



- (51) **International Patent Classification:**
H04W 56/00 (2009.01)
- (21) **International Application Number:**
PCT/SE2011/050197
- (22) **International Filing Date:**
22 February 2011 (22.02.2011)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (71) **Applicant (for all designated States except US):** TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) [SE/SE]; S-164 83 Stockholm (SE).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** LAGERQVIST, Tomas Georg [SE/SE]; Wivalliusg. 10, S-112 60 Stockholm (SE). JÄRLEHOLM, Anders Wilhelm [SE/SE]; Platåvägen 24, S-191 50 Sollentuna (SE).
- (74) **Agent:** HASSELGREN, Joakim; Ericsson AB, Patent Unit LTE, Torshamnsgatan 23, S-164 80 Stockholm (SE).
- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

- (54) **Title:** METHODS AND ARRANGEMENT FOR SUPPORTING BASE STATION SYNCHRONIZATION BY USE OF LONG WAVE SIGNALING

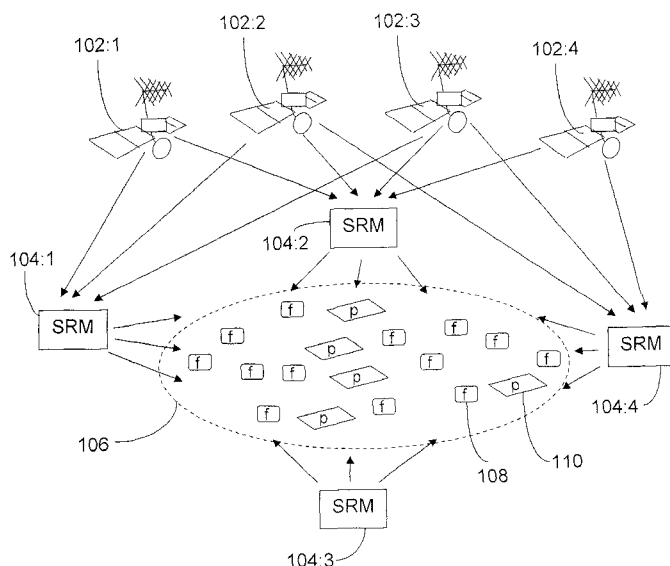


Figure 1

(57) **Abstract:** Methods and arrangements in a support node and in connection with a base station for supporting synchronization of the base station. The methods and arrangements involve conveying high-accuracy time information via long-wave signaling to the base station, which implies e.g. that base stations in unfavorable radio conditions may be synchronized without access to reliable IP connections or similar.

METHOD AND ARRANGEMENT FOR SUPPORTING BASE STATION SYNCHRONIZATION BY USE OF
LONG WAVE SIGNALING

TECHNICAL FIELD

[0001] The invention relates to methods and arrangements for supporting synchronization of base stations, especially base stations being located at sites having unfavorable radio conditions.

BACKGROUND

[0002] The requirements on exactness in regard of time and frequency for communicating over the air interface in communication systems using radio access technologies such as e.g. LTE (Long Term Evolution) or WCDMA (Wideband Code Division Multiple Access) are very high. For example, an LTE macro base station is required not to deviate in frequency from air interface-related frequencies more than 50 ppb (parts per billion), i.e. 50×10^{-9} Hz, and not to deviate in time more than 1.5 μ s for LTE-TDD (Time Division Duplex).

[0003] In order to fulfill these strict time and frequency requirements for communicating over the air interface, a base station normally relies on an external source to provide frequency and time synchronization.

[0004] For a base station with IP backhaul, frequency and time synchronization could be obtained from an external time server connected to the IP network, by use of protocols like IEEE 1588 or NTP (Network Time Protocol). Another solution is to use a GPS (Global Positioning System) receiver to achieve time and frequency synchronization.

[0005] However, the current solutions described above have several drawbacks, especially when deployed for smaller indoor base stations, such as e.g. pico base

stations and/or home base stations i.e. so-called femto products. For example, GPS receivers do not function well in unfavorable radio conditions, such as indoor environments, since they require line of sight to a number of satellites. Further, synchronization by use of protocols such as NTP and IEEE 1588 implies that very strict requirements must be fulfilled by the backhaul link, in regard of e.g. packet loss and jitter. Typically, many IP connections, e.g. in home environments, do not fulfill such high requirements.

[0006] Thus, the synchronization of small base stations, such as e.g. pico base stations and home indoor base stations, having unfavorable radio conditions, is identified as a problem.

SUMMARY

[0007] It would be desirable to enable synchronization of base stations also in locations having unfavorable radio conditions and/or in premises having relatively low-quality IP-network connections. It is an object of the invention to enable synchronization of base stations also in locations having unfavorable radio conditions and/or in premises having relatively low-quality IP-network connections. Further, it is an object of the invention to provide a method and an arrangement for enabling synchronization of base stations in a simple and cost efficient manner associated with low computational complexity. These objects may be met by a method and arrangement according to the attached independent claims. Optional embodiments are defined by the dependent claims.

[0008] According to a first aspect, a method for supporting synchronization of a base station is provided in a support module. The method comprises obtaining high-accuracy time information from a reference source, and providing said high-accuracy time information to a base station by use of long wave signaling.

[0009] According to a second aspect, an arrangement is provided in a support module. The arrangement comprises a functional unit adapted to obtain high-accuracy time information from a reference source, and further comprises a functional unit adapted to provide said high-accuracy time information to a base station by use of long wave signaling.

[00010] According to a third aspect, a method for supporting synchronization of a base station is provided. The method comprises receiving a long wave signal from at least one support module, and deriving high-accuracy time and frequency information from the received signal(s). The method further comprises synchronizing the base station based on the derived information.

[00011] According to a fourth aspect, an arrangement connectable to a base station is provided. The arrangement comprises a functional unit adapted to receive long wave signals from at least one support module. The arrangement further comprises a functional unit adapted to derive high-accuracy time and frequency information from one or more received long wave signals. Further, the arrangement comprises a functional unit adapted to synchronize the base station, based on the derived information.

[00012] The above methods and arrangements may be implemented in different embodiments. In some embodiments the external source may be a satellite based positioning system, such as the Global Positioning System (GPS). Further, the support node may obtain its geographical position based on information obtained from the reference source, and provide said position to the base station by use of long wave signaling.

[00013] The synchronization of the base station may involve using the derived time information for synchronizing an internal clock of the base station. The

synchronization could further involve deriving a high-accuracy frequency signal based on the derived high-accuracy time information, as reference frequency for synchronizing base station frequency generation, and/or deriving a carrier frequency of the long wave signaling, and synchronizing base station frequency generation, based on said derived carrier frequency.

[00014] The geographical position of the base station could be derived, based on the geographical position of at least one support module, when such information is provided by the support modules. When determined, the geographical position of the base station could be reported to a network control module.

[00015] Further, a propagation delay compensation factor may be calculated for the time information received from a first support module, based on the geographical position of said support module and the geographical position of the base station

[00016] The above methods and arrangements may be used for provision of high-accuracy timing, frequency and position information to e.g. indoor base stations. High-accuracy timing, frequency and position information may be provided to base stations in locations having unfavorable radio conditions, and no demands are made on the quality of core or backhaul equipment. The above arrangements are of relatively low complexity, which enables fast introduction in communication systems. Further, a common set of support modules may be used by several operators, and the cost for the support modules may be shared between the operators. Base stations, such as e.g. home base stations, reporting their geographical position to the network may be beneficial to support network planning and billing.

[00017] The embodiments above have mainly been described in terms of a method. However, the description above is also intended to embrace embodiments of the arrangement, adapted to enable the performance of the above described features. The different features of the exemplary embodiments above may be combined in different ways according to need, requirements or preference.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail by means of example embodiments and with reference to the accompanying drawings, in which:

Figure 1 is a schematic view illustrating a system comprising support nodes obtaining information from satellites and providing synchronization information to a set of base stations, according to an exemplifying embodiment.

Figure 2 is a block diagram illustrating an arrangement in a support module, according to an example embodiment.

Figure 3 is a block diagram illustrating an arrangement in a base station, according to an example embodiment.

Figure 4 is a schematic view illustrating an exemplifying frame format, which could be used when conveying information from a support node to a base station, according to an example embodiment.

Figure 5 is a flow chart illustrating a procedure in a support module for supporting synchronization of a base station, according to an example embodiment.

Figure 6 is a block diagram illustrating an arrangement in a support module adapted for supporting synchronization of a base station, according to an example embodiment.

Figures 7 is a flow chart illustrating a procedure for supporting synchronization of a base station, according to an example embodiment.

Figure 8 is a block diagram illustrating an arrangement connectable to a base station adapted for supporting synchronization of the base station, according to an example embodiment.

DETAILED DESCRIPTION

[00018] Briefly described, the invention relates to the provision of synchronization information to base stations, especially to base stations in locations having unfavorable radio conditions and/or base stations having a backhaul link of insufficient quality. A support node or support module, which hereinafter may be referred to as a "Synchronization Repeater Module" (SRM), is introduced, which receives exact time information, and possibly frequency information, from a reference source, e.g. by use of a GPS receiver. The SRM can then e.g. broadcast absolute high-accuracy time information, and possibly information on the position of the SRM, in the long wave frequency band. The information could thus easily be obtained also by base stations in environments having unfavorable radio conditions, which base stations could use the information for synchronization purposes. A base station could use triangulation based on signals from a number of SRMs in order to achieve absolute time and/or the position of the base station.

[00019] The SRMs are to be distributed e.g. over or around an area in which base station synchronization is to be supported, for example, a city, a building, or a cluster of buildings. The distance between the SRMs is to be relatively short. For example, the distance between two neighboring SRMs could be selected e.g. in the range of 1-3 kilometers, depending e.g. on local topography.

[00020] Within this document, the term "high-accuracy information" is used as referring to information which at least fulfills the strict requirements on exactness for communicating over an air interface, related to radio access technologies such as e.g. LTE or WCDMA or similar. The term "long wave frequencies" is used as referring to frequencies which easily propagate through e.g. buildings and stone, as for example frequencies below 500kHz, some of which even penetrate sea-water. Which exact frequency/ies that are to be used depends on which frequencies that are available or "free" in the respective country or region where the SRMs are located.

[00021] Further, the term "synchronizing" is used as referring to the action of providing high-accuracy time and frequency information to a base station in an adequate form, such that the base station may rely on the provided information e.g. to generate carrier frequencies and achieve exact timing precision, which fulfills the requirements for communicating over the air interface of the communication system in question.

[00022] Figure 1 is a schematic view, illustrating a situation where several femto base stations 108, marked "f", and pico base stations 110, marked "p", in an area 106 are provided with synchronization information from a set of SRMs 104:1-4, which obtain time and frequency information from a number of satellites 102:1-4.

[00023] In the example in figure 1, an SRM receives time reference signal(s) from the satellites by use of a satellite receiver, e.g. a GPS receiver. The satellite receiver is also used to obtain the geographical position of the SRM. The SRM then transmits, e.g. broadcasts, time reference information using a free long wave frequency band to the base stations. The SRM may further provide information of the position of the SRM over the long wave frequency band to the base stations.

[00024] When an SRM is located at a relatively, in these circumstances, "large" distance from a base station, the propagation delay of the long wave signal may become significant in relation to the required time accuracy of the RAT in question. For example, a distance of 300 meters corresponds to a propagation delay of approximately $1\mu\text{s}$. For LTE, $1\mu\text{s}$ is a significant part of the $1.5\mu\text{s}$ deviation which is allowed for the LTE air interface. To compensate for such propagation delay, a propagation delay compensation factor could be calculated for the time signal when the position of the SRM and the position of the base station are known. The compensation factor could e.g. be calculated when the distance between the SRM, from which time information is received, and the base station exceeds a predefined length, which may depend on the RAT in question. Alternatively, the propagation delay compensation factor may be calculated, and used, irrespective of the distance between the SRM and base station, i.e. even when the propagation delay is insignificant in the circumstances.

[00025] In order to enable and/or facilitate for a base station to separate and identify signals from different SRMs, some sort of multiplexing could be applied to the signals from the different SRMs. For example, code division using orthogonal pseudo random (PN) sequences could be used to multiplex the signals. Each SRM could be assigned a PN-sequence when commissioning of the SRM is done. Alternatives to PN-sequence assignment during commissioning could be to use a

measurement receiver to select a PN-sequence that is not used by other SRMs, or, a serial number, or some other identifier, of an SRM could be used when calculating the PN- sequence to use for said SRM. Alternatively, or in addition, other multiplexing techniques, such as e.g. time and/or frequency multiplexing could be used for separating the signals from different SRMs.

Exemplifying arrangement, SRM, figure 2

[00026] Figure 2 is a block diagram illustrating components of an exemplifying SRM. A GPS receiver module 202 provides PPS, i.e. a Pulse Per Second signal and a standard serial interface, e.g. NMEA0183, where position and absolute time can be read. A frame formatter 204, here implemented using a micro controller, extracts timing and positioning information from the GPS receiver module 202 and converts it to a predefined frame format, such as e.g. the proposed frame format described further below. The output bits of the frame formatter are XOR'ed with a PN sequence, generated by a PN-code generation block 206. The XOR'ed output signal is then modulated in a Phase Shift Keying (PSK) modulator 214 with a carrier frequency generated by the Phase Locked Loop (PLL) block 208. Finally, the signal is amplified by a Power Amplifier (PA) 216. In order to generate a stable, accurate carrier frequency, the PLL is phase locked to the PPS signal provided by the GPS receiver module.

[00027] In this exemplifying arrangement, and the next exemplifying arrangement illustrated in figure 3 and described below, the different components have been illustrated as being implemented using either a processor, in this case a micro controller, or a Programmable Logical Device (PLD), such as an ASIC (Application-Specific Integrated Circuit) or an FPGA (Field-Programmable Gate Array). The components being implemented using a micro controller are illustrated as having a dotted background, and the components being implemented using a

PLD are illustrated having a white background. Other implementations using different combinations of software and/or hardware are also possible.

[00028] Instead of using a GPS receiver to get time and frequency reference it is possible to use a stable reference clock connected to the SRM. The position of the SRM unit must in this case be manually provided when commissioning the SRM unit, or be derived using some other reference source.

Exemplifying arrangement, base station, figure 3

[00029] Figure 3 is a schematic view of exemplifying additional receiver parts or functions required for a base station, such as e.g. a so-called "femto" base station, to receive long wave signals from surrounding SRMs. The signal from an SRM may be converted to base band using standard modulator feed with a carrier frequency signal from the PLL 312.

[00030] By use of a PN-sequence generation block 302, a receiver block 304 and a path evaluation block 306, the received signals can be evaluated in order to detect signals from e.g. 3 or 4 SRMs. Reception from 4 SRMs is required in order to derive the correct position in longitude, latitude and altitude. In the receiver block 304 the received signal is correlated with the predefined PN sequences. When the correlation result is above a threshold, a signal from an SRM with a matching PN sequence is found. Several correlation results above the threshold may be found for a given PN sequence. These results represent the direct path, and a number of reflections. Since long wave transmission is used, the first received correlation result is considered to be the direct path.

[00031] When signals from e.g. four SRMs have been found, a data decoder block 308 can be used to decode data according to the predefined frame format. With access to the decoded data and the result from the path evaluation block, the

absolute time and position of the base station may be calculated. The result is formatted by a formatter block 314, and provided to the regular base station functionality using a serial interface, thus synchronizing the base station. In this example, a PPS and a 10MHz clock signal are also provided.

[00032] Figure 4 shows an example of a frame format, which could be used for conveying information from an SRM to a base station in the long wave frequency band. The exemplifying frame is one minute long. Thus, for example, each minute the following data could be transmitted:

- 31 bits containing current date and time
- 1 leap second warning bit
- 8 bit Cyclic Redundancy Check (CRC) field
- 16 bit position field
- 4 reserved bits

[00033] The basic frame sync can be achieved in the receiver by using a CRC-based framing method. The receiver will then continuously calculate CRC over incoming data, it will bit shift the incoming data until it finds a position where the correct CRC is decoded for a number of times. The receiver then has detected the frame sync.

[00034] Date, time, and leap second warning bit may be repeated every minute. However, in order to transmit the position, 40 frames will be needed when using 16 bits per frame for positioning information. The 40 frames form a hyper frame providing the position. The position data may be used as follows:

1. Longitude 24 bytes,
2. Latitude 24 bytes,

3. Altitude 24 bytes,
4. Hyper Frame Framing 8 byte,

where the Hyper Frame Framing is a predefined pattern that needs to be correctly decoded a number of times in order to achieve hyper frame sync.

[00035] Below, a more general procedure and arrangement in a support module, e.g. denoted SRM, and in a base station will be described with reference to figures 5-8.

Exemplifying procedure, figure 5

[00036] An embodiment of a method in a support module for supporting synchronization or calibration of a base station will now be described with reference to figure 5.

[00037] Initially, high-accuracy time and frequency information is received or retrieved from a reference source in an action 502. The reference source may be e.g. a positioning system, such as a satellite based system like GPS or another Global Navigation Satellite System (GNSS), or, a communication network fulfilling the requirements of e.g. LTE air interface communication. Alternatively, the reference source could be an atomic clock.

[00038] The support module may also obtain positioning information from said reference source or possibly from another reference source in an action 504. For example, when the reference source which provides time and frequency information does not provide positioning information, the positioning information could be obtained from another reference source. Further, the geographical position of the support module could be determined based on the positioning information obtained from the reference source. The geographical position of the

support module could be determined e.g. triangulation using signals from a number of satellites.

[00039] The obtained time and frequency information is then provided, e.g. broadcasted, to the base station by use of long wave signaling in an action 508. By providing said information in the long wave frequency band, a base station receiving the information is enabled to synchronize, i.e. obtain a time and frequency signal of an accuracy fulfilling the predefined requirements for communicating over an air interface of a communication system, as previously described.

[00040] The geographical position of the support module may also be provided in the long wave frequency band along with the time and frequency information. Providing the geographical position of the support module enables a base station receiving the information to determine the geographical position of the base station, and to e.g. calculate a propagation delay compensation factor to compensate for the propagation delay of the long wave signaling from a support module to the base station.

Exemplifying arrangement, figure 6

[00041] Below, an example arrangement 600, adapted to enable the performance of the above described procedure of supporting synchronization of a base station will be described with reference to figure 6. The support module may be a separate module located at a separate position having favourable radio conditions, or, it could be co-located with or integrated with a communication network module in a location having favourable radio conditions, such as e.g. a macro base station. The arrangement could be activated and deactivated remotely, such that e.g. many network nodes could be provided with such an arrangement, but only an adequate subset of the arrangements are selected to be active.

[00042] The support module 600 comprises an obtaining unit 602, which is adapted to receive or retrieve high-accuracy time and frequency information, and possibly positioning information, from a reference source. The obtaining unit 602 could comprise e.g. a receiver and a demultiplexing module. The reference source could, as previously described, be e.g. a GNSS, such as the GPS.

[00043] The support module 600 may further comprise a determining unit 604, which may be adapted to determine the geographical position of the support module, based on positioning information obtained from the reference source.

[00044] The support module 600 further comprises a providing unit 606, adapted to provide the high-accuracy time and frequency information, and possibly information on the geographical position of the support module, over the so-called long wave frequency band. In order to transmit in the long wave frequency band, the support module 600 further comprises a transmitter 610, capable of transmitting at "long" wavelengths, e.g. below 500 kHz, which easily penetrates and propagates through e.g. buildings and similar. The support module may further comprise various functional units for e.g. storage of intermediate information. Such functional units are illustrated in form of a memory 608, having a dashed outline.

Exemplifying procedure, figure 7

[00045] An embodiment of a method associated with a base station, for supporting synchronization or calibration of said base station will now be described with reference to figure 7. The base station is assumed to be a part of a cellular communication network, and may be located in a place having unfavorable radio conditions. Optional actions are illustrated having a dashed outline.

[00046] Initially, a long wave signal is received from at least one support module in an action 702. Then, high-accuracy time and frequency information is derived from the received signal(s) in an action 704. Further, positioning information may be derived from the received signal(s) in an action 706. The positioning information could e.g. be the respective geographical position of the support modules from which a respective signal is received. Thus, the geographical position of the base station may be determined based on the derived positioning information in an action 708.

[00047] The number of geographical references, i.e. geographical positions of support modules, needed in order to determine the geographical position of the base station depends on the required level of accuracy needed for the determined position. For example, in order to determine e.g. in which country the base station is located, in most cases only one geographical reference would be needed. However, to attain a geographical position in two dimensions, i.e. longitude, latitude, at least three support module position references are needed. In some geographical and/or architectural conditions, four geographical references may be needed to correctly determine the altitude of the base station.

[00048] The determined geographical position of the base station could be used in an action 710 for calculating a propagation delay compensation factor to be applied on the time information received from a first support module. The calculation of the propagation delay compensation factor should be based on the geographical position of said first support module and the geographical position of the base station, i.e. the distance the long wave signal from the first support module propagates or traverses before reaching the base station. The propagation delay compensation factor could be applied to the time information received from the first support module, if found necessary, and thus compensate said

information for errors introduced by the propagation delay. When the distance between a support module and the base station is relatively small, no propagation delay compensation factor will be needed. It could be determined e.g. based on the distance from the base station to the closest support module whether a propagation delay compensation factor should be calculated or not.

[00049] The determined geographical position of the base station could further be reported to a control node in the cellular communication network in an action 714, thus providing information enabling e.g. an operator to perform improved cell planning and/or to prevent misuse of mobile base stations. For example, an operator could prevent re-parenting, such as e.g. when a person brings her/his femto base station with her/him during a visit to a foreign country, and plugs it in to a local IP net, in order to make free calls.

[00050] The base station is synchronized in an action 712, based on the derived high-accuracy time and frequency information. The time information may possibly be corrected before synchronization by use of a calculated propagation delay compensation factor.

[00051] The synchronization may involve using the derived time information for synchronizing an internal clock of the base station, and may further involve generating or deriving a high-accuracy frequency signal based on the derived high-accuracy time information, for use as reference frequency for synchronizing base station frequency generation. Further or alternatively, the synchronization may involve deriving a carrier frequency of the long wave signaling, and synchronizing base station frequency generation based on said derived carrier frequency.

The frequency and time information may further be converted or formatted to any format suitable for synchronizing the base station.

Exemplifying arrangement, figure 8

[00052] Below, an example arrangement 800, adapted to enable the performance of the above, in conjunction with figure 7, described procedure of supporting synchronization of a base station will be described with reference to figure 8. The arrangement 800 is connectable to a base station (801) in a cellular communication network, and could be integrated with the base station or be arranged as a separate, e.g. "add-on" unit in connection with the base station.

[00053] The arrangement 800 comprises an obtaining unit 802, which is adapted to receive long wave signals from at least one support module. The arrangement 800 further comprises a determining unit (804), adapted to derive high-accuracy time and frequency information from one or more received long wave signals. Further, the arrangement 800 comprises a synchronization unit 808, which is adapted to synchronize the base station, based on the derived information.

[00054] The arrangement 800 may further be adapted to derive information on the geographical position of a support module from a signal received from said support module; and may further be adapted to derive the geographical position of the base station based on the derived geographical position of at least one support module.

[00055] The arrangement 800 may further comprise a compensation unit, adapted to calculate a propagation delay compensation factor for the time information received from a first support module, based on the geographical position of said support module and the geographical position of the base station.

[00056] Further, the arrangement 800 may comprise a reporting unit 810, adapted to report the geographical position of the base station to a network control node, e.g. on a higher hierarchical level than the base station.

[00057] While the procedure as suggested above has been described with reference to specific embodiments provided as examples, the description is generally only intended to illustrate the inventive concept and should not be taken as limiting the scope of the suggested methods and arrangements, which are defined by the appended claims. While described in general terms, the methods and arrangements may be applicable e.g. for different types of communication systems, using commonly available communication technologies, such as e.g. GSM/EDGE, WCDMA or LTE.

[00058] It is also to be understood that the choice of interacting units or modules, as well as the naming of the units are only for exemplifying purpose, and entities suitable to execute any of the methods described above may be configured in a plurality of alternative ways in order to be able to execute the suggested process actions.

[00059] It should also be noted that the units or modules described in this disclosure are to be regarded as logical entities and not with necessity as separate physical entities.

ABBREVIATIONS

CSD	Cellular Synchronization Distribution
GNSS	Global Navigation Satellite System

NTP	Network Time Protocol
SRM	Synchronization Repeater Module

CLAIMS

1. Method in a support module for supporting synchronization of a base station in a cellular communication network, the method comprising:
 - obtaining (502) high-accuracy time information from a reference source, and
 - providing (508) said time information to the base station by use of long wave signaling, thus enabling the base station to synchronize.
2. Method according to claim 1, wherein the reference source is a satellite based positioning system.
3. Method according to claim 2, wherein the positioning system is the Global Positioning System (GPS).
4. Method according to any of the claims 1-3, further comprising:
 - obtaining (504) information related to positioning from the reference source,
 - deriving (506) the geographical position of the support module, based on said information related to positioning obtained from the reference source, and
 - providing (508) said geographical position of the support module to the base station by use of long wave signaling.
5. Arrangement in a support module for supporting synchronization of a base station in a cellular communication network, the arrangement comprising:
 - an obtaining unit, adapted to obtain high-accuracy time information from a reference source,

- a providing unit, adapted to provide said time information to the base station by use of long wave signaling.
6. Arrangement according to claim 5, wherein the arrangement is further adapted to obtain information related to positioning from the reference source; the arrangement further comprising a determining unit, adapted to derive the geographical position of the support module, based on said information related to positioning obtained from the reference source, and wherein the arrangement is further adapted to provide said geographical position of the support module to the base station by use of long wave signaling.
 7. Method for supporting synchronization of a base station, the method comprising:
 - receiving (702) a long wave signal from at least one support module,
 - deriving (704) high-accuracy time and frequency information from the received signal(s), and
 - synchronizing (712) the base station based on the derived information.
 8. Method according to claim 7, wherein the synchronization involves at least one of:
 - using the derived time information for synchronizing an internal clock of the base station,
 - generating a high-accuracy frequency signal based on the derived high-accuracy time information, as reference frequency for synchronizing base station frequency generation, and
 - deriving a carrier frequency of the long wave signaling, and

synchronizing base station frequency generation, based on said derived carrier frequency.

9. Method according to claim 7 or 8, further comprising:
 - deriving (706) the geographical position of the at least one support module from the received signal(s), and
 - deriving (708) the geographical position of the base station based on said geographical position of the at least one support module.
10. Method according to claim 9, wherein the geographical position of the base station is derived based on the respective geographical position of at least three support modules.
11. Method according to claim 9 or 10, wherein said geographical position of the base station is reported (714) to a network control module.
12. Method according to any of claims 9-11, further comprising:
 - calculating (710) a propagation delay compensation factor for the time information received from a first support module, based on the geographical position of said support module and the geographical position of the base station.
13. Arrangement (800) connectable to a base station (801) in a cellular communication network, for supporting synchronization of said base station, the arrangement comprising:
 - an obtaining unit (802), adapted to receive long wave signals from at least one support module,
 - a determining unit (804), adapted to derive high-accuracy time and frequency information from one or more received long wave signals,

and

-a synchronization unit (808), adapted to synchronize the base station, based on the derived information.

14. Arrangement according to claim 13, further adapted to derive information on the geographical position of a support module from a signal received from said support module; and adapted to derive the geographical position of the base station based on the derived geographical position of at least one support module.
15. Arrangement according to claim 14, further comprising:
 - a reporting unit (810), adapted to report the geographical position of the base station to a network control node.
16. Arrangement according to claim 14 or 15, further comprising:
 - a compensation unit (806), adapted to calculate a propagation delay compensation factor for the time information received from a first support module, based on the geographical position of said support module and the geographical position of the base station.

1/7

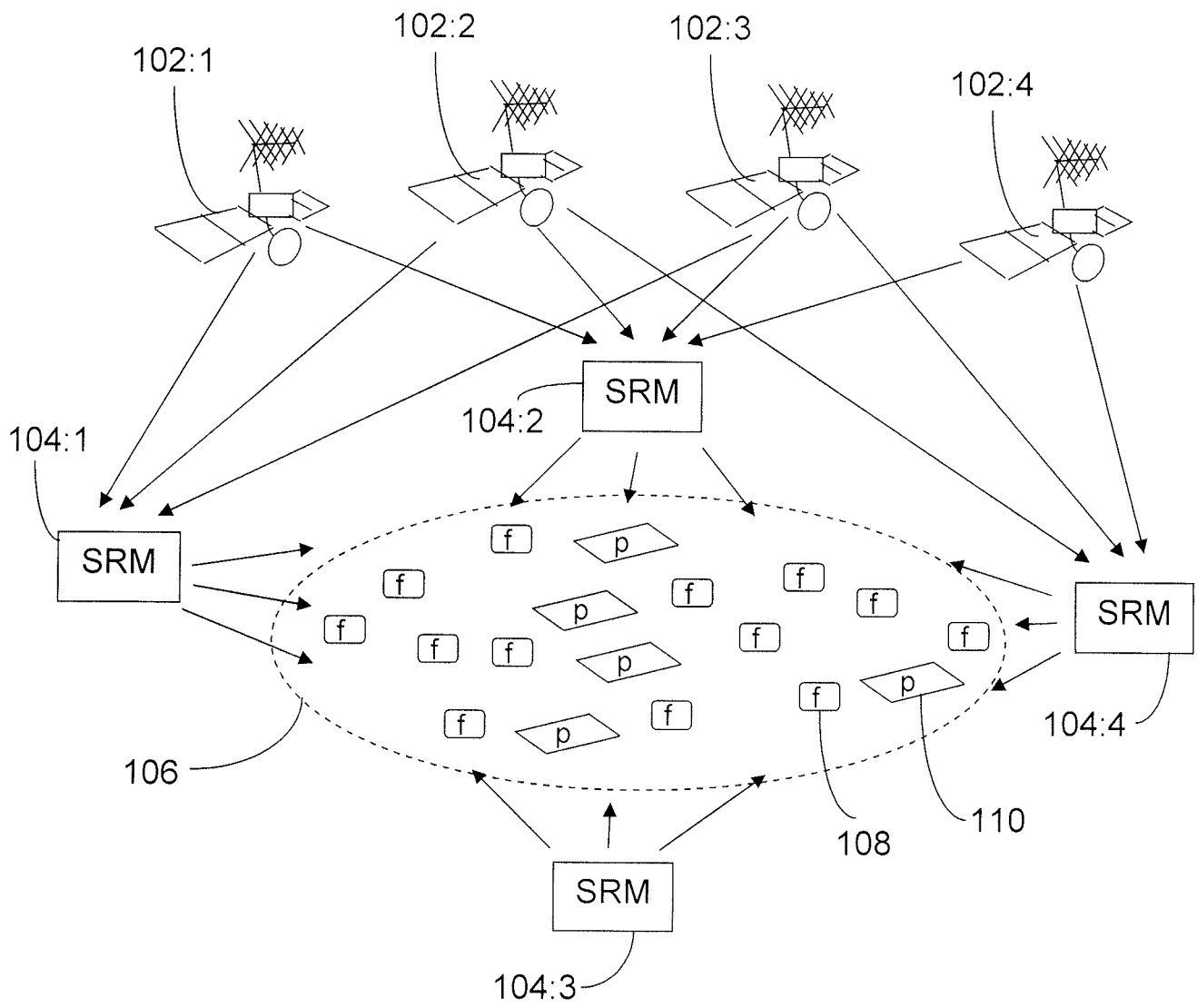


Figure 1

2/7

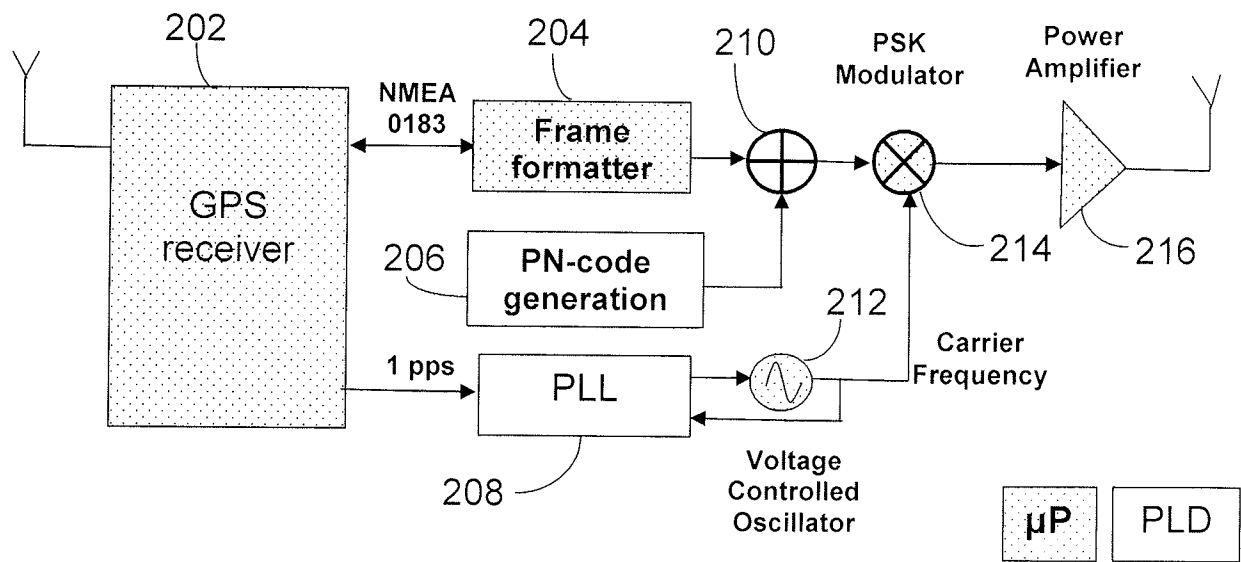
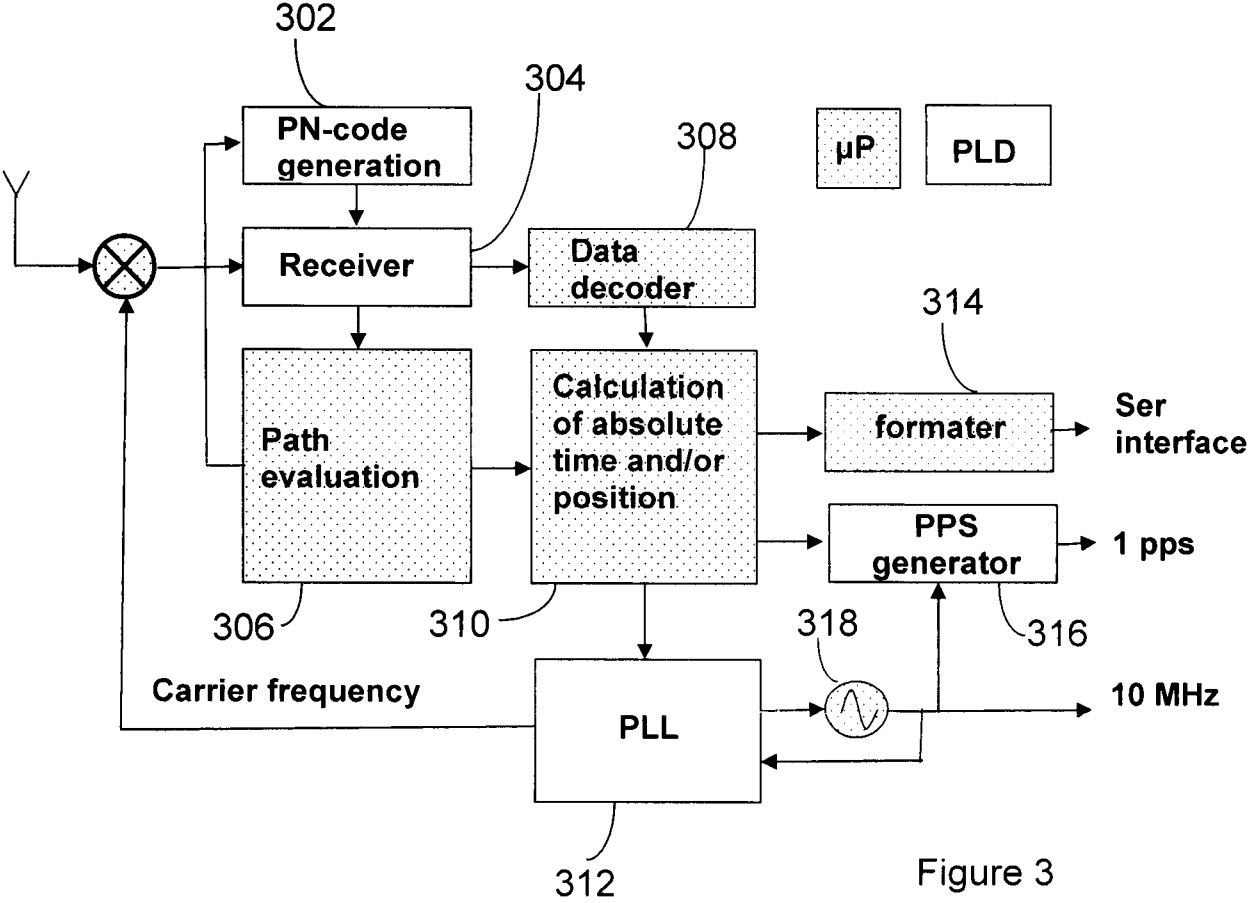


Figure 2



FRAME

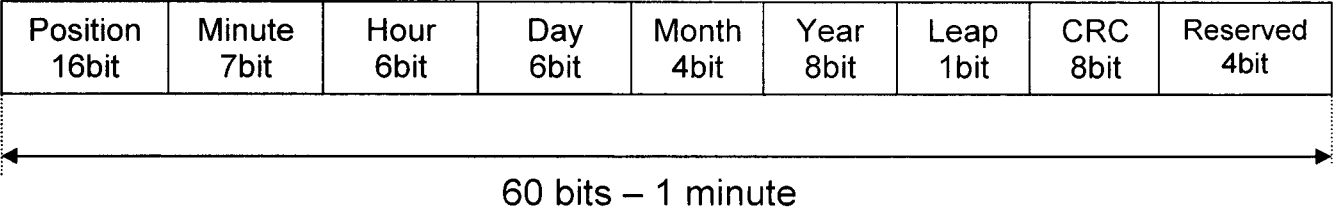


Figure 4

4/7

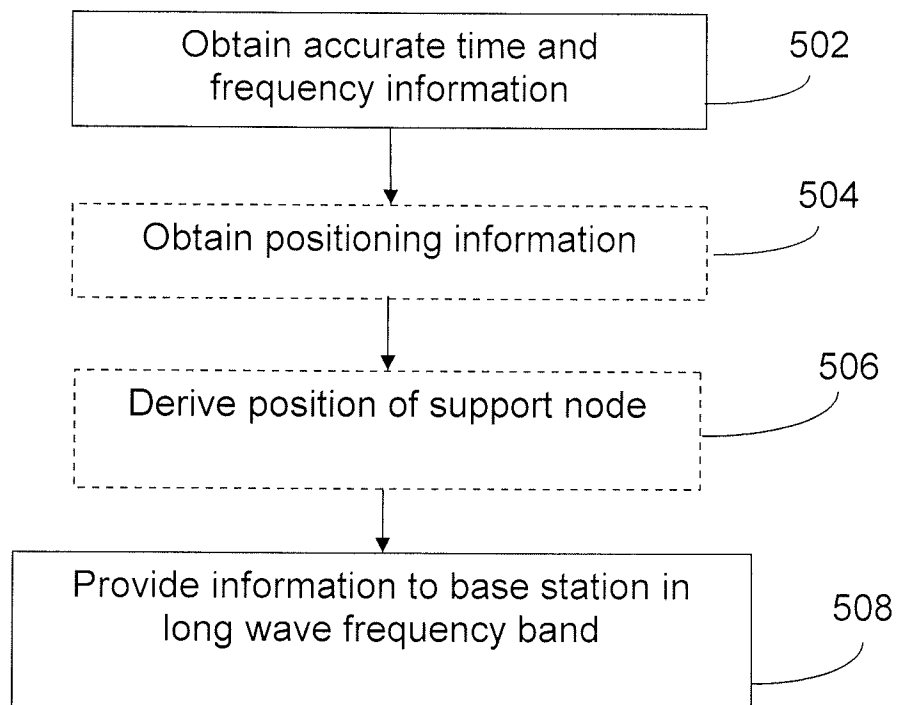


Figure 5

5/7

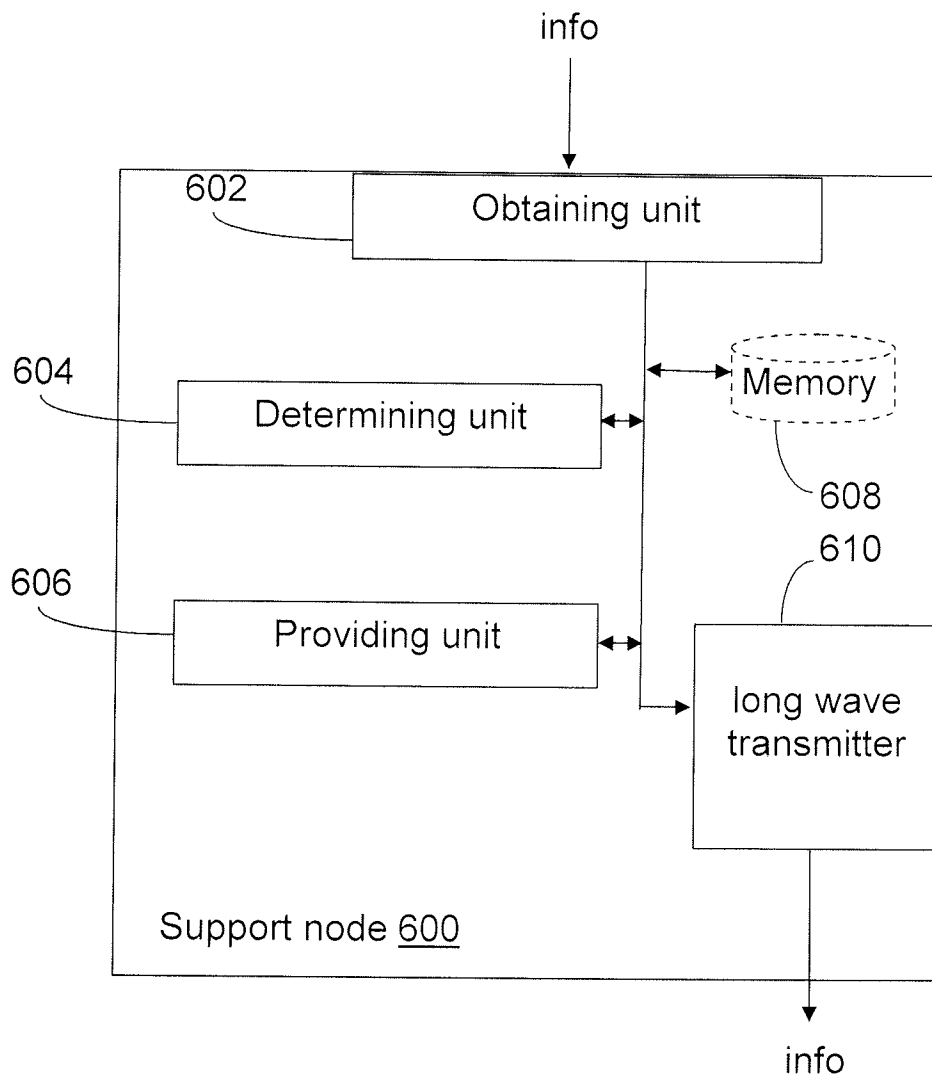


Figure 6

6/7

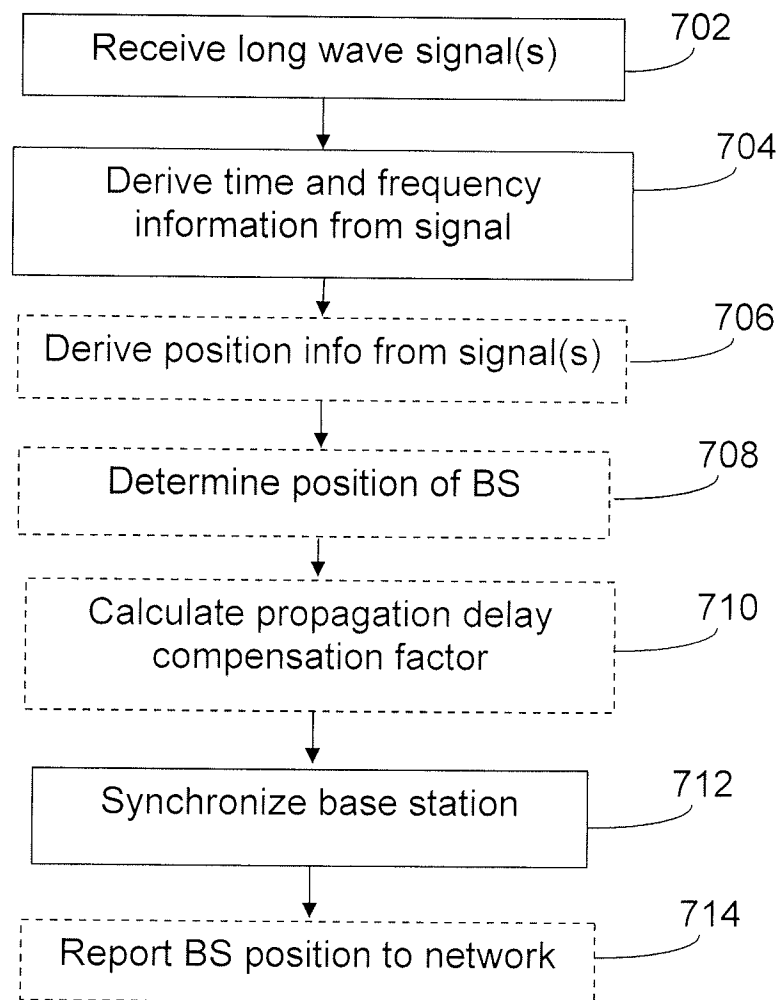


Figure 7

7/7

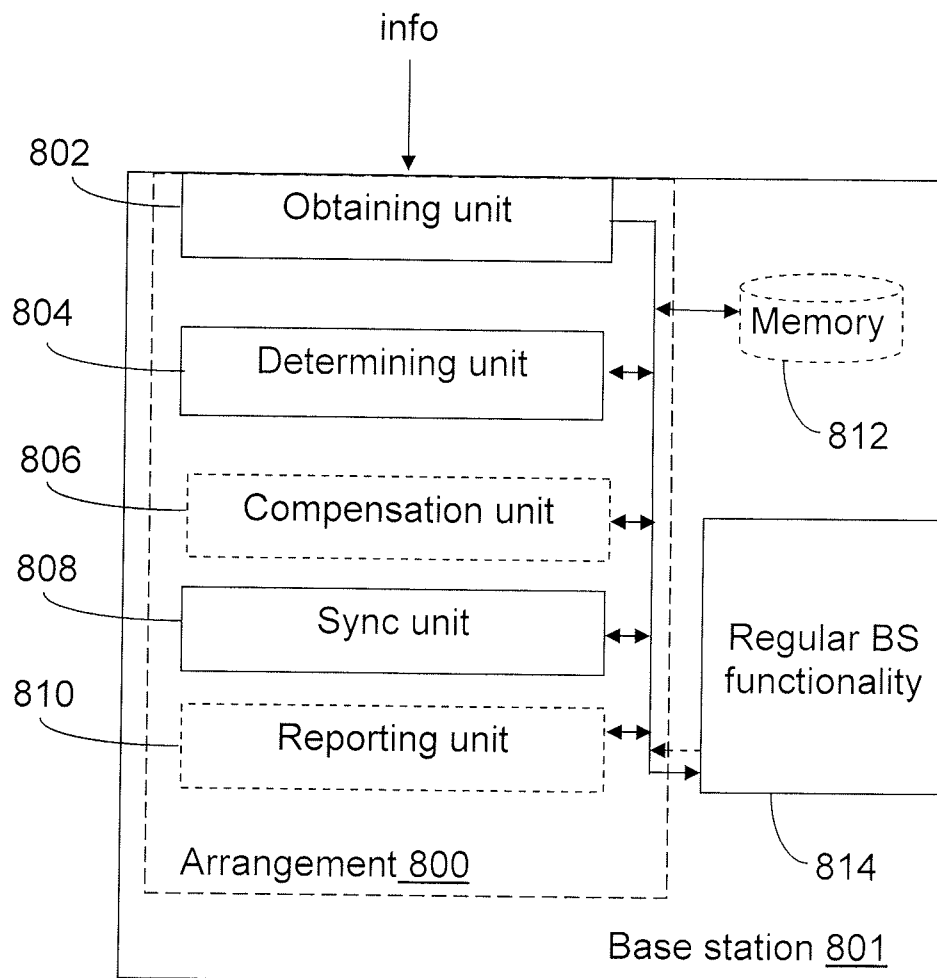


Figure 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2011/050197

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W56/00
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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	W0 94/08405 A1 (MOTOROLA INC [US]) 14 April 1994 (1994-04-14) page 2, line 28 - page 3, line 18 page 7, line 6 - line 23; figure 1 -----	1,5,7,13
X	US 6 272 118 B1 (WEWERS OTGER [DE] ET AL) 7 August 2001 (2001-08-07) column 5, line 45 - column 6, line 14; figures 2,3 -----	1,5,7,13
X	US 2004/121806 A1 (HASHIMOTO YUKIO [JP]) 24 June 2004 (2004-06-24) paragraphs [0071] - [0075]; figures 6,7 -----	1,5,7,13
A	US 2010/034190 A1 (YUN SANG-JUN [KR] ET AL) 11 February 2010 (2010-02-11) paragraphs [0005], [0011], [0018], [0064], [0072] -----	1-16



Further documents are listed in the continuation of Box C.



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

20 September 2011

Date of mailing of the international search report

27/09/2011

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

Bischof, Jean-Louis

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SE2011/050197

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9408405	A1	14-04-1994	CA 2142844 A1	14-04-1994
			CN 1088721 A	29-06-1994
			IL 107105 A	18-03-1997
			JP 3474189 B2	08-12-2003
			JP 8503822 T	23-04-1996
			US 6308077 B1	23-10-2001

US 6272118	B1	07-08-2001	AU 7278896 A	28-04-1997
			CN 1198857 A	11-11-1998
			WO 9713335 A1	10-04-1997
			DE 19536587 A1	03-04-1997
			EP 0852855 A1	15-07-1998
			ES 2136431 T3	16-11-1999

US 2004121806	A1	24-06-2004	CN 1507174 A	23-06-2004
			GB 2398459 A	18-08-2004
			HK 1065416 A1	04-05-2007
			JP 2004194086 A	08-07-2004

US 2010034190	A1	11-02-2010	KR 20080101978 A	24-11-2008
