LTE STANDARD DISTRIBUTED RELAY SYSTEM, UPLINK NOISE SUPPRESSION METHOD, AND COMPUTER DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims all benefits accruing from China Patent Application No. 202010771575.9, filed on August 4, 2020, titled "LTE STANDARD DISTRIBUTED RELAY SYSTEM, UPLINK NOISE SUPPRESSION METHOD, AND COMPUTER DEVICE" in the China National Intellectual Property Administration, the content of which is hereby incorporated by reference.

TECHNICAL FIELD

[0002] The present invention generally relates to a field of communication technology, and in particular, to a LTE standard distributed relay system, an uplink noise suppression method, and a computer device.

BACKGROUND

[0003] With development of mobile communications, bands of frequencies of signals are getting higher and higher, and the number of antenna channels is also increasing. A passive distributed system adopted in an original low frequency band is no longer suitable, and is being replaced by a distributed antenna system or a micro-distributed base station. The distributed antenna system is currently a main solution to realize wireless communication coverage of indoor places and wireless coverage of large outdoor places. The distributed antenna system (DAS) includes an Administration Unit (AU), a Subordinate Administration Unit (SAU), an Extended Unit (EU) and a Remote Unit (RU). Main Administration Units (AU and SAU) are for the base station. In an uplink, uplink signals of an external terminal will be received by channels of a plurality of cascaded remote units (RU), transmitted to the Administration Units (AU) via transmission media such as an optical fiber or a network cable, and transmitted to the base station after processing. A carrier-to-noise ratio of the uplink signals arriving at the base station is worsened due to a noise superposition of the plurality of remote units (RU) in uplink channels of such system, resulting in a background noise elevation. Reception sensitivity of the base station will be reduced due to an excessive background noise, causing problems such as serious unbalancedness of uplink and downlink signals in a coverage area, dropped calls during communication, so that uplink noise needs to be suppressed.

[0004] Usually, in noise suppression methods, the uplink signals can be divided into a plurality of resource blocks, and a signal output of a corresponding resource block can be controlled according to a comparison between energy of digital signals in each of the resource blocks and a preset threshold. Then uplink signals obtained after a reconstruction of output signals in the resource blocks can be uploaded to the base station, so as to suppress the uplink noise. However, each of stages such as division for the resource blocks, power statistics of the resource blocks and restoration of the resource blocks to base station carrier signals after noise removal, requires time to process. It is impossible to finish signal transmission within a delay period (10 microseconds to 20 microseconds) accepted by a radio frequency repeater due to a processing delay, so that the above noise suppression methods cannot be applied in a LTE (Long Term Evolution) standard distributed relay system with radio frequency access.

SUMMARY

[0005] The present invention provides a LTE standard distributed relay system, an uplink noise suppression method, and a computer device, to at least solve a problem in related art that noise suppression methods cannot be applied in a LTE standard distributed relay system with radio frequency access due to a processing delay of signals.

[0006] In a first aspect, the present invention provides a LTE standard distributed relay system. The LTE standard distributed relay system includes an uplink signal detection unit and an uplink signal transmission unit. The uplink signal detection unit includes a detection end and a control end, and the uplink signal transmission unit includes an input end and an output end. The detection end of the uplink signal detection unit and the input end of the uplink signal transmission unit are both connected to an uplink signal receiving end of the LTE standard distributed relay system. The output end of the uplink signal transmission unit is connected to a base station via a signal attenuation unit, and the control end of the uplink signal detection unit is connected to the signal attenuation unit and configured to trigger the signal attenuation unit to turn on to transmit uplink signals completely to the base station when a target uplink signal is detected by the uplink signal detection unit. The signal attenuation unit is configured to delay restoring attenuation for a preset time after being turned on, resulting in partial or complete suppression of uplink signal transmission to the base station.

[0007] In some embodiments, the signal attenuation unit includes a switch unit.

[0008] In some embodiments, the preset time ranges from 300 milliseconds to 6000 milliseconds.

[0009] In some embodiments, the uplink signal transmission unit further includes a delayer connected between the input end of the uplink signal transmission unit and the signal attenuation unit.

[0010] In some embodiments, delay time of the delayer ranges from 5 microseconds to 10 microseconds.

[0011] In a second aspect, the present invention provides an uplink noise suppression method, including: detecting whether a target uplink signal in uplink signals is received by a LTE standard distributed relay system; triggering a signal attenuation unit to turn on when the target uplink signal in the uplink signals received by the LTE standard distributed relay system is detected, so as to ensure that the received uplink signals are capable of being transmitted to a base station within a preset time. The signal attenuation unit is configured to turn on an uplink signal transmission path to transmit uplink signals completely to the base station, or attenuate the uplink signals before transmission, resulting in partial or complete suppression of uplink signal transmission to the base station, and the signal attenuation unit is further configured to delay restoring attenuation for a preset time after being triggered to turn on.

[0012] In some embodiments, the uplink signals include wideband signals, a delayer is provided before the uplink signals transmitted to the signal attenuation unit in the uplink signal transmission path, and the method further includes: configuring a delay of the delayer. The delay of the delayer ranges from 5 microseconds to 10 microseconds.

[0013] In some embodiments, the delay of the delayer is longer than or equal to a processing delay of detecting whether a target uplink signal in uplink signals is received by a LTE standard distributed relay system.

[0014] In a third aspect, the present invention provides a computer device. The computer device includes a processor and a memory that stores a computer program running on the processor. The computer program is executed by the processor to implement the steps of the uplink noise suppression method as described in the first aspect.

[0015] In a fourth aspect, the present invention provides a readable storage medium having stored a computer program, and the computer program is executed by a processor to implement the steps of the uplink noise suppression method as described in the first aspect.

[0016] Compared to a related art, the embodiments of the present application provide a LTE standard distributed relay system, an uplink noise suppression method, and a computer device. The LTE standard distributed relay system includes an uplink signal detection unit and an uplink signal transmission unit. The uplink signal detection unit includes a detection end and a control end, and the uplink signal transmission unit includes an input end and an output end. The detection end of the uplink signal detection unit and the input end of the uplink signal transmission unit are both connected to an uplink signal receiving end of the LTE standard distributed relay system. The output end of the uplink signal transmission unit is connected to a base station via a signal attenuation unit, and the control end of the uplink signal detection unit is connected to the signal attenuation unit and configured to trigger the signal attenuation unit to turn on when a target uplink signal is detected by the uplink signal detection unit. The signal attenuation unit is configured to delay restoring attenuation for a preset time after being turned on. In this way, it can be solved that a problem in related art that noise suppression methods cannot be applied in a LTE standard distributed relay system with radio frequency access due to a processing delay of signals.

[0017] The details of one or more embodiments of the present invention are set forth in the accompanying drawings and the description below. Other features, objects and advantages of the present invention will become apparent from the description, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The drawings illustrated herein are used to provide a further understanding of the present invention, constituting part of the present invention. Illustrative embodiments of the present invention and its description used for explain the present invention, does not construed as an undue qualification of the present invention. In the drawings:

[0019] FIG. 1 is a structural schematic diagram of a DAS in an embodiment of the present invention.

[0020] FIG. 2 is a principle block diagram of a remote unit in a DAS in an embodiment of the present invention.

[0021] FIG. 3 is a structural block diagram of a LTE standard distributed relay system in an embodiment of the present invention.

[0022] FIG. 4 is a flowchart of an uplink noise suppression method in an embodiment of the present invention.

[0023] FIG. 5 is a flowchart of determining whether an uplink signal sent by a remote unit is included in uplink signals in an embodiment of the present invention.

[0024] FIG. 6 is a diagram of an internal structure of a computer device in an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENT

[0025] In order to make objects, technical solutions and advantages of the present invention more clearly understood, the present invention is described and illustrated in the following with reference to the accompanying drawings and embodiments in the embodiments. It should be understood that specific embodiments described herein are only used to explain the present invention and not intended to limit the present invention. All other embodiments obtained by those skill in the art based on the embodiments of the present invention without making creative labor are within the scope of the present invention.

[0026] Obviously, the drawings described below are only some examples or embodiments of the present invention, for those of ordinary skilled in the art, the present invention may also be applied to other similar scenarios according to these drawings without making creative labor. Furthermore, it is also understood that, although efforts made in such a development process may be complex and lengthy, for those of ordinary skilled in the art related to the content disclosed in this invention, some design, manufacturing or production changes made on the basis of technical content disclosed in this invention are only conventional technical means and should not be understood as insufficient disclosed content in the present invention.

[0027] The reference to “embodiment” in the present invention means that with reference to the particular features, structures or characteristics described in the embodiments may be included in at least one embodiment of the present invention. The phrase “embodiment” appears in various positions in the description does not necessarily refer to the same embodiment, nor is it a separate or alternative embodiment that is mutually exclusive with other embodiments. It can be expressly and implicitly understood by those of ordinary skilled in the art that the embodiments described in the present invention may be combined with other embodiments in the absence of conflict.

[0028] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as a skilled person in the art would understand. The term “one”, “a”, “an”, “the” and other similar words as used in the present invention do not indicate quantitative limitations, and they can be singular or plural. The terms “include”, “comprise”, “have”, and any variation thereof, as used in the present invention, are intended to cover a non-exclusive inclusion. For example, processes, methods and systems, and products or devices

including a series of steps or modules (units) are not limited to listed steps or units, but may include steps or units not listed, or may include other steps or units inherent in those processes, methods, products or devices. The terms “connection”, “connected”, “coupling”, and other similar words as used in the present invention are not limited to physical or mechanical connections, but may include electrical connections, which can be direct connections or indirect connections. The term “plurality” in the present invention refers to two or more. “And/or” describes an association relationship between associated objects, indicating that there can be three kinds of relationships. For example, “A and/or B” can mean that A exists alone, A and B exist at the same time, and B exists alone. The character “/” indicates that the objects associated with each other are in an “or” relationship. The terms “first”, “second”, “third”, etc. involved in the present invention are only configured for distinguishing similar objects, and do not represent a specific order of the objects.

[0029] Various techniques described in the present invention may be applied to distributed antenna systems (DAS). FIG. 1 is a structural schematic diagram of a DAS in an embodiment of the present invention. Referring to FIG. 1, the DAS can include an administration unit (AU), and uplinks can support a plurality of channel signals (not shown). The administration unit (AU) can be cascaded with a remote unit (RU) and an extended unit (EU) via optical fibers, and the extended unit (EU) can be cascaded with remote units such as RU_2, RU_3, ... , RU_n. The cascade number of the remote units can be provided according to actual needs, and each of RUs can include a plurality of radio frequency channels. The radio frequency channel of the remote unit (RU) can be mapped to a certain channel of the administration unit (AU) by a carrier mapping function, the remote unit (RU) can receive uplink signals of a mobile device, and a first convergence can be completed in the extended unit (EU). The EU can transmit data flows of the uplink signals to the administration unit (AU) via the optical fibers, and a second convergence can be completed in the administration unit (AU). Then a combined signal can be sent to a channel of the administration unit (AU), and then sent to a base station for processing.

[0030] FIG. 2 is a principle block diagram of a remote unit in a DAS. In the uplinks, a radio frequency transceiver module of the remote unit can receive uplink radio frequency signals from a user end via an integrated antenna of a duplexer. The uplink radio frequency signals can be converted to digital signals by an integrated radio frequency transceiver via a low-noise amplifier, frequency conversion processing and analog-to-digital (AD) conversion, and then passed to a digital baseband processing module and a background noise

suppression module. The digital signals can be processed by synchronization, automatic gain control and digital filtering, etc. in the digital baseband processing module. Referring to FIG. 2, an uplink noise suppression method and a LTE standard distributed relay system provided by the present embodiment can be applied in the background noise suppression module. The uplink signals can be packaged into serial data according to a certain frame format after processed by the background noise suppression module, and the serial data can be sent to a digital interface module. The corresponding digital signals can be converted into optical signals or ethernet signals by the digital interface module depending upon different transmission media employed thereof, such as optical fibers or cables, and sent to main administration units. A downlink workflow can be an inverse of an uplink workflow. In the present invention, the remote unit (RU) can receive uplink radio frequency signals from the user end, and the user end may include a mobile phone, a tablet computer, a laptop, a handheld computer, a Mobile Internet Device (MID), a wearable device (e.g., a smart watch, a smart bracelet, a pedometer, etc.) or other communication modules.

[0031] FIG. 3 is a structural diagram of a LTE standard distributed relay system in an embodiment of the present invention. The LTE standard distributed relay system includes an uplink signal detection unit 310 and an uplink signal transmission unit 320. The uplink signal detection unit 310 includes a detection end and a control end, and the uplink signal transmission unit 320 includes an input end and an output end. The detection end of the uplink signal detection unit 310 and the input end of the uplink signal transmission unit 320 are both connected to an uplink signal receiving end of the LTE standard distributed relay system. The output end of the uplink signal transmission unit 320 is connected to a base station via a signal attenuation unit 321, the control end of the uplink signal detection unit 310 is connected to the signal attenuation unit 321 and configured to trigger the signal attenuation unit 321 to turn on when a target uplink signal is detected by the uplink signal detection unit 310. The signal attenuation unit 321 is configured to delay restoring attenuation for a preset time after being turned on.

[0032] In a digital communication system, the uplink signals are unmodulated or modulated digital signals, which can occupy a spectrum ranging from zero frequency or lower frequency. The uplink signals are electric waveform representations of digital information, corresponding message codes can be represented by different levels, pulses or correlated modulations. In a signal transmission process, the uplink signals may include a target uplink signal and a noise signal, so it needs to be determined by the uplink signal detection unit

310 whether the target uplink signal is included in received uplink signals. In the present invention, the target uplink signal can refer to a signal sent by the user end, that is, an effective signal, such as a mobile phone signal. The signal attenuation unit 321 can be triggered to turn on when the target uplink signal is detected by the uplink signal detection unit 310, and the signal attenuation unit 321 is configured to delay restoring attenuation for a preset time after being turned on.

[0033] Specifically, a plurality of uplink signals can be sent by the user end continually, when the remote unit receives a first uplink signal, the uplink signal detection unit 310 can detect whether the target uplink signal is included in the uplink signals, and detection time can be determined according to actual situation. In practical applications, continuous occupation time of a resource block signal can be 0.5 milliseconds (ms). A detection of resource block power can be to extract a signal of the resource block in real time, accumulate the power in the continuous occupation time and then compare the accumulated power with a noise reference value. A comparison process can be fast, such as in 0.1 microseconds (us). The extraction can include frequency selection and filtering, that is, the resource block can be separated from a baseband signal, which takes about 3 us to 8 us, so that total detection time can be 503 us to 508 us or slightly greater. When the target uplink signal is detected in the first uplink signal, the signal attenuation unit 321 can be triggered to turn on for a preset time, so as to ensure that a next uplink signal sent by the user end can be sent to the base station in time.

[0034] In the present invention, the preset time is turn-on maintenance time of the signal attenuation unit 321, the turn-on maintenance time may be arranged to be greater than or equal to an interval between a plurality of uplink signals continuously sent by the user end. In this way, the target uplink signal can be sent to the base station in time within an available delay, so as to avoid missing sending time of the uplink signals due to a detection delay. In some embodiments, the preset time ranges from 300 ms to 6000 ms.

[0035] Referring to FIG. 3, when the signal attenuation unit 321 is in a turn-on state and a transmission of a last uplink signal is completed, a built-in delay module can start timing. When the transmission of the target uplink signal is not detected in the uplinks within the preset time, that is, the power of none of the resource blocks is greater than a preset threshold, then the target uplink signal can be considered to be absent again. The noise can be stuck by turning off the signal attenuation unit 321, so that noise during a period of the uplink signals of online users can be eliminated. Once the target uplink signal is detected, the delay

module can be retimed to ensure that a function of timing of the delay module can be active when the remote unit is online and no signal is sent in the uplinks by the user.

[0036] Conventionally, when the uplink signal is first sent, it is not possible to transmit the signal of the resource block to the AU within transmission time of the resource block. A main reason is that after the power of the resource block is detected to meet transmission conditions, the sending time of the resource block may have missed. Therefore, a conventional method is only theoretically feasible by reconstructing the resource block. In fact, an available delay of a radio frequency repeater ranges from 10 us to 20 us, and a specific delay can refer to a standard of the repeater. Occupancy time of a resource block of the uplink signals in the LTE standard distributed relay system is 0.5 ms, and it takes 0.5 ms to receive the entire resource block, and then it is determined whether a user signal is in the resource block. It should be noted that a plurality of resource blocks arriving at the same time at different frequencies can be processed at the same time. Coupled with a reconstruction process of the plurality of resource blocks, it is impossible to finish the signal transmission process in 20 us. Therefore, conventional noise suppression methods cannot be applied in a LTE standard distributed relay system with radio frequency access due to a processing delay of signals.

[0037] Compared with a related art, the LTE standard distributed relay system provided in the present embodiment can use a trigger mode to control the transmission of the uplink signals. The signal attenuation unit 321 can be arranged to delay off to solve a problem of a signal processing delay, i.e., processing time required for filtering, power detection and judgment can be bypassed. Specifically, the signal attenuation unit can be triggered to turn on when the target uplink signal is detected, and can be configured to delay restoring attenuation for a preset time after being triggered to turn on. Therefore, it can be ensured that a next target uplink signal can be sent to the base station within the transmission time of the signal, and the delay can be sustained when a target uplink signal is detected. In this way, the problem can be solved that noise suppression methods in related art cannot be applied in the LTE standard distributed relay system with radio frequency access due to the processing delay of signals. The signal attenuation unit 321 can include a trigger delayer, which can always be triggered to turn on the signal attenuation unit 321.

[0038] It should be noted that since an initial state of the uplinks is a turn-off state, a first transmitted signal from the user end will be blocked. However, in an actual operation of the system, the first signal sent by the user end for connection is a PRACH (Physical Random

Access Channel) signal, and the system can be stipulated that the mobile phone can transmit the PRACH signal multiple times, so it does not affect a normal operation of the system.

[0039] For a trigger mode, when the signal attenuation unit 321 is turned on, the uplinks between the remote unit and the base station are turned on, and the uplinks can directly transmit original baseband signals to the base station. When the signal attenuation unit 321 is not triggered to turn on, a degree of attenuation can be full attenuation or partial attenuation. The full attenuation can be understood as complete suppression of the transmission of the uplink signals to the base station, and the partial attenuation can be understood as an attenuation processing of the uplink signals before the transmission of the uplink signals to the base station. The attenuation processing can be settable, such as reducing the uplink signals by 3 bits binary, that is 18 dB. Therefore, high-power signals can be attenuated and transmitted to the base station, reducing probability of complete blockage of the signal transmission, and improving fluency of the signal transmission.

[0040] In some embodiments, the signal attenuation unit can include a switch unit.

[0041] The switch unit has a turn-off state and a turn-on state. When the signal attenuation unit is triggered to turn on, that is, the switch unit is closed, the uplinks between the remote unit and the base station can be turned on, and the uplink signals can be transmitted to the base station in full carrier. When the signal attenuation unit 321 is not triggered to turn on, that is, the switch unit is open, the transmission of the uplink signals to the base station can be completely suppressed.

[0042] In some embodiments, referring to FIG. 3, the uplink signal transmission unit 320 can further include a delayer 322 connected between the input end of the uplink signal transmission unit 320 and the signal attenuation unit 321.

[0043] After the uplink signal receiving end of the LTE standard distributed relay system receives the uplink signals sent by the user end, the uplink signals can be sent to the uplink signal detection unit and the uplink signal transmission unit, respectively. The uplink signal detection unit can detect the target uplink signal in the received uplink signals. The delayer of the uplink signal transmission unit can acquire and cache the uplink signals, and transmit the cached uplink signals to the base station when the signal attenuation unit is turned on. Caching time can be delay time of the delayer.

[0044] It should be noted that the detection in the present embodiment can be different from the previous power detection of the resource blocks, but correspond to a detection of instantaneous power in frequency bands of all corresponding frequency widths after the

baseband is divided into greater bandwidths (e.g., 1.08 MHz). A prerequisite for this can be that corresponding uplink user signals is great (high) enough because a detection threshold requires exclusion of noise power (Note: the noise power has a peak-to-average ratio, the peak-to-average ratio needs to be added to the detection threshold, so that the detection cannot be triggered by the noise). For channels of the PRACH, the detection threshold can be calculated using a sum of 6 resource blocks occupied thereof, and the corresponding occupied bandwidth can be 1.08 MHz.

[0045] In some embodiments, delay time of the delayer ranges from 5 us to 10 us.

[0046] This delayer can offset the delay caused by the above power detection (including the delay of a filtering process). The delay of the delayer is provided, so that the baseband signal with the user signal just now can be sent to the base station without missing after detecting the user signal and opening the switch unit (just after the delay ends). Moreover, the user signal during a period thereof will not be lost due to delay time of a detection line response, so as to ensure integrity of the corresponding baseband signal detected above.

[0047] FIG. 4 is a flowchart of an uplink noise suppression method in an embodiment. Referring to FIG. 4, the uplink noise suppression method includes:

Step 410, detecting whether a target uplink signal in uplink signals is received by a LTE standard distributed relay system.

Step 420, triggering a signal attenuation unit to turn on when the target uplink signal in the uplink signals received by the LTE standard distributed relay system is detected, so as to ensure that the received uplink signals are capable of being transmitted to a base station within a preset time. The signal attenuation unit is configured to turn on an uplink signal transmission path or attenuate the uplink signals before transmission, and the signal attenuation unit is further configured to delay restoring attenuation for a preset time after being triggered to turn on.

[0048] In the present invention, the preset time is turn-on maintenance time of the signal attenuation unit 321, the turn-on maintenance time may be arranged to be greater than or equal to an interval between a plurality of uplink signals continuously sent by the user end. In this way, the target uplink signal can be sent to the base station in time within an available delay, so as to avoid missing sending time of the uplink signals due to the detection delay. In some embodiments, the preset time ranges from 300 ms to 6000 ms.

[0049] Referring to FIG. 3, when the signal attenuation unit 321 is in the turn-on state, a built-in delay module can start timing. When the transmission of the target uplink signal is

not detected in the uplinks within the preset time, that is, the power of none of the resource blocks is greater than a preset threshold, then the target uplink signal can be considered to be absent again. The noise can be stuck by turning off the signal attenuation unit 321, so that noise during a period of the uplink signals of online users can be eliminated. Once the target uplink signal is detected, the delay module can be retimed to ensure that the function of timing of the delay module can be active when the remote unit is online and no signal is sent in the uplinks by the user.

[0050] Compared with a related art, the uplink noise suppression method provided in the present embodiment can use a trigger mode to control the transmission of the uplink signals. The signal attenuation unit can be arranged to delay off to solve a problem of a signal processing delay, i.e., processing time required for filtering, power detection and judgment can be bypassed. Specifically, the signal attenuation unit can be triggered to turn on when the target uplink signal is detected, and can be configured to delay restoring attenuation for a preset time after being triggered to turn on. Therefore, it can be ensured that a next target uplink signal can be sent to the base station within the transmission time of the signal. In this way, the problem can be solved that noise suppression methods in related art cannot be applied in the LTE standard distributed relay system with radio frequency access due to the processing delay of signals.

[0051] For the trigger mode, when the signal attenuation unit is turned on, the uplinks between the remote unit and the base station are turned on, and the uplink signals can be transmitted to the base station in full carrier. When the signal attenuation unit is not triggered to turn on, a degree of attenuation can be full attenuation or partial attenuation. The full attenuation can be understood as complete suppression of the transmission of the uplink signals to the base station, and the partial attenuation can be understood as at least part of the uplink signals are transmitted to the base station after an attenuation processing of the uplink signals. The attenuation processing can be settable, such as reducing the uplink signals by 3 bits binary, that is 18 dB. Therefore, high-power signals can be attenuated and transmitted to the base station, reducing probability of complete blockage of the signal transmission, and improving fluency of the signal transmission.

[0052] It is understood that when the signal attenuation unit 321 is not triggered to turn on, at least part of the uplink signals are transmitted to the base station after the attenuation processing of the uplink signals. In this way, the part of the uplink signals can reach the base

station when the uplink signals are strong enough, so as to enable communications, except that both the signal and noise in the uplink signals are attenuated.

[0053] In some embodiments, the uplink signals can include wideband signals, the delayer is provided before the uplink signals transmitted to the signal attenuation unit in the uplink signal transmission path, and the method further includes a step of configuring a delay of the delayer.

[0054] After the uplink signal receiving end of the LTE standard distributed relay system receives the uplink signals sent by the user end, the uplink signals can be sent to the uplink signal detection unit and the uplink signal transmission unit, respectively. The uplink signal detection unit can detect the target uplink signal in the received uplink signals. The delayer of the uplink signal transmission unit can acquire and cache the uplink signals and transmit the cached uplink signals to the base station when the signal attenuation unit is turned on. Caching time can be delay time of the delayer.

[0055] It should be noted that the detection in the present embodiment can be different from the previous power detection of the resource blocks, but correspond to a detection of instantaneous power in the frequency bands of all corresponding frequency widths after the baseband is divided into greater bandwidths (e.g., 1.08 MHz). A prerequisite for this can be that corresponding uplink user signals is great (high) enough because a detection threshold requires exclusion of noise power (Note: the noise power has a peak-to-average ratio, the peak-to-average ratio needs to be added to the detection threshold, so that the detection cannot be triggered by the noise). For channels of the PRACH, the detection threshold can be calculated using a sum of the 6 resource blocks occupied thereof, and the corresponding occupied bandwidth can be 1.08 MHz.

[0056] In some embodiments, the delay of the delayer is longer than or equal to a processing delay of detecting whether the target uplink signal in uplink signals is received by the LTE standard distributed relay system.

[0057] In the present embodiment, the delay time of the delayer ranges from 5 us to 10 us.

[0058] This delayer can offset the delay caused by the above power detection (including the delay of a filtering process). The delay of the delayer is provided, so that the baseband signal with the user signal just now can be sent to the base station without missing after detecting the user signal and opening the switch unit (just after the delay ends). Moreover, the user signal during the period thereof will not be lost due to the delay time of the detection line response, so as to ensure integrity of the corresponding baseband signal detected above.

[0059] In some embodiments, the step of detecting whether the target uplink signal in uplink signals is received by the LTE standard distributed relay system includes:

Step 510, acquiring a channel type in signal transmission of the uplink signals and a modulation rule corresponding to the channel type.

Step 520, acquiring occupied resource information of the uplink signals based on the channel type in signal transmission and the modulation rule of the channel type.

Step 530, filtering the occupied resource information by a segmented filter group, and acquiring a digital signal of a preset bandwidth filter corresponding to the occupied resource information.

Step 540, calculating power of digital signals of a plurality of the preset bandwidth filters, and comparing thereof with a preset threshold.

Step 550, determining whether the target uplink signal is contained in the uplink signals based on a comparison result.

[0060] The channel type in signal transmission of the uplink signals and a modulation rule corresponding to the channel type can affect the occupied resources of the uplink signals. Therefore, in order to determine whether the target uplink signal is contained in the uplink signals, a detection of power of a corresponding channel (time frequency) can be changed based on a respective modulation rule of the channel (time frequency) and time frequency rules of the channels dynamically allocated and synchronized with the base station, thereby improving accuracy of determination. In the present invention, the occupied resource information can include power information of the signals.

[0061] Specifically, for a PUSCH (Physical Uplink Shared Channel) channel, a mobile phone signal can be transmitted by resource blocks. But a PUCCH (Physical Uplink Control Channel) signal, or a SRS (Sounding Reference Signal) signal would not occupy an entire resource block, but only occupy a part of the resource block. Therefore, for the PUCCH signal or the SRS signal, because it does not occupy the entire resource block, it is better to take the resource according to the occupied resource of a base station specification, and transmitting process by the resource block will reduce determination sensitivity. In addition, the resources of the PRACH signals are also related to a system frame number of the base station, so that the PRACH signals need to be synchronized according to the system frame number of the base station.

[0062] Referring to FIG. 3, after acquiring occupied resource information of the uplink signals, the digital signal of each of the resource blocks can be acquired from the uplink

signals by the segmented filter group. The power of the digital signal of each of the resource blocks can be then calculated separately, and the power of the digital signal of each of the resource blocks can be compared with the preset threshold. When the power of each of the digital signal is less than the preset threshold, it is determined that the target uplink signal is not contained in the uplink signals. When the power of the digital signal of any of the resource blocks is greater than the preset threshold, it is determined that the target uplink signal is contained in the uplink signals. That is, as long as the power of the digital signal of one resource block is greater than the preset threshold, it is considered that the user is in a coverage area.

[0063] In some embodiments, when the power of the digital signal of any of the resource blocks is greater than the preset threshold, the signal attenuation unit can be triggered by an output signal of an or gate.

[0064] Referring to FIG. 3, each of comparison results can be input to a corresponding receiving end of the or gate. When the power of the digital signal of any of the resource blocks is greater than the preset threshold, it is determined that the target uplink signal is contained in the digital signals of the resource blocks, and a signal denoted as 1 can be output to the corresponding receiving end of the or gate. When the power of the digital signal of all the resource blocks is less than the preset threshold, it is determined that the target uplink signal is not contained in the digital signals of all the resource blocks at that time, and a signal denoted as 0 can be output to the corresponding receiving end of the or gate. An output end of the or gate can be connected to the signal attenuation unit. When any receiving end of the or gates receives the signal denoted as 1, the output end of the or gate can output a signal denoted as 1 to the signal attenuation unit, and trigger the signal attenuation unit to turn on. Therefore, the uplinks between the remote unit and the base station can be turned on, and the uplink signals can be transmitted to the base station via the uplinks.

[0065] In some embodiments, the method further includes: acquiring the number of the remote units in the DAS, and setting the preset threshold according to the number of the remote units.

[0066] The greater the number of the remote units, the greater pressure to eliminate noise. The preset threshold is increased to remove the coverage of users at an edge in the present embodiment, thereby increasing noise elimination ratio, and reducing pressure to eliminate noise.

[0067] In some embodiments, the method can further include the following steps. When the user signal is high (strong), a corresponding great bandwidth (such as 1.08 MHz) filter, instantaneous power detection, and a delayer (baseband signal delay) can be provided. In this way, it is possible to avoid a problem of losing the user signal due to the detection delay, especially a problem of transmitting the uplink signals by the user for the first time.

[0068] When the user signal is high (strong), a base station uplink bandwidth can be divided into passband bandwidths of 1.08 MHz of a greater bandwidth filter similar to frequency domains divided by the resource blocks. In this way, the delay of the filter is relatively small (2 us to 3 us), so that a total processing delay can reach 5 us to 10 us, and delay requirements of a radio frequency repeater system can be achieved.

[0069] It should be noted that the peak-to-average ratio of the general noise (signal) can be less than 15 dB, so that the noise (signal) can not trigger the threshold by setting the threshold higher than 15 dB. Therefore, the threshold can only be triggered by a real mobile signal (the target uplink signal), and only the real mobile signal can be captured. When the uplinks have a high enough load-to-noise ratio, a corresponding threshold with a high load-to-noise ratio can be set.

[0070] In some embodiments, the step of calculating the power of the digital signals of the plurality of the preset bandwidth filters includes:

acquiring the instantaneous power of the digital signals of the preset bandwidth filters at any time position;

determining that the target uplink signal is contained in the uplink signals when any of the instantaneous power of the digital signals is greater than the preset threshold.

[0071] The preset bandwidth can usually be a greater bandwidth, such as 1.08 MHz. Time to acquire the instantaneous power of the above filter can be shortened due to the increase of a detection bandwidth. Correspondingly, the delay of the filter can also be shorter, so that a detection speed can be accelerated accordingly. When the detection speed is fast enough, received carrier data can first be stored for a delay, while detecting whether the target uplink signal is contained in the uplink signals, if so, the data stored for a delay can be transmitted to the base station, so as to avoid a problem of blocking or missing an initial access signal.

[0072] The detection time can be reduced by acquiring the instantaneous power of the digital signals of the preset bandwidth filters at any time position, instead of detecting the power of the whole resource block as mentioned above. A signal delayer can be arranged to solve a problem of a signal processing delay, i.e., processing time required for filtering,

power detection and determination can be compensated. Then the signal attenuation unit can be triggered to turn on when the instantaneous power of the digital signal detected reaches the preset threshold, so that the detection process can be performed in real time. The signal attenuation unit can be triggered to turn on as soon as a determination condition is reached, regardless of the time position of the preset bandwidth filters.

[0073] It should be noted that the detection method provided in the present embodiment is different from a power discrimination method of the resource blocks described above. The method in the present embodiment does not accurately detect the power of the uplink signals of the user (e.g., does not acquire the power of the resource blocks), but only distinguish the noise from the uplink signals of the user, and the method is used under a condition of a higher uplink load-to-noise ratio. In addition, the method can also be used as a supplement to the power discrimination method of the resource blocks, so as to distinguish a first user signal transmitted by the user with higher power and turn on the uplinks in time, and avoid a problem of blocking the first resource block in the power discrimination method.

[0074] In some embodiments, the method can further include statistics of data, the data can include resource blocks with user signals and the number of resource blocks occupied by the user signals, etc., so as to record a proportion of using the remote unit. A statistical process of data of the DAS can be provided in order to facilitate subsequent optimization of the DAS.

[0075] It should be noted that the steps shown in the above processes or in the flowcharts of the accompanying drawings can be performed in a computer system such as a FPGA (Field Programmable Gate Array) system, or, alternatively, a computer system employing a set of computer-executable instructions. In addition, although a logical order is shown in the flowcharts, the steps shown or described can be executed in an order different from the order herein in some case.

[0076] Furthermore, the uplink noise suppression method in the embodiment of the present invention described in conjunction with FIG. 4 can be implemented by a computer device. FIG 6 is a schematic diagram of a hardware structure of the computer device according to an embodiment of the present invention.

[0077] The computer device can include a processor 61 and a memory 62 that stores computer program instructions.

[0078] Specifically, the processor 61 can include a Central Processing Unit (CPU), or an Application Specific Integrated Circuit (ASIC), or one or more integrated circuits configured to implement embodiments of the present invention.

[0079] The memory 62 can include a mass storage for data or instructions. By way of example but not limitation, the memory 62 can include a Hard Disk Drive (HDD), a floppy disk drive, a Solid State Drive (SSD), a flash memory, an optical disk, a magnetic-optical disk, a magnetic tape, an Universal Serial Bus (USB) Drive, or a combination of two or more thereof. In suitable cases, the memory 62 can include removable or non-removable (or fixed) media. In suitable cases, the memory 62 can be internal or external to a data processing device. In particular embodiments, the memory 62 is non-volatile memory. In particular embodiments, the memory 62 can include a Read-Only Memory (ROM) and a Random Access Memory (RAM). In suitable cases, the ROM can be a mask-programmed ROM, a Programmable Read-Only Memory (PROM), an Erasable Programmable Read-Only Memory (EPROM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), an Electrically Alterable Read-Only Memory (EAROM), a Flash Memory (FLASH), or a combination of two or more thereof. In suitable cases, the RAM can be a Static Random-Access Memory (SRAM) or a Dynamic Random Access Memory (DRAM). The DRAM can be a Fast Page Mode Dynamic Random Access Memory (FPMDRAM), an Extended Date Out Dynamic Random Access Memory (EDODRAM), or a Synchronous Dynamic Random-Access Memory (SDRAM), etc.

[0080] The memory 62 can be used to store or cache various data files to be processed and/or communicated for use, and possible computer program instructions executed by the processor 61.

[0081] The processor 61 can read and execute the computer program instructions stored in the memory 62, to implement any of the uplink noise suppression methods in the above embodiments.

[0082] In some embodiments, the computer device can further include a communication interface 63 and a bus 60. Referring to FIG. 6, the processor 61, the memory 62, and the communication interface 63 connect and communicate with each other via the bus 60.

[0083] The communication interface 63 is configured to implement communications among modules, apparatuses, units and/or devices in the embodiments of the present invention. The communication interface 63 can also be implemented data communications with other

components such as: external devices, image/data acquisition devices, databases, external storage and image/data processing workstations and the like.

[0084] The bus 60 can include hardware, software, or both. The bus 60 is configured to couple components of the computer device to one another. The bus 60 can include, but is not limited to, at least one of the following: a Data Bus, an Address Bus, a Control Bus, an Expansion Bus, or a Local Bus. By way of example but not limitation, the bus 60 can include an Accelerated Graphics Port (AGP) or other graphics buses, an Extended Industry Standard Architecture (EISA) bus, a Front Side Bus (FSB), Hyper Transport (HT) interconnects, an Industry Standard Architecture (ISA) bus, InfiniBand interconnects, a Low Pin Count (LPC) bus, a memory bus, a Micro Channel Architecture (MCA) bus, a Peripheral Component Interconnect (PCI) bus, a PCI-Express (PCI-X) bus, a Serial Advanced Technology Attachment (SATA) bus, a Video Electronics Standards Association Local Bus (VLB) bus, other appropriate bus, or a combination of two or more thereof. In suitable cases, the bus 60 can include one or more buses. Although specific buses are described and illustrated in the embodiments of the present invention, any suitable bus or interconnect can be contemplated in the present invention.

[0085] The computer device can execute the uplink noise suppression method in the embodiment of the present invention based on the acquired program instructions, thereby implementing an uplink noise suppression method in combination with FIG. 3.

[0086] Furthermore, in conjunction with the uplink noise suppression method in the above embodiments, a computer-readable storage medium can be provided in an embodiment of the present invention. The computer-readable storage medium can store computer program instructions, and the computer program instructions can be executed by the processor to implement any of the uplink noise suppression methods in the above embodiments.

[0087] The technical features of the above-described embodiments may be combined in any combination. For the sake of brevity of description, not all possible combinations of the technical features in the above embodiments are described. However, as long as there is no contradiction between the combinations of these technical features, all should be considered as within the scope of this invention.

[0088] The above-described embodiments are merely illustrative of several embodiments of the present invention, and the description thereof is relatively specific and detailed, but is not to be construed as limiting the scope of the invention. It should be noted that a number of variations and modifications may be made by those skilled in the art without departing

from the spirit and scope of the invention. Therefore, the scope of the invention should be determined by the appended claims.

WE CLAIM:

1. A LTE standard distributed relay system, characterized by comprising:

an uplink signal detection unit comprising a detection end and a control end;

an uplink signal transmission unit comprising an input end and an output end, wherein

the detection end of the uplink signal detection unit and the input end of the uplink signal transmission unit are both connected to an uplink signal receiving end of the LTE standard distributed relay system,

the output end of the uplink signal transmission unit is connected to a base station via a signal attenuation unit, the control end of the uplink signal detection unit is connected to the signal attenuation unit and configured to trigger the signal attenuation unit to turn on to transmit uplink signals completely to the base station when a target uplink signal is detected by the uplink signal detection unit, and the signal attenuation unit is configured to delay restoring attenuation for a preset time after being turned on, resulting in partial or complete suppression of uplink signal transmission to the base station.

2. The LTE standard distributed relay system of claim 1, wherein the signal attenuation unit comprises a switch unit.

3. The LTE standard distributed relay system of claim 1, wherein the preset time ranges from 300 milliseconds to 6000 milliseconds.

4. The LTE standard distributed relay system of claim 1, wherein the uplink signal transmission unit further comprises a delayer connected between the input end of the uplink signal transmission unit and the signal attenuation unit.

5. The LTE standard distributed relay system of claim 4, wherein delay time of the delayer ranges from 5 microseconds to 10 microseconds.

6. An uplink noise suppression method, characterized by comprising:

detecting whether a target uplink signal in uplink signals is received by a LTE standard distributed relay system;

triggering a signal attenuation unit to turn on when the target uplink signal in the uplink signals received by the LTE standard distributed relay system is detected, so as to ensure that the received uplink signals are capable of being transmitted to a base station within a preset time, wherein the signal attenuation unit is configured to turn on an uplink signal transmission path to transmit uplink signals completely to the base station, or attenuate the uplink signals before transmission, resulting in partial or complete suppression

of uplink signal transmission to the base station, and the signal attenuation unit is further configured to delay restoring attenuation for a preset time after being triggered to turn on.

7. The uplink noise suppression method of claim 6, wherein the uplink signals comprise wideband signals, a delayer is provided before the uplink signals transmitted to the signal attenuation unit in the uplink signal transmission path, and the method further comprises:

configuring a delay of the delayer, wherein the delay of the delayer ranges from 5 microseconds to 10 microseconds.

8. The uplink noise suppression method of claim 7, wherein the delay of the delayer is longer than or equal to a processing delay of detecting whether a target uplink signal in uplink signals is received by a LTE standard distributed relay system.

9. A computer device, characterized by comprising a processor and a memory that stores a computer program running on the processor, wherein the computer program is executed by the processor to implement the steps of the uplink noise suppression method of any one of claims 6 to 8.

10. A readable storage medium having stored a computer program, characterized in that the computer program is executed by a processor to implement the steps of the uplink noise suppression method of any one of claims 6 to 8.