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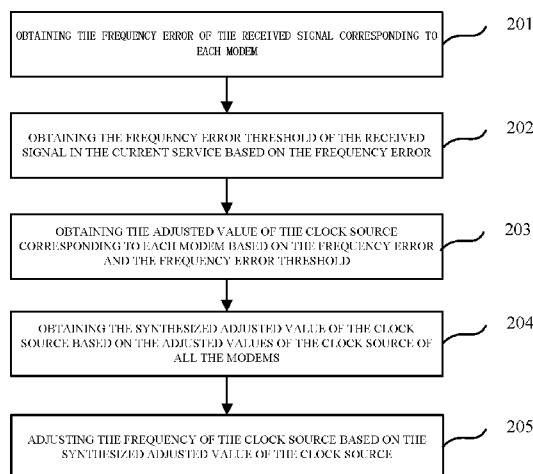
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MEDIUM FOR ADJUSTING FREQUENCY ERROR OF TERMINAL

Fig. 2

(57) Abstract: The embodiments of present invention provide a method, apparatus, mobile communication terminal, computer program and storage medium for adjusting the frequency error of the terminal, and the terminal includes a plurality of modems using a same clock source. The method includes; obtaining the frequency error of a received signal of each of the plurality of modems, wherein the frequency error is a difference between a carrier frequency of the received signal and a nominal frequency; obtaining a frequency error threshold of the received signal in a current service based on the frequency error; obtaining an adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold; obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems; and adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source. According to the embodiments, the frequency error of the mobile communication terminal can be quickly corrected as long as the frequency of the clock source is adjusted. Furthermore, as the frequency errors of the plurality of modems are all considered, the performances of the plurality of modems may be balanced.

METHOD, APPARATUS, MOBILE COMMUNICATION TERMINAL, COMPUTER PROGRAM AND STORAGE MEDIUM FOR ADJUSTING FREQUENCY ERROR OF A TERMINAL

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to a communication field, and more particularly to a method, apparatus, mobile communication terminal, computer program and storage medium for adjusting frequency error of a terminal.

DESCRIPTION OF THE PRIOR ART

[0002] Dual-SIM-Dual-Call (DSDC) is a new feature of current mobile communication terminals, which enables end users to use two different network operator's services with two SIM (Subscriber Identity Module) cards. A mobile communication terminal with DSDC feature can support two SIM cards from different operators and keep camping on the network and standby. Moreover, differing from the Dual-SIM-Dual-Standby (DSDS) technology, DSDC is able to originate or receive services from the two camped networks simultaneously. That is to say, one SIM card in a call will not impact on another SIM card browsing Internet or answering another call.

[0003] Due to the fact that different operators often use different 3G (3rd-Generation) radio access technologies, it is impossible for a single SIM card to support a mobile communication terminal to use another operator's service if the end user does not change the mobile communication terminal number. So this market demand makes that the mobile communication terminal with DSDC feature is strongly recommended by some operators and also very popular among end users.

[0004] So far there are two main structures for the mobile communication terminal with DSDC feature:

[0005] One is that there are two modem systems with different clock sources in the mobile communication terminal. Such a structure is very easy to be realized, but also in high cost.

[0006] Another one is that there are two modem systems in the mobile communication terminal, but these two modem systems use a same clock source (referring to Fig. 1), which is in low cost. These two modem systems may correct frequency error by correcting their PLL (Phase Locked Loop), but it needs a long response time. Sometimes such long response time may affect the performance of the mobile communication terminal seriously and even lead to call failure.

[0007] Thus, a method for quickly correcting the frequency error of the mobile communication terminal is desired.

SUMMARY OF THE INVENTION

[0008] The embodiments of the present invention disclose a method, apparatus, mobile communication terminal, computer program and storage medium for adjusting the frequency error of the terminal to solve the problem of being unable to quickly correcting the frequency error of the mobile communication terminal in prior art.

[0009] In some embodiments of the present invention, a method for adjusting frequency error of a terminal is provided, wherein the terminal comprises a plurality of modems using a same clock source, the method comprises:

[0010] obtaining the frequency error of a received signal of each of the plurality of modems, wherein the frequency error is a difference between a carrier frequency of the received signal and a nominal frequency;

[0011] obtaining a frequency error threshold of the received signal in a current service based on the frequency error;

[0012] obtaining a adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold;

[0013] obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems; and

[0014] adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source.

[0015] Preferably, the step of obtaining the frequency error threshold of the received signal in the current service based on the frequency error comprises:

[0016] obtaining a simulation SNR (Signal to Noise Ratio) corresponding to the frequency error;

[0017] obtaining a real SNR of the received signal;

[0018] obtaining an interference SNR of the received signal based on the simulation SNR and the real SNR, wherein the interference SNR is the SNR corresponding to all other interference effect except the frequency error;

[0019] obtaining the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service based on the interference SNR and the SNR threshold of the received signal in the current service; and

[0020] obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service.

[0021] Preferably, there is a further step before the step of obtaining the simulation SNR corresponding to the frequency error, and the further step comprises: obtaining the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on the system simulation, and thus obtaining a corresponding relationship table of the simulation SNR and the frequency error threshold;

[0022] the step of obtaining the simulation SNR corresponding to the frequency error comprises: querying the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error; and

[0023] the step of obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service comprises: querying the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

[0024] Preferably, the interference SNR of the received signal may be obtained by the following equation:

$$[0025] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

[0026] wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[0027] Preferably, the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service may be obtained by the following equation:

$$[0028] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[0029] wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and the SNR_{target} is the SNR threshold of the received signal in the current service.

[0030] Preferably, the synthesized adjusted value of the clock source may be obtained by the following equation:

$$[0031] \quad ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

$$[0032] \quad Average_i = \frac{g+h}{2}$$

$$[0033] \quad ADJ_{value} = \alpha_1 \times Average_1 + \dots + \alpha_i \times Average_i + \dots + \alpha_n \times Average_n$$

[0034] wherein ADJ_i is a range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, R_i is a frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem, ADJ_{value} is the synthesized adjusted value of the source clock, α_i is the weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is a number of the modems.

[0035] Preferably, the step of adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source comprises:

[0036] adjusting the frequency of the clock source by using the synthesized adjusted value of the clock source when the synthesized adjusted value of the clock source falls in the range of the adjusted values of the clock source corresponding to all the modems;

[0037] selecting the adjusted value of the clock source based on the following conditions when the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems:

[0038] when one of the modems is in service and the other modems are not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in service;

[0039] when one of the modems is in CS (Circuit Switching) service and the other modems are in PS (Packet Switching) service or not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in CS service;

[0040] when all the modems are all in CS service or PS service, adjusting the frequency of the clock source based on the frequency error threshold of the modem selected by a user.

[0041] In some embodiments of the present invention, an apparatus for adjusting frequency error of a terminal is provided, wherein the terminal comprises a plurality of modems using a same clock source, the apparatus comprises:

[0042] a frequency error obtaining module, being configured for obtaining the frequency error of a received signal of each of the plurality of modems, wherein the frequency error is the difference between a carrier frequency of the received signal and a nominal frequency;

[0043] a frequency error threshold obtaining module, being configured for obtaining a frequency error threshold of the received signal in a current service based on the frequency error;

[0044] a first adjusted value of clock source obtaining module, being configured for obtaining an adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold;

[0045] a second adjusted value of clock source obtaining module, being configured for obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems; and

[0046] a frequency adjusting module, being configured for adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source.

[0047] Preferably, the frequency error threshold obtaining module comprises:

[0048] a simulation SNR obtaining sub-module, being configured for obtaining a simulation SNR (Signal to Noise Ratio) corresponding to the frequency error;

[0049] a real SNR obtaining sub-module, being configured for obtaining a real SNR of the received signal;

[0050] an interference SNR obtaining sub-module, being configured for obtaining an interference SNR of the received signal based on the simulation SNR and the real SNR, wherein

the interference SNR is the SNR corresponding to all other interference effect except the frequency error;

[0051] a first obtaining sub-module, being configured for obtaining the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service based on the interference SNR and the SNR threshold of the received signal in the current service; and

[0052] a second obtaining sub-module, being configured for obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service.

[0053] Preferably, the apparatus for adjusting the frequency error of the terminal further comprises:

[0054] a relationship table generating module, being configured for obtaining the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on a system simulation, and thus obtaining a corresponding relationship table of the simulation SNR and the frequency error threshold;

[0055] the simulation SNR obtaining sub-module is further configured for querying the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error; and

[0056] the second obtaining sub-module is further configured for querying the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

[0057] Preferably, the interference SNR of the received signal may be obtained by the following equation:

[0058]
$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

[0059] wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[0060] Preferably, the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service may be obtained by the following equation:

[0061]
$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[0062] wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and the SNR_{target} is the SNR threshold of the received signal in the current service.

[0063] Preferably, the synthesized adjusted value of the clock source may be obtained by the following equation:

[0064]
$$ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

[0065]
$$Average_i = \frac{g+h}{2}$$

[0066]
$$ADJ_{value} = \alpha_1 \times Average_1 + \dots + \alpha_i \times Average_i + \dots + \alpha_n \times Average_n$$

[0067] wherein ADJ_i is a range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, R_i is a frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem, ADJ_{value} is the synthesized adjusted value of the source clock, α_i is the weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is a number of the modems.

[0068] Preferably, the frequency adjusting module comprises:

[0069] a first adjusting sub-module, being configured for adjusting the frequency of the clock source by using the synthesized adjusted value of the clock source when the synthesized adjusted value of the clock source falls in a range of the adjusted values of the clock source corresponding to all the modems;

[0070] a second adjusting sub-module, being configured for performing the following operations when the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems:

[0071] when one of the modems is in service and the other modems are not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in service;

[0072] when one of the modems is in CS (Circuit Switching) service and the other modems are in PS (Packet Switching) service or not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in CS service;

[0073] when all the modems are all in CS service or PS service, adjusting the frequency of the clock source based on the frequency error threshold of the modem selected by a user.

[0074] In some embodiments of the present invention, the mobile communication terminal is further provided, which comprises the apparatus for adjusting the frequency error of the terminal.

[0075] In some embodiments of the present invention, the computer program is further provided, which is used to implement the method for adjusting the frequency error of the terminal.

[0076] In some embodiments of the present invention, a storage medium is further provided, which is used to store the computer program.

[0077] Naturally, the present invention is not limited to the above features and advantages. In fact, many other features and advantages are obvious for those skilled in the art under the teaching of the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0078] Fig. 1 is a structure schematic diagram of the mobile communication terminal in prior art;

[0079] Fig. 2 is a schematic flowchart of a method for adjusting the frequency error of the terminal according to a first embodiment of the present invention;

[0080] Fig. 3 is a schematic flowchart of a method for adjusting the frequency error of the terminal according to a second embodiment of the present invention;

[0081] Fig. 4 is a corresponding relationship table for the frequency error threshold and a signal to noise ratio (SNR) according to the embodiments of the present invention;

[0082] Fig. 5 is a corresponding relationship table for the frequency error and a control value of a clock source according to the embodiments of the present invention; and

[0083] Fig. 6 is a structure block diagram of an apparatus for adjusting the frequency error of the terminal according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0084] The First Embodiment

[0085] Fig. 2 shows the schematic flowchart of the method for adjusting the frequency error of the terminal according to the first embodiment of the present invention. The terminal in the present embodiment may be a mobile communication terminal, which may include a plurality of modems using a same clock source. The method for adjusting the frequency error of the terminal may include the following steps:

[0086] Step 201: obtaining the frequency error of a received signal of each of the plurality of modems, and the frequency error may be a difference between a carrier frequency of the received signal of the modem and a nominal frequency;

[0087] Because the frequency error obtained by such calculation in this step does not consider the factor of current service of the modem, this frequency error may not be directly used for calculating the corresponding adjusted value of the clock source.

[0088] Step 202: obtaining a frequency error threshold of the received signal in the current service based on the frequency error;

[0089] Step 203: obtaining an adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold;

[0090] Step 204: obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems;

[0091] Step 205: adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source.

[0092] According to the method of the above embodiment, the frequency error of the mobile communication terminal can be quickly corrected as long as the frequency of the clock source is adjusted. Furthermore, as the frequency errors of the plurality of modems are all considered, the performances of the plurality of modems may be balanced.

[0093] In the above step 202, the frequency error threshold of the received signal of the modem in the current service can be obtained in many ways, which are illustrated as follows by example.

[0094] The Second Embodiment

[0095] According to the system simulation, the frequency error of the received signal and the SNR correspond to each other in the predetermined service. The greater the frequency error

is, the lower the SNR is. In the embodiments of the present invention, the frequency error threshold of the received signal in the predetermined service may be obtained by means of the above correspondence.

[0096] Furthermore, in the embodiments of the present invention, the interference of the received single may be divided into two parts, one of which is the frequency error effect, and the other one of which is all other interference effect. In the embodiments of the present invention, the SNR corresponding to all other interference effect may be calculated first, and then the SNR corresponding to the frequency error capable of being tolerable by the received signal may be calculated based on the SNR threshold of the received signal of the modem in the current service and the SNR corresponding to all other interference effect obtained by calculation, thus the frequency error threshold of the received signal is obtained.

[0097] Fig. 3 shows the schematic flowchart of the method for adjusting the frequency error of the terminal according to the second embodiment of the present invention. The terminal in the present embodiment may be a mobile communication terminal, which may include a plurality of modems using the same clock source. The method for adjusting the frequency error of the terminal may include the following steps:

[0098] Step 301: obtaining the frequency error of a received signal of each of the plurality of modems, and the frequency error may be a difference between a carrier frequency of the received signal of the modem and a nominal frequency;

[0099] Step 302: obtaining a simulation SNR corresponding to the frequency error;

[00100] Step 303: obtaining a real SNR corresponding to the received signal;

[00101] Step 304: obtaining an interference SNR of the received signal based on the simulation SNR and the real SNR, and the interference SNR may be the SNR corresponding to all other interference effect except the frequency error;

[00102] The interference SNR of the received signal may be obtained by the following equation:

$$[00103] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

[00104] Wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[00105] Step 305: obtaining the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service based on the interference SNR and the SNR threshold of the received signal in the current service;

[00106] The SNR corresponding to the frequency error capable of being tolerable by the modem in the current service may be obtained by the following equation:

$$[00107] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[00108] Wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and SNR_{target} is the SNR threshold of the received signal in the current service.

[00109] Step 306: obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service;

[00110] Step 307: obtaining the adjusted value of the clock source corresponding to each of the plurality of modems based on the frequency error and the frequency error threshold;

[00111] The adjusted value of the clock source corresponding to the modem may be obtained by the following equation:

$$[00112] \quad ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

$$[00113] \quad Average_i = \frac{g+h}{2}$$

[00114] Wherein ADJ_i is a range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, and R_i is the frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem.

[00115] Step 308: obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems;

[00116] The synthesized adjusted value of the clock source may be obtained by the following equation:

$$[00117] \quad ADJ_{value} = \alpha_1 \times Average_1 + \dots + \alpha_i \times Average_i + \dots + \alpha_n \times Average_n$$

[00118] Wherein ADJ_{value} is the synthesized adjusted value of the source clock, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, α_i is a weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is a number of the modems.

[00119] Wherein the weight corresponding to each modem may be set as required, and it may be assumed that the terminal includes two modems, and the weight corresponding to each of the modems may be 0.5, or it may be assumed that one of the modems is more important and the weight thereof may be set to 0.6 and the weight of the other modem may be set to 0.4.

[00120] Step 309: adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source.

[00121] Naturally, the simulation SNR in the above step 302 may be obtained by a system simulation, thus the following steps may be added before the step 302: obtaining the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on the system simulation, and thus obtaining the corresponding relationship table of the simulation SNR and the frequency error threshold. Fig. 4 shows an example of such corresponding relationship table. In Fig. 4, the communication standard may include TD-SCDMA (Time Division-Synchronous Code Division Multiple Access), WCDMA (Wideband Code Division Multiple Access), and so on, and the service may include CS (Circuit Switching) service, PS (Packet Switching) service, and so on.

[00122] In this regard, the step 302 may be embodied as follows: querying the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error.

[00123] The step 305 may be embodied as follows: querying the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

[00124] According to the method of the above embodiment, the frequency error threshold of the received signal of the modem in the current service can be quickly obtained by querying

the corresponding relationship table of the frequency error threshold and the SNR which may be obtained by simulation in advance, thus the efficiency for correcting the frequency error of the mobile communication terminal can be further improved.

[00125] There are two cases for the synthesized adjusted value of the clock source in the above embodiment:

[00126] Case 1: the synthesized adjusted value of the clock source falls in the range of the adjusted values of the clock source corresponding to all the modems. In this case, the frequency of the clock source may be adjusted based on the synthesized adjusted value of the clock source.

[00127] Case 2: the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems. In this case, the following steps may be carried out:

[00128] When one of the modems is in service and the other modems are not in service (for example, in idle or in registering mode), the frequency of the clock source may be adjusted based on the frequency error threshold of the modem being in service;

[00129] When one of the modems is in CS service and the other modems are in PS service or not in service, the frequency of the clock source may be adjusted based on the frequency error threshold of the modem being in CS service;

[00130] When all the modems are all in CS service or PS service, the frequency of the clock source may be adjusted based on the frequency error threshold of the modem selected by a user.

[00131] Because such steps consider the current service of the modem and the user's selection, the correction result of the frequency error of the terminal is more accurate.

[00132] The Third Embodiment

[00133] In the following, for example, it is assumed that the terminal for carrying out the method of adjusting the frequency error of the terminal is a mobile communication terminal including two modems to specifically describe the method of adjusting the frequency error of the terminal.

[00134] It should be noted that the two modems in the present embodiment (modem A and modem B) may work at the same time and use a same clock source, each of the two modems may support CS service and PS service, and the mobile communication terminal is also called a DSDC terminal.

[00135] (1) Firstly, the adjusted values of the clock source corresponding to modem A and modem B may be calculated.

[00136] For modem A:

[00137] 1) Obtaining the frequency error of the received signal corresponding to modem A, wherein the frequency error is the difference between the carrier frequency of the received signal corresponding to modem A and the nominal frequency;

[00138] 2) Querying the table as shown in Fig. 4 to obtain the simulation SNR corresponding to the frequency error;

[00139] 3) Obtaining the real SNR of the received signal corresponding to modem A;

[00140] 4) Obtaining the interference SNR of the received signal corresponding to modem A based on the simulation SNR and the real SNR, wherein the interference SNR is the SNR corresponding to all other interference effect excepting the frequency error;

[00141] The interference SNR of the received signal may be obtained by the following equation:

$$[00142] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

[00143] Wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[00144] 5) Obtaining the SNR corresponding to the frequency error capable of being tolerable by modem A in the current service based on the interference SNR and the SNR threshold of the received signal in the current service;

[00145] The SNR corresponding to the frequency error capable of being tolerable by modem A in the current service may be obtained by the following equation:

$$[00146] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[00147] Wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by modem A in the current service, and SNR_{target} is the SNR threshold of the received signal in the current service. As the current service of modem A is known, the SNR threshold of the current service may be obtained by querying 3GPP (the 3rd Generation Partner Project) standard.

[00148] 6) Querying the table as shown in Fig. 4 based on the SNR corresponding to the frequency error capable of being tolerable by modem A in the current service to obtain the

frequency error threshold Range_A of the received signal in the current service, and it is assumed that the range of Range_A is $(-\Delta f_A, \Delta f_A)$;

[00149] 7) Obtaining the adjusted value of the clock source corresponding to modem A based on the frequency error and the frequency error threshold of modem A;

[00150] Wherein the adjusted value of the clock source corresponding to modem A may be as follows:

$$[00151] \quad \text{ADJ}_A = \left\{ \frac{-\Delta f_A - \Delta f_{AC}}{R_A}, \frac{\Delta f_A - \Delta f_{AC}}{R_A} \right\} = \{a, b\}$$

$$[00152] \quad \text{Average}_A = \frac{a+b}{2}$$

[00153] Wherein ADJ_A is the range of the adjusted value of the clock source corresponding to modem A, Δf_{AC} is the frequency error of the received signal of modem A, $(-\Delta f_A, \Delta f_A)$ is the frequency error threshold of the received signal of modem A, Average_A is the adjusted value of the clock source corresponding to modem A, and R_A is a frequency ratio between the carrier frequency of the received signal and the frequency of clock source of modem A.

[00154] For modem B:

[00155] 1) Obtaining the frequency error of the received signal corresponding to modem B, wherein the frequency error is the difference between the carrier frequency of the received signal corresponding to modem B and the nominal frequency;

[00156] 2) Querying the table as shown in Fig. 4 to obtain the simulation SNR corresponding to the frequency error;

[00157] 3) Obtaining the real SNR of the received signal corresponding to modem B;

[00158] 4) Obtaining the interference SNR of the received signal corresponding to modem B based on the simulation SNR and the real SNR, wherein the interference SNR is the SNR corresponding to all other interference effect excepting the frequency error;

[00159] The interference SNR of the received signal may be obtained by the following equation:

$$[00160] \quad \frac{1}{\text{SNR}_{\text{interference}}} + \frac{1}{\text{SNR}_{FE}} = \frac{1}{\text{SNR}_{\text{real}}}$$

[00161] Wherein, $\text{SNR}_{\text{interference}}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[00162] 5) Obtaining the SNR corresponding to the frequency error capable of being tolerable by modem B in the current service based on the interference SNR and the SNR threshold of the received signal in the current service;

[00163] The SNR corresponding to the frequency error capable of being tolerable by modem B in the current service may be obtained by the following equation:

$$[00164] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[00165] Wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by modem B in the current service, and SNR_{target} is the SNR threshold of the received signal in the current service. As the current service of modem B is known, the SNR threshold of the current service may be obtained by querying 3GPP standard.

[00166] 6) Querying the table as shown in Fig. 4 based on the SNR corresponding to the frequency error capable of being tolerable by modem B in the current service to obtain the frequency error threshold $Range_B$ of the received signal in the current service, and it is assumed that the range of $Range_B$ is $(-\Delta f_B, \Delta f_B)$;

[00167] 7) Obtaining the adjusted value of the clock source corresponding to modem B based on the frequency error and the frequency error threshold of modem B;

[00168] Wherein the adjusted value of the clock source corresponding to modem B may be as follows:

$$[00169] \quad ADJ_B = \left\{ \frac{-\Delta f_B - \Delta f_{BC}}{R_B}, \frac{\Delta f_B - \Delta f_{BC}}{R_B} \right\} = \{c, d\}$$

$$[00170] \quad Average_B = \frac{c+d}{2}$$

[00171] Wherein ADJ_B is the range of the adjusted value of the clock source corresponding to modem B, Δf_{BC} is the frequency error of the received signal of modem B, $(-\Delta f_B, \Delta f_B)$ is the frequency error threshold of the received signal of modem B, $Average_B$ is the adjusted value of the clock source corresponding to modem B, and R_B is the frequency ratio between the carrier frequency of the received signal and the frequency of clock source of modem B.

[00172] (3) Then, acquiring the synthesized adjusted value of the clock source based on the adjusted values of the clock source of modem A and modem B;

$$[00173] \quad ADJ_{value} = \alpha \times Average_A + \beta \times Average_B$$

[00174] Wherein ADJ_{value} is the synthesized adjusted value of the clock source, α is the weight corresponding to modem A, and β is the weight corresponding to modem B.

[00175] There may exist two cases for the obtained synthesized adjusted value of the clock source:

[00176] Case 1: If $ADJ_{value} \in ADJ_A$ and $ADJ_{value} \in ADJ_B$, ADJ_{value} is good for both of the modems. Therefore, the frequency of the clock source may be adjusted based on ADJ_{value} . More specifically, the frequency of the clock source may be adjusted based on the corresponding relationship table of the frequency error and the controlled value of the clock source as shown in Fig. 5, and the corresponding relationship table in Fig. 5 may be obtained by a system simulation.

[00177] Case 2: If $ADJ_{value} \notin ADJ_A$ and $ADJ_{value} \notin ADJ_B$, a selection should be made between two modems:

[00178] When one of the modems is in service and the other modem is not in service (for example, in idle or in registering mode), the frequency of the clock source may be adjusted based on the frequency error threshold of the modem being in service;

[00179] When one of the modems is in CS service and the other modem is in PS service or not in service, the frequency of the clock source may be adjusted based on the frequency error threshold of the modem being in CS service;

[00180] When both of the modems are both in CS service or PS service, the frequency of the clock source may be adjusted based on the frequency error threshold of the modem selected by a user.

[00181] (4) In the end, the frequency of the clock source may be adjusted based on the synthesized adjusted value of the clock source.

[00182] An embodiment of the present invention provides a computer program for implementing the method for adjusting the frequency error of the terminal.

[00183] A further embodiment of the present invention provides a storage medium for storing the computer program.

[00184] The Fourth Embodiment

[00185] Fig. 6 shows a structure block diagram of an apparatus for adjusting the frequency error of the terminal according to the fourth embodiment of the present invention, and the terminal includes a plurality of modems using a same clock source. The apparatus may include:

[00186] A frequency error obtaining module 601, being configured for obtaining the frequency error of a received signal of each of the plurality of modems, wherein the frequency error may be the difference between a carrier frequency of the received signal and a nominal frequency;

[00187] A frequency error threshold obtaining module 602, being configured for obtaining the frequency error threshold of the received signal in the current service based on the frequency error;

[00188] A first adjusted value of clock source obtaining module 603, being configured for obtaining the adjusted value of the clock source corresponding to each of the plurality of modems based on the frequency error and the frequency error threshold;

[00189] The adjusted value of the clock source corresponding to each modem may be obtained by the following equation:

$$[00190] \quad ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

$$[00191] \quad Average_i = \frac{g+h}{2}$$

[00192] Wherein ADJ_i is the range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, and R_i is the frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem.

[00193] A second adjusted value of clock source obtaining module 604, being configured for obtaining the synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems;

[00194] The synthesized adjusted value of the clock source may be obtained by the following equation:

$$[00195] \quad ADJ_{value} = \alpha_1 \times Average_1 + \cdots \alpha_i \times Average_i + \cdots + \alpha_n \times Average_n$$

[00196] Wherein ADJ_{value} is the synthesized adjusted value of the source clock, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, α_i is a

weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is a number of the modems.

[00197] A frequency adjusting module 605, being configured for adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source.

[00198] According to the apparatus of the above embodiment, the frequency error of the mobile communication terminal can be quickly corrected as long as the frequency of the clock source is adjusted. Furthermore, as the frequency errors of the plurality of modems are all considered, the performances of the plurality of modems may be balanced.

[00199] According to the system simulation, the frequency error of the received signal and the SNR correspond to each other in the predetermined service. The greater the frequency error is, the lower the SNR is. In the embodiment of the present invention, the frequency error threshold of the received signal in the predetermined service may be obtained by means of the above correspondence.

[00200] Specifically, the frequency error threshold obtaining module 602 may include:

[00201] A simulation SNR obtaining sub-module, being configured for obtaining a simulation SNR corresponding to the frequency error;

[00202] A real SNR obtaining sub-module, being configured for obtaining a real SNR of the received signal;

[00203] An interference SNR obtaining sub-module, being configured for obtaining an interference SNR of the received signal based on the simulation SNR and the real SNR, wherein the interference SNR may be the SNR corresponding to all other interference effect except the frequency error;

[00204] The interference SNR of the received signal may be obtained by the following equation:

[00205]
$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

[00206] Wherein, $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

[00207] A first obtaining sub-module, being configured for obtaining the SNR corresponding to the frequency error capable of being tolerable by the modem in the current

service based on the interference SNR and the SNR threshold of the received signal in the current service;

[00208] The SNR corresponding to the frequency error capable of being tolerable by the modem in the current service may be obtained by the following equation:

$$[00209] \quad \frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

[00210] Wherein, $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and the SNR_{target} is the SNR threshold of the received signal in the current service.

[00211] A second obtaining sub-module, being configured for obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service.

[00212] The apparatus for adjusting the frequency error of the terminal may also include:

[00213] A relationship table generating module, being configured for obtaining the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on the system simulation, and thus obtaining the corresponding relationship table of the simulation SNR and the frequency error threshold;

[00214] Then, the simulation SNR obtaining sub-module is further configured for querying the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error.

[00215] The second obtaining sub-module is further configured for querying the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

[00216] The frequency adjusting module 605 may include:

[00217] A first adjusting sub-module, being configured for adjusting the frequency of the clock source by using the synthesized adjusted value of the clock source when the synthesized adjusted value of the clock source falls in the range of the adjusted values of the clock source corresponding to all the modems;

[00218] A second adjusting sub-module, being configured for performing the following operations when the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems:

[00219] When one of the modems is in service and the other modems are not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in service;

[00220] When one of the modems is in CS service and the other modems are in PS service or not in service, adjusting the frequency of the clock source based on the frequency error threshold of the modem being in CS service; and

[00221] When all the modems are all in CS service or PS service, adjusting the frequency of the clock source based on the frequency error threshold of the modem selected by a user.

[00222] A further embodiment of the present invention provides a mobile communication terminal including the apparatus for adjusting the frequency error of the terminal.

What is claimed is:

1. A method for adjusting frequency error of a terminal, wherein the terminal comprises a plurality of modems using a same clock source, the method comprising:

obtaining a frequency error of a received signal of each of the plurality of modems, wherein the frequency error is a difference between a carrier frequency of the received signal and a nominal frequency;

obtaining a frequency error threshold of the received signal in a current service based on the frequency error;

obtaining an adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold;

obtaining a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems; and

adjusting a frequency of the clock source based on the synthesized adjusted value of the clock source.

2. The method for adjusting the frequency error of the terminal according to claim 1, wherein the step of obtaining the frequency error threshold of the received signal in the current service based on the frequency error comprises:

obtaining a simulation Signal to Noise Ratio (SNR) corresponding to the frequency error;

obtaining a real SNR of the received signal;

obtaining an interference SNR of the received signal based on the simulation SNR and the real SNR, wherein the interference SNR is the SNR corresponding to all other interference effect except the frequency error;

obtaining the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service based on the interference SNR and the SNR threshold of the received signal in the current service; and

obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service.

3. The method for adjusting the frequency error of the terminal according to claim 2, wherein

before the step of obtaining the simulation SNR corresponding to the frequency error, and the method further comprises: obtaining the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on a system simulation, and thus obtaining a corresponding relationship table of the simulation SNR and the frequency error threshold;

the step of obtaining the simulation SNR corresponding to the frequency error comprises: querying the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error; and

the step of obtaining the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service comprises: querying the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

4. The method for adjusting the frequency error of the terminal according to claim 2 or 3, wherein the interference SNR of the received signal is obtained by the following equation:

$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

5. The method for adjusting the frequency error of the terminal according to claim 2 or 3, wherein the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service is obtained by the following equation:

$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and the SNR_{target} is the SNR threshold of the received signal in the current service.

6. The method for adjusting the frequency error of the terminal according to claim 1, wherein the synthesized adjusted value of the clock source is obtained by the following equation:

$$ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

$$Average_i = \frac{g + h}{2}$$

$$ADJ_{value} = \alpha_1 \times Average_1 + \dots + \alpha_i \times Average_i + \dots + \alpha_n \times Average_n$$

wherein ADJ_i is a range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, R_i is a frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem, ADJ_{value} is the synthesized adjusted value of the source clock, α_i is a weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is the number of the modems.

7. The method for adjusting the frequency error of the terminal according to claim 1, wherein the step of adjusting the frequency of the clock source based on the synthesized adjusted value of the clock source comprises:

adjusting the frequency of the clock source by using the synthesized adjusted value of the clock source when the synthesized adjusted value of the clock source falls in the range of the adjusted values of the clock source corresponding to all the modems;

selecting the adjusted value of the clock source based on the following conditions when the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems:

adjusting the frequency of the clock source based on the frequency error threshold of the modem being in service when one of the modems is in service and the other modems are not in service;

adjusting the frequency of the clock source based on the frequency error threshold of the modem being in CS service when one of the modems is in Circuit Switching (CS) service and the other modems are in Packet Switching (PS) service or not in service;

adjusting the frequency of the clock source based on the frequency error threshold of the modem selected by a user when all the modems are in CS service or PS service.

8. An apparatus for adjusting frequency error of a terminal, wherein the terminal comprises a plurality of modems using a same clock source, the apparatus comprising:

a frequency error obtaining module, configured to obtain a frequency error of a received signal of each of the plurality of modems, wherein the frequency error is a difference between a carrier frequency of the received signal and a nominal frequency;

a frequency error threshold obtaining module, configured to obtain a frequency error threshold of the received signal in a current service based on the frequency error;

a first adjusted value of clock source obtaining module, configured to obtain an adjusted value of the clock source corresponding to each modem based on the frequency error and the frequency error threshold;

a second adjusted value of clock source obtaining module, configured to obtain a synthesized adjusted value of the clock source based on the adjusted values of the clock source of all the modems; and

a frequency adjusting module, configured to adjust the frequency of the clock source based on the synthesized adjusted value of the clock source.

9. The apparatus for adjusting the frequency error of the terminal according to claim 8, wherein the frequency error threshold obtaining module comprises:

a simulation SNR (Signal to Noise Ratio) obtaining sub-module, configured to obtain a simulation SNR corresponding to the frequency error;

a real SNR obtaining sub-module, configured to obtain a real SNR of the received signal;

an interference SNR obtaining sub-module, configured to obtain an interference SNR of the received signal based on the simulation SNR and the real SNR, wherein the interference SNR is the SNR corresponding to all other interference effect except the frequency error;

a first obtaining sub-module, configured to obtain the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service based on the interference SNR and the SNR threshold of the received signal in the current service; and

a second obtaining sub-module, configured to obtain the frequency error threshold of the received signal in the current service based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service.

10. The apparatus for adjusting the frequency error of the terminal according to claim 9, wherein the apparatus further comprises:

a relationship table generating module, configured to obtain the simulation SNR and the frequency error threshold of the received signal when all the modems execute the predetermined services in corresponding communication standards based on a system simulation, and thus obtaining a corresponding relationship table of the simulation SNR and the frequency error threshold;

wherein the simulation SNR obtaining sub-module is further configured to query the corresponding relationship table based on the frequency error to obtain the simulation SNR corresponding to the frequency error; and

the second obtaining sub-module is further configured to query the corresponding relationship table based on the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, to obtain the frequency error threshold corresponding to the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service as the frequency error threshold of the received signal.

11. The apparatus for adjusting the frequency error of the terminal according to claim 8 or 9, wherein the interference SNR of the received signal is obtained by the following equation:

$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE}} = \frac{1}{SNR_{real}}$$

wherein $SNR_{interference}$ is the interference SNR, SNR_{FE} is the simulation SNR, and SNR_{real} is the real SNR.

12. The apparatus for adjusting the frequency error of the terminal according to claim 8 or 9, wherein the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service is obtained by the following equation:

$$\frac{1}{SNR_{interference}} + \frac{1}{SNR_{FE_required}} = \frac{1}{SNR_{target}}$$

wherein $SNR_{interference}$ is the interference SNR, $SNR_{FE_required}$ is the SNR corresponding to the frequency error capable of being tolerable by the modem in the current service, and the SNR_{target} is the SNR threshold of the received signal in the current service.

13. The apparatus for adjusting the frequency error of the terminal according to claim 8, wherein the synthesized adjusted value of the clock source is obtained by the following equation:

$$ADJ_i = \left\{ \frac{-\Delta f_p - \Delta f_i}{R_i}, \frac{\Delta f_p - \Delta f_i}{R_i} \right\} = \{g, h\}$$

$$Average_i = \frac{g + h}{2}$$

$$ADJ_{value} = \alpha_1 \times Average_1 + \dots + \alpha_i \times Average_i + \dots + \alpha_n \times Average_n$$

wherein ADJ_i is a range of the adjusted value of the clock source corresponding to the i th modem, Δf_i is the frequency error of the received signal of the i th modem, $(-\Delta f_p, \Delta f_p)$ is the frequency error threshold of the received signal of the i th modem, $Average_i$ is the adjusted value of the clock source corresponding to the i th modem, R_i is a frequency ratio between the carrier frequency of the received signal and the frequency of clock source of the i th modem, ADJ_{value} is the synthesized adjusted value of the source clock, α_i is a weight corresponding to the i th modem, and α_i is greater than 0 and less than 1, $\alpha_1 + \dots + \alpha_i + \dots + \alpha_n = 1$, and n is the number of the modems.

14. The apparatus for adjusting the frequency error of the terminal according to claim 8, wherein the frequency adjusting module comprises:

a first adjusting sub-module, configured to adjust the frequency of the clock source by using the synthesized adjusted value of the clock source when the synthesized adjusted value of the clock source falls in the range of the adjusted values of the clock source corresponding to all the modems;

a second adjusting sub-module, configured to perform the following operations when the synthesized adjusted value of the clock source does not fall in the range of the adjusted values of the clock source corresponding to all the modems:

the second adjusting sub-module, configured to adjust the frequency of the clock source based on the frequency error threshold of the modem being in service when one of the modems is in service and the other modems are not in service;

the second adjusting sub-module, configured to adjust the frequency of the clock source based on the frequency error threshold of the modem being in CS service when one of the modems is in CS service and the other modems are in PS service or not in service;

the second adjusting sub-module, configured to adjust the frequency of the clock source based on the frequency error threshold of the modem selected by a user when all the modems are in CS service or PS service.

15. A mobile communication terminal, wherein the mobile communication terminal comprises the apparatus for adjusting the frequency error of the terminal according to any one of claims 8-14.

16. A computer program, wherein the computer program is used to implement the method for adjusting the frequency error of the terminal according to any one of claims 1-7.

17. A storage medium, wherein the storage medium is used to store the computer program according to claim 16.

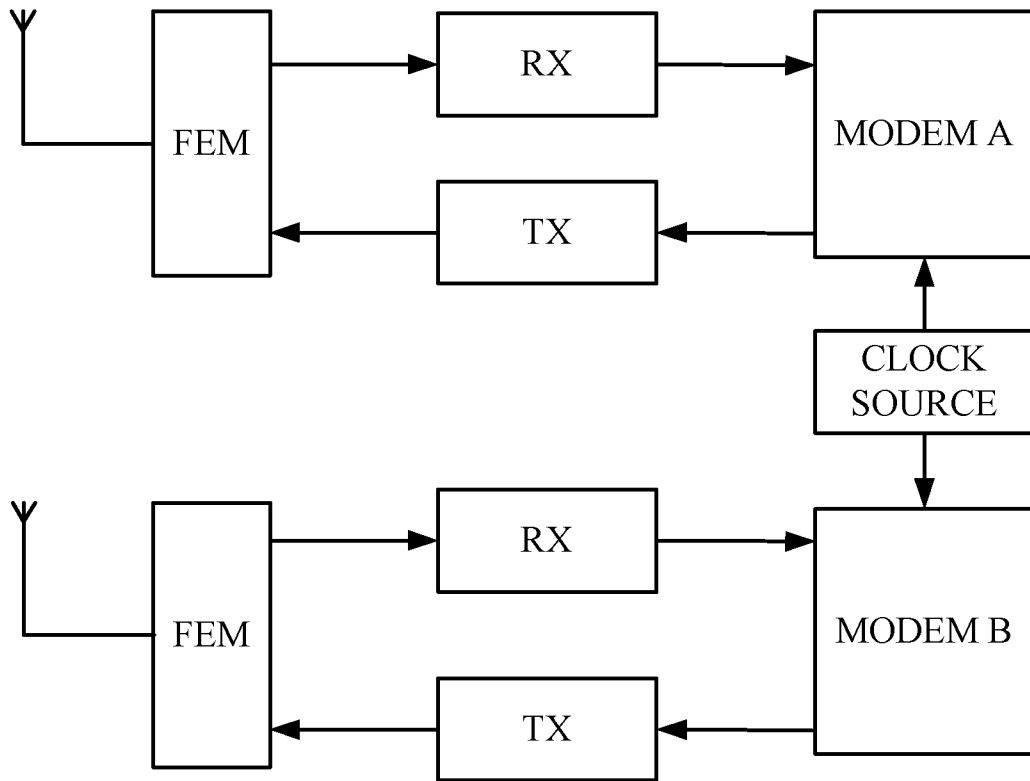


FIG. 1

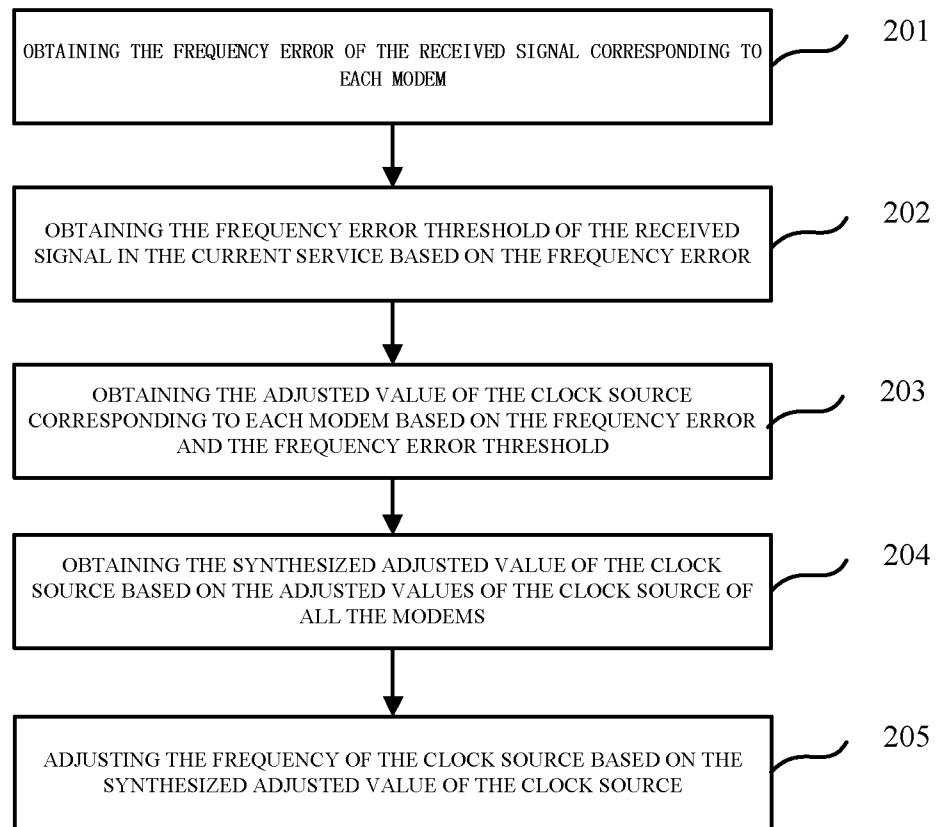


Fig. 2

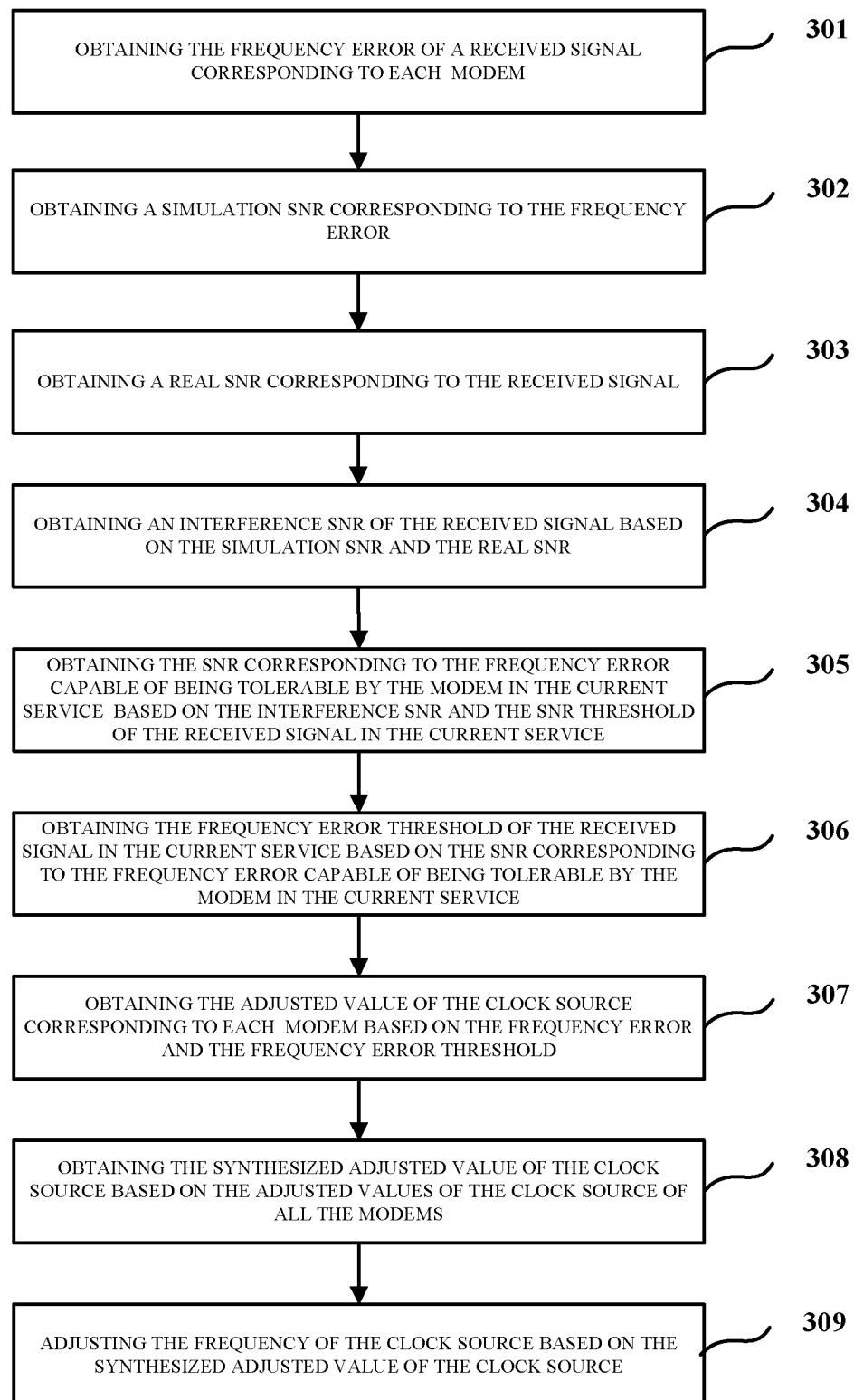


FIG. 3

	SERVICE TYPE	FREQUENCY ERROR THRESHOLD		
		SNR	UPPER LIMIT	LOWER LIMIT
COMMUNICATION STANDARD	Service 1	SNR ₁	Δf_{111}	$-\Delta f_{111}$
		SNR ₂	Δf_{112}	$-\Delta f_{112}$
		...	...	...
		SNR _n	Δf_{11n}	$-\Delta f_{11n}$
	...	...	...	...
	Service n	SNR ₁	Δf_{1n1}	$-\Delta f_{1n1}$
		SNR ₂	Δf_{1n2}	$-\Delta f_{1n2}$
		...	...	...
		SNR _n	Δf_{1nn}	$-\Delta f_{1nn}$
	...	...	...	...

FIG. 4

FREQUENCY ERROR(Hz)	INCREMENT OF THE CONTROLLED VALUE OF THE CLOCK SOURCE
Δf_1	value ₁
...	...
Δf_n	value _n

FIG. 5

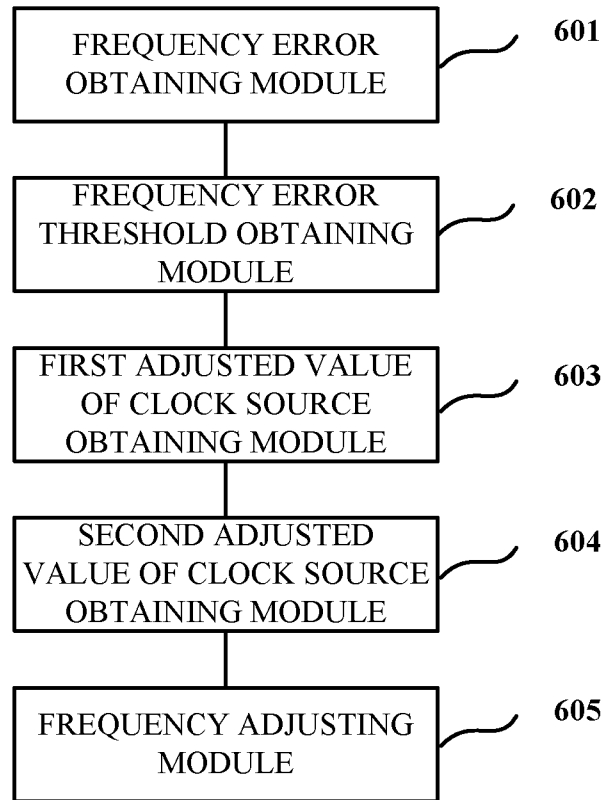


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/074307

A. CLASSIFICATION OF SUBJECT MATTER

H04L 27/00 (2006.01) i

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)

IPC: H04L, H04B, H04W, H04M

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 practicable, search terms used)

WPI,EPODOC,CNKI,CNPAT,IEEE: adjust, frequency, error, shift, multiple, mode, modem, share, clock, threshold

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101399794 A (BEIJING T3G TECHNOLOGY CO., LTD.) 01 April 2009 (01.04.2009) description, page 4 paragraph 7-page 9 paragraph 1 and figures 1-8	1,6,8,13,15-17
X	CN 102045082 A (SPREADTRUM COMMUNICATIONS (SHANGHAI) INC.) 04 May 2011 (04.05.2011) description, paragraphs [0012]-[0054] and figures 1-6	1,6,8,13,15-17
A	CN 102098250 A (ST-ERICSSON SEMICONDUCTOR (BEIJING) CO., LTD.) 15 June 2011 (15.06.2011) the whole document	1-17
A	CN 101826850 A (BEIJING T3G TECHNOLOGY CO., LTD.) 08 September 2010 (08.09.2010) the whole document	1-17

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
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