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(54) Benævnelse: **FREMGANGSMÅDE TIL DRIFT AF ET TOGKONTROLSYSTEM**

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Method for Operating a Train Control System

Background of the Invention

The invention relates to a method for operating a train control system for influencing a rail-bound vehicle with an onboard monitoring unit (OBU), wherein the train control system comprises a line control center (Radio Block Center, RBC) and an external signaling system with at least one signal and a first balise group positioned upstream of the signal and a second balise group arranged at the signal, wherein the vehicle is monitored by the line control center, the method comprising: assignment of the vehicle to the signal, determination of a current signal aspect of the assigned signal, issuing of a movement authority to the vehicle by the line control center depending on the determined signal aspect through a radio link.

A method for operating a train control system is known, for example, from [01].

In Europe, the European Train Control System (ETCS) is primarily used, which is a component of the European Rail Traffic Management System (ERTMS). Another component of the ERTMS is the railway mobile communication system GSM-R. ETCS is used in all European countries in high-speed and conventional rail traffic.
[01] describes various levels and modes under which ETCS can be used.

In ETCS Level 1, communication between the line and the vehicle occurs discontinuously through balises, which are often located at the sites of distant and main signals. ETCS information is transmitted as soon as the vehicle passes the balise. The most important information transmitted by the balises includes line gradients, maximum line speeds, the point where the vehicle should come to a stop, as well as signal states/signal aspects ("Stop," "Proceed," etc.). The balises receive the information to be transferred to the vehicle from a Lineside Electronic Unit (LEU), which is connected to the interlocking unit or the signals.

ETCS Level 2 is characterized by constant communication between the vehicle and the ETCS control center (RBC) through GSM-R or Euroradio. For this, an accurate

determination of the train's position and direction is necessary. The vehicle computer regularly transmits position and direction information through GSM-R to the line. If the line is not also suitable for ETCS Level 1, the balises are usually fixed data balises and therefore only send static messages to the vehicle.

In both ETCS Level 1 and ETCS Level 2, information regarding free track sections is determined by the fixed track vacancy detection from the interlocking unit and transmitted to the ETCS center. The track is divided into block sections, as with conventional safety technology, whereby the train may only enter the next block section if it is not occupied by another train, including the subsequent protection line, but is reported as clear.

For the various ETCS levels, the modes Full Supervision (FS) and Limited Supervision (LS) are defined. Together with the mode, the ETCS information forms a movement authority. This allows the vehicle-side ETCS equipment to continuously monitor compliance with the permitted speed (and direction) and promptly trigger an emergency braking, regardless of nationally defined track geometries and signal distances.

In the "Limited Supervision" (LS) mode, the signal aspects of the signals (external signaling) are reused. This means the vehicle operator reads the signal information directly from the external signaling. It is operated "according to external signaling."

In "Full Supervision" (FS) mode, however, the signal aspects of the signals (external signaling) are replaced by cab signaling (FS Mode). The vehicle operator reads the signal information from the driver's cab display. In principle, external signaling can be dispensed with in FS Mode.

While in FS Mode the train is fully monitored by the ETCS, in LS Mode only background monitoring takes place. The train driver is therefore still required to pay attention to the lineside signaling in LS Mode.

The Limited Supervision Mode was specifically designed for ETCS Level 1 to reduce costs or to enable the use of ETCS Level 1 on lines that do not have fixed distant signal intervals. For ETCS Level 2, the Mode Limited Supervision is not designed; therefore, many necessary functions are lacking to realize a corresponding operation.

The document EP 3 124 351 A1 describes a train control system.

Object of the invention

The object of the invention is to provide a method that enables Limited Supervision in ETCS Level 2 mode, whereby on the one hand development costs and hardware costs can be reduced, and on the other hand a high level of safety can be achieved.

Description of the invention

The invention is defined by the features of claim 1.

The object is achieved according to the invention by the vehicle being driven by a driver following external signaling, and the monitoring is conducted by the line control center in the background, in such a way that the line control center communicates discontinuously with the vehicle, wherein the movement authority is requested by passing over the first balise group, and the movement authority is transmitted to the vehicle depending on the determined current signal aspect, wherein the movement authority contains linking information, thereby masking the second balise group and thus not being evaluated.

In the method according to the invention, the control of the vehicle (at least one car, wherein the car can include a locomotive and possibly additional cars, particularly a train) is primarily conducted by the driver, with the driver's control being supplemented by background monitoring. The vehicle operator decides, depending on the external signals, whether/how the train is accelerated or decelerated, or at what speed it travels ("Driving according to external signaling"). The background monitoring intervenes only in the event of an error by the train driver and, if necessary, triggers a safety response. This means that the train driver does not operate according to the specifications of the train control system, but according to the specifications of the external signaling. Since the responsibility lies with the train driver, unlike ETCS Level 2 FS, the track center only needs to meet minimal safety requirements for the train control system. This reduces the development costs of the system used.

By using background monitoring, passing signals showing stop can be prevented by having the vehicle register with the RBC at the start of the journey ("Start of Mission"). This prevents driving against stop signals, as the line control center can issue an SR (Staff Responsible) authority, where only the maximum allowable speed is monitored, or an OS (on sight) authority that allows a lower maximum speed than the nationally prescribed

values (National Values) dictate. Therefore, fewer balises are required in the method according to the invention than in ETCS Level 1 LS. Furthermore, lineside electronic units (LEU) are not required at every signal, as is the case with ETCS Level 1 LS, for example.

Background monitoring also allows for immediate intervention without being bound to the positions of the balise.

Crucial for the execution of the procedure is the use of linking information in the movement authority. Through the linking information, it can be ensured that the second balise group is masked and thus not evaluated. "Linking Information" refers to the logical connection of a balise group with a subsequent balise group. In the case of linking, balise groups following one another in the direction of travel are announced and monitored with their identities and the distances to be traveled between them. If a balise group is not listed in the linking information, its information will not be used by the vehicle-side monitoring device. The linking information is used to mask the second balise group. After passing the location of a virtual balise group, the linking information on the vehicle is deleted and each balise is read again.

The balises serve to determine the location of the vehicle. According to the invention, the first balise group is used in front of the signal to inform the line control center that the vehicle is in front of the signal and a movement authority must be issued to avoid a safety reaction.

A "movement authority" is a message transmitted from the line to the vehicle and evaluated there. From the movement authority, the braking capacity of the vehicle, the odometry, and other input data, braking curves, among other things, are derived, which form the basis of the vehicle's speed monitoring, particularly within the framework of ETCS. The movement authority includes, among other things, the duration or the end of the movement authority, i.e., the location up to which the journey may be conducted and, if applicable, a Permitted Braking Distance (an allowable braking distance). For example, the announcement of a permissible braking distance when "Expecting stop" is indicated at a distant signal causes the vehicle to reduce its speed to such an extent that the permissible braking distance is still maintained when the associated main signal indicating stop is passed, according to the respective braking capability.

The movement authority from the line control center includes linking information to a virtual (non-existent) balise group behind the second balise group. Hereby, the

information from the second balise group is not evaluated by the vehicle (in particular, it is not forwarded to the line control center), and the safety reaction in the event of receiving a movement authority from the vehicle is prevented (masking of the second balise group). If the vehicle does not receive the movement authority, the second balise group is read and the ID is sent to the line control center. In the presence of a distant signal and a main signal, this applies to both balise groups at the distant signal as well as to both balise groups at the main signal. If due to a malfunction the movement authority is not received by the vehicle-side monitoring device, the second balise group is evaluated, which triggers a safety reaction on the vehicle-side monitoring device.

The transmitted movement authority allows for continuation without interference when the signal indicates to proceed, with interference before the distant signal when the signal indicates to stop (compliance with the permissible braking distance at a distance after the distant signal), and interference before the main signal with movement authority up to the main signal. There is no display of movement authority in the driver's cab, as the train driver operates based on external signaling and is only monitored in the background. As soon as a stop signal changes to proceed, the movement authority is renewed and the influence is lifted.

The train control system is preferably ETCS, and the vehicle is operated in ETCS Level 2 Limited Supervision (LS) mode. Preferably, the line control center initially grants a preliminary movement authority with a specified maximum length and mode profile "Limited Supervision" before crossing the first balise group. The specified maximum length is preferably > 32 km ("unlimited movement authority").

In this specific procedural variant, the procedure is carried out with a reduced planning effort for the technical system compared to an operating mode ETCS Level 1 LS and/or ETCS Level 2 FS. The procedure is thus carried out with a system that is incompletely designed for an operating mode ETCS Level 1 LS and/or ETCS Level 2 FS. Project planning is understood as the project-specific configuration of the system. An incomplete planning means that not all data required for ETCS Level 1 LS or ETCS Level 2 FS are planned. This means that with the method according to the invention, a lower planning effort is required in relation to ETCS Level 2 FS and ETCS Level 1 LS. In particular, with the method according to the invention, the distances between approach signals and main signals do not need to be planned. The distances between main signals do not need to be planned.

The inclination angles and speed profiles of the line do not need to be designed. The distances between the first and second balise groups at the distant and main signals are set to a uniform value and do not need to be individually designed. The method according to the invention thus requires significantly reduced planning effort for the technical system compared to an operating mode ETCS Level LS and/or ETCS Level 2 FS.

When the vehicle passes over the balise group, preferably a static information, in particular the balise ID, is read by the vehicle, especially by the onboard monitoring unit (OBU). The static information can, in addition to the balise ID, also, for example, Text messages and/or information regarding speed restriction areas included.

Preferably, the first balise group and the second balise group include fixed data balises (passive balises) that can exclusively transmit static information to the vehicle.

The static information transmitted from the first balise group to the vehicle when passing over it is at least partially transmitted by the vehicle to the line control center, particularly through the radio link, preferably using GSM-R or Euroradio.

Preferably, the assignment of the vehicle to the signal is carried out by the line control center based on the static information transmitted from the vehicle to the line control center. In particular, the location of the vehicle can be determined using the ID. With the help of the specific location data, the route center can carry out the assignment of the vehicle to the signal. The assignment of the vehicle to the distant or main signal and thus the determination of its position is therefore carried out by means of the balises, preferably exclusively by means of the balises. The positional data used for allocation can, in principle, also be determined using other location methods, e.g., GPS, inertial navigation, magnetic field maps. The vehicle would have to cyclically report its position, determined by the tracking method, to the line control center, which would then perform a signal assignment.

If the vehicle does not receive a new movement authority from the line control center after passing over the first balise group, by which the second balise group is masked, the vehicle reads the second balise group in a particularly preferred procedural variant, and a safety reaction, in particular an automatic braking of the vehicle, is initiated. The safety response preferably takes the form of a temporary speed restriction (= slow speed zone). The slow travel section is located particularly in front of a signal before a hazard area (main signal). The balise that triggers the transmission of a slow speed section is preferably located at the site of a distant signal. The slow speed section causes the vehicle

to be decelerated to a low speed before the main signal, so that a possible emergency braking at the second balise group does not lead to passing the danger point behind the main signal. She forces the vehicle to brake. Additionally, the locomotive driver receives a text message regarding the reason triggering the safety response. A reason for not receiving the movement authority can be, for example, a delay or disruption, such as in the transmission of static information to the line control center.

A specific procedural variant provides that by passing over the second balise group, the vehicle receives an acknowledgment-required instruction, particularly with a text message, and that the automatic braking occurs in response to the absence of an acknowledgment of the acknowledgment-required instruction.

Preferably, the acknowledgment-required instruction includes an unfulfillable acknowledgment condition, for example, with an acknowledgment time t=0 or acknowledgment path s=0 as the acknowledgment condition.

The determination of the current signal aspect is preferably carried out by tapping route information at an interlocking unit through the route center.

In a particularly preferred variant of the procedure, the at least one signal comprises a approach signal and a main signal, and the balise groups include a first approach signal balise group positioned before the approach signal and a first main signal balise group positioned before the main signal, as well as a second approach signal balise group arranged at the approach signal and a second main signal balise group arranged at the main signal.

If the vehicle is to proceed beyond the main signal (particularly when the distant signal shows "expecting proceed" or the main signal shows "Proceed"), it is preferably provided that the movement authority transmitted to the vehicle includes information regarding the mode profile "Limited Supervision" and a length beyond the main signal. Furthermore, additional information may be provided with the movement authority, such as track gradient, maximum track speed, or the permissible speed indicated by the signal in the following track section, etc.

If the distant signal initially displays "Expecting stop" and the signal aspect changes in such a way that it permits a movement beyond the main signal (main signal is upgraded from "Stop" to "Proceed"), then the movement authority is extended. It is particularly advantageous if, after a signal upgrade (change of the signal aspect to "Proceed" or "Proceed expected"), the route center immediately extends the movement authority and

does not wait until a new balise group has been passed over, as is necessarily the case in Level 1 Limited Supervision, for example. With the method according to the invention, however, the movement authority can be extended at any time when the signal is in drive position. This allows the number of balises to be reduced compared to ETCS Level 1 Limited Supervision.

If the vehicle is not supposed to proceed beyond the main signal (particularly when the distant signal indicates "Expecting stop" or the main signal shows "Stop"), it is preferably provided that the movement authority transmitted to the vehicle includes information regarding a permitted braking distance, and that compliance with the braking distance is monitored by the vehicle's onboard monitoring unit (OBU). In this case, the line control center sends an unlimited movement authority with mode profile LS after passing over the first balise group before the distant signal. The Permitted Braking Distance monitors in the background that the train driver is braking the vehicle. If he does not do this, the vehicle will be forcibly braked by the Onboard Unit when exceeding the permissible speed. A movement authority that includes a Permitted Braking Distance thus activates the background monitoring. This prevents the vehicle from passing the main signal. Since the inventive method can thus prevent starting against stop signals by using background monitoring by the track center, the number of balises can be further reduced compared to ETCS Level 1 LS.

If the distant signal initially shows "expecting proceed" and the main signal changes from "Proceed" to "Stop," the line control center sends a Conditional Emergency Stop to the location of the main signal. If the vehicle is still in front of the main signal, the existing movement authority is thereby shortened and the train is braked to the main signal. Preferably, the second balise group is used to trigger a safety reaction.

A particularly preferred method variant provides that the linking information contained in the movement authority includes information regarding a virtual balise group, which causes the linking information on the vehicle to be deleted upon passing the location of the virtual balise group, and all subsequent balises to be read again. After passing the first balise group, the first balise group is stored on the vehicle as the Last Relevant Balise Group (LRBG). All travel permit distances, the linking information, etc., always refer to this LRBG until a new balise group becomes the LRBG. The virtual balise group is located at a certain distance behind the first balise group, which is known through the linking information in the movement authority of the vehicle-side monitoring device. The vehicle

measures its own position in relation to the LRBG. After the vehicle has covered this distance, the linking information regarding the virtual balise group will be deleted, thereby deactivating the linking on the vehicle until new linking information is sent from the route center. The deletion of the linking information preferably occurs when passing the location of the virtual balise group with the front (safe) train head. By deleting the linking information, the first balise group will be read again at the next signal. If the linking information were not deleted, the next balise groups would not be read. This makes it possible to mask the second Balise groups at the distant and main signals. The position data of the virtual balise group is chosen so that it lies behind the masked second balise group.

Further advantages of the invention arise from the description and the drawing. Similarly, the aforementioned features and those further elaborated can be used according to the invention individually or in any combination. The embodiments shown and described are not to be understood as an exhaustive list, but rather have an exemplary character for the description of the invention.

Detailed Description of the Invention and Drawing

Fig. 1 shows the essential elements of the assurance system used for the process according to the invention, as well as the transmission of the information necessary for the process.

Fig. 2 shows a line with approach signal and main signal, as well as the balise groups used for the method according to the invention.

Fig. 1 shows a traction vehicle **F** on a line **S** in front of a signal **Sig** (track signal). The line S is equipped with a first balise group **SigB 1** and a second balise group **SigB2**. Using the balise groups SigB 1, SigB 2, static information, particularly balise identification number **ID** and text messages **TXT**, are transmitted to a monitoring device **OBU** (On Board-Unit) within the vehicle F. The monitoring device OBU includes a receiving unit **EB** for receiving the information transmitted by the balise groups SigB 1, SigB 2. The monitoring device may also have a transmission channel on which it transmits energy. This allows the balise to receive its energy for its own power supply. An additional transmission device may be included in the monitoring system to enable it to read not only balises but also loops, i.e., line conductor loops. For receiving radio signals from a line control center **RBC** and for

transmitting radio signals to the line control center RBC, a GSM transmission and reception device is provided, which preferably is based on the GSM mobile communication standard. Upon passing over the first balise group SigB1, the monitoring device OBU receives the balise ID of the balise group SigB1 that has just been passed over. The monitoring device OBU transmits this balise ID to the line control center RBC, so that it can determine the location of the vehicle. The line control center RBC assigns vehicle F to a distant or main signal based on the balise ID and the direction of travel.

At the same time, the line control center RBC intercepts signal information at an interlocking unit **IL**, which in turn is connected to the signals Sig on the line S. Based on the location information of vehicle F and the signal concept of the signal Sig, the line control center RBC creates a movement authority MA and sends it through the radio link to the onboard unit OBU of vehicle F.

Depending on the signal aspect, the movement authority MA is issued with or without restrictions.

The control of the vehicle primarily lies with a driver who follows the external signaling. The monitoring device OBU is solely intended for background monitoring, for example, to trigger a safety reaction in the event of a driver's erroneous decision.

The position of vehicle F is not continuously monitored by the line control center RBC. The monitoring is initiated when the vehicle F, after passing over a balise group SigB1, SigB2, sends their balise ID to the line control center RBC. If due to a transmission disturbance a balise ID is not transmitted to the trackside center RBC, a safety reaction is initiated by the second balise group SigB2, which decelerates the vehicle F.

Fig. 2 shows a line S with an approach signal **VSig** and a main signal **HSig**, a first approach signal balise group **VSigB1**, a second approach signal balise group **VSigB2**, a first main signal balise group **HSigB1**, and a second main signal balise group **HSigB2**. The first approach signal balise group VSigB1 is located at a distance d1 before the approach signal VSig. The balise ID of the first distant signal balise group VSigB1 serves the line control center RBC for assigning the vehicle F to the distant signal VSig. The second approach signal balise group VSigB2 is used to initiate a safety reaction if the ID of the first approach signal balise group VSigB1 was not sent to the line control center RBC.

The first main signal balise group HSigB1 is located at a distance d2 before the main signal HSig. The balise ID of the first main signal balise group HSigB1 is used by the track-side control center RBC to associate the vehicle F with the main signal HSig. The second main

signal balise group HSigB2 is used to initiate a safety reaction if the balise ID of the first main signal balise group HSigB1 was not sent to the line control center RBC.

The distances d1, d2 should be as short as possible and as long as necessary, and they depend on the line speed and duration, the reading of the balise group, the transmission of the balise ID to the line control center RBC, and the receipt of a new driving command. In particular, the new driving command must be on vehicle F before passing the Balise SigB2, otherwise a safety reaction will occur. Assuming an exemplary duration for reading a telegram from the balise of approximately 1 second, for processing on the vehicle of approximately 0.5 seconds, for sending to the line control center of approximately 1 second, for processing in the line control center of approximately 0.5 seconds, for sending to the vehicle of approximately 1 second, for processing the new movement authority MA on the vehicle of approximately 0.5 seconds, results in approximately 4.5 seconds, and from this, at an assumed speed of 160 km/h, distances d1, d2 of approximately 200 meters.

Fig. 2 also shows (dashed) virtual balise groups **ViB**. This does not refer to actual balise groups in the sense of hardware, but to location data that is transmitted to the vehicle F as linking information with the movement authority MA. The linking information specifies up to which point balises, which may be passed over, are not to be read. At the location of the virtual balise groups ViB, this "readout prohibition" is lifted, and subsequently overridden balises are read out again.

The following describes the method according to the invention using a line S with an approach signal VSig and a main signal HSig, as shown in Fig. 2:

The vehicle F is traveling on line S. The monitoring device OBU in vehicle F reads the first approach signal balise group VSigB1 before the approach signal VSig and sends the balise ID to the line control center RBC. The line control center RBC can now assign the vehicle F to the distant signal VSig or the main signal HSig. (As a rule, the balise ID of the distant signal VSig is directly assigned to the main signal HSig.) Only in cases where an assignment to the main signal HSig is not possible at the location of the approach signal VSig, must the approach signal or a switch position information be evaluated.

If the distant signal VSig shows "**Expecting proceed**," the line control center RBC sends a travel command to vehicle F for LS Mode beyond the main signal HSig, using linking information. This masks the approach signal balise group VSigB2 and is not evaluated by the vehicle F.

If the distant signal VSig indicates "**Expecting stop**," the line control center RBC sends vehicle F a driving command for LS Mode with a Permitted Braking Distance of x meters and linking information. This masks the approach signal balise group VSigB2 and is not evaluated by the vehicle F. Through the Permitted Braking Distance, the vehicle F monitors in the background that the train driver decelerates the vehicle F. If he does not do this, the vehicle F will be braked as a safety reaction by the monitoring device OBU when exceeding the permissible speed.

If the vehicle F does not receive a new movement authority MA from the line control center RBC due to a delay or disturbance before the distant signal VSig, in which the second distant signal balise group VSigB2 is masked, the train reads the second distant signal balise group VSigB2 and receives a Temporary Speed Restriction at a distance of y meters. This forces the vehicle F to brake, additionally, the train driver receives a text message about the reason for the executed safety reaction.

Proceeding at approach signal VSiq "Expecting proceed":

The vehicle F continues until the monitoring device OBU reads the main signal balise group HSigB1 in front of the main signal HSig and sends the corresponding balise ID to the line control center RBC. The line control center RBC can now assign vehicle F to the main signal HSig. The assignment is not strictly necessary if the main signal HSig still shows "Proceed" at this time. If the main signal HSig still shows "Proceed" at this time, the track center RBC sends the vehicle F a movement authority MA for LS Mode far beyond the main signal HSig. The movement authority MA contains linking information that causes the second main signal light group HSigB2 to be masked and not evaluated by vehicle F.

In the event that no reassignment to the main signal occurs when crossing the main signal balise group HSigB1, a new movement authority MA must still be generated, which masks the second main signal balise group HSigB2. This is triggered by the reporting of the first main signal balise group HSigB1, thereby canceling the safety response at the second main signal balise group HSigB2. This eliminates the need to design the distance between approach signal VSig and main signal HSig. (This can be approximately 700m to 1500m long).

If the main signal HSig changes to "Stop" (stop condition), an evaluation is carried out by the RBC route center. The vehicle F receives a Conditional Emergency Stop from the line control center RBC at the location of the main signal HSig. (d2+z meters after the first

main signal balise group HSigB1, where z is a correction factor needed to compensate for the difference between the main signal HSig and the end of the associated track clearance detection section behind the main signal HSig). If the stop condition of the main signal HSig was caused by vehicle F, for example, because vehicle F regularly passed the main signal HSig and thus blocked the next track section, the emergency stop is ignored, as it is a regular stop condition intended to prevent another vehicle from entering the same track section. If the vehicle F is still located before the main signal HSig, an emergency braking is initiated as a safety reaction.

Proceeding when the distant signal indicates "Expecting stop":

Due to the approach signal influence, the vehicle F brakes to a speed to comply with the Permitted Breaking Distance. At this speed, the train travels until the on-board unit OBU monitoring device in vehicle F reads the first main signal balise group HSigB1 before the main signal HSig and sends the balise ID to the line control center RBC. The line control center RBC can now assign vehicle F to the main signal HSig. The line control center RBC sends vehicle F a movement authority MA for LS Mode up to the main signal HSig, where vehicle F is to come to a stop.

If the main signal HSig changes to "**Proceed**," the track center RBC sends vehicle F a driving command for LS Mode far beyond the main signal HSig. The movement authority MA contains linking information that causes the second main signal light group HSigB2 to be masked and not evaluated by vehicle F.

The stop event of the HSig is evaluated by the RBC, and the train receives a Conditional Emergency Stop at the location of the HSig (d2+z meters after the first balise group HSigB1, where z is a correction factor needed to compensate for the difference between the main signal and the end of the track-clear section, particularly the area between two axle counting points or the area of a track circuit behind the signal). If the stop condition of the main signal HSig was caused by vehicle F, for example, because vehicle F passed the main signal HSig regularly and thus blocked the next track section, the emergency stop is ignored. If the vehicle F is still located before the main signal HSig, an emergency braking is initiated as a safety reaction.

If the vehicle F does not receive a new movement authority MA from the track center RBC due to a delay or disturbance before the main signal HSig, which masks the second main balise group HSigB2, and the train driver unlawfully passes the main signal HSig, the

vehicle F reads the second balise group HSigB2, and an automatic brake is initiated. For this purpose, a text message TXT requiring acknowledgment is sent from the second main balise group HSigB2 to the vehicle F, with the acknowledgment conditions chosen such that they cannot be fulfilled (e.g., unfulfillable acknowledgment time/distance t=0 / s=0). Due to the lack of acknowledgment, the forced execution will be initiated.

If the train is located between the first distant signal balise group VSigB1 and the main signal HSig, an authorization for LS Mode can be issued to the vehicle F at any time when the signal HSig is set to proceed, thereby lifting the supervision by the line control center RBC (until passing the next balise group).

In the method according to the invention, a localization of the vehicle F is carried out, in particular by means of the balise groups. Preferably, the location determination is carried out exclusively using the balise groups. Due to the location determination, the vehicle F is assigned a signal. If the signal indicates "Stop" or "Expecting stop," monitoring of vehicle F by the line control center RBC is initiated.

The method according to the invention is based on the fact that when the first balise group VSigB1, HSigB1 is passed over, a movement authority MA is sent to the vehicle F depending on the current signal aspect with linking information, and the second balise group VSigB2, HSigB2 is masked by this linking information, meaning it is not read out. In the event of a missing movement authority MA, after passing the first balise group VSigB1, HSigB1, the second balise group VSigB2, HSigB2 will be read, which may trigger a safety reaction.

Bibliography

[01] https://de.wikipedia.org/wiki/European_Train_Control_System

List of reference numerals

EB Reception unit for (in particular inductive) receiving of the information transmitted by the balise groups

GSM Transmission and reception unit for sending and receiving radio signals

F Vehicle

ID Balise ID

IL Interlocking unit

MA Movement authority

OBU Onboard monitoring unit

RBC Line control center

S Line

TXT Text message subject to acknowledgment of receipt

ViB Virtual balise group

Sig Signal

HSig Main signal

VSig Approach signal

SigB1 First signal balise group

SigB2 Second signal balise group

VSigB1 First approach signal balise group

VSigB2 Second approach signal balise group

HSigB1 First main signal balise group

HSigB2 Second main signal balise group

Patentkrav

1. Fremgangsmåde til betjening af et togstyringssystem til styring af et skinnebundet køretøj (F) med en indbygget overvågningsindretning (OBU), hvor togstyringssystemet har en linjestyringscentral (RBC) og ekstern signalering med mindst et signal (Sig; HSig, VSig) og en første balisegruppe (SigB, HSigB1, VSigB1) opstrøms for signalet (Sig; HSig VSig) og anden balisegruppe (SigB2; HSigB2, VSigB2) anbragt ved signalet (Sig; HSig, VSig), hvor køretøjet (F) overvåges af linjestyringscentralen (RBC), hvor fremgangsmåden omfatter:

- tildeling af køretøjet (F) til signalet (Sig; HSig, VSig),
- bestemmelse af et aktuelt signalaspekt af det tildelte signal (Sig; HSig, VSig),
- udstedelse af en bevægelsesbemyndigelse (MA) til køretøjet (F) af linjestyringscentralen (RBC) afhængigt af det fastlagte signalaspekt via en radioforbindelse,
- bevægelse af køretøjet (F) af en køretøjsfører ifølge den eksterne signalering,
- hvor overvågningen af linjestyringscentralen (RBC) finder sted i baggrunden, **kendetegnet ved, at**
  - linjestyringscentralen (RBC) kommunikerer diskontinuerligt med køretøjet (F), hvor der anmodes om bevægelsesbemyndigelsen (MA) ved at passere den første balisegruppe (SigB1; HSigB1, VSigB1),
  - bevægelsesbemyndigelsen (MA) overføres til køretøjet (F) afhængigt af det fastlagte aktuelle signalaspekt, hvor bevægelsesbemyndigelsen (MA) indeholder oplysninger om sammenkædning, hvorved den anden balisegruppe (SigB2; HSigB2, VSigB2) er maskeret og derfor ikke evalueres.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** togstyringssystemet er er ETCS, og køretøjet (F) drives i driftstilstanden ETCS-Level 2 Limited Supervision.

3. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** når køretøjet (F) passerer balisegruppen (HSigB1; VSigB1, HSigB2; VSigB2), læses statisk information, især balise-ID (ID), af køretøjet (F), især af den indbyggede overvågningsindretning (OBU).

4. Fremgangsmåde ifølge krav 3, **kendetegnet ved, at** den statiske information (ID), der transmitteres af den første balisegruppe (SigB1; HSigB1, VSigB1) til køretøjet (F), når køretøjet passerer den første balisegruppe (SigB1; HSigB1, VSigB1), transmitteres i det mindste delvist fra køretøjet (F) til linjekontrolcentralen (RBC), især ved hjælp af radioforbindelsen, fortrinsvis via GSM-R eller Euroradio.

5. Fremgangsmåde ifølge krav 4, **kendetegnet ved, at** køretøjet (F) tildeles signalet (HSig, VSig) af linjestyringscentralen (RBC) ved hjælp af den statiske information (ID), der transmitteres af køretøjet (F) til linjestyringscentralen (RBC).

6. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** hvis køretøjet (F) efter at have passeret den første balisegruppe (SigB1; HSigB1, VSigB1) ikke modtager en ny bevægelsesbemyndigelse (MA) fra linjestyringscentralen (RBC), hvorved den anden balisegruppe (SigB2; HSigB2, VSigB2) er maskeret, udlæser køretøjet (F) den anden balisegruppe (SigB2; HSigB2, VSigB2), og en sikkerhedsreaktion, i særdeleshed automatisk opbremsning af køretøj (F), igangsættes.

7. Fremgangsmåde ifølge krav 6, **kendetegnet ved, at** ved at passere den anden balisegruppe (SigB2; HSigB2, VSigB2) modtager køretøjet (F) en instruktion (TXT), der kræver bekræftelse, især med en tekstmeddelelse, og at den automatiske opbremsning sker som en reaktion på manglende bekræftelse af den instruktion, der kræver bekræftelse.

8. Fremgangsmåde ifølge krav 7, **kendetegnet ved, at** instruktionen (TXT), der kræver bekræftelse, omfatter en bekræftelsesbetingelse, som ikke kan opfyldes.

9. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** det aktuelle signalaspekt bestemmes af linjestyringscentralens (RBC) aflytning af linjeinformation ved en sammenlåsningsenhed (IL).

10. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** det mindst ene signal (HSig, VSig) omfatter et forsignal (VSig) og et hovedsignal (HSig), og balisegrupperne (HSigB1, VSigB1, HSigB2, VSigB2) indbefatter en første forsignal-balisegruppe (VSigB1) opstrøms for forsignalet (VSig) og en første hovedsignal-balisegruppe (HSigB1) opstrøms for hovedsignalet (HSig) samt en anden forsignal-balisegruppe (VSigB2) anbragt ved forsignalet og en anden hovedsignal-balisegruppe (HSigB2) anbragt ved hovedsignalet.

11. Fremgangsmåde ifølge krav 10, **kendetegnet ved, at** hvis køretøjet (F) skal fortsætte forbi hovedsignalet (HSig), indeholder bevægelsesbemyndigelsen (MA), der sendes til køretøjet (F), information om tilstandsprofilen "Limited Supervision" og en længde ud over hovedsignalet (HSig).

12. Fremgangsmåde ifølge et af kravene 10 til 11, **kendetegnet ved, at** hvis køretøjet (F) ikke skal fortsætte forbi hovedsignalet (HSig), omfatter bevægelsesbemyndigelsen (MA), der sendes til køretøjet (F), oplysninger om en tilladt bremselængde, og
at overholdelsen af bremselængden overvåges af den indbyggede overvågningsenhed (OBU) (OBU).

13. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** den anden balisegruppe (HSigB2, VSigB2) bruges til at udløse en sikkerhedsreaktion.

14. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** oplysningerne om sammenkædning indeholdt i bevægelsesbemyndigelsen (MA) omfatter information vedrørende en virtuel balisegruppe (VB), som bevirker, at oplysningerne om sammenkædning på køretøjet (F) bliver slettet igen, når placeringen af den virtuelle balisegruppe (VB) passeres, og at alle andre baliser bliver læst igen.

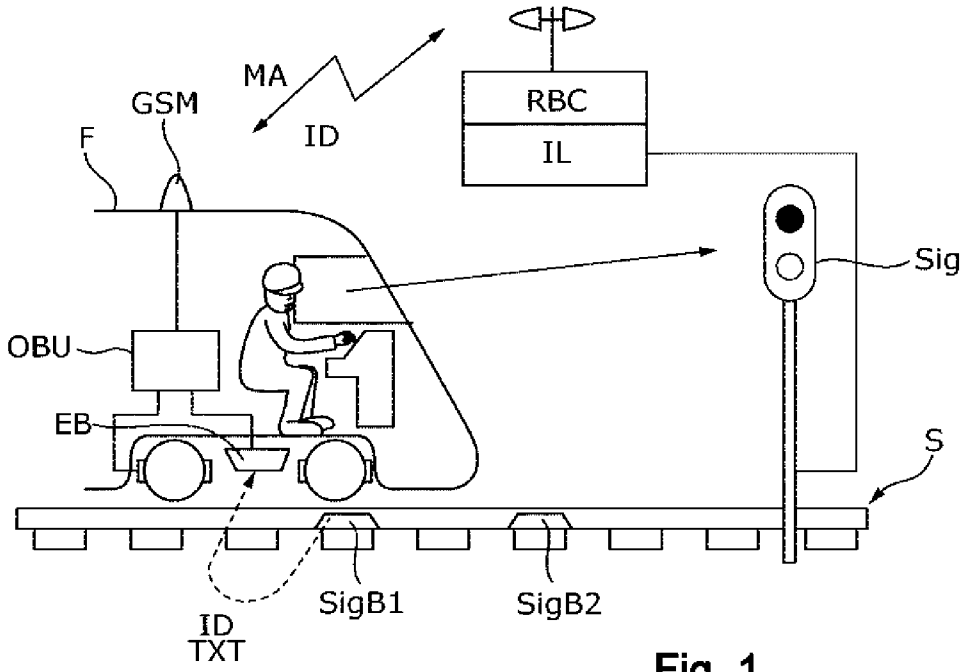

MA
ID
GSM
F
RBC
IL
Sig
OBU
EB
S
SigB1
SigB2
ID
TXT

Fig. 1

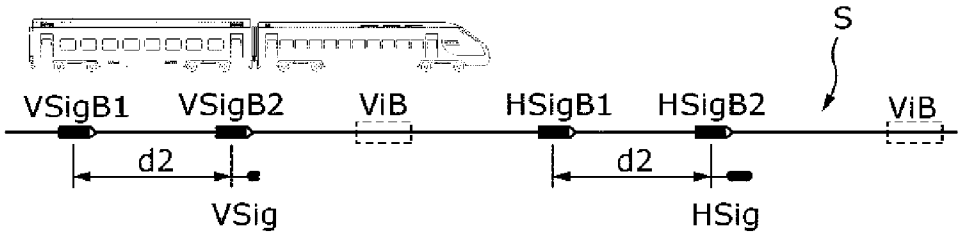

S
VSigB1
VSigB2
ViB
HSigB1
HSigB2
ViB
d2
d2
VSig
HSig

Fig. 2