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(54) **MONITORING SYSTEM FOR MONITORING ONE OR MORE WORK ZONES WITHIN A RAIL TRACK**

- (57) A first aspect of the present description provides a monitoring system for monitoring one or more work zones within a rail track, wherein the rail track is managed by at least one railway safety system such as an interlocking and by a rail traffic control system, wherein the rail traffic control system is configured to establish one or more sections within the rail track according to a schedule; wherein the railway safety system is communicatively connected to the rail traffic control system and is configured to receive the established one or more sections and to accordingly establish a track occupancy notification in
- the railway safety system which prohibits trains from travelling along the established one or more sections, and the monitoring system comprising:
a central processing unit which is situated remotely from the one or more work zones; and
at least one monitoring interface, which monitoring interface is configured to provide an interface with the railway safety system, and
wherein the monitoring interface further comprises communication means for transmitting a current state of the established one or more sections to the central processing unit.

Description

[0001] The present invention relates to a monitoring system for monitoring one or more work zones within a rail track.

[0002] The present invention also relates to a monitoring interface for a monitoring system for monitoring one or more work zones within a rail track.

[0003] Since the railway network is used intensively, some regular maintenance has to be carried out. Maintenance on the railway network, or here in the context of the present description also generally referred to as rail tracks or a rail track, is carried out by track workers who can carry out repairs or maintenance in or near the track in order to keep the track operational and safe.

[0004] In places where works are carried out, which areas are referred to as work zones, it is important to ensure the safety of the track workers. To this end, part of the track, being at least the work zone as that part where works are carried out, can be taken out of service. There are various ways to take one or more parts of a rail track out of service. It is for example possible to use a short-circuiting lance to cause a short-circuit in a track circuit, whereby the presence of a train in that part of the track is simulated. This has the result that the signal of that part of the track turns red and other trains are no longer able to enter these zones because the zone is no longer free but occupied. This and other forms of taking out of service are realized by the railway safety means, also referred to as the train protection means, and the systems present therefor. Such railway safety systems ensure a very high degree of safety; for instance a signal may only turn green and a train may thus only enter a zone if there are no trains in the zone, any switches are in the correct position and secured, no other routes are set, and all safety requirements are met, etc. These railway safety systems are oriented locally, which means that there are multiple local or regional and largely separately operating railway safety systems for the railway network which are for example accommodated in relay houses or in a traffic control centre. There is therefore no central control or coordination of such railway safety means.

[0005] The planning for the implementation and adjustment of the schedule is regulated at another level and other systems are configured for this. Track traffic control means are responsible for the implementation of the schedule. If, according to the schedule, a certain service is planned, the track traffic control means are responsible for ensuring that the train in question is also able to perform this service and will, to this end, "establish" certain parts of the track, being one or more sections or routes. With sections or a route established by the track traffic control means, a certain part of the track is thus assigned to the train in question and the train in question is the only train that can make use of this assignment. Such track traffic control systems, also referred to as rail traffic control systems, are oriented centrally, inter alia because

this fits with the schedule which also overarches various local regions. Although it is important that the routes or sections established or set by the track traffic control means are also blocked for other trains, the safety and thus operational reliability is primarily ensured by the local railway safety systems.

[0006] If a part of the track, for example for the purpose of carrying out works and therefore defining a work zone, is realized by the systems of the rail traffic control means, by establishing one or more sections and thus realizing a track occupancy notification or a route obstruction or obstruction of one or more sections, also referred to as disruption in the present description, or by the systems of the railway safety means, by generating a short-circuit using a short-circuiting lance or establishing an occupancy notification via the interlocking, the result is functionally the same in both cases, namely that no trains can enter the work zone. The track occupancy notification, or disruption or obstruction of one or more sections, which is established from the rail traffic control means in the context of the schedule may be referred to as a planned track occupancy notification. A track occupancy notification which is established outside the rail traffic control means directly in the railway safety means, for example with the aid of a short-circuiting lance or in the interlocking, will realize a track occupancy in a relevant section of the rail track corresponding to the work zone, as a result of which the signals turn red and a route can no longer be established (by the signaller) over this work location. In both the scenario of the track occupancy notification from the rail traffic control means and in the scenario from the train protection means, the result is thus in both cases that a route can no longer be established. The difference between the two scenarios, if the origin of the track occupancy notification is unable to be made in the operating and control panels and systems of the signaller.

[0007] Whilst the local railway safety systems meet one of the highest degrees of operational reliability and functional safety, SIL4, most central systems of the central track traffic control means do not. And although that is possibly less important for the signaller, it is important and necessary if the safety of employees on the track is concerned, and thus in the event of a work zone containing track workers.

[0008] There is therefore a need to be able to provide in a simple manner a system or method for defining a work zone and taking this work zone out of service within the currently available systems of the track in such a way that a high degree of operational reliability and additionally the high degree of safety are met.

[0009] A first aspect of the present description provides a monitoring system for monitoring one or more work zones within a rail track, wherein the rail track is managed by at least one railway safety system such as an interlocking and by a rail traffic control system,

wherein the rail traffic control system is configured

to establish one or more sections within the rail track according to a schedule;
wherein the railway safety system is communicatively connected to the rail traffic control system and is configured to receive the established one or more sections and to accordingly establish a track occupancy notification in the railway safety system which prohibits trains from travelling along the established one or more sections, and the monitoring system comprising:

a central processing unit which is situated remotely from the one or more work zones; and
at least one monitoring interface, which monitoring interface is configured to provide an interface with the railway safety system, and
wherein the monitoring interface further comprises communication means for transmitting a current state of the established one or more sections to the central processing unit.

[0010] For the purpose of establishing one or more work zones such that track workers in the work zone and/or in the immediate vicinity of the work zone can carry out works on the track, a safe workspace needs to be created. Such safe workspaces can be set up by providing one or more warning systems such as train detection units, in the case of which track workers are warned if trains or other rolling stock are approaching the work zone, but for a higher degree of safety it is more preferable for the work zone to be kept clear of (approaching) trains or other rolling stock.

[0011] Such a safe work zone is typically established from the railway safety means and not from the track or train traffic control means. Such safety and traffic control systems are classified at different levels within the track traffic control chain. In this chain, the schedule is at a higher level than the safety, which is present at a relatively low level in the chain. That does not mean that this level is of lesser importance. On the contrary, safety is a very basic part of the chain for controlling the track, and if a problem occurs at this deeper, relatively lower level, one or more actions will not be able to be carried out at upper levels. A typical example of this is that if a short-circuit is created between two rails, by a train that is present or by a short-circuiting lance, then that part of the track or that block within the open track is blocked since it generates a track occupancy notification. This has the result that traffic control cannot overrule this and can still establish a train as part of the schedule. This train cannot enter the zone of the blockage. How this works in practice is that the trains which should run according to the schedule are scheduled in the systems for track traffic control/rail traffic control. These systems control, with the setting of the routes or one or more sections, which trains can run where. If there is a disruption, the signallers can use these systems to input an order to set or establish a different route or section or sections, by

setting the switches in different positions and assigning lanes to this train. This setting may be carried out manually, partially automatically or fully automatically. These set routes or one or more sections are sent to a local relay house, in which, depending on the generation of track safety (first, second or third generation on the basis of conventional or mechanical protection, relay protection or b-relays or electronic interlocking, or via the most modern PLCs or other computer-controlled safety means, or by means of interlocking in a cloud environment, wherein no taking-out-of-service means are fitted at the wayside of the track, the safety systems perform control or the order is also able to be carried out. If another train is already running, or there is a short-circuit or another obstruction or blockage from this safety means, the order is not approved and the train thus cannot enter the section or zone of the track. Only when all the conditions are met can the train enter the section. When that is the case, the safety systems will actuate the relevant parts to report the track as occupied, wherein the signals turn to red and switches and crossings are adjusted accordingly.

[0012] For the overall safety of the track, reliance is as such thus largely placed on these track safety systems. Therefore, these have to meet a high degree of operational reliability and possible errors in these systems must be small enough that they are acceptable from safety considerations. To indicate the degree of safety of these systems, they often have to meet certain predetermined safety levels. Within the track, use is for example frequently made of safety integrity levels or SIL levels. SIL0 means that none of the set standards are met, whilst SIL1 is a basic standard and SIL3 is a very high and operationally reliable standard. It is generally the case that the higher the SIL classification, the safer the system and the smaller the remaining residual risk if certain systems fail. The systems within railway safety typically satisfy SIL3 or higher.

[0013] Since the rail traffic control means rely on the safety of the underlying railway safety systems certified to SIL3 or higher, this high standard is not required for these rail traffic control systems. And since obtaining a higher SIL standard increases the complexity and costs, such systems are also not certified or standardized as such in practice.

[0014] As described, the establishing of work zones can conventionally be regulated from the train protection means, or alternatively via the track traffic control means. Using the train protection means, this is typically oriented locally, which makes the establishing and managing of a work zone comprising track sections that belong to different local safety systems highly complex. However, using the traffic control means, this has the disadvantage that the safety does not meet the same high standard as when this is realized via the train protection systems.

[0015] Instead of improving the track traffic control systems to meet the higher (SIL) classification, or adapting the safety systems to make them directly manageable

by traffic control means, the present invention provides a system with a monitoring interface and central processing unit, whereby it is possible to establish an interface in a retrofitted manner with the existing systems such that the orders which are configured from the track traffic control means, such as the setting of a lane but now for the purpose of establishing a work zone, and which will ultimately be received in the underlying systems of the train protection means are fed back to a central processing unit via the monitoring interface. In this way, the monitoring interface, the central processing unit and the communication therebetween can be configured in such a way that certain desired high safety levels are met. The monitoring interface, the central processing unit and the communication therebetween can thus be configured for SIL3, SIL4 or an even higher certification and in this way the entire chain from establishing a work zone, via the track traffic control means up to the train protection means can as a whole meet the higher safety level such as SIL3, SIL4 or higher, without modifications to the existing systems being required.

[0016] The communication between the monitoring interface and the central processing unit is preferably effected wirelessly. In particular, this wireless communication is a wireless public telecommunication network such as a 4G or 5G network. On this public telecommunication network, the connection can be securely established by means of security technologies known to those skilled in the art.

[0017] For the connection between the central processing unit and the monitoring interface, use is preferably made of a 4G network topology, and more preferably of a 5G network topology, use being made of one or more of the following security protocols.

1. Authentication and Key Agreement (AKA): This is a security protocol used in 3G and 4G networks to authenticate subscribers and to establish a shared secret key which is used to protect subsequent communication.
2. LTE-AKA: This is an extension of AKA which is used in LTE networks and which offers additional security functions, such as protection against the tracking of subscribers and improved authentication performance.
3. Enhanced Subscriber Identity Module (eSIM): This is a SIM card which is installed in a device and provides safe storage of subscribers' login details and keys. It is used in 4G and 5G networks to ensure safe authentication and to make safe access to network services possible.
4. Transport Layer Security (TLS): This is a protocol that is used to make safe communication via Internet possible. It is used in 4G and 5G networks to secure the communication between network elements and to protect sensitive data such as subscribers' login details.
5. IP Security (IPSec): This is a protocol that is used

to secure IP-based communication by encrypting and authenticating data. It is used in 4G and 5G networks to provide safe communication between devices and network elements.

6. Certificate-based authentication: this is a security protocol that is used in 5G networks to authenticate devices and network elements with the aid of digital certificates. This offers a higher security level than traditional authentication on the basis of username and password.

[0018] All the mentioned security protocols can be used in (public) telecommunication networks such as 3G, 4G and 5G and can serve different purposes. Of the mentioned security protocols, Transport Layer Security (TLS) and IP Security (IPSec) are preferred since they are readily implementable within 4G and 5G networks and have the effect that the security of the communication between network elements and devices is greatly increased, and thus also between the central processing unit and the monitoring interface according to the present application.

[0019] In a further embodiment, the established one or more sections comprises one of the one or more work zones within the rail track, and the track occupancy notification for at least the one or more work zones relates to a disruption notification or route obstruction or obstruction of one or more sections, for the transmission of a current state of the established one or more sections at least comprising the disruption notification or route obstruction or obstruction of one or more sections to the central processing unit by the monitoring interface by means of the communication means.

[0020] The established one or more sections or route is fundamentally established from the system or the systems of the rail traffic control means. This means that it concerns one or more established or set sections for the purpose of implementing the schedule. Such schedules comprise information regarding trains, routes and times at which these run, which together make up the schedule and are planned sufficiently for implementing the schedule. Furthermore, there is also short term planning, which can be planned up to a few hours in advance or at most 1 to 2 days in advance and as a result of which changes can be made to the schedule. Reasons for this may be to respond to certain planned circumstances or the availability of staff and equipment. It is also possible for delayed trains to be rescheduled, whereby a change is made to the schedule in a similar manner. Planned or unexpected maintenance works may or must be carried out on established routes or sections. These works are often carried out at one or more consecutive work zones. The planning has to be adapted accordingly, on the one hand in order to divert the trains and reschedule them, but above all, from a safety aspect, in order to ensure that no trains can enter the work zone or zones during the works.

[0021] In order to prevent a train from being able to travel through a certain work zone or one or more sec-

tions, the route has to have a track occupancy notification. This means that that part of the track is set to occupied in the railway safety systems. The signal is set to red, for example by way of an applied short-circuiting lance, as a result of which other trains are unable to travel along this route or sections, and in the event of automatic train influencing systems, this is automatically prevented from happening.

[0022] However, such a track occupancy notification may originate from the systems of the rail traffic control means, and therefore provide an occupancy notification which corresponds to the actual physical presence of a train on the route in question. However, it may also originate from the railway safety means, for example because a short-circuiting lance is applied between two rails, whereby the presence of a train is simulated without this train actually being physically present. It is, however, also possible for such simulation of a train, resulting in a track occupancy notification, to also have a different origin. For instance, an interface on one of the systems of the railway safety means may be used to generate an occupancy notification in a software-based manner. This has the same result. After all, when implementing a schedule or change thereto, the railway safety means will not offer any possibility of setting the route or sections since they are not clear. Within the currently available systems, such a track occupancy notification is actually shown not as a track occupancy but as a disruption and is also displayed or otherwise signalled as such within the systems of the rail traffic control means and railway safety means.

[0023] In a further embodiment, the established one or more sections which result in a track occupancy notification which relates to a disruption notification are established by a taking-out-of-service interface for taking the one or more work zones within a rail track out of service directly in the railway safety system.

[0024] In a further embodiment, the established one or more sections which result in a track occupancy notification are established from the rail traffic control system according to the schedule.

[0025] In a further embodiment, the monitoring interface is certified according to safety integrity level 3 or higher, and in particular safety integrity level 4 or higher.

[0026] Safety Integrity Level, SIL, is a measure of the reliability of safety-related systems and equipment used in sectors such as rail transport. SIL is used to evaluate the failure probability of a safety-related system and the level of risk reduction that it can offer.

[0027] Within the context of railway systems, SIL is used to assess the safety of different systems and components, including train management systems, signalling systems, brake systems and other safety-critical equipment, as well as the rail traffic control systems and railway safety systems according to the present application. SIL offers a quantitative measure of the effectiveness of the safety-related systems and helps to ensure that they meet the required safety standards.

[0028] SIL is based on the principles of the International Electrotechnical Commission (IEC) 61508 standard, which is often used in the railway industry. The standard defines at least four SIL levels, which each correspond to a specific safety performance target level. These levels run from SIL 1, which offers the lowest level of safety performance, to SIL 4, which offers the highest level of safety performance.

[0029] In order to achieve a specific SIL level, a system or component must be designed, tested and verified to meet the requirements of the SIL standard. This includes a thorough analysis of the reliability and failure modes of the system, as well as the development of measures to reduce the risk of failure.

[0030] Railway systems usually require a high level of safety integrity, with many systems and components requiring a SIL 2 or SIL 3 certification. This is because the consequences of a malfunction in a safety-critical system in the railway industry can be serious, including the possibility of death or serious injury.

[0031] Rail traffic control systems usually only meet a low safety level such as SIL 1. This also applies to the rail traffic control system to which the monitoring system according to the present description can be connected. Railway safety systems such as the one corresponding to the present application usually meet SIL 3 or SIL 4. When transmission is performed from the railway safety system to the rail traffic control system, or in other words if the rail traffic control system reads the information about established routes or one or more sections or disruptions from the railway safety means, the SIL 3 or SIL 4 level of the safety systems is no longer maintained. After all, the SIL 1 rail traffic control system thus becomes the weakest link with the greatest probability of malfunction or error.

[0032] By means of the monitoring interface which is connected to the railway safety system, it becomes possible to remedy this disadvantage. The interface specifically communicates outside the rail traffic control system, by communicating the information about established routes (or sections thereof) (according to a schedule) and/or information about disruptions (planned or non-planned works established from the train protection means) directly to a central processing unit. The information is thus made accessible, without it being routed through an SIL 1 system and thus degraded in terms of safety level.

[0033] When the information is accessible from the railway safety means, and can be made available from the central processing unit, it becomes possible to make the information available, preferably by means of authorization, to the signallers, who usually make use of and have access to the rail traffic control systems. More preferably, the central processing unit makes the accessible information directly available within the rail traffic control systems. This can be the case in the various applications of the rail traffic control means, where the accessible information is made available and it is thus also preferably clear whether and, if so, which lanes or sections are taken

out of service or are affected by a disruption. Examples of such systems are train number tracking systems, the operating panel, train transport process control systems, automatic route setting systems, train management systems, or other graphic or textual interfaces.

[0034] From a decentralized or regional location, but preferably a central location such as the rail operations control centre (ROCC), the signallers can monitor the train traffic and have access to the rail traffic control systems. Within these systems, the monitoring interface according to the present description can be used to communicate the accessible information about set sections or routes and disruptions. For example by displaying this information in the panels of the signallers. Preferably, from the monitoring interface to the central processing unit, the information is augmented with the origin of the notification, that is to say whether it relates to an established or set route or sections, or a disruption. Such that in the central processing unit and onward, such as in the panels of the signallers, this distinction remains visible. In this case, the occupancy notification can not only be made visible with a higher degree of security, and in accordance with a higher SIL level, in particular higher than SIL1, more particularly SIL3 or SIL4, but a distinction can additionally be made between a planned train according to the schedule or a disruption as a result of planned or unexpected works.

[0035] In particular, the monitoring interface and more preferably also the central processing unit and all communication therebetween is accredited according to SIL3, SIL4 or higher.

[0036] There are different measures that can be taken to increase the SIL level in the system, for example through the use of redundancy. One way of increasing the SIL level is by providing redundancy in the system. This means that critical components and systems have back-ups, such that if one fails, the other can take over without jeopardizing the safety. The monitoring interface can, for example, be of double form, or at least important parts of that system such as the power supply, the control means and the communication means thereof.

[0037] In a further embodiment, the monitoring interface comprises at least two control units and at least two communication means which are of redundant form.

[0038] In a further embodiment, the redundancy is effected in such a way that the at least two control units and the at least two communication means are produced from different electronic components.

[0039] In a further embodiment, the redundancy is effected in such a way that the at least two control units and the at least two communication means are produced as different designs.

[0040] In a further embodiment, the redundancy is effected in such a way that the at least two communication means are configured for communication by means of different communication protocols.

[0041] Redundancy in the communication means can be effected by means of one or more back-up systems

to ensure that communication can still take place in the event of a disruption or interruption of the primary communication system. The back-up systems can relate to various parts or details, or to the entire system, but more preferably to the communication module and/or the control unit and/or the power supply for the interface. Instead of back-up systems, the interface may also be configured for alternative communication channels such as other protocols, other network topologies or network channels, such as a combination of data and speech, long distance and short distance, point-to-point and mesh, different forms of encryption, etc. This contributes to communication being able to be continued even if the primary channel fails.

[0042] The interface may also be configured for the use of multiple and/or different communication paths. This means that redundancy can be incorporated in communication systems by using multiple communication paths such as one or more fibre optic cables and/or one or more wireless networks.

[0043] In a further embodiment, the monitoring interface is received in a housing of a train protection system of the rail track.

[0044] In a further embodiment, the monitoring interface is implemented as a software-based monitoring interface for software-based provision of an interface with a part of the train protection system.

[0045] In a further embodiment, the system comprises a cluster of a multiplicity of monitoring interfaces received in different local housings of the railway safety system, and wherein the central processing unit is configured to transmit all the current states of all the established sections or routes to the central processing unit and to there visualize the one or more work zones that are comprised from a compilation of all the established sections or routes, from the different local housings of the railway safety system.

[0046] In a further embodiment, at least the monitoring interface is received in a relay house of the railway safety system of the rail track.

[0047] In a further embodiment, the monitoring interface is configured to be connected to one or more relays, and/or PLCs, and/or RBCs, and/or ASKs of the railway safety system.

[0048] The interface may be configured to be physically coupled as an interface with one of the railway safety systems. This means that it is embodied as a physical interface which can be releasably connected to one of these systems, including a relay, PLC or RBC or ASK.

[0049] The interface may also form an integral part of one of these systems, as a result of which the interface is no longer releasably connected but permanently connected to one of the systems.

[0050] However, the interface may also be embodied as a software-based interface, which means that it relates to a computer program product which can be implemented within one or more of the software environments within the railway safety system.

[0051] A second aspect provides a monitoring interface for a monitoring system according to the first aspect and/or a further embodiment thereof.

[0052] The invention will now be discussed in more detail on the basis of a figure. In the figure:

Figure 1 shows a schematic depiction of a monitoring system according to one example of an embodiment according to the invention.

[0053] For better understanding of the invention, corresponding components will be denoted by the same reference numerals in the following description of the figure.

[0054] Figure 1 shows a monitoring system for monitoring one or more work zones (10, 10', 10'') within a rail track, wherein the rail track is managed by at least one railway safety system (101, 101', 101'') such as an interlocking and by a rail traffic control system (100).

[0055] The rail traffic control means are housed in a local, regional but preferably central control centre. The rail traffic control means implements the schedule according to plan as much as possible, i.e. according to the schedule. In practice, a lot of disruptions occur and it is the task of the track traffic control means to compensate for these disruptions. This may concern the changing of the order of trains if a train is delayed, or the bypassing of a track that is out of service due to unforeseen circumstances. This also includes the last-minute running of additional trains if there is a sudden demand for transport.

[0056] Recurring disruptions can indicate that a schedule is not satisfactory, resulting in trains regularly getting in each other's way. In order to compensate for disruptions in the schedule, it may also be the case that additional infrastructure is required, such as an additional track or additional switches.

[0057] The schedule, once prepared and possibly adapted and supplemented, is subsequently implemented by virtue of the one or more sections accordingly being set in the systems of the rail traffic control means or the route being established.

[0058] When establishing one or more sections or routes, a part of a track is assigned to a certain train. This train is the only train that can make use of this assignment. The interlocking, or more generally railway safety systems, protect these routes, ensuring that no other trains are routed to a track that has already been assigned to another train. Another function of the establishing of sections or routes is signalling. If a route or section has been established and protected, the train driver must be aware that they can travel along the route or section, where the latter has been established and before which point they must thus stop, and how fast they can travel along it. They must have a travel authorization. In the case of fully automated train systems, this information must be sent to the equipment of the automatic train management means.

[0059] Since the trains, whether automatically or not, should not or even cannot enter the routes or sections in accordance with these signals, this makes it possible to create a safe work zone for track workers. This safe work

zone, for which a track occupancy notification is established in the railway safety system, thus ensures that trains are prohibited from entering the established route or sections.

[0060] The track occupancy notification may be initiated by the track workers, by locally producing a short-circuit between two rails. This results in a track occupancy notification. After all, the railway safety means think that a train is present. The signals subsequently turn to red, which information can also be displayed in the systems of the in-cab signalling. However, if a short-circuit is generated and thus a train is simulated within the railway safety means, this is referred to as a disruption and not as a planned established route.

[0061] With a disruption caused in this way, the safety of the track workers in the work zone is regulated. However, if these are signalled from the systems of the rail traffic control means, they do not meet the desired SIL safety level that the railway safety systems meet, namely at least SIL3 but preferably SIL4.

[0062] In order to bring the whole chain to a higher safety level, and to enable the chain to meet SIL3 or SIL4, all the components of the chain have to meet at least SIL3 or SIL4. This is possible with the monitoring interface according to the present invention. Since it meets and is certified according to SIL3 or more preferably SIL4, and it directly forms an interface with the railway safety means, in order to provide a separate communication channel outside the rail traffic control means, whereby the status or current state of the established route or sections can be read with a high degree of operational reliability (wherein the established route or sections can thus relate to a route or section of established origin according to a schedule to be implemented, or a disruption corresponding to a simulation of the presence of a train within the local railway safety means).

[0063] This is shown in Figure 1. Various locations 1, 1', 1'' are shown. These locations can comprise one or more work zones 10, 10', 10''. One or more work zones that belong and are connected to the same local safety systems 101, 101', 101'' may be concerned. However, a cluster of work zones that belong to different railway safety systems 101, 101', 101'' may also be concerned. As indicated above, in the context of the present application the railway safety systems are understood to mean all kinds of railway safety systems, including, but not limited to, conventional mechanical route protection, route protection on the basis of relays, but especially electronic route protection on the basis of microprocessors, PLCs or cloud-based interlocking, ixl. In this context, the monitoring interface may relate to an entirely or partially physical interface unit that is physically electronically coupled to one or more railway safety systems. However, the monitoring interface may also relate to an entirely or partially software-based implementation, wherein the interface is functionally coupled to one or more railway safety systems on site or in a cloud environment.

[0064] A schedule is implemented centrally from the

rail traffic control means 100 and routes or sections are accordingly established locally 1, 1', 1" according to this schedule. The signaller 150b monitors this and can intervene in it.

[0065] However, the routes or sections can only be established if the local railway safety system 101, 101', 101" allows it because the relevant lane is clear.

[0066] Each of the railway safety systems 101, 101', 101" can be equipped with a monitoring interface 15, 15', 15", which monitoring interface is configured to provide an interface with the railway safety system 101, 101', 101".

[0067] The monitoring interface 15, 15', 15" ensures that the data from the railway safety system 101, 101', 101" is made accessible, and in particular makes a current state of the established route, being a planned established route or a disruption, accessible to a central processing unit 150. By means of the central processing unit 150, the information 150a can be made accessible to one or more external parties 150a, but preferably also to the rail traffic control system 100, such that the signaller 150b can read it there with a higher degree of operational reliability.

Claims

1. Monitoring system for monitoring one or more work zones within a rail track, wherein the rail track is managed by at least one railway safety system such as an interlocking and by a rail traffic control system,

wherein the rail traffic control system is configured to establish one or more sections within the rail track according to a schedule;
wherein the railway safety system is communicatively connected to the rail traffic control system and is configured to receive the established one or more sections and to accordingly establish a track occupancy notification in the railway safety system which prohibits trains from travelling along the established one or more sections, wherein the monitoring system comprises:

a central processing unit which is situated remotely from the one or more work zones;
and
at least one monitoring interface, which monitoring interface is configured to provide an interface with the railway safety system,
and
wherein the monitoring interface further comprises communication means for transmitting a current state of the established one or more sections to the central processing unit.

2. Monitoring system for monitoring one or more work

zones within a rail track according to Claim 1, wherein the established one or more sections comprises one of the one or more work zones within the rail track, and the track occupancy notification for at least the one or more work zones relates to a disruption notification or a route obstruction, or obstruction of one or more sections, for the transmission of a current state of the established one or more sections at least comprising the disruption notification or obstruction of a route or of one or more sections to the central processing unit by the monitoring interface by means of the communication means.

3. Monitoring system for monitoring one or more work zones within a rail track according to Claim 2, wherein the established one or more sections which result in a track occupancy notification which relates to a disruption notification or obstruction of a route or of one or more sections are established by a taking-out-of-service interface for taking the one or more work zones within a rail track out of service directly in the railway safety system.
4. Monitoring system for monitoring one or more work zones within a rail track according to Claim 2, wherein the established one or more sections which result in a track occupancy notification are established from the rail traffic control system according to the schedule.
5. Monitoring system for monitoring one or more work zones within a rail track according to one or more of the preceding claims, wherein the monitoring interface is certified according to safety integrity level 3 or higher, and in particular safety integrity level 4 or higher.
6. Monitoring system for monitoring one or more work zones within a rail track according to one or more of the preceding claims, wherein the monitoring interface comprises at least two control units and at least two communication means which are of redundant form.
7. Monitoring system for monitoring one or more work zones within a rail track according to Claim 6, wherein the redundancy is effected in such a way that the at least two control units and the at least two communication means are produced from different electronic components.
8. Monitoring system for monitoring one or more work zones within a rail track according to Claim 6 or 7, wherein the redundancy is effected in such a way that the at least two control units and the at least two communication means are produced as different designs.

9. Monitoring system for monitoring one or more work zones within a rail track according to Claim 6, wherein the redundancy is effected in such a way that the at least two communication means are configured for communication by means of different communication protocols. 5

10. Monitoring system for monitoring one or more work zones within a rail track according to one of the preceding claims, wherein the monitoring interface is received in a housing of a train protection system of the rail track. 10

11. Monitoring system for monitoring one or more work zones within a rail track according to one of the preceding claims, wherein the monitoring interface is implemented as a software-based monitoring interface for software-based provision of an interface with a part of the train protection system. 15
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12. Monitoring system for monitoring one or more work zones within a rail track according to one of the preceding claims, wherein the system comprises a cluster of a multiplicity of monitoring interfaces received in different local housings of the railway safety system, and wherein the central processing unit is configured to transmit all the current states of all the established one or more sections to the central processing unit and to there visualize the one or more work zones that are comprised from a compilation of all the established one or more sections, from the different local housings of the railway safety system. 25
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13. Monitoring system for monitoring one or more work zones within a rail track according to one of the preceding claims, wherein at least the monitoring interface is received in a relay house of the railway safety system of the rail track. 35

14. Monitoring system for monitoring one or more work zones within a rail track according to one of the preceding claims, wherein the monitoring interface is configured to be connected to one or more relays, and/or PLCs, and/or RBCs, and/or ASKs of the railway safety system. 40
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15. Monitoring interface for a monitoring system according to one of the preceding claims. 50
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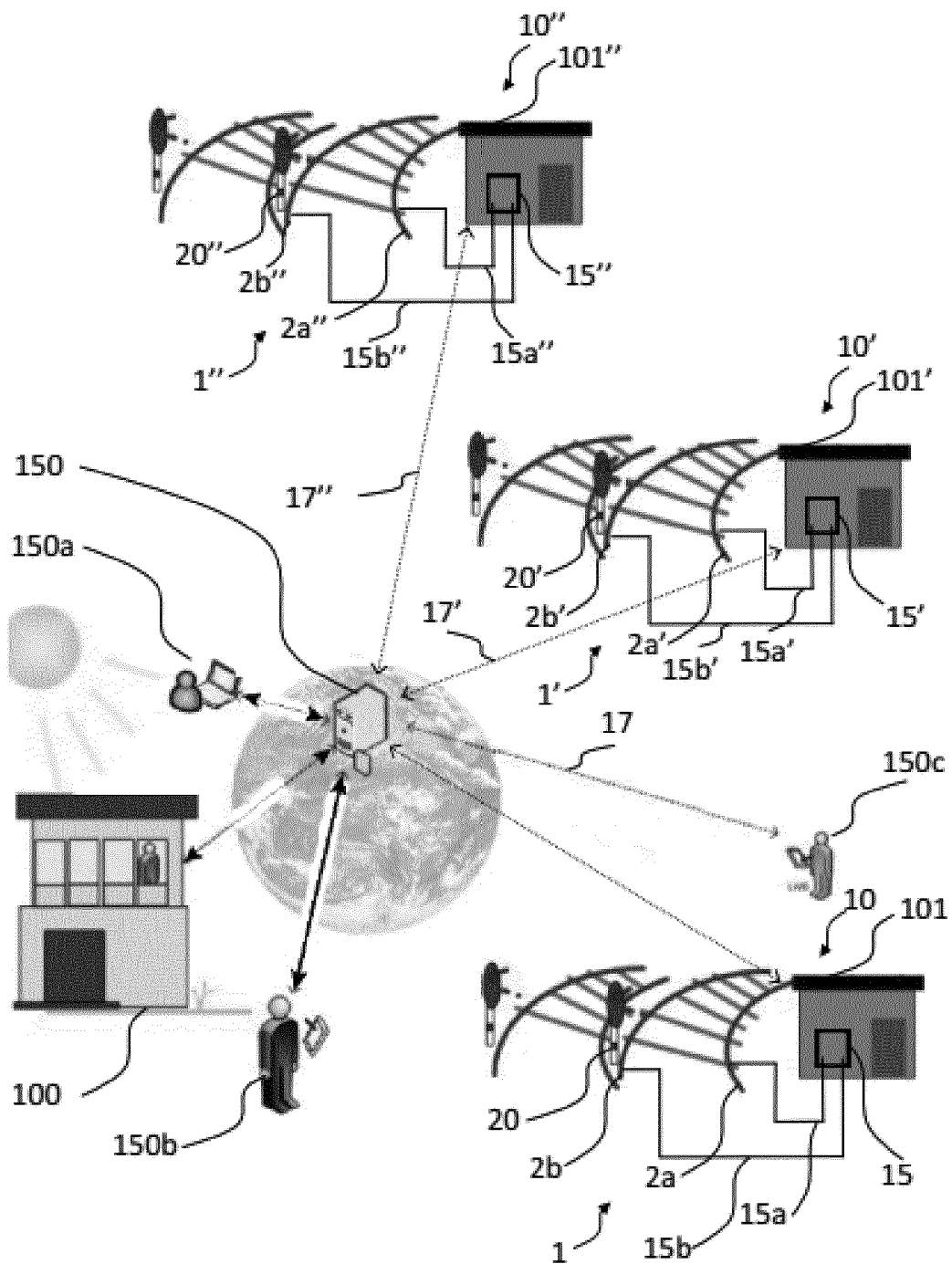


Fig. 1



EUROPEAN SEARCH REPORT

Application Number

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Place of search Munich		Date of completion of the search 15 May 2024	Examiner Pita Priegue, Miguel
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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