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Description

Communication system for a rail vehicle and method for operating the communication system

The invention relates to a communication system for a rail vehicle and a method for operating a communication system of a rail vehicle.

In principle it is desirable for communication systems to address functional devices of the communication system unambiguously. Based on the addressing, information, for example in the form of data packets, can be routed to the functional device by means of the communication system during a transmission. In the case of multiple units the same and/or different functional devices may be arranged in a single car and/or in multiple cars.

Hitherto control of a function of the functional device and communication with the functional device has been carried out by means of a control application based on an absolute location or an absolute position of the component within the rail vehicle. In this case the control application is designed for a respective configuration of the rail vehicle.

US 2006/180709 A1 describes a method and system for train inauguration over an internet protocol (IP) based communication network. A leading car of a plurality of cars that form a train is identified. The train includes at least one unit of cars, wherein the first unit includes the leading car. Network and configuration information is discovered for cars in the train using a discovery protocol. The network and configuration information is broadcast to units in the train.

Car and unit topology of the train is generated based on the network and configuration information and the leading car that is identified. NAT translation addresses are generated for fixed IP addresses of devices in the plurality of cars. Routing information is exchanged between routers to enable communication between devices in the train using the NAT translation addresses.

DE 10 2006 018 163 A1 describes a method for automatic address assignment to mobile communication participants, which in particular are assigned to rail vehicles. At least one identifier of immediately adjacent communication participants is determined for address assignment of the communication participants and this is sent to a communication participant acting as a higher-level unit. The unit recognises neighbourhood relationships between the communication participants on the basis of the transmitted data, based on these recognised neighbourhood relationships determines the sequence of communication participants, and undertakes or triggers an address assignment based thereon.

EP 1 995 147 A1 describes a transmission system for rail vehicles. The transmission system comprises a transmission device having a plurality of transmission ports. The transmission device is mounted on each of a plurality of vehicles and is designed for the transmission of data received at a port to a required transmission port in accordance with a prescribed instruction. A transmission path connects the transmission devices which are mounted in each of the plurality of vehicles. An electrical device is connected to a corresponding transmission device and is designed to exchange data with the transmission device. A transmission relay control device is arranged in a corresponding transmission

device and is designed to set a transmission station address of the electrical device, which is connected to a host transmission device. The transmission device is designed, when setting the address of an electrical device using an automatic address setting function in a network in which a plurality of electrical devices of the same type is arranged, to generate a status in which only the transmission device itself and an electrical device connected to the transmission device are connected to the network. This status is generated by stopping an exchange of data with another transmission device and labelling the transmission station addresses of the electrical device in accordance with a prescribed setting.

In light of this, the object of the invention is to increase flexibility as regards the configurability of the rail vehicle.

This object is achieved by a communication system for a rail vehicle, comprising: a communication network which has at least one functional device, wherein the at least one functional device is assigned a functional network address for addressing the functional device by means of a control application, and the functional network address has a function-specific portion which represents a function of the functional device in a predefined configuration of the rail vehicle.

It has been recognised with the invention that the distribution of functional devices is dependent on the configuration of the rail vehicle. Thus devices for supplying and transforming energy can, depending on the space requirement and performance, be arranged in one or more different cars of the rail vehicle. Devices for bistro or

restaurant operation can be situated in one or more specially provided cars of the rail vehicle. Furthermore, devices for air conditioning of driver's cabs and/or passenger spaces, sanitary facilities and other specialised devices (e.g. a train conductor compartment, access facilities for disabled persons, etc.) can be situated in one or more different locations in the rail vehicle. To execute a control application it has been necessary in the previous solutions for the control application to be designed for a particular configuration of the rail vehicle. In other words: the control application can correctly address the functional devices in previous solutions only if the configuration is as specified. If the configuration changes, the control application has to change, so that functional devices can be correctly addressed in the context of the application of the control application.

The inventive communication system achieves this object in that functional devices can be addressed by means of the control application using a functional network address which is at least partially independent of the configuration of the rail vehicle. This has the important advantage that the control application for the rail vehicle can be designed independently of the configuration of the rail vehicle. Even if the configuration changes, the same control application can therefore still be used. In this way it is made easier to change the configuration of the rail vehicle, for example by removing a restaurant car or a traction car, since the control application or at least important parts thereof do not need to be modified. This increases the flexibility during operation of the rail vehicle.

The communication network preferably comprises an Ethernet network or is designed as such. The rail vehicle is preferably

embodied as a multiple unit.

The functional device is formed by a plurality of network components which can be addressed jointly using a functional network address. One example of a functional device within the meaning of the invention is a car of the rail vehicle with individual network components present in the car.

The person skilled in the art understands the term “control application” preferably as control and communication software. The control application is further preferably a control application provided for the vehicle driver and operable from the driver's cab. The person skilled in the art understands the phrase “addressing the functional device by means of a control application” to the effect that the control application is designed to address the functional device using the functional network address.

According to the expert understanding, the configuration represents a distribution of functional devices along or within the rail vehicle and their associated function. In particular, the person skilled in the art understands the configuration as a specific combination of several cars to form a multiple unit (multiple unit configuration).

According to the invention the functional network address comprises a relative portion which identifies a functional device to be addressed from among a plurality of functional devices with the same function. It has been recognised that, in particular when the rail vehicle is configured with a plurality of functional devices with the same function, ambiguity can arise in the addressing based on the function-specific portion. In order to achieve unambiguous addressing

in such a configuration, the relative portion serves to identify the functional device to be addressed from among the plurality of functional devices with the same function.

In a preferred development, the relative portion represents a relative position of the functional device relative to a further functional device with the same function. The relative position preferably represents a position of the functional device along a longitudinal extension, further preferably viewed in the direction of travel of the rail vehicle.

The relative position in a series of functional devices with the same function preferably comprises a position number which represents the position of the functional device within the series.

An example of a functional network address when addressing a car as functional devices is “TW2”. Here the function-specific portion “TW” represents the function “multiple unit” and the position number “2” represents the second multiple unit in a series of several multiple units of the rail vehicle.

According to the invention the communication system comprises a communication device which is designed to map the functional network address to a network address of a network component of a configuration-dependent network structure of the rail vehicle. The person skilled in the art understands the term “communication device” preferably as a communication layer for translating the functional network address used by means of the control application into a network address which is used by the communication protocols present in the vehicle. The network address preferably includes an IP address. All of the

data addressed to a functional device by means of the control application preferably passes through the communication layer.

When using the form of embodiment for addressing cars within a multiple unit configuration by means of the control application, the communication device is preferably designed independently of the multiple unit configuration. The design of the communication device is further preferably dependent on a communication network or bus used in the multiple unit and on an assignment of a network component to a car that can be addressed for the desired functionality. Thus to control traction local to a car the control application for example merely needs to address the desired multiple unit using the functional network address. The communication device translates the functional network address used by the control application into a network address of the control device (as a network component) of the traction car which is responsible for traction control.

In a preferred development of the communication system, the network structure preferably comprises an Ethernet network, consisting of networks for communication at vehicle or car level “vehicle bus” (preferably PROFINET), and a “train bus” for communication at train level (preferably an Ethernet train backbone (ETB)). The network structure preferably depends on the configuration. In other words: the communication device translates the functional network address into a network address, for example an IP address, which is dependent on the configuration and the associated network structure of the rail vehicle.

According to a further preferred development of the communication system, the communication device is designed to

carry out the mapping on the basis of a determination of the configuration of the rail vehicle. As part of the determination, a functional device is preferably assigned a functional attribute which specifies a function of the functional devices.

For the exemplary application when addressing cars within a multiple unit configuration, this can be understood as follows: the communication device knows the communication network or communication bus present in the rail vehicle. Furthermore, the communication device knows which control device can be addressed as a network component in a car (e.g. traction car) for a desired functionality (e.g. traction control). In order that the communication device is enabled to map the functional network address to a network address of the network structure with a specific multiple unit configuration, the determination of the multiple unit configuration provides a basis for this.

According to a further development, the determination can be carried out on the basis of a train inauguration and/or on the basis of specified configuration information. The determination on the basis of a train inauguration represents a dynamic and automated method for determining the configuration. As part of the train inauguration, an inauguration result is preferably determined. Using the inauguration result, the communication device translates the functional network address into the network address of the network structure of the rail vehicle. The train inauguration preferably includes an ETB inauguration. Alternatively or additionally, the configuration can be provided statically using the specified configuration information. For example, the configuration can be predetermined by a design of the rail

vehicle. Alternatively or additionally, several different configuration information items can be provided, each of which represents one of several configuration variants. In addition, the configuration can be selected from several predefined configuration variants. The selection is preferably made by the operating or maintenance personnel of the rail vehicle.

The invention further relates to a method for operating a communication system of a rail vehicle, comprising: determination of a configuration of the rail vehicle, assignment of a functional network address to a functional device of a communication network of the communication system on the basis of the determined configuration, and addressing the at least one functional device of the communication network using the functional network address by means of a control application, wherein the functional network address comprises a function-specific portion which represents a function of the functional device.

A preferred form of embodiment of the inventive method comprises: mapping the functional network address to a network address of a network component of a configuration-dependent network structure of the rail vehicle by means of a communication device.

According to a further preferred form of embodiment of the inventive method the determination of the configuration comprises: determination of a function of the functional device and a position of the functional device within and/or along the rail vehicle.

According to a further preferred embodiment of the inventive method the mapping is performed on the basis of the

determination of the configuration of the rail vehicle.

In a development of the method the determination is performed on the basis of a train inauguration and/or using predetermined configuration information.

For embodiments, developments, details of embodiments and advantages of the inventive method, reference is made to the description for the corresponding system features.

An exemplary embodiment of the invention will now be explained on the basis of the drawings, in which

Figure 1 shows a schematic cross-sectional view of a rail vehicle according to an exemplary embodiment of an inventive communication system and

Figure 2 shows a schematic flow chart of an exemplary embodiment of an inventive method.

Figure 1 shows a rail vehicle 10 in a lateral cross-sectional view. In the embodiment under consideration, the rail vehicle 10 is designed as an association of several cars 1-7 with at least one multiple unit. The rail vehicle 10 is provided for transporting passengers.

The rail vehicle 10 moves in a driving mode in the direction of travel 9. The rail vehicle 10 comprises a communication network 20 which has a train bus 32 and in each of the cars 1-7 an Ethernet network 21-27 with a vehicle bus, in particular in accordance with the Profinet standard. The train bus 32 is designed as an Ethernet train backbone 33. The train bus 32 and the Ethernet networks 21-27 form a network structure 34 of

the rail vehicle 10. The network structure 34 depends on a configuration of the rail vehicle 10 which represents a distribution of the cars 1-7 and their assigned function along the rail vehicle 10. The cars 1-7 together with their respective Ethernet networks 21-27 each form a functional device 41-47 of the communication network 20 in the view shown in Figure 1.

Car 1 is an end car EW in the forward direction of travel 9. Car 7 is an end car EW in the rearward direction of travel 9. Car 2 is an intermediate car MW which has no drive. The cars 3, 4 and 6 are traction cars TW, wherein the cars 3 and 6 each have a pantograph 11 and 12 respectively. The traction cars 3, 4 and 6 are used to drive the rail vehicle 10 and each have (not shown) a transformer, a traction converter, an auxiliary supply converter and at least one traction motor.

A computing unit 51 or 52 is arranged in each of the cars 1 or 7. The computing units 51 and 52 are each designed to execute a control application 60 in the form of control and communication software. In the context of the execution of the control application 60 it is necessary to address at least one of the functional devices 41-47.

The addressing of the functional devices 41-47 is described below using the example of the traction cars 3, 4 and 6: for addressing traction cars, the control application 60 uses a functional network address TW1, TW2 and/or TW3. Viewed in the direction of travel 9, the car 3, which can be addressed by means of the control application 60 using the functional network address TW1, is in the absolute position 3. Car 4, which can be addressed by means of the control application 60 using the functional network address TW2, is located in the

absolute position 4. Car 6, which can be addressed by means of the control application 60 using the functional network address TW3, is located in the absolute position 6.

In a method step A (Figure 2) a configuration of the rail vehicle 10 is determined during a train inauguration. In other words: the configuration according to method step A is determined in that the function of the cars 1-7 and the position of the cars 1-7 within the rail vehicle 10 is determined in a method step AA.

The respective function of a car is indicated by function attributes, for example: “leading”, “can provide higher-level traction control”, “has traction”, etc. Thus as part of the train inauguration for the exemplary embodiment shown in Figure 1, it is determined that the cars 1 or 7 are each designed as end cars which can control the traction at a higher level. A functional network address EW1 or EW2 of the car 1 or 7 has a function-specific portion “EW” and a relative portion “1” or “2”. The function-specific portion “EW” represents the function of the end car 1 or 7, whereby it can control the traction at a higher level.

Furthermore, it is determined as part of the train inauguration that the cars 3, 4 and 6 are each designed as traction cars. The functional network address TW1, TW2 or TW3 of the car 3, 4 or 6 respectively has a function-specific portion “TW” and a relative portion “1”, “2” or “3”. The function-specific portion “TW” represents the function of the cars 3, 4 or 6, whereby these have traction.

In a method step B, the control application 60 addresses one of the functional devices 41-47 by means of the respective

functional network address. For example, the control application 60 addresses the car 6 using the functional network address TW3. The functional network address TW3 is mapped to a network address, for example an IP address, of the network structure 34 of the rail vehicle 10 by means of a communication device 61 of the car 1 and a communication device 62 of the car 7 in a method step C. In other words: the communication device 61 or 62 translates the functional network address TW3 into an IP address of the network structure 34 of the rail vehicle 10. If, for example, it is desired to control the traction of the third traction car 6, the communication device 61 translates the functional network address TW3 used by the control application 60 into an IP address 35 of a control device 36 of the car 6 which is responsible for traction control.

The use of the functional network address by the control application 60 has the advantage that the control application 60 is enabled to address functional devices 41-47 of the rail vehicle 10 independently of the current configuration of the rail vehicle 10. The control application 60 does not have to be modified when the configuration of the rail vehicle 10 is changed.

Patentkrav

1. Kommunikationssystem til et skinnekøretøj (10), omfattende:
- et kommunikationsnetværk (20), der omfatter mindst en funktionsindretning (41-47), der er dannet af en flerhed af netværkskomponenter, der sammen kan adresseres ved hjælp af en funktionel netværksadresse,
o hvor den funktionelle netværksadresse (TW1; TW2; TW3) til adressering af funktionsindretningen (43; 44; 46) er tilordnet til den mindst ene funktionsindretning (43; 44; 46) ved hjælp af en styreapplikation (60),
o hvor den funktionelle netværksadresse (TW1; TW2; TW3) har en funktionsspecifik andel (TW), der repræsenterer en funktion af funktionsindretningen (43; 44; 46) ved en forudbestemt konfiguration af skinnekøretøjet (10), og
o hvor den funktionelle netværksadresse (TW1; TW2; TW3) omfatter en relativ andel ("1"; "2"; "3"), der identificerer en funktionsindretning (43; 44; 46), der skal adresseres, blandt en flerhed af funktionsindretninger (43, 44, 46) med samme funktion (TW), og
- en kommunikationsindretning (61, 62), der er udformet til at afbillede den funktionelle netværksadresse (TW3) på en netværksadresse (35) af en netværkskomponent (36) af en konfigurationsafhængig netværksstruktur (34) af skinnekøretøjet (10).

2. Kommunikationssystem ifølge krav 1,
hvor den relative andel ("1"; "2"; "3") repræsenterer en relativ position af funktionsindretningen (43; 44; 46) i forhold til en yderligere funktionsindretning (43; 44; 46) med samme funktion.

3. Kommunikationssystem ifølge krav 1 eller 2,
hvor netværksstrukturen (34)
- fortrinsvis omfatter et ethernet-netværk, bestående af netværk til kommunikation på køretøjs- eller vognplan, fortrinsvis PROFINET, og
- en togbus (32), fortrinsvis et Ethernet-Train-Backbone (33).

4. Kommunikationssystem ifølge mindst et af de foregående krav, hvor kommunikationsindretningen (61, 62) er udformet til at udføre afbildningen på baggrund af en fastlæggelse af skinnekøretøjets (10) konfiguration.

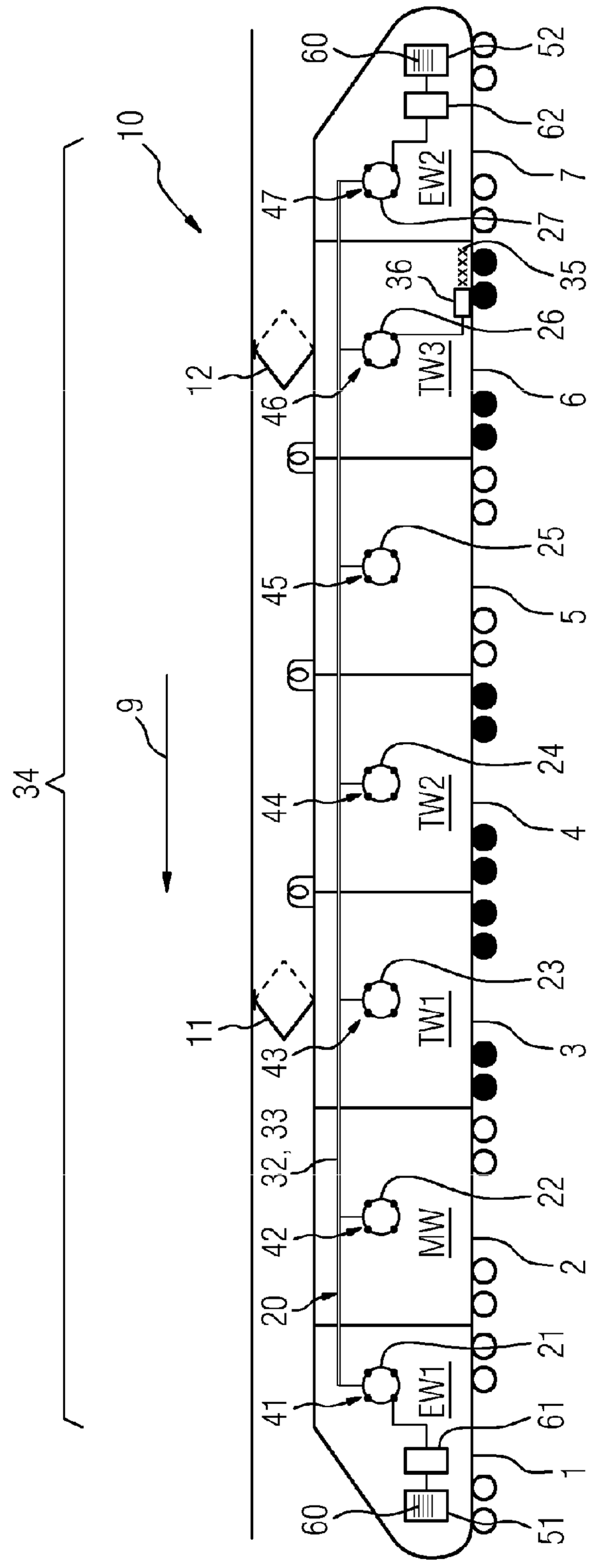
5. Kommunikationssystem ifølge krav 4, hvor fastlæggelsen kan udføres
- på baggrund af en ibrugtagning af toget og/eller
- vedhjælp af på forhånd angivet konfigurationsinformation.

6. Fremgangsmåde til drift af et kommunikationssystem i et skinnekøretøj (10), omfattende:
at fastlægge (A) en konfiguration af skinnekøretøjet (10), at tilordne en funktionel netværksadresse (TW1; TW2; TW3) til en funktionsindretning (43; 44; 46) af et kommunikationsnetværk (20) af kommunikationssystemet på baggrund af den fastlagte konfiguration, hvor funktionsindretningen (41-47) er dannet af en flerhed af netværkskomponenter, der kan adresseres sammen ved hjælp af den funktionelle netværksadresse,
at adressere (B) den mindst ene funktionsindretning (43; 44; 46) af kommunikationsnetværket (20) ved hjælp af den funktionelle netværksadresse (TW1; TW2; TW3) ved hjælp af en styreapplikation (60) og
at afbillede (C) den funktionelle netværksadresse på en netværksadresse (35) af en netværkskomponent (36) af en konfigurationsafhængig netværksstruktur (34) af skinnekøretøjet (10) ved hjælp af en kommunikationsindretning (61, 62), hvor den funktionelle netværksadresse (TW1; TW2; TW3) omfatter en funktionsspecifik andel (TW), der repræsenterer en funktion af funktionsindretningen (43; 44; 46), og hvor den funktionelle netværksadresse (TW1; TW2; TW3) omfatter en relativ andel ("1"; "2"; "3"), der identificerer en funktionsindretning (43; 44; 46), der skal adresseres, blandt en flerhed af funktionsindretninger (43, 44, 46) med samme funktion (TW).

7. Fremgangsmåde ifølge krav 6, hvor fastlæggelsen (A) af konfigurationen omfatter:
at fastlægge (AA) en funktion af funktionsindretningen (41-47) og en position af funktionsindretningen (41-47) i og/eller langs skinnekøretøjet (10).

8. Fremgangsmåde ifølge krav 6 eller 7,
hvor afbildningen (C) sker på baggrund af fastlæggelsen (A) af skinnekøretøjets (10) konfiguration.

9. Fremgangsmåde ifølge mindst et af de foregående krav 6-8,
hvor fastlæggelsen (A) sker
- på baggrund af en ibrugtagning af toget og/eller
- ved hjælp af på forhånd angivet konfigurationsinformation.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34
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46
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44
43
42
41
20
32, 33
EW2
TW3
TW2
TW1
MW
EW1
36
xxxx
60
52
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1
51

FIG 1

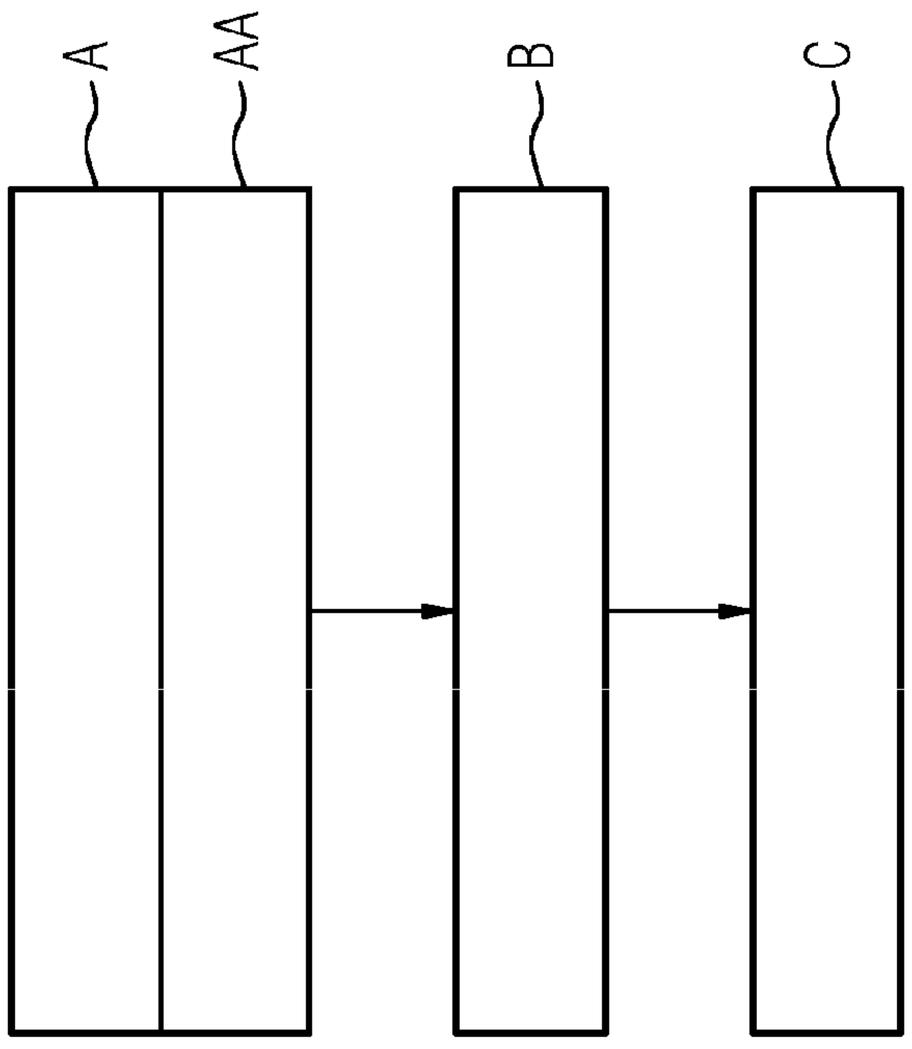

FIG 2