realization of cross-train communication by the vehicle-mounted VOBC of each train unit through global IP and the routing of cross-train communication by a network communication device, and the exchange of information through a security communication protocol (such as RSSP1), so as to obtain the identification number VIDs and the coupling marshalling state of Cab ends of other train units of the marshalled train safely and reliably, as well as other information that needs to be delivered to each other in the process of operation.

[0025] The method also comprises:

1. directly identifying, by the vehicle-mounted VOBC of a single marshalling train, the type of marshalling train according to a fact that the Cabs at both ends of the train unit are not connected, and setting, by the vehicle-mounted VOBC, the parameter of marshalling train (TF) to be available (Available);

2. directly identifying, by the vehicle-mounted VOBC of multi-marshalling train which has 2 train units at most, the type of marshalling train according to VOBC-VOBC cross-train communication of different train units; and setting, by the vehicle-mounted VOBC, the parameter of marshalling train (TF) to be available (Available); and

3. in a project of multi-marshalling train with more than 2 train units, after the marshalled train restarts, and the number of intermediate marshalling train units between the head and tail trains cannot be safely identified through the communication among all the train units, and after the vehicle-mounted VOBC determines the coupling marshalling information is consistent with the applied TF parameter, setting, by the vehicle-mounted VOBC, the TF parameter state to be available; when a multi-marshalling train is inserted from a non-CBTC zone to a CBTC zone and the marshalled train is inserted as shown in FIG. 3, calculating, by the ZC, the valid coupling marshalling information only after all the train units have completely entered the CBTC zone and been located.

[0026] In the identification and management method of the marshalled train with flexible marshalling for operation in the present invention, the vehicle-mounted VOBC and the trackside ZC independently identify and manage the marshalled train, cooperate to verify, automatically identify the marshalling state of the flexible marshalling train, load the TF parameter of the marshalled train, and better realize the automatic, safe and reliable control of the flexible marshalling train by the signal system, ensure the safety of flexible marshalling line operation, and improve the operational efficiency of online coupling/dis-marshalling.

[0027] The above is an introduction of method embodiments, and the solution of the present invention is further explained by apparatus embodiments.

[0028] Provided in the present invention is a marshalled train management apparatus, comprising:

a train marshalling information module, for a vehicle-mounted VOBC to identify a marshalled train;

a coupling marshalling information module for a trackside ZC to identify the marshalled train;

a movement authorization calculation module, for the trackside ZC to calculate a valid movement authorization for the marshalled train when a marshalled train parameter state is available, and feed back coupling marshalling information to an associated vehicle-mounted VOBC;

a check module, for the vehicle-mounted VOBC to check a currently applied marshalled train parameter state thereof, and safely control the train to run if the state is available and the valid movement authorization is received;

a verification module, for the vehicle-mounted VOBC to verify the marshalled train parameter state according to the train marshalling information or the coupling marshalling information from the ZC; and

a state detection module, for re-performing the calculation and verification process of the vehicle-mounted VOBC and the trackside ZC when a coupling state of the marshalled train changes during online coupling or dis-marshalling.

[0029] A person skilled in the art can clearly understand that for the convenience and simplicity of description, the specific working process of each described module can refer to the corresponding process in the above-mentioned method embodiments, and it is not be repeated herein.

[0030] The electronic device of the present invention comprises a central processing unit (CPU) that can perform various appropriate actions and processes according to computer program instructions stored in a read-only memory (ROM) or loaded from a storage unit into a random access memory (RAM). In the RAM, various programs and data required for operations of the device can also be stored. The CPU, ROM, and RAM are connected to each other via a bus. An input/output (I/O) interface is also connected to the bus.

[0031] A plurality of components in the device are connected to the I/O interface, wherein the plurality of components comprise: an input unit, such as a keyboard, a mouse; an output unit, such as various types of displays,

a speaker; a storage unit, such as a disk, an optical disc; and a communication unit, such as a network card, a modem, a wireless communication transceivers. The communication unit allows the device to exchange information/data with other devices through a computer network such as the Internet and/or various telecommunications networks.

[0032] The processing unit performs each step of the method and each process described above, such as the method consisted of the steps S1 to S6. For example, in some embodiments, the method consisted of the steps S1 to S6 may be realized as a computer software program that is physically contained in a machine readable medium, such as a storage unit. In some embodiments, parts or all of the computer program may be loaded and/or installed on the device via the ROM and/or communication unit. When the computer program is loaded into the RAM and executed by the CPU, one or more steps of S1 to S6 of the method described above can be performed. Alternatively, in other embodiments, the CPU may be configured to execute the steps S1 to S6 of the method by any other appropriate means (e.g., by means of a firmware).

[0033] The functions described above herein can be performed, at least in part, by one or more hardware logical components. For example, without limitation, demonstration types of hardware logic components that can be used include: a Field Programmable Gate Array (FPGA), an Application-Specific Integrated Circuits (ASIC), an Application-Specific Standard Product (ASSP), a System-On-Chip (SOC), a Complex Programmable Logic Device (CPLD), etc.

[0034] Program codes for implementing the method of the present invention may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general-purpose computer, a special-purpose computer or another programmable data processing apparatus so that the program codes, when being executed by the processor or controller, implements the functions or operations specified in the flow charts and/or block diagrams. The program codes can be executed entirely on a machine, partially on a machine, partially on a remote machine as a stand-alone software package, or completely on a remote machine or server.

[0035] In the context of the present invention, the machine readable medium may be a tangible medium that may contain or store a program for use by or in conjunction with an instruction executing system, apparatus or device. The machine readable medium may be a machine readable signal medium or a machine readable storage medium. The machine readable medium may include, but are not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the above. More specific examples of the machine readable storage medium would include an electrical connection based on one or more wires, a portable computer disk, a hard disk, a Random Access Memory (RAM), a Read-Only Memory (ROM), an Erasable Programmable ROM (EPROM or flash memory), optical fibers, a convenient Compact Disk-ROM (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the above.

[0036] The above are only specific embodiments of the present invention, but the protection scope of the present invention is not limited to this, and any technical person familiar with the technical field can easily think of various equivalent modifications or replacements within the technical scope disclosed by the present invention, and these modifications or replacements shall be covered by the protection scope of the present invention. Therefore, the protection scope of the present invention shall be subject to the protection scope of the claims.

Claims

1. A marshalled train management method, wherein a CBTC system automatically identifies and manages a marshalled train after the marshalled train restarts or a marshalling state changes, and the method specifically comprises the following steps:

   step S1: identifying, by a vehicle-mounted VOBC, train marshalling information and transmitting the train marshalling information to a trackside ZC;
   step S2: identifying, by the trackside ZC, coupling marshalling information and transmitting the connecting marshalling information to a vehicle-mounted CC;
   step S3: when the coupling marshalling information or the train marshalling information is valid, calculating, by the trackside ZC, a valid movement authorization for the marshalled train;
   step S4: checking, by the vehicle-mounted VOBC, a currently applied marshalled train parameter state thereof; if the coupling marshalling information or the train marshalling information is valid, setting the marshalled train parameter state to be available, and if the state is available and the valid movement authorization is received, safely controlling the train to run;
   step S5: verifying, by the vehicle-mounted VOBC, an availability state of the marshalled train parameter state in real time according to the coupling marshalling information or the train marshalling information; and
   step S6: when a coupling state of the marshalled train changes during online coupling or dis-marshalling, returning to step S1) to re-perform the calculation and verification steps of the vehicle-mounted VOBC and the trackside ZC.

2. The marshalled train management method accord-

ing to claim 1, wherein the step S1 is specifically as follows:
obtaining, by the vehicle-mounted VOBC, identification number VIDs of other train units in the marshalled train and a coupling state of a Cab terminal by means of communication between train units, calculating and transmitting the train marshalling information to the trackside ZC.

3. The marshalled train management method according to claim 1, wherein the step S2 is specifically as follows:
according to train marshalling information from each train unit and an envelope order of each train unit, constructing and transmitting, by the trackside ZC, coupling marshalling information to the vehicle-mounted CC.

4. The marshalled train management method according to claim 3, wherein the train marshalling information of each train unit comprises an identification number of each train unit and coupling state information of each terminal.

5. The marshalled train management method according to claim 1, wherein checking a currently applied marshalled train parameter state thereof in the step S4 is specifically as follows:
checking, by the vehicle-mounted VOBC, the currently applied marshalled train parameter state thereof according to the train marshalling information calculated thereby or the coupling marshalling information from the ZC.

6. The marshalled train management method according to claim 5, wherein when the marshalled train is restarted, the vehicle-mounted VOBC verifies that a marshalled train parameter applied thereby is consistent with the coupling marshalling information from the trackside ZC or the calculated train marshalling information, and then authorizes the train to run in an energy monitoring mode.

7. The marshalled train management method according to claim 1, wherein the step S5 is specifically as follows:

after the vehicle-mounted VOBC is restarted and initialized, and after the marshalled train parameter applied thereby is verified to be correct according to the coupling marshalling information from the trackside ZC, setting the marshalled train parameter state to be available; and after the train marshalling information calculated by the vehicle-mounted VOBC or the coupling marshalling information from the trackside ZC is consistent with the marshalled train parameter applied thereby, when any one subsystem is degraded and cannot figure out valid, trusting and applying the information from the other party to safely control the train to run.

8. The marshalled train management method according to claim 1, wherein after the verification in the step S5 is passed, the train marshalling information calculated by the vehicle-mounted VOBC and the coupling marshalling information calculated by the trackside ZC are trustable.

9. The marshalled train management method according to claim 1, wherein in the step S6, when the marshalled train coupling state changes, the vehicle-mounted VOBC and the trackside ZC automatically recalculate and verify a marshalled train parameter.

10. A marshalled train management apparatus, comprising:

a train marshalling information module, for a vehicle-mounted VOBC to identify a marshalled train;
a coupling marshalling information module, for a trackside ZC to identify the marshalled train;
a movement authorization calculation module, for the trackside ZC to calculate a valid movement authorization for the marshalled train when a marshalled train parameter state is available, and feed back coupling marshalling information to an associated vehicle-mounted VOBC;
a check module, for the vehicle-mounted VOBC to check a currently applied marshalled train parameter state thereof, and safely control the train to run if the state is available and the valid movement authorization is received;
a verification module, for the vehicle-mounted VOBC to verify the marshalled train parameter state according to the train marshalling information or the coupling marshalling information from the ZC; and
a state detection module, for re-performing the calculation and verification process of the vehicle-mounted VOBC and the trackside ZC when a coupling state of the marshalled train changes during online coupling or dis-marshalling.

11. An electronic device, comprising a processor and a memory in which a computer program is stored, wherein the processor, when executing the program, implements the method according to any one of claims 1-9.

12. A computer-readable storage medium in which a computer program is stored, wherein the program, when being executed by a processor, implements the method according to any one of claims 1-9.

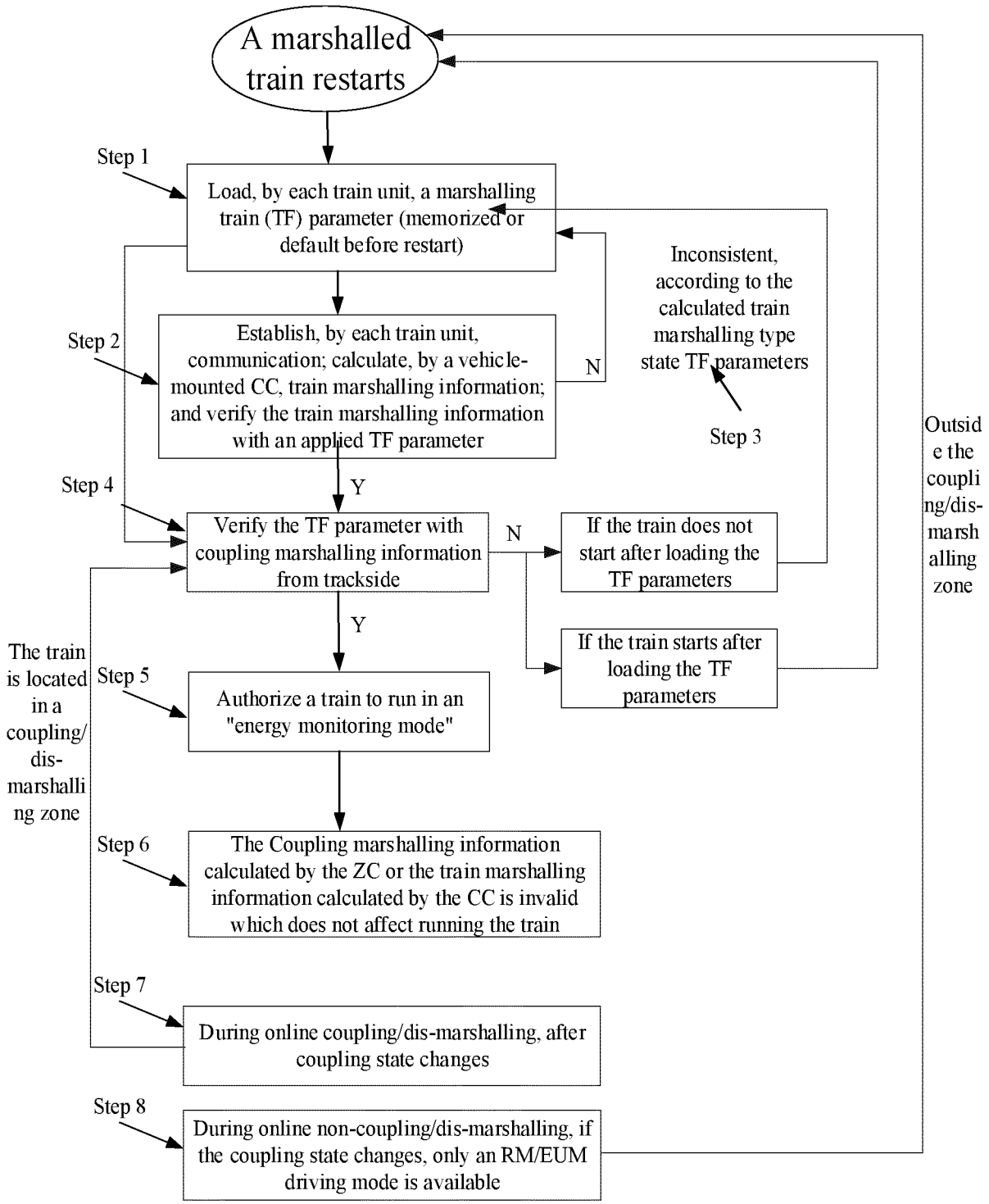
A marshalled train restarts
Step 1
Load, by each train unit, a marshalling train (TF) parameter (memorized or default before restart)
Step 2
Establish, by each train unit, communication; calculate, by a vehicle-mounted CC, train marshalling information; and verify the train marshalling information with an applied TF parameter
N
Y
Inconsistent, according to the calculated train marshalling type state TF parameters
Step 3
Step 4
Verify the TF parameter with coupling marshalling information from trackside
N
If the train does not start after loading the TF parameters
Y
If the train starts after loading the TF parameters
The train is located in a coupling/dis-marshalling zone
Step 5
Authorize a train to run in an "energy monitoring mode"
Step 6
The Coupling marshalling information calculated by the ZC or the train marshalling information calculated by the CC is invalid which does not affect running the train
Step 7
During online coupling/dis-marshalling, after coupling state changes
Step 8
During online non-coupling/dis-marshalling, if the coupling state changes, only an RM/EUM driving mode is available
Outside the coupling/dis-marshalling zone

FIG. 1

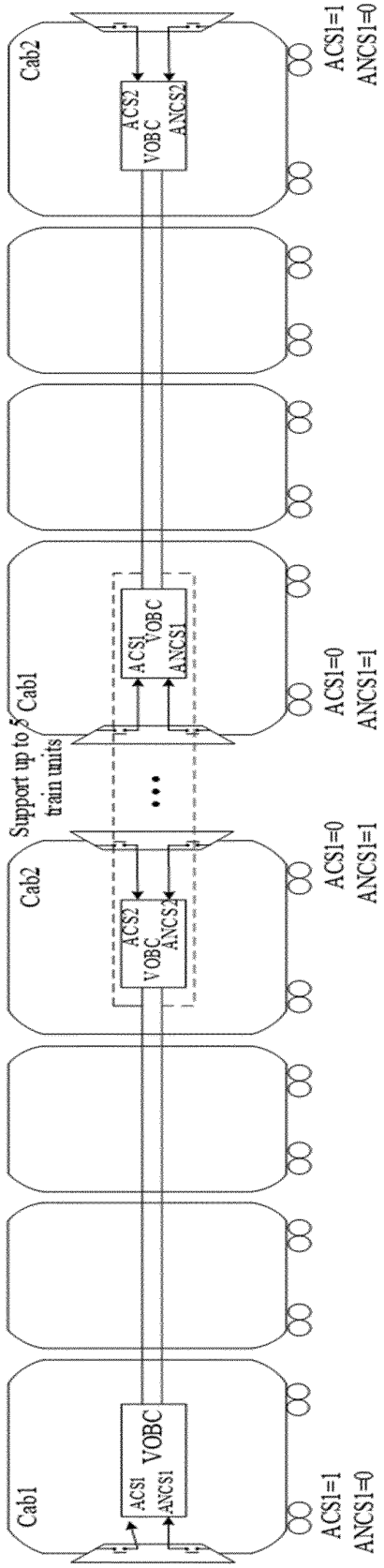
Cab2
ACS2
VOBC
ANCS2
ACS1=1
ANCS1=0
Cab1
ACS1
VOBC
ANCS1
ACS1=0
ANCS1=1
Support up to 5 train units
Cab2
ACS2
VOBC
ANCS2
ACS1=0
ANCS1=1
Cab1
ACS1
VOBC
ANCS1
ACS1=1
ANCS1=0

FIG. 2

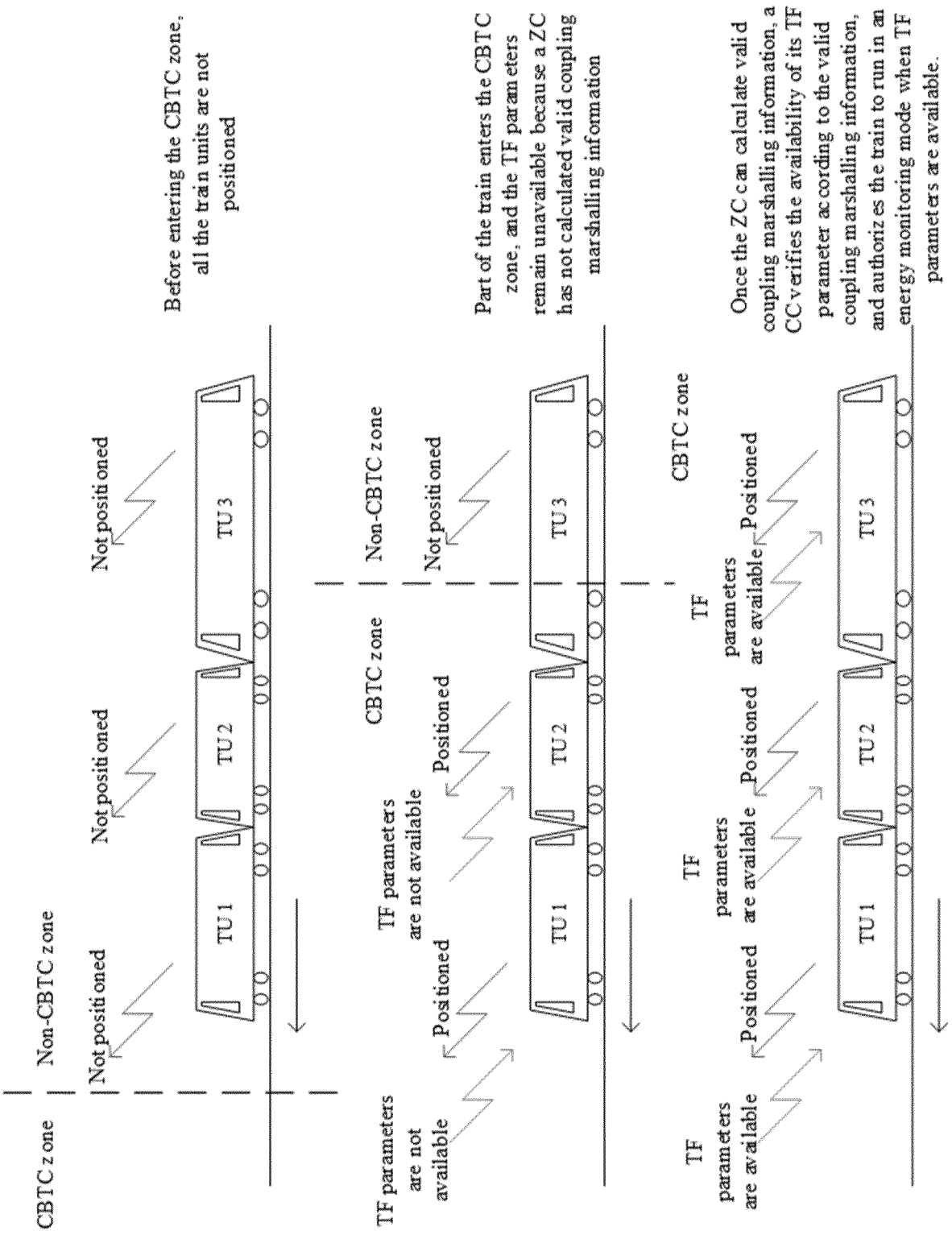
CBTC zone
Non-CBTC zone
Not positioned
Not positioned
Not positioned
TU 1
TU 2
TU 3
Before entering the CBTC zone, all the train units are not positioned
TF parameters are not available
Positioned
TF parameters are not available
CBTC zone
Non-CBTC zone
Positioned
Not positioned
TU 1
TU 2
TU 3
Part of the train enters the CBTC zone, and the TF parameters remain unavailable because a ZC has not calculated valid coupling marshalling information
TF parameters are available
Positioned
TF parameters are available
Positioned
CBTC zone
TF parameters are available
Positioned
TU 1
TU 2
TU 3
Once the ZC can calculate valid coupling marshalling information, a CC verifies the availability of its TF parameter according to the valid coupling marshalling information, and authorizes the train to run in an energy monitoring mode when TF parameters are available.

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/134988

A. CLASSIFICATION OF SUBJECT MATTER

B61L27/20(2022.01)i;B61B1/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B61L; B61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXTC, CNKI: 编组, 轨旁, 区域, 车载, 控制, 授权, 许可; ENTXT, VEN: marshal, group, rail, track, zone, area, vehicle, control, authorization, permission.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 114274981 A (CASCO SIGNAL LTD.) 05 April 2022 (2022-04-05) description, paragraphs 8-78, and figures 1-3	1-12
A	CN 111874008 A (CASCO SIGNAL LTD.) 03 November 2020 (2020-11-03) description, paragraphs 8-71, and figures 1-4	1-12
A	CN 112319558 A (UNITTEC CO., LTD.) 05 February 2021 (2021-02-05) description, paragraphs 23-59, and figures 1-3	1-12
A	CN 111267915 A (CASCO SIGNAL LTD.) 12 June 2020 (2020-06-12) entire document	1-12
A	CN 107685749 A (SIGNAL & COMMUNICATION RESEARCH INSTITUTE OF CHINA ACADEMY OF RAILWAY SCIENCES; CHINA ACADEMY OF RAILWAY SCIENCES; BEIJING HUATIE INFORMATION TECHNOLOGY DEVELOPMENT GENERAL CO., LTD.; BEIJING RUICHI NATIONAL RAILWAY INTELLIGENT TRANSPORT SYSTEM ENGINEERING TECHNOLOGY CO., LTD.) 13 February 2018 (2018-02-13) entire document	1-12

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 February 2023	**16 February 2023**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/134988

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 114274981 A	05 April 2022	None	
CN 111874008 A	03 November 2020	CN 111874008 B	03 September 2021
CN 112319558 A	05 February 2021	CN 112319558 B	03 January 2023
CN 111267915 A	12 June 2020	None	
CN 107685749 A	13 February 2018	CN 107685749 B	11 May 2021

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