(54) **Data transmission over packet switched network**

(57)   A method for transmitting measurement data 28a comprise the steps of: receiving measurement data 28a in a first communication module 22a; time stamping the measurement data 28a in the first module with a time tag 34; transmitting the measurement data 28a to a second communication module 22b via a packet switched data network 24; and outputting the transmitted measurement data 30a after a predefined delay time Δt_D after the time stamping of the measurement data 28a.
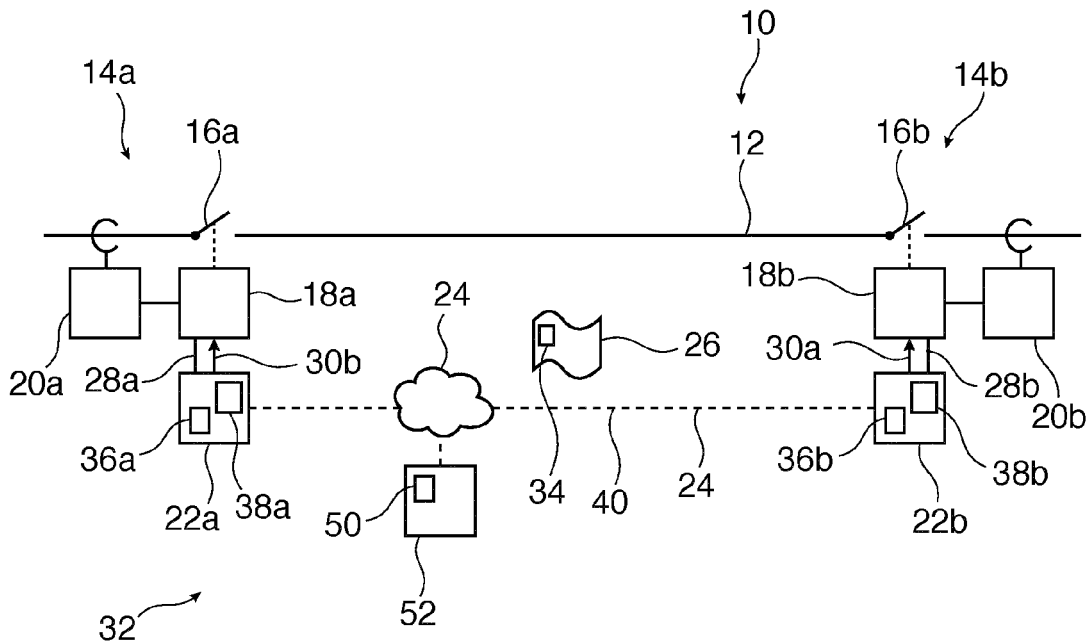
Fig. 1

EP 2 618 502 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of data transmission in electric power systems. In particular, the invention relates to transmission of data over a packet switched data network between time-synchronized communication modules.

BACKGROUND OF THE INVENTION

[0002] In line differential protection, an electrical power line is protected by two line differential protection relays placed at two distant locations or ends of the power line. By comparing phase information of the current in the power line at the different locations, a differential protection relay may detect critical situations on the power line like short circuits and may isolate the power line from the electrical grid before damage to the electrical equipment will result.

[0003] Conventionally, at each of the different locations of the power line a measurement device is located that measures the actual current through the power line. The data of each measurement device may then be sent to the differential protection relay, which compares data from different measurement device, for example to determine a phase shift between the two currents at two different points of the power line. Here, the problem arises that data measured at the same time needs to be compared, and that a protection relay may therefore need to know the time delays caused by the communication link.

[0004] Electric power utilities, in most cases, use circuit switched SDH (Synchronous Digital Hierarchy) or SONET (Synchronous Optical Network) networks for wide area communication of mission critical operational data like teleprotection signalling or SCADA control and supervision data. Alternatively, data communication between distant locations of an electrical utility may rely on packet switched data networks like Ethernet. However, packet switched data networks may have a variable packet latency, or packet delay variation, i.e. the transmission times of packets sent from a first device to a second device may vary over time. Furthermore, the transmission time of a packet sent from a first device to a second device may differ from a transmission time of a packet sent from the second device to a first device. Hence, synchronizing data transmitted over a packet switched network may prove difficult.

DESCRIPTION OF THE INVENTION

[0005] It may be an object of the invention to use packet switched communication networks for transmitting synchronous Time Division Multiplex (TDM) data to a remote line differential protection relay. This object may be achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims and the following description.

[0006] An aspect of the invention relates to a method of transmitting data over a packet switched data network between time-synchronized communication modules.

[0007] According to an embodiment of the invention, the method comprises the steps of: receiving synchronous TDM data in a first, or source, communication module; generating a time stamp at the first module, the time stamp being indicative of a receive time of the synchronous TDM data at the first module, in particular of the receive time of a first bit of a sequence of bits to be subsequently packed into a data packet; transmitting the received quantity of data in a data packet to a second, or destination, communication module via a packet switched data network; and outputting the transmitted data in synchronous form, by the second module, after lapse of a predefined time delay following the receive time of the data at the first module. In short, the method emulates a circuit switched communication link with a predefined and controllable delay between a source and a destination of the synchronous TDM data.

[0008] The time stamp is generated from a first clock of the first communication module that is synchronized to a second clock at the second module. The predefined time delay, or delay time, has a constant value at least for a certain period of time, and may be configured and eventually adapted by an operator or an automated adaptation mechanism. An actual output time at the second module may be determined by the first module, in which case the output time is transmitted to the second module along with the data, or by the second module based on the time stamp transmitted from the first module.

[0009] In a preferred embodiment, the invention is applied to communication of measurement or control or protection data for the benefit of an electric power transmission system or the operating utility, respectively. In particular, for the purpose of line differential protection, the second module is connected to a differential line protection relay to which the output data is provided. Standard line differential protection relays are designed for receiving a synchronous TDM data stream with constant time delay, and thus need not be replaced when used in conjunction with a communication link to a remote line differential protection relay which is established via packet switched network hardware according to the invention.

[0010] In a preferred embodiment, a transmission time is calculated at the second module based on a difference between the time stamp and a clock time of a second clock of the second communication module that is indicative of a packet receive time at the second module. After waiting for a wait time based on the difference between the transmission time and a predefined delay time, the second communication module may output the transmitted data. The act of waiting or delaying the output may be achieved by writing, at the second module, the transmitted data to an appropriate position of a jitter output buffer.

[0011] Further aspects of the invention relate to a com-

puter program for transmitting data over a packet switched data network, which, when being executed by a processor or FPGA, is adapted to carry out steps of the method as described in the above and in the following, and to a computer-readable medium, in which such a computer program is stored.

[0012] A computer-readable medium may be a floppy disk, a hard disk, an USB (Universal Serial Bus) storage device, a RAM (Random Access Memory), a ROM (Read Only memory), an EPROM (Erasable Programmable Read Only Memory) and a FLASH memory. A computer readable medium may also be a data communication network, e.g. the Internet, which allows downloading a program code.

[0013] A further aspect of the invention relates to a destination, or second, communication module, for example, a communication module connected to a protection relay of an electric power system. The communication module may be part of the protection relay or may be a separate device communicatively connected to the protection relay.

[0014] According to an embodiment of the invention, the destination communication module is adapted for executing the method as described in the above and in the following. For example, the destination communication module may be adapted for receiving transmitted data from a source, or first, communication module via the packet switched data network. The communication module may be configured to output the transmitted data following expiry of a predefined time delay after a time stamping of the data in the source communication module.

[0015] A further aspect of the invention relates to a communication system for an electrical power system, which comprises at least two such communication modules that are interconnected by a packet switched data network.

[0016] According to an embodiment of the invention, the communication system is adapted for executing the method as described in the above and in the following. Such a communication system may be adapted for providing synchronous TDM data with a predefined delay time to a remote protection relay.

[0017] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The subject matter of the invention will be explained in more detail in the following text with reference to exemplary embodiments which are illustrated in the attached drawings.

Fig.1 schematically shows an electrical power system according to an embodiment of the invention.

Fig. 2 shows a diagram with time delays according

to an embodiment of the invention.

Fig. 3 shows a flow diagram for a method of transmitting data according to an embodiment of the invention.

Fig. 4 shows a flow diagram for a method of synchronizing communication modules according to an embodiment of the invention.

[0019] In principle, identical parts are provided with the same reference symbols in the figures.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0020] Fig.1 shows an electrical power system 10 with a power line 12. In the power line 12, two protection relays 18a, 18b are situated at remote locations or substations 14a, 14b. It may be possible that the two protection relays 18a, 18b are more than ten or even more than a hundred kilometres distant from each other.

[0021] Each protection relay 18a, 18b controls a switch 16a, 16b for interrupting the power line 12. For example, the power line 12 may be disconnected from a power grid with one of the switches 16a, 16b.

[0022] Furthermore, each protection relay 18a, 18b is connected to a measurement module 20a, 20b for measuring a current in the power line 12 and a communication module 22a, 22b for data communication with further equipment of the electric power system 10.

[0023] The two protection relays 18a, 18b are interconnected for data communication via a packet switched data network 24, which, for example, may be an Ethernet, or IP, or MPLS network. In particular, the communication modules 22a, 22b may exchange data packets 26 with each other.

[0024] For example, the measurement module 20a may generate measurement data, which is provided to protection relay 18a for processing, and subsequently received as synchronous TDM measurement data 28a in the first communication module 22a and stored in a data packet 26. The first communication module 22a may transmit the data packet 26 via the data network 24 to the second communication module 22b, which extracts the transmitted synchronous TDM measurement data 30a from the data packet 26 and outputs the data to the protection relay 18b.

[0025] The protection relay 18b may be adapted for receiving measurement data from the measurement module 20b and may compare the transmitted measurement data 30a with the former data for retrieving phase difference information between the measured currents at the two locations of the measurement modules 20a, 20b.

[0026] It has to be noted that the protection relays 18a, 18b may be equally designed and that the data exchange and the processing of the data may be completely sym-

metric. For example, synchronous TDM data 28b from the protection relay 18b may be transmitted to the protection relay 18a and may be output as transmitted synchronous TDM data 30b.

[0027] Since the transmission of the data packet 26 via the data network 24 needs time, the transmitted measurement data 30a is delayed with respect to measurement data that has been measured by the measurement module 20b at the same time as the measurement module 20a has measured the measurement data 28a.

[0028] The protection relay 18a, 18b may be configured that it assumes that the transmitted measurement data 30a, 30b has a constant time delay with respect to the local measurement at the measurement module 20a, 20b.

[0029] Since the data network 24 is packet switched, the transmission time of the data packet 26 between the two communication modules 22a, 22b may vary over time and may also be asymmetric with respect to the direction of the transmission. For example, the transmission time of a data packet 26 sent from communication module 22a to the communication module 22b may differ from a transmission time of a data packet 26 sent from the communication module 22b to the communication module 22a. The non-constant transmission times of the data packets 26 may also be called packet delay variation.

[0030] The communication system 32 (comprising the communication modules 22a, 22b and the data network 24) is able to compensate for this variable jitter as will be explained in the following.

[0031] To achieve this, the communication module 22a stores a time stamp or tag 34 in the data packet 26. The time tag 34 may be generated from the clock time of a local clock 36a of the communication module 22a. After receiving the data packet 26, the communication module 22b calculates the transmission time of the specific transmission of the data packet 26 and waits until a predefined delay time has elapsed before the transmitted measurement data 30a is output to the protection relay 18b. During the wait time, the data packet 26 and/or the measurement data 28a may be stored in a jitter buffer 38b of the communication module 22b. (Also, the communication module 22a may have a jitter buffer 38a for storing data packets 26 from the communication module 22b).

[0032] Fig. 2 shows a diagram with the different times that may be used during this calculation.

[0033] At time point t_s, the data 28a is stored in the data packet and time stamped with the time tag 34. At time point t_R, the data 28a is received at the second communication module 22b and at time point to, the transmitted data 30a is output to the protection relay 18b.

[0034] The communication module 22b calculates the transmission time Δt_T as a difference between the time points t_R and t_s and the wait time Δt_W as a difference between the predefined delay time Δt_D and the transmission time Δt_T. The time point t_R is determined based on the clock time of the local clock 36b of the second communication module 22b.

[0035] Fig. 3 shows a method of transmitting data that will be explained with reference to Fig. 1 and 2.

[0036] In step 100, the first measurement module 20a generates first measurement data by measuring a first current at first location of the power line 12.

[0037] In step 102, the measurement data is processed or handled at the protection relay 18a and subsequently received in the first communication module 22a as synchronous TDM measurement data 28a. The first communication module 22a writes the synchronous TDM measurement data 28a in the data packet 26.

[0038] For example, some 0.125 μs to several ms of synchronous TDM data 28a are packet into an Ethernet, IP or MPLS packet 26 as payload.

[0039] In step 104, the communication module 22a time stamps the first measurement data 28a with a time tag 34. The time tag 34 is generated with the actual clock time of the first clock 36a. The time tag 34 may be stored in the data packet 26. For example, a time tag 34 indicating the time of day information at which the first bit of the data 28a in the packet 26 was received in the communication module 22a is additionally packed into the Ethernet, IP or MPLS packet as part of the payload.

[0040] In step 106, the data packet 26 and in particular the first measurement data 28a and the time tag 34 are transmitted to the second communication module 22b via the packet switched data network 24.

[0041] In step 108, the data packet 26 is received in the second communication module 22b. The second communication module 22b may extract the first measurement data 28a and the time tag 34 from the data packet 26.

[0042] Furthermore, the second communication module 22b calculates the transmission time Δt_T and the wait time Δt_W from the time tag 34. The transmission time Δt_T is calculated based on a difference between an actual clock time of the second clock 36b and the time tag 34 in the second communication module 22b. The wait time Δt_W is calculated based on a difference between the predefined delay time Δt_D and the transmission time Δt_T.

[0043] In step 110, the communication module 22b stores the transmitted measurement data 30a in a jitter buffer 38b of the second communication module 22b and waits for the calculated wait time Δt_W. In such a way, the communication module 22b delays the outputting of the transmitted measurement data 30a for the wait time Δt_W.

[0044] In step 112, the second communication module 22b outputs the transmitted measurement data 30a at the predefined delay time Δt_D after the time stamping of the synchronous TDM measurement data 28a. The transmitted measurement data 30a may comprise the measured values of the measurement of the current at the measurement module 20a.

[0045] In particular, the transmitted measurement data 30a is output to the protection relay 18b.

[0046] Summarized, the measurement data 28a sent off at the time point t_s is output at a time point to, which is controlled to be a predefined delay time Δt_D after the

time point t_s. In such a way, the method may be seen as circuit emulation over the packet switched network 24, for example for the application of line differential protection, or the communication system 32 may be seen as including an emulated circuit switched communication link 40.

[0047] Thus, the method may provide a circuit emulation service over an Ethernet based wide area communication network 24, which is suitable for the application of line differential protection.

[0048] For example, the Ethernet, IP or MPLS packet 26 containing the measurement data 28a of a particular time interval, which may have been received by the communication module 22a via a synchronous communication link, is transferred to the destination node, i.e. the communication module 22b, of the circuit emulation service. In the communication module 22b, the measurement data 28a may be serialized again and placed in the jitter buffer 38b. The jitter buffer 38b may be used for compensating communication delay variations on the packet switched network 24. Using a synchronized frequency to read out the data bits, a synchronous TDM signal 30a may be regenerated, which may be emulated via the packet switches network 24 and low resulting jitter and wander values may be guaranteed.

[0049] The information of the additionally transmitted time tag 34 may be used to control the delay of the emulated circuit 40 with high accuracy. By means of the time tag 34, the receiving node of the circuit emulation service (i.e. the second communication module 22b) may get the exact absolute time when the first bit of a particular data interval of the measurement data 28a has arrived at the sending node of the circuit emulation service (i.e. the communication module 22a).

[0050] It has to be noted that several technologies are available which may support an emulation of circuit switched lines over packet switched networks, like e.g. circuit emulation service over packet CESoP. These technologies may support low packet delay variation and thus low asymmetrical communication delay of synchronous TDM signals, when combined with highly accurate synchronization of the communication network elements, e.g. synchronous Ethernet Sync-E or when combined with a point to point communication path through a packet switched network with reserved bandwidth and guaranteed priority for a particular communication service, like e.g. multiprotocol label switch (MPLS).

[0051] However, in the case of an asymmetrical communication delay between the modules 22a, 22b only the method as described in the above and in the following may be suitable to achieve the requirements on the data synchronization that are usually required by line differential protection.

[0052] In step 114, the measurement module 20b generates second measurement data by measuring a second current at second location of the power line 12. The second measurement data is provided to the protection relay 18b.

[0053] When the two measurements of the measurement modules 20a, 20b are performed at the same time, the arrival times of the corresponding measurement data at the protection relay 18b have a predefined delay time Δt_D relative to each other.

[0054] In step 116, the protection relay 18b processes the measurement data in such a way that measurements at equal time points are compared. The protection relay 18b is aware of the constant delay time Δt_D and shifts the transmitted measurement data 30a accordingly. For example, phase information of two different points of the power line 12 may be compared and line differential protection may be performed with the communication link 40 between the line protection relays 18a and 18b.

[0055] The two protection relays 18a, 18b may timewise correlate the measurement data 30a, 30b from the remote end with the local measurement data by compensating a known, fix and jitter free delay between local measurement data and remote measurement data 30a, 30b.

[0056] The emulated circuit switched communication link 40 may have the following properties.

[0057] The communication link 40 may have a fixed communication delay Δt_D of not more than 10 ms per direction. This may be motivated by the requirement on the protection application in the protection relay 18a, 18b to react within certain time limits to faults on the protected power line 12.

[0058] The communication link 40 may add low jitter to the current measurement values in the measurement data 28a, 28b, transmitted over the communication link 40.

[0059] The communication link 40 may have a differential delay between go- and return communication that is not more than 160μs. A requirement of 160 μs may be motivated by a target of the line differential protection to detect phase errors of as low as 3° which corresponds to about 160 μs in a 50 Hz power grid.

[0060] Fig. 4 shows a flow diagram for a method for synchronizing the clocks 36a, 36b of the communication modules 22a, and 22b. The method of Fig. 4 may be executed prior to the method of Fig. 3.

[0061] For the circuit emulation service over the packet switched network 24 suitable for the application of line differential protection, not only a precise frequency synchronization of two communication modules 22a, 22b may be required in order to keep the jitter (and wander, 'slow jitter') of the emulated circuit 40 low, but additionally a precise time of day synchronization of the communication modules 22a, 22b may be required in order to precisely control the communication delay of the emulated circuit 40 in each direction. Assuming that the communication delay in each direction can be adjusted with an accuracy of 160 μs / 2 = 80 μs per direction, the resulting asymmetrical delay between the two directions is well controlled to be within the limit of 160 μs.

[0062] These requirements may be met by synchronizing the local clocks 36a, 38b with a global master clock

50. As is indicated in Fig. 1, a further device 52 connected to the packet switched data network 24 may comprise the master clock 50.

[0063] In step 200, the first clock 36a of the first communication module 22a is synchronized with a master clock 50 via the packet switched data network 24.

[0064] In step 202, the second clock 36b of the second communication module 22b is synchronized with the master clock 50 via the packet switched data network 24.

[0065] In such a way, the first clock 36a used for generating the time tag 34 and the second clock 36b used for calculating the delay time Δt_T may be synchronized with high accuracy. For the synchronization of the clocks 36, 36b, 50, the time and frequency synchronization protocol according IEEE 1588v2, also called precision time protocol (PTP) may be used, in order to achieve a frequency and time synchronization of all communication nodes, i.e. communication modules 22a, 22b, 52 in the communication network 24.

[0066] If all network nodes, i.e. communication modules 22a, 22b, and 52 implement e.g. a profile according to IEEE C37.238 - power profile - of IEEE 1588v2, the uncertainty in synchronization per single network node 22a, 22b, 52 may be not more than 50 ns. In other words, a data network 24 comprising 200 communication nodes may still achieves a synchronization error which is not more than 10 μs. This may be sufficient in order to achieve a point to point circuit emulation service, which has the required accuracy in path delay adjustment.

[0067] The synchronous TDM measurement data 28a, which is received in the communication module 22a, which forms a starting point of the circuit emulation line 40 over the packet switched network 24, may then be time stamped with high accuracy, using the local clock 36a that is synchronized via the data network 24 with IEEE 1588v2.

[0068] Using the local clock 36b that may be also synchronized to the same IEEE 1588v2 master clock 50 like the clock 36a, the receiving node, i.e. the communication module 22b, of the circuit emulation service may then delay the regeneration of the synchronous transmitted measurement data 30a, such that a predefined communication delay Δt_D is met with high accuracy.

[0069] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art and practising the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or controller or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate

that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A method of transmitting data over a packet switched data network (24) between time-synchronized communication modules (22a, 22b), the method comprising the steps of:

    receiving synchronous TDM data (28a) in a first communication module (22a);
    generating, by the first module (22a), a time stamp (34) indicative of a receive time of the synchronous TDM data (28a) at the first module;
    transmitting, in a data packet (26), the received synchronous TDM data (28a) to a second communication module (22b) via the packet switched data network (24);
    outputting, by the second module (22b), the transmitted synchronous TDM data (30a) at an output time (to) determined by adding a predefined delay time (Δt_D) to the time stamp (34).

2. The method of claim 1, further comprising the steps of:

    transmitting the time stamp (34) in the data packet (26) to the second module (22b);
    or
    determining, by the first module (22a), the output time (to), and transmitting the output time (to) in the data packet (26) to the second module (22b).

3. The method of claim 1 or 2, wherein
the communication modules (22a, 22b) are nodes of a communication network of an electric power system and the synchronous TDM data (28a) include one of measurement, protection, or control data, specifically, wherein
the second communication module (22b) provides the transmitted synchronous TDM data (30a) to a line differential protection relay (18b) configured to protect a power line (12) of the power system.

4. The method of one of the preceding claims, further comprising the steps of:

    calculating, by the second communication module (22b), a transmission time (Δt_T) based on a difference between a packet receive time of the data packet (26) at the second module (22b) and the time stamp (34);
    calculating a wait time (Δt_W) as a difference between the predefined delay time (Δt_D) and the transmission time (Δt_T);

delaying the outputting of the transmitted synchronous TDM data (30a) for the wait time (Δt_W).

5. The method of claim 4, further comprising the step of:

storing the transmitted synchronous TDM data (30a) in a jitter buffer (38b) of the second communication module (22b) for the wait time (Δt_W).

6. The method of one of the preceding claims, further comprising the steps of:

synchronizing a first clock (36a) of the first communication module (22a) with a master clock (50), the first clock (36a) used for time stamping the synchronous TDM data (28a);
synchronizing a second clock (36b) of the second communication module (22b) with the master clock (50),
wherein the first clock (36a) and the second clock (36b) are synchronized via the packet switched data network (24) with the master clock (50).

7. The method of claim 6,
wherein for synchronization the precision time protocol (PTP) according to time and frequency synchronization protocol IEEE 1588v2 is used.

8. A computer program for transmitting data over a packet switched data network (24) between time-synchronized communication modules (22a, 22b), which, when being executed by a processor of a destination communication module (22b) adapted to exchange data packets with a source communication module (22a) over the packet switched data network (24), makes the destination communication module (22b) perform the step of - outputting, at an output time (to), synchronous TDM data (30a) transmitted in a data packet (26) from the source module (22a), wherein the output time (to) is determined by adding a predefined delay time (Δt_D) to a time stamp (34) generated by the source module (22a) and indicative of a receive time of synchronous TDM data (28a) at the source module (22a).

9. A computer-readable medium, in which a computer program according to claim 8 is stored.

10. A destination communication module (22b) adapted to exchange data packets with a source communication module (22a) over a packet switched data network (24), wherein the communication modules are time-synchronized, **characterized in that** the destination module (22b) is configured to
output, at an output time (to), synchronous TDM data (30a) transmitted in a data packet (26) from the source module (22a), wherein the output time (to) is determined by adding a predefined delay time (Δt_D) to a time stamp (34) generated by the source module (22a) and indicative of a receive time of synchronous TDM data (28a) at the source module (22a).

11. The destination communication module (22b) of claim 10, **characterized in that** it is configured to calculate a transmission time (Δt_T) based on a difference between a packet receive time of the data packet (26) at the destination module (22b) and the time stamp (34);
calculate a wait time (Δt_W) as a difference between the predefined delay time (Δt_D) and the transmission time (Δt_T);
delay the outputting of the transmitted synchronous TDM data (30a) for the wait time (Δt_W).

12. A communication system (32) for an electrical power system (10),
wherein the communication system (32) comprises a first communication module (22a) and a second communication module (22b);
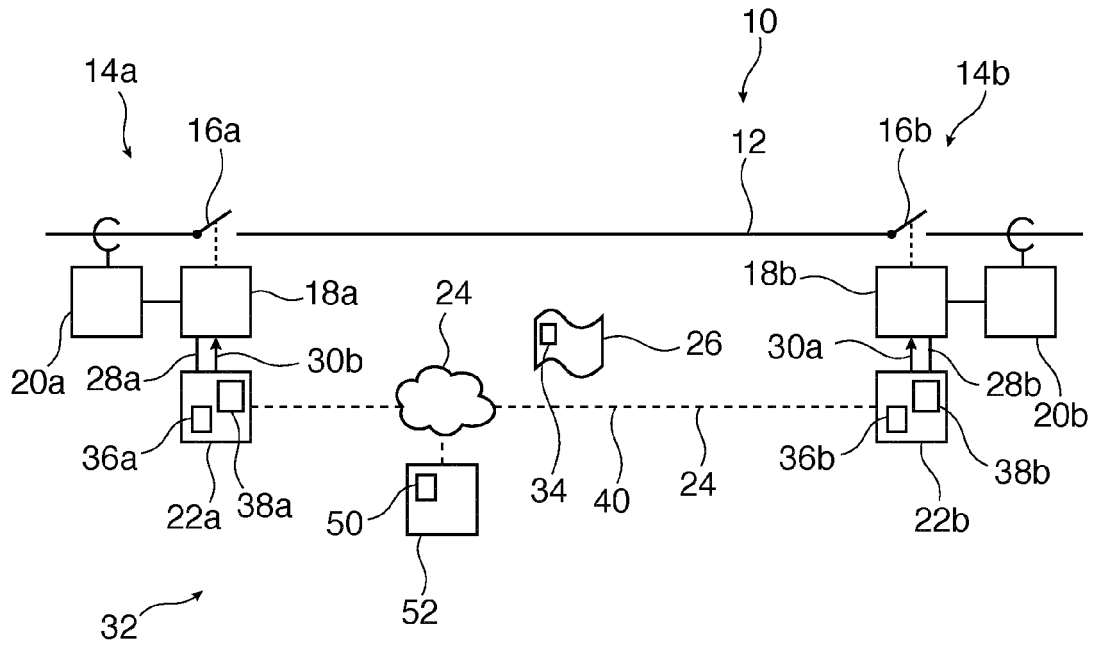wherein the communication system (32) is adapted for executing the method according to one of claims 1 to 7.
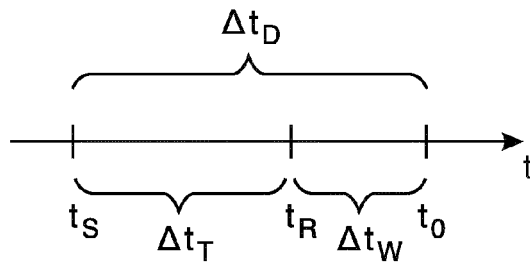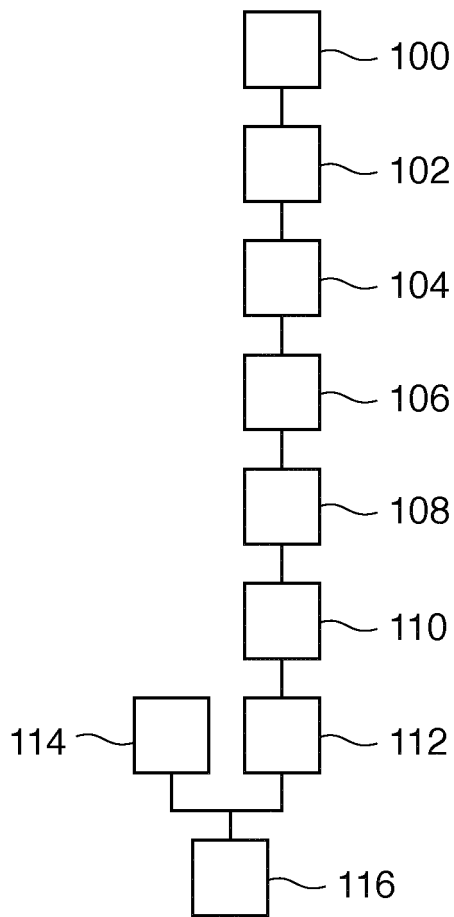
Fig. 1

Fig. 2

Fig. 3

Fig. 4

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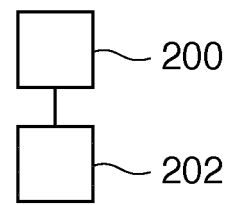
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EUROPEAN SEARCH REPORT

Application Number

EP 12 15 1667

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	MONTGOMERY W A: "TECHNIQUES FOR PACKET VOICE SYNCHRONIZATION", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE SERVICE CENTER, PISCATAWAY, US, vol. SAC-01, no. 6, 1 December 1983 (1983-12-01), pages 1022-1028, XP000563228, ISSN: 0733-8716, DOI: 10.1109/JSAC.1983.1146024	1,2,4-11	INV. H04J3/06 H02H1/00 H02H7/26
Y	* abstract * * parts I, II and III.D * -----	3,12	
Y	US 2008/071482 A1 (ZWEIGLE GREGARY C [US] ET AL) 20 March 2008 (2008-03-20) * abstract * * paragraph [0008] - paragraph [0012] * * paragraph [0029] - paragraph [0097] * -----	3,12	
Y	US 2009/088989 A1 (GUZMAN-CASILLAS ARMANDO [US]) 2 April 2009 (2009-04-02) * abstract * * paragraph [0021] - paragraph [0105] * -----	3,12	TECHNICAL FIELDS SEARCHED (IPC) H04J H02H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 July 2012	Chauvet, Christophe

1

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.** EP 12 15 1667

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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09-07-2012

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2008071482	A1	20-03-2008	AU	2007297701 A1	27-03-2008
			CA	2663609 A1	27-03-2008
			US	2008071482 A1	20-03-2008
			WO	2008036303 A2	27-03-2008
US 2009088989	A1	02-04-2009	CA	2701278 A1	02-04-2009
			US	2009088989 A1	02-04-2009
			WO	2009042964 A1	02-04-2009

EPO FORM P0459

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