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(54) INTEGRATED VEHICLE UNIT FOR TOLLING OPERATIONS

(57) A vehicle unit (10), the vehicle unit (10) is communicatively connected to a network entity (20), the vehicle unit (10) comprises a recording module (12), a communication module (14), a vehicle positioning module (16), and a tolling module (18), the recording module (12) is operative for recording vehicle information data, the tolling module (18) is operative for receiving an authenticated Global Navigation Satellite Systems, GNSS, position signal of the vehicle from the vehicle positioning module (16), and performing at least one vehicle tolling operation comprising recording of tolling event data, wherein the recording module (12), the tolling module (18), the communication module (14) and the vehicle positioning module (16) are integrated on a same hardware (30), wherein the communication module (14) is operative for transmitting the recorded vehicle information data, tolling event data and/or vehicle position information data to the network entity (20).

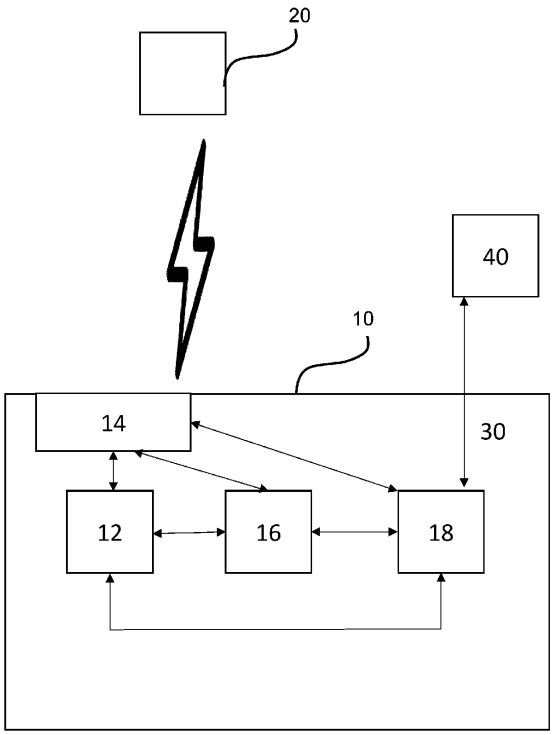

Fig. 2

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Description

Technical Field

[0001] The present disclosure relates generally to integrated vehicle units.

Background

[0002] Today, transportation by vehicle requires measurement of parameters and information relating to the driver activities. This is not exclusively done to satisfy regulations regarding road transportation, but also for fleet management to measure and increase performance and efficiency, as well as for the purpose of electronic road tolling, monitoring vehicle or engine performance parameters, monitoring data relevant for special transports e.g. dangerous goods, livestock or refrigerated food etc. Therefore, most vehicles, such as lorry trucks, carry a vehicle unit to measure, store and possible also report the collected data. In this document, the term "vehicle unit" shall mean a digital unit capable of gathering information relating to the vehicle. Examples of such information may be a geographical location, driving hours, distance travelled, start time, finish time, rest time, driver name, starting location and finishing location, exhaust measurements, fuel consumption, temperature data from vehicle or cargo sensors, opening and closing of cargo doors or operation of other vehicle systems, e.g. cranes and lifts etc. Such information, in this document also known as vehicle related information data, or vehicle information data, or vehicle information, can further be driving video, driver identity, speed information, position information, time information, environment information, etc. One example of a vehicle unit is a digital tachograph, capable of recording and digitally compiling and storing the vehicle data including driving times and rest periods as well as periods of other work and availability taken by the driver of a heavy vehicle. Under EU legislation it is currently mandatory to install digital tachographs in vehicles having a mass of more than 3,5 tons. In USA, similar rules exists, relating to an Electronic Logging Device (ELD) with the purpose of recording the driver's duty and vehicle speed in order to ensure the driver is compliant with the driving hours' legislation or the working time directive or similar legislation stipulated by authorities.

[0003] The vehicle unit is normally located in the cabin of the vehicle, where the vehicle unit is arranged in the instrument board, so that the vehicle operator may operate the vehicle unit in adjacency to start or stop of a journey. In order to calculate and estimate the speed and the travel distance, or other parameters for instance as listed above, of the vehicle, the vehicle unit is connected to one or more sensors, where the sensors are capable of measuring, for instance, the motion of the wheels or other parameters. For this purpose, a motion sensor is attached to the gearbox of the vehicle to receive pulses, i.e. speed and movement information, which is sent to the tachograph.

[0004] It is known to use onboard vehicle units (OBU's) for electronic tolling purposes, i.e. as equipment to access tolled infrastructures and enable the registration of use of the related infrastructures and networks in e.g. the EU. Bulky external units and hardware, OBU's, are assembled in the vehicle to enable tolling operations. Such OBU's require external power, often connected to power outlet/cigarette lighter. This requires constant monitoring by the driver to ensure functional status of the OBU. As such, the OBU can obstruct the view of the driver and it need to be maintained/refurbished by a TSP (Tolling Service Provider). Thus, there are safety and cost related drawbacks of these known solutions.

[0005] European Electronic Toll Service (EETS) tolling with OBU's uses GNSS positioning to establish position and DSRC gantry logging to establish passing a tolling gate, provided by further separate hardware equipment in the vehicle.

[0006] Although it has been proposed to use e.g. tachographs for tolling services, these solutions, just like the EETS tolling OBU's, require additional hardware including separate DSRC units, plug-in communication units or GNSS units with unauthenticated GNSS data. Such solutions are thus afflicted with similar drawbacks as outlined above. General challenges in enabling separate units to work seamlessly and without delay further adds to safety, reliability/confidence and cost related drawbacks.

Summary

[0007] It is an object of the invention to address at least some of the problems and issues outlined above. It is an object of embodiments of the invention to provide a vehicle unit that is operative for performing tolling operation that is safer, and more reliable to use. It is another object of embodiments of the invention to provide a vehicle unit that is operative for performing tolling operation that reduces costs related to manufacturing, installment and maintenance. It is possible to achieve one or more of these objects and possibly others by using vehicle units as defined in the attached independent claims.

[0008] In a first aspect of the disclosure there is provided a vehicle unit, the vehicle unit is communicatively connected to a network entity, the vehicle unit comprises a recording module, a communication module, a vehicle positioning module, and a tolling module, the recording module is operative for recording vehicle information data, the tolling module is operative for receiving an authenticated Global Navigation Satellite Systems, GNSS, position signal of the vehicle from the vehicle positioning module, and performing at least one vehicle tolling operation comprising recording of tolling event data, wherein the recording module, the tolling module, the communication module and the vehicle positioning module are integrated on a same hardware, wherein the

communication module is operative for transmitting the recorded vehicle information data, tolling event data and/or vehicle position information data to the network entity.

[0009] According to another embodiment, the vehicle unit is a tachograph.

[0010] According to another embodiment, wherein the tolling module is further operative for secure data handling when performing the vehicle tolling operation.

[0011] According to another embodiment, the tolling module is operative for communicating with an external vehicle-mounted module via Dedicated short-range communication, DSRC.

[0012] According to another embodiment, wherein the same hardware is the same printed circuit board, PCB.

[0013] According to another embodiment, wherein the tolling module is operative for signing and/or encrypting of the recorded tolling event data, wherein the communication module is operative for transmitting the signed and/or encrypted tolling event data.

[0014] According to another embodiment, wherein the recording module is operative for signing and/or encrypting of the recorded vehicle information data, wherein the communication module is operative for transmitting the signed and/or encrypted vehicle information data.

[0015] According to another embodiment, wherein the recording module is calibrated by the tolling event data recorded by the tolling module.

[0016] According to another embodiment, wherein the tolling module is calibrated by the vehicle information data recorded by the recording module.

[0017] In a second aspect of the disclosure there is provided a vehicle comprises the vehicle unit according to any one of the preceding embodiments.

Brief Description of Drawings

[0018] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1a and 1b schematically show a vehicle and a vehicle unit, according to possible embodiments.

Fig. 2 schematically shows function modules of the vehicle unit.

Detailed Description

[0019] Referring to fig. 1a and 1b, a vehicle 500 can be equipped with a vehicle unit 10. The vehicle 500 can be any kind of vehicle, e.g., car, truck, bus, etc. The vehicle unit 10 can be a tachograph and operative for recording vehicle information data and other related operations.

[0020] Referring to fig. 2, the vehicle unit 10 is communicatively connected to a network entity 20, the vehicle unit 10 comprises a recording module 12, a communication module 14, a vehicle positioning module 16, and a tolling module 18, the recording module 12 is operative for recording vehicle information data, the tolling module 18 is operative for receiving an authenticated Global Navigation Satellite Systems, GNSS, position signal of the vehicle from the vehicle positioning module 16, and performing vehicle tolling operation comprising recording of tolling event data, wherein the recording module 12, the tolling module 18, the communication module 14 and the vehicle position module 16 are integrated on a same hardware 30, wherein the communication module 14 is operative for transmitting the recorded vehicle information data, tolling event data and/or vehicle position information data to the network entity 20.

[0021] The vehicle unit 10 comprises four different modules: the recording module 12, the communication module 14, the vehicle position module 16 and the tolling module 18.

[0022] The recording module 12 is operative for recording vehicle information data, e.g., driving activities, driving video, driver identity, speed information, position information, time information, environment information, etc. The driving activities, driving video and/or driver identity can be obtained by a camera. The speed information can be obtained by all kinds of speed sensors on the vehicle. The position information can be obtained from the vehicle position module 16. The time information can be obtained from vehicle time system or time signal from external system. The environment information can be obtained from environment sensors.

[0023] The communication module 14 is communicatively connected to a network entity 20 and works as a communication interface for the vehicle unit 10. The communication module 14 can be e.g., a physical connector, such as Universal Serial Bus (USB), Ethernet, High-Definition Multimedia Interface (HDMI), or wireless technologies like Wi-Fi, Bluetooth, or Near Field Communication (NFC). The communication module 14 can also encompass higher-level protocols and software interfaces that govern how data is structured, encoded, and transmitted. Examples of such protocols include network protocols like Transmission Control Protocol/Internet Protocol (TCP/IP), messaging protocols like Message Queuing Telemetry Transport (MQTT), or web protocols like Hypertext Transfer Protocol (HTTP). The network entity 20 may be a network device of any kind of wireless communication network. Example of such wireless communication networks are Global System for Mobile communication (GSM), Enhanced Data Rates for GSM Evolution (EDGE), Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access 2000 (CDMA 2000), Long Term Evolution (LTE) Frequency Division Duplex (FDD) and Time Division Duplex (TDD), LTE Advanced, Wireless Local Area Networks (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), WiMAX Advanced, as well as 5G wireless communication networks based on technology such as New Radio (NR), or even 6G. The network entity 20 may also be a network device of any kind of wired

communication network. For example, the network entity 20 can be a user equipment (UE), or a network server, or a cloud device.

[0024] The communication module 14 is operative for transmitting the data from the vehicle unit 10 to the network entity 20. The data from the vehicle unit 10 can be the recorded vehicle information data from the recording module 12, tolling event data from the tolling module 18, and/or vehicle position information data from the vehicle positioning module 16. By transmitting the data to the network entity 20, the data has a backup in the network entity 20. There is also possible to access the data via the network entity 20.

[0025] The vehicle positioning module 16 is operative for receiving an authenticated Global Navigation Satellite System (GNSS) position signal from a GNSS system. Then the vehicle positioning module 16 can provide the authenticated GNSS position signal to the tolling module 18, the recording module 12 and/or the communication module 14.

[0026] The tolling module 18 is operative for performing at least one tolling related operation, e.g., recording tolling event data, receiving/sending tolling related information, making payment, etc. Since tolling is performed in a specific position, e.g., a specific road, bridge, tunnel, or other transportation infrastructure, the vehicle position is critical for tolling, so that the tolling module 18 receives the authenticated GNSS position signal from the vehicle positioning module 16. The tolling module 18 is also operative for sending the recorded tolling event data to the communication module 14, so that the communication module 14 can transmit the recorded tolling event data to the network entity 20.

[0027] The recording module 12, the communication module 14, the vehicle positioning module 16 and the tolling module 18 are integrated on the same hardware 30.

[0028] By this embodiment, the recording function, the positioning function, the tolling function and the communication function are integrated in one vehicle unit. Data can be shared by modules within the vehicle unit 10. The size of the vehicle unit 10, and the related hardware, can be decreased, and the driver's view will not be blocked. Furthermore, an authenticated GNSS position signal is used by the tolling module 18, so that tolling operation can be performed more accurately and with a high level or authentication and reliability/confidence.

[0029] According to another embodiment, the vehicle unit 10 is a tachograph.

[0030] According to another embodiment, the tolling module 18 is further operative for secure data handling when performing the vehicle tolling operation. This can be implemented by a secure microprocessor or secure module, preferably in a Secure Access Module, or Secure Application Module, (SAM), in the vehicle unit (10). According to one embodiment the SAM further comprises a secure database. In the context of the present invention, the term "secure microcontroller" should be understood as a certified microcontroller for high security applications, for example certified towards Common Criteria EAL4 and/or ITSEC E3 HIGH. A secure microcontroller is used when demands on protection of data are high. It decreases risk for manipulation of data which therefore could be seen as trusted. According to one embodiment, the SAM and/or secure microcontroller is comprised in the vehicle positioning module or the tolling module 18. According to one embodiment, the SAM and/or secure microcontroller is implemented in the vehicle positioning module or the tolling module 18 or the recording module (12).. According to one embodiment, the SAM is arranged on the hardware 30.

[0031] By this embodiment, the tolling related data is handled in a secure way in the tolling module 18, so that the safety of the tolling operation can be improved.

[0032] According to another embodiment, tolling module 18 is operative for communicating with an external vehicle-mounted module 40 via Dedicated short-range communication, DSRC.

[0033] Referring to fig. 2, the tolling module 18 is operative for communicating with an external vehicle-mounted module 40 via DSRC. The external vehicle-mounted module 40 can be e.g., a communication module, so that the tolling module 18 can communicate with external tolling system via the external vehicle-mounted module 40.

[0034] According to another embodiment, the same hardware 30 is the same printed circuit board, PCB.

[0035] By this embodiment, the modules of the vehicle unit 10 are integrated on the same PCB, so that the vehicle unit 10 comprises one PCB with integrated functions. An advantage of this is that it enables the functions to work seamlessly and without delay which provides safety, reliability/confidence and reduces costs. Furthermore, the overall size of the vehicle unit 10 is significantly reduced.

[0036] According to another embodiment, the tolling module 18 is operative for signing and/or encrypting of the recorded tolling event data, wherein the communication module 14 is operative for transmitting the signed and/or encrypted tolling event data.

[0037] By this embodiment, the tolling module 18 can sign/encrypt the recorded tolling event data, and the communication module 14 transmits the signed/encrypted tolling event data, so that the tolling event data is difficult to be tampered with. An advantage of this is that it further increases the authenticity and reliability of the tolling event data. Reliability of the data and confidence in its correctness is for instance beneficial for tolling chargers as well as vehicle owners for ensuring that the correct fees based on accessed network are payable.

[0038] According to another embodiment, the recording module 12 is operative for signing and/or encrypting of the recorded vehicle information data, wherein the communication module 14 is operative for transmitting the signed and/or encrypted vehicle information data.

[0039] By this embodiment, the recording module 12

can sign/encrypt the recorded vehicle information data, and the communication module 14 transmits the signed/encrypted vehicle information data, so that the vehicle information data is difficult to be tampered with.

[0040] According to another embodiment, the recording module 12 is calibrated by the tolling event data recorded by the tolling module 18.

[0041] For example, when the tolling module 18 records that two adjacent tolling events having a 95km distance in between, but the recording module 12 records that the two adjacent tolling events having a 97km distance in between, the recording module 12 is calibrated based on the tolling event data of the tolling module 18, and the distance is calibrated to 95km. Since the tolling module 18 utilizes the authenticated GNSS position signal from the vehicle positioning module 16, the tolling event data is more accurate and is used to calibrate the recording module 12.

[0042] According to another embodiment, the tolling module 18 is calibrated by the vehicle information data recorded by the recording module 12.

[0043] For example, the vehicle information data recorded by the recording module 12 may comprise speed data obtained by speed sensor on the vehicle. Based on the speed data and time data, an accurate distance can be obtained. In such a situation, the vehicle information data can be used to calibrate the tolling module 18.

[0044] According to one embodiment, the herein described invention a fully integrated vehicle unit for performing tolling operations is provided which limits the amount of additional separate hardware needed.

[0045] According to another embodiment, a vehicle 500 is provided. The vehicle 500 comprises the vehicle unit 10 according to any one of the preceding embodiments.

[0046] Although the description above contains a plurality of specificities, these should not be construed as limiting the scope of the concept described herein but as merely providing illustrations of some exemplifying embodiments of the described concept. It will be appreciated that the scope of the presently described concept fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the presently described concept is accordingly not to be limited. Reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." Further, the term "a number of", such as in "a number of wireless devices" signifies one or more devices. All structural and functional equivalents to the elements of the above-described embodiments that are known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed hereby. Moreover, it is not necessary for an apparatus or method to address each and every problem sought to be solved by the presently described concept, for it to be encompassed hereby. In the exemplary figures, a broken line generally signifies that the feature within the broken line is optional.

Claims

1. A vehicle unit (10), the vehicle unit (10) is communicatively connected to a network entity (20), the vehicle unit (10) comprises a recording module (12), a communication module (14), a vehicle positioning module (16), and a tolling module (18), the recording module (12) is operative for recording vehicle information data, the tolling module (18) is operative for receiving an authenticated Global Navigation Satellite Systems, GNSS, position signal of the vehicle from the vehicle positioning module (16), and performing at least one vehicle tolling operation comprising recording of tolling event data, wherein the recording module (12), the tolling module (18), the communication module (14) and the vehicle positioning module (16) are integrated on a same hardware (30), wherein the communication module (14) is operative for transmitting the recorded vehicle information data, tolling event data and/or vehicle position information data to the network entity (20).

2. The vehicle unit (10) according to claim 1, the vehicle unit (10) is a tachograph.

3. The vehicle unit (10) according to claim 1 or 2, wherein the tolling module (18) is further operative for secure data handling when performing the vehicle tolling operation.

4. The vehicle unit (10) according to any one of the preceding claims, the tolling module (18) is operative for communicating with an external vehicle-mounted module (40) via Dedicated short-range communication, DSRC.

5. The vehicle unit (10) according to any one of the preceding claims, wherein the same hardware (30) is the same printed circuit board, PCB.

6. The vehicle unit (10) according to any of the preceding claims, wherein the tolling module (18) is operative for signing and/or encrypting of the recorded tolling event data, wherein the communication module (14) is operative for transmitting the signed and/or encrypted tolling event data.

7. The vehicle unit (10) according to any of the preceding claims, wherein the recording module (12) is operative for signing and/or encrypting of the recorded vehicle information data, wherein the communication module (14) is operative for transmitting the signed and/or encrypted vehicle information data.

8. The vehicle unit (10) according to any of the preceding claims, wherein the recording module (12) is calibrated by the tolling event data recorded by the

tolling module (18).

9. The vehicle unit (10) according to any one of the preceding claims, wherein the tolling module (18) is calibrated by the vehicle information data recorded by the recording module (12).

10. A vehicle (500) comprises the vehicle unit (10) according to any one of the preceding claims.

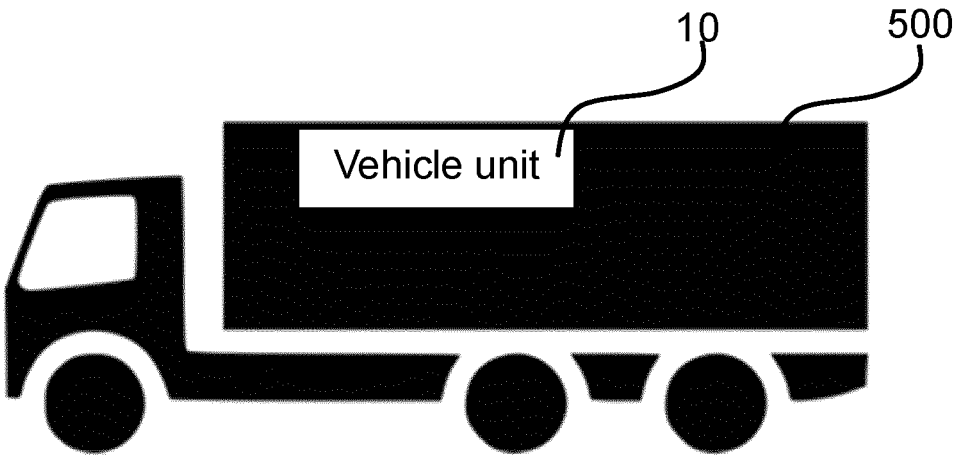

Fig. 1a

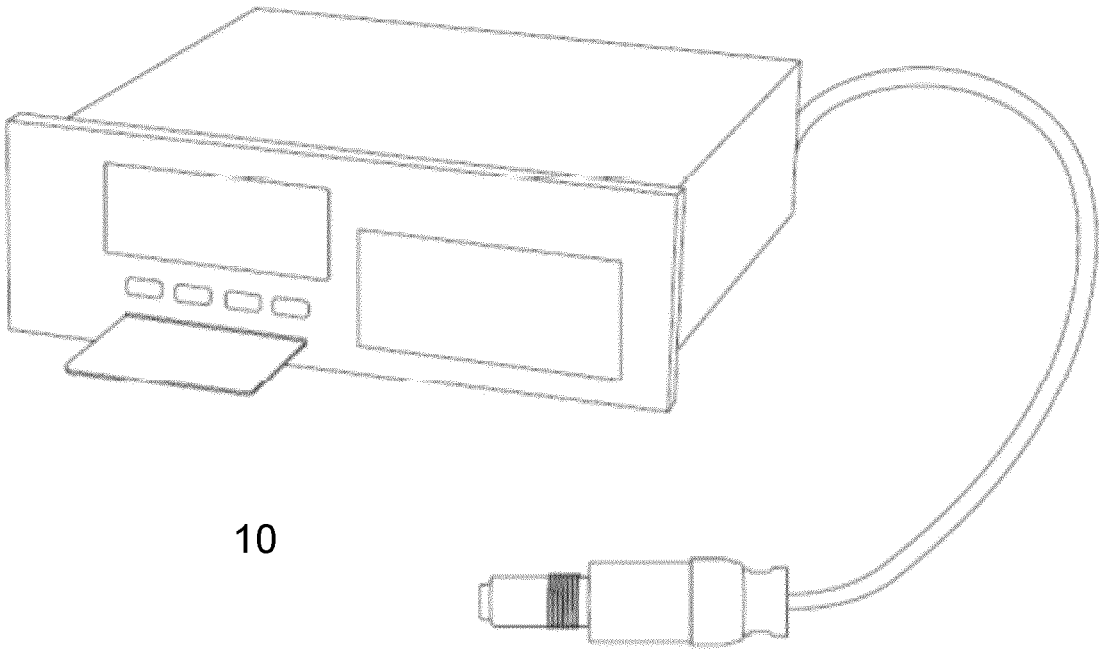

Fig. 1b

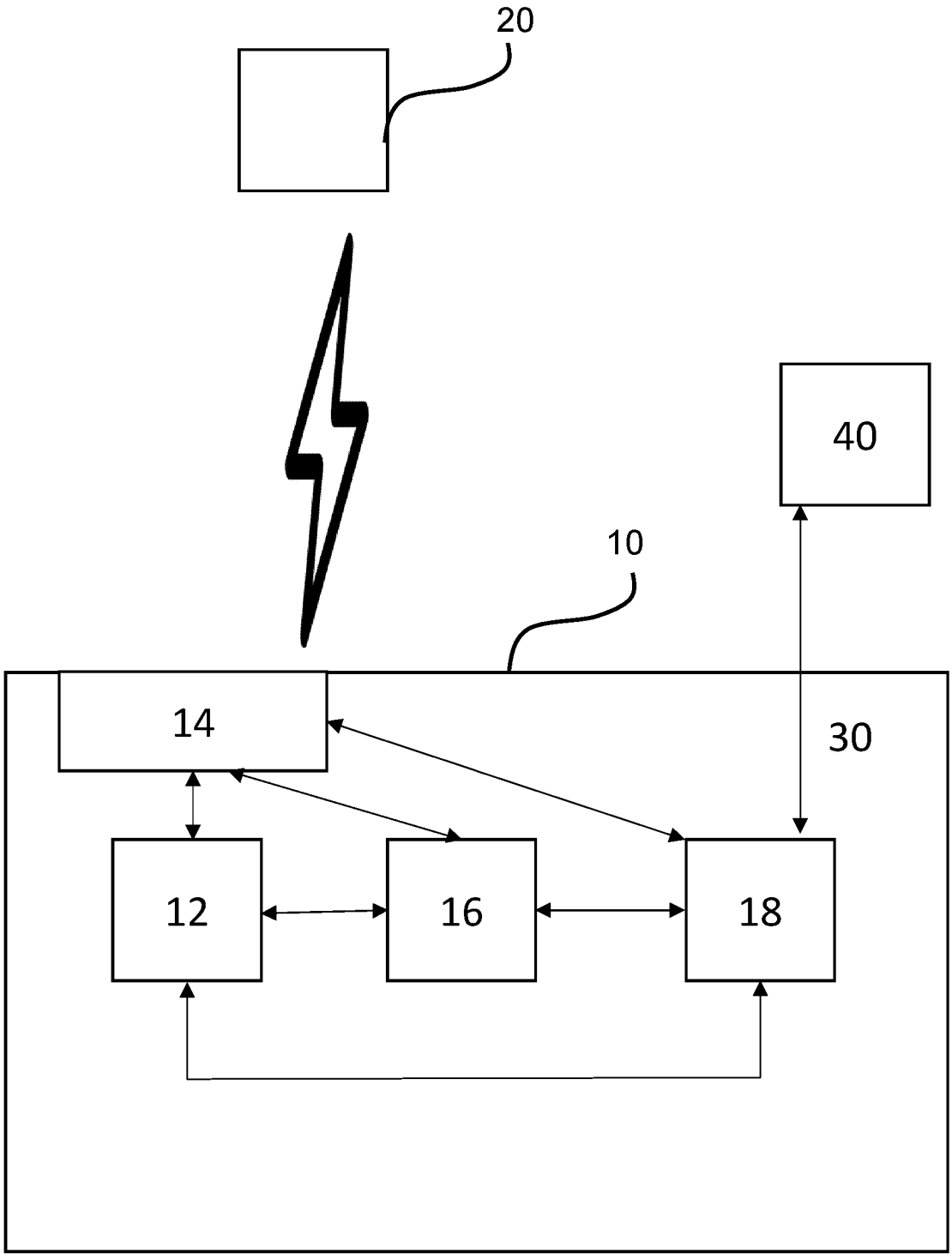

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 6119

DOCUMENTS CONSIDERED TO BE RELEVANT

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TECHNICAL FIELDS SEARCHED (IPC)

G07B
G07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 November 2024	Pfyffer, Gregor

CATEGORY OF CITED DOCUMENTS

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