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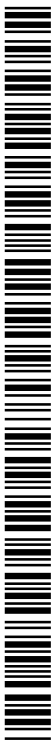
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(54) **Title:** BASE STATION SYNCHRONIZATION

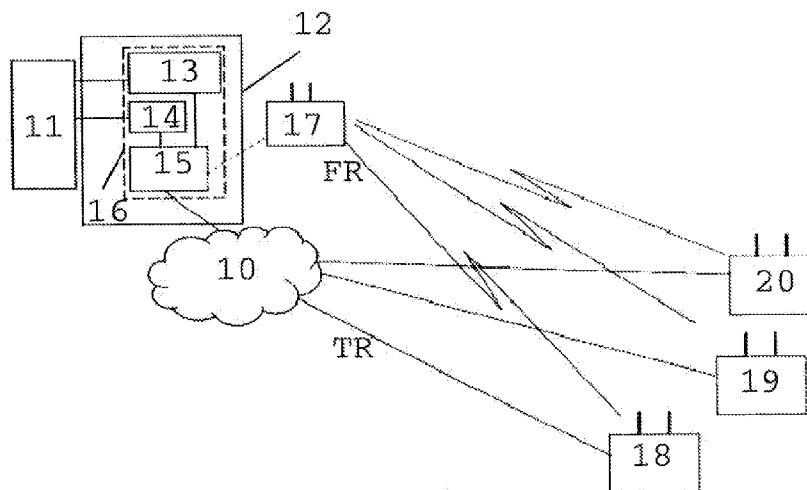


FIG. 1

(57) **Abstract:** The invention relates to transmission and reception of clock synchronization data in a wireless communication system. According to the invention a device (12) for transmitting clock synchronization data obtains at least one time reference (TR) of a wireless communication system clock (11), controls transmission of a frequency reference (FR) of the wireless communication system clock (11) via an air interface (16) of the wireless communication system, and provides transmission of the time reference via a transport network (10) associated with the wireless communication system, while the base station (18) receives the frequency reference (FR), locks its own oscillator to the frequency of the frequency reference, receives the time reference (TR) from the transport network (10) and adjusts timing that is controlled by the oscillator based on the time reference.

BASE STATION SYNCHRONIZATION

TECHNICAL FIELD

5 The invention relates generally to wireless communication systems. More particularly, the invention relates to a method, device and computer program product for transmitting clock synchronization data to a base station of a wireless communication system as well as to a method in a base station for receiving clock synchronization data from a clock synchronisation device of a wireless communication system as well as a base station of a wireless communication system.

15 BACKGROUND

The size of wireless communication systems in terms of the number of nodes they include have increased rapidly in recent years. One type of communication system where this trend is especially strong is the cellular system.

One reason for this growth is the reduction in size of some system nodes, such as base stations. Base stations can nowadays be fairly small and cover a small area. This allows great flexibility in the systems but also puts high demands on them.

As the size of the base stations decrease there is a desire to make them as simple as possible in order to keep the costs down. However, they must still have a first-rate functionality.

One area where this is evident is the issue of clocks and timing.

A base station used in a wireless communication system
5 needs a stable frequency reference to be able to communicate with mobile stations at a reasonable bitrate. Demand for higher bitrates is increasing over time, depending of new end user features that requires large amount of data to be transferred to and from the
10 mobile stations.

This leads to the requirement of more bandwidth and higher frequencies, which emphasises the need for exact timing.

15

This exact timing can in many instances be obtained using an oscillator that is heated and kept at a specific temperature with the help of a temperature regulation device, such as an Oven.

20

Yet another solution is to use a Global Positioning System (GPS) receiver for time and frequency synchronization of the local oscillator.

25 The use of GPS is for instance described in US 7,606,541.

Stable oscillators are costly and require volume/space in the device. Warming the oscillator will first of all
30 require the additional arrangement needed for keeping a certain temperature, which adds to the cost and the

complexity. However, it will also draw extra energy,
which even further raises the costs. The time until a
stable frequency can be generated is further rather
long depending of time sample integrating and
5 oscillator warming, which means that valuable time may
be lost before the required accuracy is obtained.

When synchronization is solved with the help of a GPS,
the obvious drawback is that the GPS signal is not
10 always available, typically not in indoor systems.
Furthermore, there is here a requirement of additional
receivers for receiving GPS signals.

As can be seen, there is therefore a need for
15 alternative ways of obtaining accurate timing of a base
station.

SUMMARY

20 The invention is therefore directed towards providing
an alternative way of obtaining accurate timing of a
base station.

One object of the invention is thus to provide an
25 alternative way of obtaining accurate timing of a base
station.

This object is according to a first aspect of the
invention achieved through a method for transmitting
30 clock synchronization data to a base station of a
wireless communication system. The method comprises:

obtaining at least one time reference of a wireless communication system clock,
transmitting a frequency reference of the wireless communication system clock via an air interface of the
5 wireless communication system, and
transmitting the at least one time reference via a transport network associated with the wireless communication system.

10 The object is according to a second aspect of the invention achieved through a device for transmitting clock synchronization data to a base station of a wireless communication system. This device comprises:
a time reference obtaining unit for obtaining at least
15 one time reference of a wireless communication system clock, and
a transmission control unit configured to
control transmission of a frequency reference of the wireless communication system clock via an air
20 interface of the wireless communication system,
and
provide transmission of the at least one time reference via a transport network associated with the wireless communication system.

25

The above-mentioned object is according to a third aspect of the invention achieved through a computer program product for transmitting clock synchronization data to a base station of a wireless communication
30 system, the computer program product comprising a computer readable storage medium comprising a set of

instructions causing a synchronization handling module of a clock synchronisation device to:
obtain at least one time reference of a wireless communication system clock,
5 control transmission of a frequency reference of the wireless communication system clock via an air interface of the wireless communication system, and provide transmission of the at least one time reference via a transport network associated with the wireless
10 communication system.

In one variation of the invention, the method may further comprise obtaining the frequency reference of the wireless communication system clock and the device
15 may comprise a frequency reference obtaining unit for obtaining the frequency reference of the wireless communication system clock.

In another variation of the invention, more than one
20 time reference is transmitted.

In yet another variation of the invention the frequency reference is transmitted using a wireless communication interface of the wireless communication system. For
25 this purpose the transmission control unit of the device may be connected to a wireless communication interface of the wireless communication system and configured to control it to transmit the frequency reference.

30

The above-mentioned object is according to a fourth aspect of the invention achieved through a method in a

base station for receiving clock synchronization data from a clock synchronisation device of a wireless communication system. The method comprises:
receiving a frequency reference via an antenna of the
5 base station,
locking an oscillator to the frequency of the frequency reference,
receiving at least one time reference via a transport network associated with the wireless communication
10 system, and
adjusting timing controlled by the oscillator based on the time reference.

The object is according to a fifth aspect of the
15 invention achieved through a base station of a wireless communication system. This base station comprises:
at least one antenna,
a reference signal receiver,
an oscillator,
20 a time counter operated by the oscillator,
an oscillator locking unit configured to receive a frequency reference from the antenna via the reference signal receiver and to lock said oscillator to the frequency of the frequency reference,
25 a timing adjusting unit configured to receive at least one time reference from a transport network associated with the wireless communication system and to adjust the timing of the time counter based on the time reference.

30

In a further variation of the invention the latter method comprises estimating the delay of the time

reference through the transport network and adjusting
the timing also based on the estimated delay. In this
same aspect the timing adjusting unit of the base
station is further configured to estimate the delay of
5 the time reference through the transport network and
adjust the timing also based on the estimated delay.

The delay may be estimated based on the time of
reception of at least one previously received time
10 reference.

The estimating performed in the method may also
comprise averaging the delay of a number of time
references, where the estimated delay used in the
15 adjusting of the timing is the averaged time delay.
This means that the timing adjusting unit of the base
station may be further configured to average the delay
of a number of time references, where the estimated
delay used in the adjusting of the timing is the
20 averaged time delay.

The frequency reference may finally be provided via a
carrier having a frequency below 400 MHz.

25 The invention has many advantages. Through the
invention it is possible to obtain both time and
frequency stability using a less precise oscillator.
This allows a simpler, smaller and more economical base
station design. The local base station oscillator does
30 thus not have to have long term stable properties and
can therefore be low cost. As no special heating

arrangement is required the energy consumption is furthermore low.

It should be emphasized that the term

5 "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components, but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

10

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail in relation to the enclosed drawings, in which:

15

fig. 1 schematically shows a wireless communication system comprising a system clock connected to a synchronization handling device as well as a number of base stations communicating with the synchronisation handling device via a transport network as well as via a further wireless interface,

20

fig. 2 shows a block schematic of one variation of a base station,

fig. 3 shows a flow chart of a method for transmitting clock synchronisation data being performed in the synchronisation handling device,

25

fig. 4 shows a flow chart of the method for receiving clock synchronisation data being performed in the base station, and

30 fig. 5 schematically shows a computer program product comprising computer program code with instructions

performing the functionality of the synchronisation handling device.

DETAILED DESCRIPTION

5

In the following description, for purposes of explanation and not limitation, specific details are set forth such as particular architectures, interfaces, techniques, etc. in order to provide a thorough
10 understanding of the invention. However, it will be apparent to those skilled in the art that the invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known devices, circuits, and
15 methods are omitted so as not to obscure the description of the invention with unnecessary detail.

The present invention concerns the handling of synchronisation of base station oscillators in a
20 wireless communication system.

One such wireless communication system is schematically shown in fig. 1.

25 The wireless communication system may here be a cellular or mobile communication system such as Long-Term Evolution (LTE), Universal Mobile Telecommunications System (UMTS) or Global System for Mobile Communications (GSM). As one variation the
30 system may be a Time Division Duplex (TDD) system. These are just a few examples of systems where the invention can be implemented and it should be realized

that the invention can just as well be implemented in other types of systems such as systems based on Wireless Local Area Networks (WLANs).

5 The exemplifying wireless communication system 10 comprises a number of base stations, where a first base station 18 is a base station having an oscillator that is to be synchronised according to the principles of the invention. There is here furthermore a second and a
10 third base station 19 and 20, where the second and third base stations 19 and 20 may or may not be of the same type as the first base station 18, i.e. performing the synchronisation according to the invention.

15 In the wireless communication system there is furthermore a central time source or wireless communication system clock 11, which may be an atomic clock keeping a very precise time. To this central time source 11 there is connected a device 12 for
20 transmitting clock synchronisation data. This device will in the following be referred to as a clock synchronisation device 12. The clock synchronisation device 12 comprises a synchronisation handling module 16, which module in turn comprises a number of units.
25 There is here a frequency obtaining unit 13, a time reference obtaining unit 14 and a transmission control unit 15. Here both the time reference obtaining unit 14 and frequency reference obtaining unit 13 are connected to the central clock 11 as well as to the transmission
30 control unit 15. The transmissions control unit 15 is in turn connected to a transport network 10 as well as to a wireless interface 17 associated with the wireless

communication system. This wireless interface is in this example another base station also communicating with mobile stations. It should here be realized that the wireless interface may be another type of
5 interface, such as a separate radio transmitter to which the clock synchronisation device 12 may have sole access. It may thus be a transmitter that does not concern itself with regular wireless communication to mobile stations.

10

The transport network 10 is here a transport network associated with the wireless communication system. This means that it may be a part of the wireless communication system. As an alternative it may be a
15 transport network to which devices of the wireless communication system have access. As another alternative this network may be shared with other systems. The transport network 10 may here be a packet based data communication network, for instance a
20 Transmission Control Protocol/Internet Protocol (TCP/IP) network.

Fig. 2 shows a block schematic of the first base station 18. This base station 18 includes a first
25 antenna 22 connected to a reference signal receiver 24, which receiver 24 is in turn connected to an oscillator locking unit 28. The oscillator locking unit 28 is in turn connected to an oscillator 32 via a filter 30. The oscillator 32 provides a frequency which is sent to a
30 scaling unit 26 as well as to a time counter 34 and to a radio circuit 38. The scaling unit 26 is connected to the oscillator locking unit 28 and the time counter 34

is also connected to the radio circuit 38, which radio circuit is connected to a second antenna 40. The time counter 34 is here furthermore connected to a timing adjusting unit 36 which is provided with an interface 5 (not shown) to the transport network.

As mentioned above there is in wireless communication systems a trend towards increased bit rates, higher frequencies and smaller base stations, which puts 10 harder requirements on the time keeping ability of the time keeping units provided in such base stations, which time keeping units may be oscillators, time counters and clocks. This is combined with a need to keep the base stations as small and inexpensive as 15 possible, such as for instance in order to provide pico or even femto base stations that may be placed indoors.

This means that it is necessary to use oscillators in the base stations that are cheap and as a consequence 20 less exact. However, they should still be able to keep an exact time.

The invention is based on the concept that a standard packet-based data communication network is used for 25 transmitting a time reference, while a frequency reference is transmitted using a wireless interface. The central idea behind the invention is thus to transmit a stable frequency reference over the air, which wireless nodes can use as a frequency reference, 30 while time synchronisation data is transmitted over a packet-based data communication network.

The functioning of the system will now be described in some more detail with reference also being made to fig. 3, which shows a flow chart of a method for transmitting clock synchronisation data being performed in the synchronisation handling device, and to fig. 4, which shows a flow chart of a method for receiving clock synchronisation data being performed in the first base station.

10 The clock synchronisation device 12 is provided for synchronisation base stations in the wireless communication system and consequently for synchronising the first base station 18. In order to do this the frequency reference obtaining unit 13 is connected to
15 the wireless communication system clock 11 and obtains a frequency reference, step 42, which may be the frequency used by the system clock 11. It may also be a scaled version of this frequency, either scaled up or scaled down. The time reference obtaining unit 14 also
20 connects to the system clock 11 and obtains a time reference, step 44. These references are then provided to the transmission control unit 15. The transmission control unit 15 in turn connects to or is already connected to the wireless interface 17 associated with
25 the wireless communication system, which in this embodiment is the associated base station. The frequency reference obtaining unit 13 and transmission control unit 15 may here makes sure that the wireless interface then wirelessly transmits the frequency
30 reference FR to the devices of the system via the wireless system air interface, step 46. This

transmission may here be a continuous transmission of the frequency referenced FR. The transmission control unit 15 may here provide a communication link between the frequency reference obtaining unit 13 and the
5 associated wireless interface 17 via which an oscillator of the wireless interface is tuned to the frequency or a scaled version of the frequency of the system clock. The frequency obtaining unit may thus control the associated wireless interface to transmit
10 the frequency reference FR. The wireless interface may also be employing an extremely stable oscillator. The frequency used may here be a carrier or a subcarrier. The frequency used is selected such that it easily penetrates obstacles like walls etc. and may be much
15 lower than the frequency used by ordinary radio base station systems. In one exemplifying variation of the invention the carrier may be a carrier having a frequency below 400 MHz. It may as a further example be a Longwave carrier that may be in the range 40 - 200
20 kHz. It should however be realized that the invention is not limited to these frequencies but other may be used, for instance GSM frequencies. From this it can thus be gathered that the wireless interface 17 may be set to transmit the frequency reference.

25

The transmission control unit 15 also connects to the transport network 10 and transmits the one or more time references TR via the transport network 10. These may be transmitted as User Datagram Protocol (UDP) or TCP
30 packets. The time references TR may furthermore be provided as time stamped data packets, which means that the time reference obtaining unit 14 may be a time

stamping unit that puts a time stamp of the system clock 11 to data packets being sent by the transmission control unit 15 via the transport network 10.

5 In the first base station 18, the frequency reference FR is received by the reference signal receiver 24 via the first antenna 22, step 50, and forwarded to the frequency locking unit 28. The frequency locking unit 28, which may be a phase detector, also receives the
10 frequency of the oscillator 32, which may be scaled up or down by the scaling unit 26 in case the frequency reference and oscillator frequency differ. The phase detector 28 then detects the difference in phase between these frequencies and provides a control signal
15 based on the difference, which is filtered by the filter 30. This control signal has the function of adjusting the oscillator frequency to the frequency of the frequency reference FR. In this way the oscillator frequency is locked to the frequency reference by the
20 oscillator locking unit 28, step 52. This adjusted frequency is then used for operating the radio communication unit 38 as well as for operating the time counter 34, which is also a local clock.

25 Even though the frequency is adjusted in this way, which leads to the local clock not having any time drift, the time may still be offset from the correct time. In order to address this, the timing adjusting unit 36 receives the one or more time references TR via
30 the transport network 10, step 54. The one or more time references are then used for adjusting the timing of the time counter 34 that is controlled by the

oscillator 32. In this way the timing controlled by the oscillator 32 is adjusted based on the received time reference TR, step 58.

5 It takes time for packets to pass through the transport network 10 and this time is furthermore different between the various network nodes. The time may also differ between packets intended for the same node. This means that the time stamp of a packet will reflect a
10 time in the past rather than the current time. This also means that it may be necessary to determine the delay through the network, which delay determination may be based on the difference between the time of arrival of a packet and the time stamp it has. This may
15 furthermore be done through averaging a number of such differences and apply the averaged value to a received time reference and more particularly to apply the averaged times to the time stamp of a received packet. The estimation of transport network delay may more
20 particularly be performed using Precision Time Protocol (PTP) as described in the IEEE standard IEEE 1588. Therefore the timing adjusting unit 36 may estimate the transport network delay TND, step 55, and form an adjusted time reference ATR through adjusting the time
25 reference TR with the transport network delay TND, step 56. This adjusted time reference ATR may then be used by the timing adjusting unit 36 for adjusting the timing of the time counter 34 and therefore for adjusting the timing of the oscillator.

30

As can be seen a central reference transmitter may send a continuous reference signal to all nodes in the

wireless communication system, where one, several or all nodes here comprise a receiver that detects the reference signal and locks its local oscillator. The synchronization using the transport network, often
5 denoted IP-Sync, is then only used to synchronize the time, while frequency stability is assured by the reference signal from the wireless interface 17, which thus is a reference frequency transmitter.

10 In this way it is possible to obtain both time and frequency stability using a less precise oscillator. This allows a simpler, smaller and more economical design of the base station. The local base station Oscillator does thus not have to have long term stable
15 properties and can therefore be low cost. The correct timing is furthermore obtained fast as compared with stable oscillators. As no special heating arrangement is required the energy consumption is furthermore low.

20 There are several advantages with using a low reference frequency, such as an LW frequency. This ensures that that the ordinary communication in the wireless communication system is not interfered by the frequency reference. Another advantage is that the low frequency
25 signals more easily propagate through walls and windows. This means that it is possible to obtain the frequency reference also when a base station is placed indoors in a building, and it may even be placed in a basement.

The reference signal can be an un-modulated carrier, a carrier modulated with a single tone or even several tones. It is also possible to provide counter values that can be used for initial, rough, time
5 synchronization (un-compensated for air time travel delays).

In the embodiment described above there was a separate antenna and reference signal receiver. It should here
10 be realized that as an alternative it is possible to use the regular radio receiver 38 and antenna 40 also for this purpose.

In the system described above there was only one
15 wireless interface used to transfer the frequency reference. It should be realized that a frequency reference could be transferred using several different wireless interfaces in order to be able to reach all the nodes of the wireless communication system.

20
This also means that a base station may be able to receive the frequency reference from several sources. These sources may furthermore use different frequencies. The base station may then select one of
25 the sources, for instance the one from which it has the best reception of frequency reference. It may then inform the clock synchronisation about the selected frequency reference. The clock synchronisation device may then inform the base station about a scaling factor
30 to be used to obtain the correct frequency with which to adjust the local oscillator.

It should also be realized that it is possible to omit the filter from the base station as well as to omit the scaling unit. It is also possible to add another scaling unit between reference signal receiver and
5 oscillator locking unit. The wireless interface used by the clock synchronisation device may alternatively be provided with an own stable oscillator, in which case the frequency obtaining unit may be omitted.

10 The timing adjusting unit of the first base station and the synchronisation handling module of the clock synchronisation device may with advantage be provided in the form of a processor with associated program memory including computer program code for performing
15 its functionality. It should be realized that they may also be provided in the form of hardware, like for instance in the form of Application Specific Integrated Circuits (ASIC) or Digital Signal Processors (DSP). The computer program code may also be provided as a set of
20 computer program code instructions on a computer-readable storage medium, for instance in the form of a data carrier, like a CD ROM disc or a memory stick, which will implement the function of the above-described timing adjusting unit and synchronisation
25 handling module when being loaded into the above-mentioned program memory and run by the processor.

One such computer readable storage medium in the form of a CD ROM disc 60 with computer program code 62 is
30 schematically shown in fig. 5.

While the invention has been described in connection with what is presently considered to be most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed
5 embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements. Therefore the invention is only to be limited by the following claims.

CLAIMS

1. A method for transmitting clock synchronization data (FR, TR) to a base station (18) of a wireless communication system comprising the steps of:
5 obtaining (44) at least one time reference (TR) of a wireless communication system clock (11),
transmitting (46) a frequency reference of the wireless communication system clock (11) via an air
10 interface of the wireless communication system, and
transmitting (48) said at least one time reference via a transport network (10) associated with the wireless communication system.
- 15 2. The method according to claim 1, further comprising
obtaining (42) the frequency reference (FR) of the wireless communication system clock (11).
3. The method according to claim 1 or 2, wherein the
20 step of transmitting at least one time reference comprises transmitting more than one time reference.
4. The method according to any previous claim, wherein
the step of transmitting a frequency reference is
25 performed using a wireless communication interface (17) of the wireless communication system.
5. The method according to claim 4, wherein the
frequency reference is provided using a carrier
30 having a frequency below 400 MHz.

6. A device (12) for transmitting clock synchronization data to a base station (18) of a wireless communication system comprising:
- 5 a time reference obtaining unit (14) for obtaining at least one time reference (TR) of a wireless communication system clock (11), and
- 10 a transmission control unit (15) configured to control transmission of a frequency reference of the wireless communication system clock (11) via an air interface of the wireless communication system, and
- provide transmission of said at least one time reference via a transport network (10) associated with the wireless communication system.
- 15
7. The device according to claim 6, further comprising a frequency reference obtaining unit (13) for obtaining the frequency reference (FR) of the wireless communication system clock.
- 20
8. The device according to claim 6 or 7, wherein the transmission control unit is connected to a wireless communication interface (17) of the wireless communication system and configured to control it to
- 25 transmit said frequency reference.
9. A computer program product for transmitting clock synchronization data to a base station of a wireless communication system, the computer program product
- 30 comprising a computer readable storage medium (60) comprising a set of instructions (62) causing a

synchronization handling module (16) of a clock
synchronisation device (12) to:
obtain at least one time reference (TR) of a
wireless communication system clock (11),
5 control transmission of a frequency reference of the
wireless communication system clock via an air
interface of the wireless communication system, and
provide transmission of said at least one time
reference via a transport network (10) associated
10 with the wireless communication system.

10. A method in a base station (18) for receiving
clock synchronization data (FR, TR) from a clock
synchronisation device (12) of a wireless
15 communication system, comprising the steps of:
receiving (50) a frequency reference (FR) via an
antenna (22) of the base station,
locking (52) an oscillator (32) to the frequency of
the frequency reference,
20 receiving (54) at least one time reference (TS) via
a transport network (10) associated with the
wireless communication system, and
adjusting (58) timing controlled by the oscillator
based on the time reference.

25

11. The method according to claim 10, further
comprising estimating (55) the delay of the time
reference through the transport network and
adjusting the timing also based on the estimated
30 delay.

12. The method according to claim 11, wherein the delay is estimated based on the time of reception of at least one previously received time reference.
- 5 13. The method according to claim 11 or 12, further comprising averaging the delay of a number of time references, wherein the estimated delay used in the adjusting of the timing is the averaged time delay.
- 10 14. The method according to any of claims 10 - 13, wherein the frequency reference is received via a carrier having a frequency below 400 MHz.
- 15 15. A base station (18) of a wireless communication system comprising:
at least one antenna (22),
a reference signal receiver (24),
an oscillator (32),
a time counter (34) operated by the oscillator,
20 an oscillator locking unit (28) configured to receive a frequency reference (FR) from said antenna via said reference signal receiver and to lock said oscillator to the frequency of the frequency reference,
25 a timing adjusting unit (36) configured to receive at least one time reference (TR) from a transport network (10) associated with the wireless communication system and to adjust the timing of the time counter based on the time reference.
- 30 16. The base station according to claim 15, wherein the timing adjusting unit is further configured to

estimate the delay of the time reference through the transport network and adjust the timing also based on the estimated delay.

- 5 17. The base station according to claim 16, wherein the timing adjusting unit is further configured to average the delay of a number of time references, wherein the estimated delay used in the adjusting of the timing is the averaged time delay.

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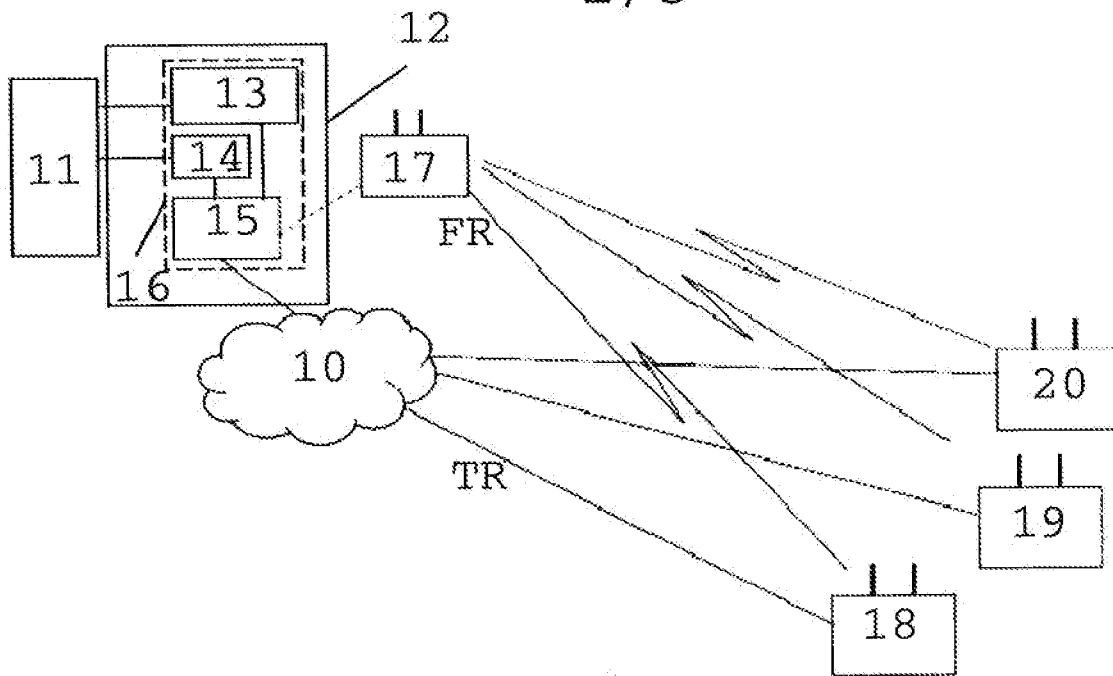


FIG. 1

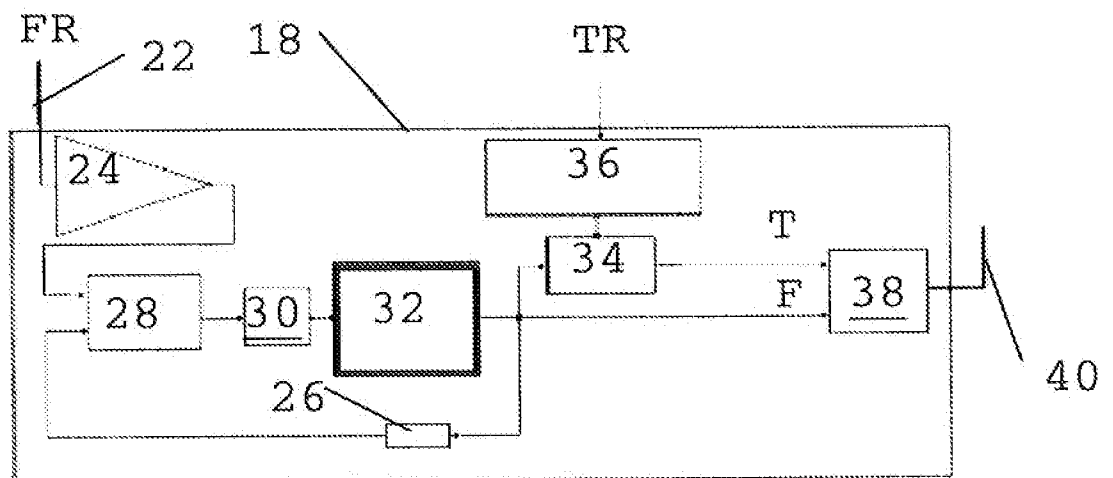


FIG. 2

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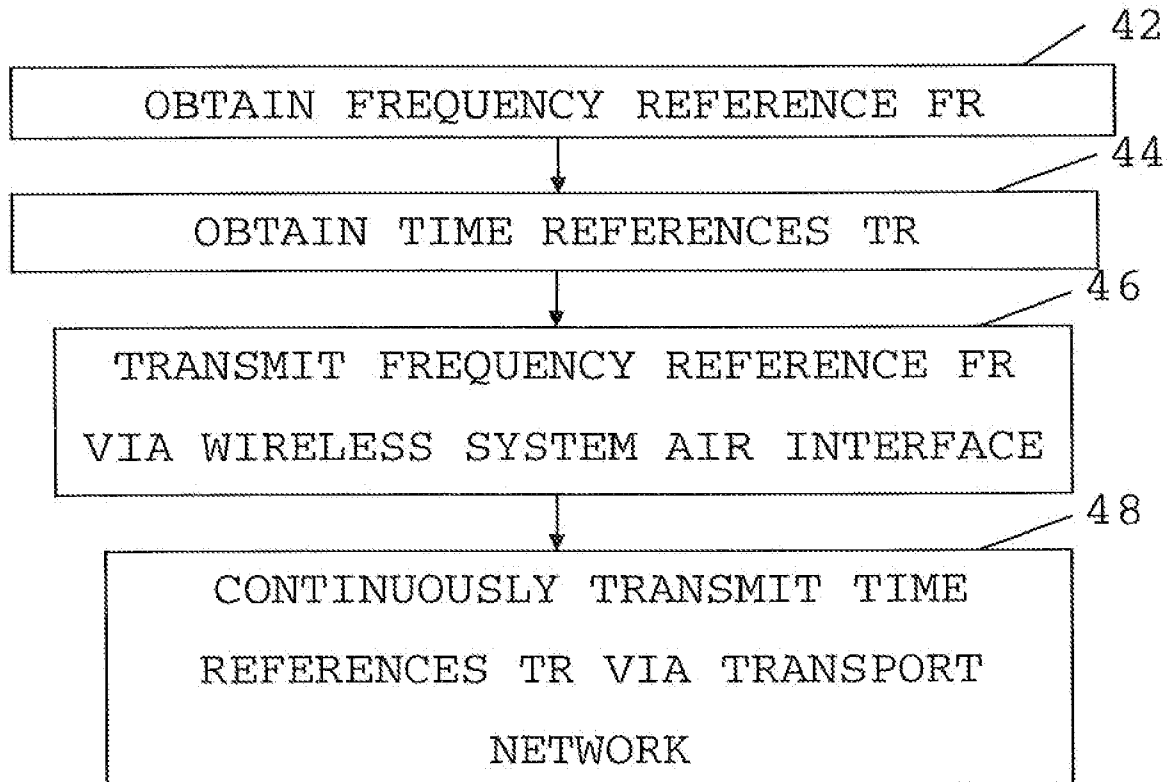


FIG. 3

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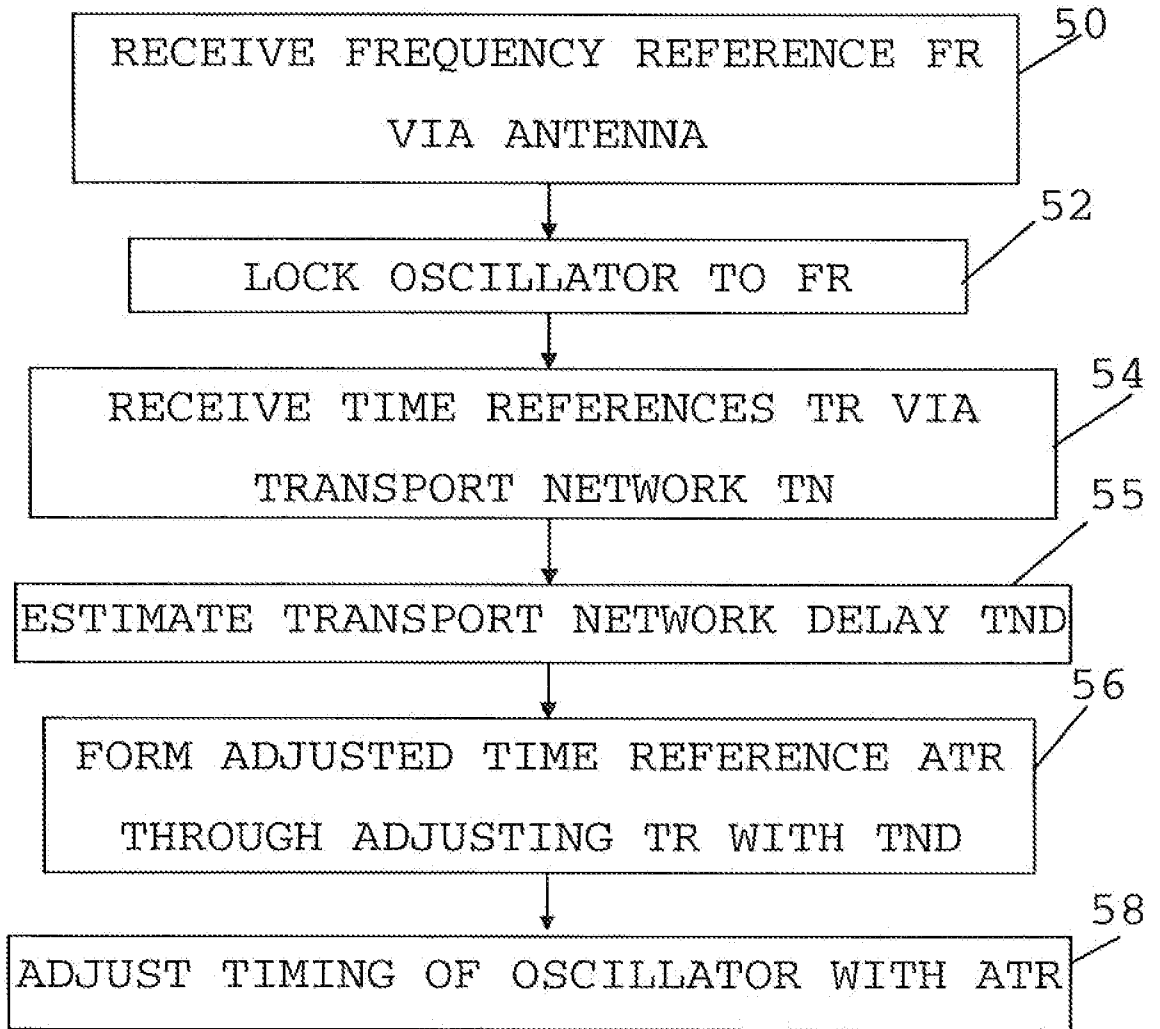


FIG. 4

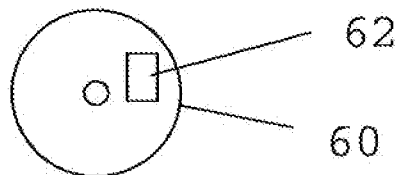


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No PCT/SE2011/050496

A. CLASSIFICATION OF SUBJECT MATTER INV. H04W56/00 H04J3/06 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04W H04J H04B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, INSPEC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/025978 A1 (UBIQUISYS LTD [GB]; HATALA EDWARD [GB]; KEEVILL PETER [GB]) 6 March 2008 (2008-03-06) abstract page 6, line 18 - page 9, line 25 figures 1,2 claims	1-17
A	----- US 2008/085721 A1 (HIRANO MIKE [US] ET AL) 10 April 2008 (2008-04-10) the whole document	1-17
A	----- US 2005/041692 A1 (KALLSTENIUS THOMAS [SE]) 24 February 2005 (2005-02-24) the whole document -----	1-17
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family	
Date of the actual completion of the international search	Date of mailing of the international search report	
17 January 2012	24/01/2012	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Dejonghe, Olivier	

INTERNATIONAL SEARCH REPORT

Information on patent family members

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