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(54) **Title:** METHOD AND APPARATUS FOR DATA TRANSMISSION IN A WIRELESS COMMUNICATION SYSTEM

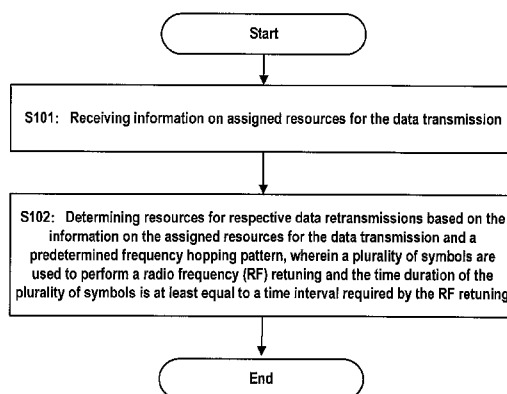


Fig. 1

(57) **Abstract:** Embodiments of the present disclosure relate to data transmission in a wireless communication system. In an embodiment of the present disclosure, there are provided a method and apparatus of data transmission in a wireless communication system. The method comprises receiving information on assigned resources for the data transmission; and determining resources for respective data retransmissions based on the information on the assigned resources for the data transmission and a predetermined frequency hopping pattern. Particularly, a plurality of symbols are used to perform a radio frequency (RF) retuning and a time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning. With embodiments of the present disclosure, there is provided a new solution for data transmission in which the RF retuning can be performed in a plurality of symbols, which might obtain the frequency diversity and at the same time can reduce transmission mistakes and improve the transmission efficiency.

METHOD AND APPARATUS FOR DATA TRANSMISSION IN A WIRELESS COMMUNICATION SYSTEM

5 FIELD OF THE INVENTION

[0001] Embodiments of the present disclosure generally relate to wireless communication techniques and more particularly relate to a method and apparatus for data transmission in a wireless communication system.

10 BACKGROUND OF THE INVENTION

[0002] With the constant increase of mobile data services, the 3rd Generation Partnership Project (3GPP) organization has developed long-term evolution (LTE) specifications and LTE-Advanced (LTE-A) specifications. As the next generation cellular communication standard, an LTE or LTE-A system can operate in both
15 Frequency Division Duplex (FDD) mode and Time Division Duplex (TDD) mode.

[0003] Machine-to-Machine (M2M) communication, which may also be called as Machine-Type Communications (MTC), is an emerging communication pattern. It refers to communication between computers, embedded processors, smart sensors, actuators and mobiles devices without or with only limited human intervention and it is
20 quite advantageous in many applications such as sensing in extreme or hazard environment. Generally, many of MTC UEs are targeted for low-end applications (low average revenue per user, and low data rate) that can be handled adequately by GSM/GPRS and thus they may be implemented at low cost.

[0004] As LTE deployments evolve, it is desirable to reduce the cost of overall
25 network maintenance by minimizing the number of Radio Access Technologies (RATs). However, there are deployed more and more MTC UEs in the field, which increases reliance on GSM/GPRS networks, and thus cost for operating these networks are increased. Hence, it will be very beneficial if low-end MTC UEs may be migrated from GSM/GPRS to LTE Networks.

30 [0005] Besides, in RAN1, #78bis, reduced UE bandwidth of 1.4MHz for both downlink and uplink was agreed to be prioritized as the most important complexity reduction technique for Rel.13 MTC UEs.

[0006] In US patent application publication No. US2013/0294399A1, there is disclosed a data transmission method for machine type communication (MTC) and MTC Apparatus. In this application, each of a plurality of subframes configured with time slots and frequency resources is divided into a first region for transmitting control information and a second region for transmitting data; and resources for the MTC is allocated to the second according to a predetermined hopping period and a predetermined hopping frequency, wherein the RF retuning will be performed in the first region if the time for retuning is shorter than the time length of the first region or the first region and a part of the second region if the time for retuning is longer than the time length of the first region. However, in the solution as disclosed in US2013/0294399A1, there might be transmission mistakes during the transmission of MTC, especially when the tuning time is longer than the time length of the first region.

[0007] Therefore, there is a need for a new solution of data transmission in a wireless communication system.

SUMMARY OF THE INVENTION

[0008] In the present disclosure, there is provided an improved solution for uplink data transmission in a wireless communication system so as to solve or at least partially mitigate at least a part of problems in the prior art.

[0009] According to a first aspect of the present disclosure, there is provided a method for data transmission in a wireless communication system. The method may comprise receiving information on assigned resources for the data transmission; and determining resources for respective data retransmissions based on the information on the assigned resources for the data transmission and a predetermined frequency hopping pattern. Particularly, a plurality of symbols are used to perform a radio frequency (RF) retuning and the time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning.

[0010] In an embodiment of the present disclosure, the plurality of symbols may be a part of a subframe and resting symbols of the subframe may be used to perform the data retransmission.

[0011] In another embodiment of the present disclosure, the subframe may be the first one of subframes planned for the data retransmission at the next hopped

frequency. Or alternatively, the subframe may be the last one of subframes planned for the data retransmission before the next frequency hopping.

[0012] In a further embodiment of the present disclosure, the number of symbols may be determined as a minimal value that meets the RF retuning.

5 [0013] In a still further embodiment of the present disclosure, a whole subframe may be used to perform the RF retuning.

[0014] In a yet embodiment of the present disclosure, the whole subframe may be the first one of subframes planned for the data retransmission at the next hopped frequency. Or alternatively, the whole subframe may be the last one of subframes
10 planned for the data retransmission before the next frequency hopping.

[0015] In a still further embodiment of the present disclosure, the predetermined frequency hopping pattern may indicate a frequency hopping interval of at least two subframes in the time domain.

[0016] In a yet further embodiment of the present disclosure, the RF retuning
15 may be performed in a special subframe between two frequency hoppings.

[0017] In a yet still embodiment of the present disclosure, a hopping interval for frequency hopping in the time domain may be determined based on a configuration of subframe used for the data transmission.

[0018] In another embodiment of the present disclosure, the data transmission
20 may be an uplink data transmission for Machine Type Communication (MTC).

[0019] According to a second aspect of the present disclosure, there is also provided an apparatus for data transmission in wireless communication system, comprising: an information receiving module configured to receive information on assigned resources for the data transmission; and a resource determination module,
25 configured to determine resources for respective data retransmissions based on the information on the assigned resources for the data transmission and a predetermined frequency hopping pattern, wherein a plurality of symbols are used to perform a radio frequency (RF) retuning and the time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning.

30 [0020] According to a third aspect of the present disclosure, there is also provided a computer-readable storage media with computer program code embodied thereon, the computer program code configured to, when executed, cause an apparatus

to perform actions in the method according to any embodiment in the first aspect.

[0021] According to a fourth aspect of the present disclosure, there is provided a computer program product comprising a computer-readable storage media according to the fifth aspect.

5 [0022] With embodiments of the present disclosure, there is provided a new solution for data transmission in a wireless communication system, in which the RF retuning can be performed in a plurality of symbols, which might obtain the frequency diversity and at the same time can reduce transmission mistakes and improve the transmission efficiency.

10 BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The above and other features of the present disclosure will become more apparent through detailed explanation on the embodiments as illustrated in the embodiments with reference to the accompanying drawings, throughout which like
15 reference numbers represent same or similar components and wherein:

[0024] Fig. 1 schematically illustrates a flowchart of a method of data transmission in a wireless communication system according to an embodiment of the present disclosure;

20 [0025] Fig. 2 schematically illustrates an exemplary frequency hopping pattern of the frequency hopping interval for an FDD system according to an embodiment of the present disclosure;

[0026] Fig. 3A schematically illustrates exemplary configuration of the RF retuning for an FDD system according to an embodiment of the present disclosure;

25 [0027] Fig. 3B schematically illustrates another exemplary configuration of the RF retuning for an FDD according to an embodiment of the present disclosure;

[0028] Fig. 4A schematically illustrates a further exemplary configuration of the RF retuning for an FDD system according to an embodiment of the present disclosure;

30 [0029] Fig. 4B schematically illustrates a still further exemplary configuration of the RF retuning for an FDD system according to an embodiment of the present disclosure;

[0030] Fig. 5 schematically illustrates a frame configuration for a TDD system;

[0031] Fig. 6 schematically illustrates an exemplary configuration of the RF retuning for a TDD system according to an embodiment of the present disclosure;

[0032] Fig. 7 schematically illustrates another exemplary configuration of the RF retuning for a TDD system according to an embodiment of the present disclosure;

5 and

[0033] Fig. 8 schematically illustrates a block diagram of an apparatus for data transmission in a wireless communication system according to an embodiment of the present disclosure.

10 DETAILED DESCRIPTION OF EMBODIMENTS

[0034] Hereinafter, the solution as provided in the present disclosure will be described in details through embodiments with reference to the accompanying drawings. It should be appreciated that these embodiments are presented only to enable those skilled in the art to better understand and implement the present disclosure, not intended
15 to limit the scope of the present disclosure in any manner.

[0035] In the accompanying drawings, various embodiments of the present disclosure are illustrated in block diagrams, flow charts and other diagrams. Each block in the flowcharts or blocks may represent a module, a program, or a part of code, which contains one or more executable instructions for performing specified logic
20 functions, and in the present disclosure, a dispensable block is illustrated in a dotted line. Besides, although these blocks are illustrated in particular sequences for performing the steps of the methods, as a matter of fact, they may not necessarily be performed strictly according to the illustrated sequence. For example, they might be performed in reverse sequence or simultaneously, which is dependent on natures of respective
25 operations. It should also be noted that block diagrams and/or each block in the flowcharts and a combination of thereof may be implemented by a dedicated hardware-based system for performing specified functions/operations or by a combination of dedicated hardware and computer instructions.

[0036] Generally, all terms used in the claims are to be interpreted according to
30 their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the/said [element, device, component, means, step, etc]" are to be interpreted openly as referring to at least one instance of said element, device,

component, means, unit, step, etc., without excluding a plurality of such devices, components, means, units, steps, etc., unless explicitly stated otherwise. Besides, the indefinite article “a/an” as used herein does not exclude a plurality of such steps, units, modules, devices, and objects, and etc.

5 [0037] Additionally, in a context of the present disclosure, a user equipment (UE) may refer to a terminal, a Mobile Terminal (MT), a Subscriber Station (SS), a Portable Subscriber Station (PSS), Mobile Station (MS), or an Access Terminal (AT), and some or all of the functions of the UE, the terminal, the MT, the SS, the PSS, the MS, or the AT may be included. Furthermore, in the context of the present disclosure,
10 the term “BS” may represent, e.g., a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a radio header (RH), a remote radio head (RRH), a relay, or a low power node such as a femto, a pico, and so on.

 [0038] Next, reference will be made to the accompany drawings to describe the solution as provided therein. In the following, the uplink transmission and MTC
15 will be taken as examples to describe the embodiments of the present disclosure; however, it should be appreciated that the present disclosure is not limited thereto and in fact the solution as provided herein can also be used for the downlink data transmission.

 [0039] Fig. 1 schematically illustrates a flowchart of a method of data transmission in a wireless communication system according to an embodiment of the
20 present disclosure. As illustrated in Fig. 1, first as step S101, information on assigned resources for the data transmission is received. For the uplink data transmission, for example, after determining assigned resource for a UE, the eNB sends the uplink grant to the UE through Physical Downlink Control Channel (PDCCH)/enhanced PDCCH (EPDCCH) and the UE receives the uplink grant from the eNB. The uplink grant may
25 indicate information on transmission resource assigned to the UE for the uplink transmission. For example, the uplink grant may comprise information for assigned physical resource blocks (PRBs), and/or the location of narrow band for the data transmission. The assigned PRBs may indicate original assigned physical resource blocks (PRBs) for the uplink data transmission. The location of narrow band for the
30 data transmission indicates the frequency resources which can be used for the uplink data transmission. As agreed in RAN 1# 781bis, a reduced bandwidth of 1.4MHz will be used. Thus, the location of narrow band indicates a segment of consecutive

frequency resources, which may be indicated by the central frequency and the total bandwidth. The uplink grant may also comprise the number of the data retransmission N , i.e., the repetition times of PUSCH. The repetition times N can be configured by for example, high-layer signaling or through PDCCH/EPDCCH.

5 [0040] Then at step S102, resources for respective data retransmissions are determined based on the information on the assigned resource and a predetermined frequency hopping pattern. Particularly, a plurality of symbols will be used to perform a radio frequency (RF) retuning and a time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning.

10 [0041] As is known, many of MTC UEs are targeted for low-end applications (low average revenue per user, and low data rate), and those UEs also have a low SNR, which means a bad signal quality. To make up for the problems of bad signal quality, retransmission is used for MTC. Through the data retransmission, it is possible to use the joint detection, which could increase the possibility of obtaining the transmitted data
15 correctly.

 [0042] On the other hand, in order to obtain frequency diversity gain, the frequency hopping will be performed so as to improve the transmission efficiency of MTC terminals. The frequency hopping may be performed in accordance with a predetermined frequency hopping pattern. The predetermined frequency hopping
20 pattern indicates the way in which a frequency hopping is to be performed, particularly parameters used in the frequency hopping. For example, the predetermined frequency hopping pattern may indicate a frequency hopping interval m , a base frequency f_0 , and a frequency offset Δf or frequency offset pattern to be used in frequency hopping. The frequency hopping interval m indicates the number of uplink subframes after which a
25 frequency hopping will be performed in the time domain, which can be a predetermined value or configured by the eNB. The base frequency f_0 indicates the frequency at which the data transmission is performed. The base frequency f_0 may be determined based on the location of narrow band as indicated by the uplink grant. The frequency offset Δf or the frequency offset pattern indicates the amount of the frequency change
30 after a frequency hopping is performed, which can be a predetermined value or configured by the eNB.

 [0043] Fig. 2 schematically illustrates an exemplary frequency hopping pattern

for an FDD system according to an embodiment of the present disclosure. As illustrated in Fig. 2, two consecutive uplink frames are illustrated, each of which comprises ten uplink subframes numbered from 0 to 9. In Fig. 2, the frequency hopping interval is determined as 4, which means the transmission frequency for MTC UEs will be changed or hopped every four subframes. In Fig. 2, the x axis denotes a change over time and y axis denotes the change of frequency.

[0044] Fig. 3A schematically illustrates exemplary configurations of the RF retuning for an FDD system according to an embodiment of the present disclosure. As illustrated in Fig. 3A, the frequency hopping interval is 4, which is same as that in Fig. 2. In the configuration as illustrated in Fig. 3A, the plurality of symbols used for the RF retuning are a part of one subframes and particularly, is a part of the first one of the four subframes planned for the data retransmission at the next hopped frequency, as illustrated by block filled with dots in Fig. 3A. That is to say, a first part of symbols in this subframe will be used to perform the RF retuning while the remaining symbols in this subframe will be used to perform the data retransmission on the PUSCH.

[0045] Particularly, the UE will determine the Physical Resource Block(s) (PRB) used to transmit the i -th PUSCH when i is less than N (the predetermined number of data retransmission). For example, regarding the second data retransmission as illustrated in Fig. 3A, the UE will determine subframes 4 to 7 will be used for the i -th PUSCH transmission, wherein the first j symbols in the first subframe will be used to perform the RF tuning. The number of symbols may be determined as a minimal value that meets the RF retuning. It can be understood that the resource for the RF retuning is assigned in a unit of symbol and thus it will not introduce any transmission mistake due to a transmission beginning from the middle of a symbol.

[0046] Generally, it requires about a half of subframe to perform the RF retuning and thus if the remaining symbols can be used to the data retransmission, it will be advantageous since the remaining resource can be used efficiently. However, it can be understood that it is also possible to use more symbols than that is required.

[0047] Moreover, the UE will also determine f_i , i.e., the frequency used to transmit the i -th PUSCH based on, for example, the base frequency f_0 , and the frequency offset Δf as indicated by the predetermined frequency hopping pattern. For example f_i may be determined as $f_0 + i \cdot \Delta f$ or be determined based on f_0 and the

predetermined frequency offset pattern. Then the UE can perform the RF retuning in the determined plurality of symbols and after the RF retuning is finished, it may start to transmit the i-th PUSCH at the hopped frequency.

[0048] Fig. 3B schematically illustrates another exemplary configuration of the RF retuning for an FDD according to an embodiment of the present disclosure. Different from the configuration as illustrated in Fig. 3A, the plurality of symbols in the last one of the four subframes planned for the data retransmission before the next frequency hopping will be used to perform the RF tuning, instead of those in the first one of subframes planned for the data retransmission at the next hopped frequency. Through the configuration as illustrated in Fig. 3B, it is also possible to achieve the RF retuning before the frequency hopping for the next data retransmission.

[0049] Figs. 4A and 4B schematically illustrate two further alternative exemplary configurations of the RF retuning for an FDD system according to embodiments of the present disclosure. Different from Figs. 3A and 3B, in Figs. 4A and Fig. 4B, a whole subframe is used to perform the RF retuning instead of only a part of one subframe. This means all symbols in the subframe are used for the RF tuning although the time length required by the RF retuning might be shorter than the time duration of a subframe. In Fig. 4A, the first one of the four subframes planned for the data retransmission at the next hopped frequency is used to transmit the i-th PUSCH, while in Fig. 4B, the last one of the four subframes planned for the data retransmission before the next frequency hopping. By this, enough time is reserved for the RF retuning and thus it may also ensure the performing of the RF retuning.

[0050] Hereinabove, the embodiments of the present disclosure are described with reference to a FDD system; however, the present disclosure is not only limited to the FDD system. In Fact, it is also applicable to a TDD system as well. Next, description will be made to a solution for a TDD system as provided herein.

[0051] For a purpose of illustration, in Fig. 5, there is schematically illustrated an exemplary frame structure for a TDD system. As illustrated in Fig. 5, similar to a FDD radio frame, a TDD radio frame also consists of ten subframes labeled with 0 to 9. While different from the FDD radio frame, each of the subframes may be used for DL transmission or UL transmission, or used as a special subframe between the DL period and the UL period. Taking configuration 0 as an example, subframes 0 and 5 are used

for the DL transmission, subframes 2 to 4 and subframes 7 to 9 are used for the UL transmission and subframes 1 and 6 are used as special subframes, which are labeled as “D”, “U” and “S” respectively.

[0052] For example, regarding TDD configuration 0, there are three consecutive uplink subframe (i.e., subframes 2 to 4 and subframes 7 to 9), in such a case the hopping interval may be for example 3 uplink subframes. Thus, for the TDD configuration 0, similar to those illustrated in Fig.3A and 3B, the RF retuning can be performed in a plurality of symbols of the first one of subframes planned for the data retransmission at the next hopped frequency or the last one of subframes planned for the data retransmission before the next frequency hopping. Or alternatively, a whole subframe can be used to perform the RF retuning. The whole subframe particularly may be the first one of subframes planned for the data retransmission at the next hopped frequency or the last one of subframes planned for the data retransmission before the next frequency hopping.

[0053] However, the inventors further notice that the TDD frame has its own special structure, i.e., there is a special subframe between the DL period and the UL period, which is always located immediately after an downlink subframe “U” and before an uplink subframe “U.” Thus, it is possible to have the RF retuning to be performed during the special subframe.

[0054] Reference is made to Fig. 6, which schematically illustrates an exemplary configuration of the RF retuning for a TDD system according to an embodiment of the present disclosure. In Fig. 6, frame configuration 0 is taken as an example again, which comprises three consecutive uplink subframes after each special subframe. In other word, a special subframe will be available every three uplink subframes. In such a case, the frequency hopping interval can be set as 3 and the special subframe between the frequency hoppings can be used to perform the RF retuning. In such a way, not only can the frequency diversity gain be obtained by the MTC during the repetitions but also the transmission mistakes can be avoided, and at the same time the impact of RF retuning time can further be reduced.

[0055] Fig. 7 schematically illustrates another exemplary configuration of the RF retuning for a TDD system according to an embodiment of the present disclosure. In Fig. 7, the configuration of the RF retuning is for frame configuration 0 but the

frequency hopping interval is set as 6 instead of 3 of Fig. 6. Thus only the special subframe corresponding subframe 1 in a second frame is used to perform the RF tuning, which is located between two frequency hoppings. It can be understood that, for frame configuration 0, the frequency hopping interval can be determined as the multiple of 3. That is to say, the frequency hopping interval can be determined based on the characteristics of the configuration.

[0056] From Fig. 5, it is clear that different frame configurations have different patterns and thus frequency hopping intervals suitable for different frame configurations are also different. Thus, the frequency hopping interval can be determined based on a configuration of subframe used for the data transmission. That is to say, for different subframe configurations, it can use different frequency hopping interval according to characteristics of different subframe configurations. Taking configuration 0 as an example, there are three consecutive subframes after a special subframe. Thus, in order to use the special subframe for RF retuning, the frequency hopping interval may be the multiple of 3, i.e., 3, 6 and so on, as illustrated in Figs. 6 and 7. For configuration 2, it contains two consecutive uplink subframes, and thus the frequency hopping interval may be the multiple of 2, i.e., 2, 4, 6 and so on. While, for configuration 6 which includes two or three consecutive uplink subframes after a special subframe, the frequency hopping interval may be the multiple of 5, i.e. 5, 10 and so on. In such a way, it may ensure that there is always a special subframe which can be used for the RF retuning.

[0057] With embodiments of the present disclosure, there is provided a new solution for data transmission in wireless communication system, in which the RF retuning can be performed in a plurality of symbols. That means when determining resource for the RF retuning, it considers not only the time length required by the RF retuning but also the starting point of the data retransmission to ensure that the data retransmission could start from a starting point of symbol instead of a middle thereof. In such a way, transmission mistakes can be reduced and the transmission efficiency can be improved. Besides, in the present disclosure, there is proposed to use a frequency hopping interval of at least two, preferable, 3 or more, which means cross-subframe channel estimation can be used, and thus the accuracy of channel estimation during each hopping period will be improved.

[0058] In addition to the method as described above, there is also provided an apparatus for data transmission in a wireless communication system according to an embodiment of the present disclosure. Next reference will be made to Fig. 8 to describe the apparatus as provided in the present disclosure.

5 [0059] As illustrated in Fig. 8, apparatus 800 may comprise an information receiving module 810 and a resource determination module 820. The information receiving module 810 is configured to receive information on assigned resources for the data transmission. The resource determination module 820 may be configured to determine resources for respective data retransmissions based on the information on the
10 assigned resources for the data transmission and a predetermined frequency hopping pattern. Particularly, a plurality of symbols are used to perform a radio frequency (RF) retuning and the time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning.

[0060] In an embodiment of the present disclosure, wherein the plurality of
15 symbols may be a part of a subframe and resting symbols of the subframe may be used to perform the data retransmission. The subframe can be the first one of subframes planned for the data retransmission at the next hopped frequency. Or alternatively, the subframe can be the last one of subframes planned for the data retransmission before the next frequency hopping. Particularly, the number of symbols may be determined as a
20 minimal value that meets the RF retuning.

[0061] In another embodiment of the present disclosure, a whole subframe may be used to perform the RF retuning. Particularly, the whole subframe may be the first one of subframes planned for the data retransmission at the next hopped frequency. Or alternatively, the whole subframe may be the last one of subframes planned for the
25 data retransmission before the next frequency hopping.

[0062] In a still further embodiment of the present disclosure, the predetermined frequency hopping pattern may indicate a frequency hopping interval of at least two subframes in the time domain.

[0063] In a yet further embodiment of the present disclosure, the RF retuning
30 may be performed in a special subframe between two frequency hoppings. Particularly, the frequency hopping interval in the time domain may be determined based on a configuration of subframe used for the data transmission.

[0064] In a yet further embodiment of the present disclosure, the data transmission may be an uplink data transmission for Machine Type Communication (MTC).

[0065] It is noted that the apparatus 800 may be configured to implement functionalities as described with reference to Figs. 1 to 7. Therefore, for details about the operations of modules in these apparatus, one may refer to those descriptions made with respect to the respective steps of the methods with reference to Figs. 1 to 7.

[0066] It is further noted that the components of the apparatus 800 may be embodied in hardware, software, firmware, and/or any combination thereof. For example, the components of apparatus 800 may be respectively implemented by a circuit, a processor or any other appropriate selection device. Those skilled in the art will appreciate that the aforesaid examples are only for illustration not limitation.

[0067] In some embodiment of the present disclosure, apparatus 800 may comprise at least one processor. The at least one processor suitable for use with embodiments of the present disclosure may include, by way of example, both general and special purpose processors already known or developed in the future. Apparatus 800 may further comprise at least one memory. The at least one memory may include, for example, semiconductor memory devices, e.g., RAM, ROM, EPROM, EEPROM, and flash memory devices. The at least one memory may be used to store program of computer executable instructions. The program can be written in any high-level and/or low-level compliable or interpretable programming languages. In accordance with embodiments, the computer executable instructions may be configured, with the at least one processor, to cause apparatus 800 to at least perform operations according to the method as discussed with reference to Figs. 1 to 7 respectively.

[0068] Hereinbefore, detailed descriptions of solutions as provided in the present disclosure are given with reference to specific embodiments of the present disclosure; however, the present disclosure is not limited thereto. It may be appreciated that embodiments of the present disclosure are described with reference to MTC; however, the present invention is not limited thereto and the present invention may be used any communication with a low SNR in LTE system. Besides, hereinabove, the uplink data transmission is described; however, the solution as provided in the present disclosure can also be used in the downlink data transmission.

In such a case, the object of concern will be downlink subframe instead of the uplink subframe, and after the information on assigned resource is determined by the eNB, the information will send to the module for determining resource for the data retransmission in the eNB and the resource determination will be performed at the eNB, instead of the UE. Besides, for the TDD system, the frequency hopping interval may be determined by considering the number of consecutive downlink subframes and the availability of the special subframe.

[0069] Additionally, based on the above description, the skilled in the art would appreciate that the present disclosure may be embodied in an apparatus, a method, or a computer program product. In general, the various exemplary embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the disclosure is not limited thereto. While various aspects of the exemplary embodiments of this disclosure may be illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[0070] The various blocks shown in the accompanying drawings may be viewed as method steps, and/or as operations that result from operation of computer program code, and/or as a plurality of coupled logic circuit elements constructed to carry out the associated function(s). At least some aspects of the exemplary embodiments of the disclosures may be practiced in various components such as integrated circuit chips and modules, and that the exemplary embodiments of this disclosure may be realized in an apparatus that is embodied as an integrated circuit, FPGA or ASIC that is configurable to operate in accordance with the exemplary embodiments of the present disclosure.

[0071] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any disclosure or of what may be claimed, but rather as descriptions of features that may be specific to particular

embodiments of particular disclosures. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple
5 embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

10 [0072] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system
15 components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products.

[0073] Various modifications, adaptations to the foregoing exemplary
20 embodiments of this disclosure may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. Any and all modifications will still fall within the scope of the non-limiting and exemplary embodiments of this disclosure. Furthermore, other embodiments of the disclosures set forth herein will come to mind to one skilled in the
25 art to which these embodiments of the disclosure pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings.

[0074] Therefore, it is to be understood that the embodiments of the disclosure are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims.
30 Although specific terms are used herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

WHAT IS CLAIMED IS:

1. A method of data transmission in a wireless communication system, comprising:
receiving information on assigned resources for the data transmission; and
5 determining resources for respective data retransmissions based on the information
on the assigned resources for the data transmission and a predetermined frequency
hopping pattern, wherein a plurality of symbols are used to perform a radio frequency
(RF) retuning and the time duration of the plurality of symbols is at least equal to a time
interval required by the RF retuning.

10 2. The method according to Claim 1, wherein the plurality of symbols are a part of
a subframe and resting symbols of the subframe are used to perform the data
retransmission.

15 3. The method according to Claim 2, wherein the subframe is any one of the first
one of subframes planned for the data retransmission at the next hopped frequency or
the last one of subframes planned for the data retransmission before the next frequency
hopping.

20 4. The method according to any of Claims 1 to 3, wherein the number of symbols
is determined as a minimal value that meets the RF retuning.

25 5. The method according to Claim 1, wherein a whole subframe is used to perform
the RF retuning.

6. The method according to Claim 5, wherein the whole subframe is any one of the
first one of subframes planned for the data retransmission at the next hopped frequency
or the last one of subframes planned for the data retransmission before the next
frequency hopping.

30 7. The method according to any one of Claims 1 to 6, wherein the predetermined
frequency hopping pattern indicates a frequency hopping interval of at least two

subframes in the time domain.

8. The method according to Claim 1, wherein the RF retuning is performed in a special subframe between two frequency hoppings.

5

9. The method according to Claim 8, wherein a frequency hopping interval in the time domain is determined based on a configuration of subframe used for the data transmission.

10 10. The method according to any one of Claims 1 to 9, wherein the data transmission is an uplink data transmission for Machine Type Communication (MTC).

11. An apparatus for data transmission in wireless communication system, comprising:

15 an information receiving module, configured to receive information on assigned resources for the data transmission; and

a resource determination module, configured to determine resources for respective data retransmissions based on the information on the assigned resources for the data transmission and a predetermined frequency hopping pattern, wherein a plurality of
20 symbols are used to perform a radio frequency (RF) retuning and the time duration of the plurality of symbols is at least equal to a time interval required by the RF retuning.

12. The apparatus according to Claim 11, wherein the plurality of symbols are a part of a subframe and resting symbols of the subframe are used to perform the data
25 retransmission.

13. The apparatus according to Claim 12, wherein the subframe is any one of the first one of subframes planned for the data retransmission at the next hopped frequency or the last one of subframes planned for the data retransmission before the next
30 frequency hopping.

14. The apparatus according to any of Claims 11 to 13, wherein the number of

symbols is determined as a minimal value that meets the RF retuning.

15. The apparatus according to Claim 11, wherein a whole subframe is used to perform the RF retuning.

5

16. The apparatus according to Claim 15, wherein the whole subframe is any one of the first one of subframes planned for the data retransmission at the next hopped frequency or the last one of subframes planned for the data retransmission before the next frequency hopping.

10

17. The apparatus according to any one of Claims 11 to 16, wherein the predetermined frequency hopping pattern indicates a frequency hopping interval of at least two subframes in the time domain.

15

18. The apparatus according to Claim 11, wherein the RF retuning is performed in a special subframe between two frequency hoppings.

19. The apparatus according to Claim 18, wherein a frequency hopping interval in the time domain is determined based on a configuration of subframe used for the data transmission.

20

20. The apparatus according to any one of Claims 11 to 19, wherein the data transmission is uplink data transmission for Machine Type Communication (MTC).

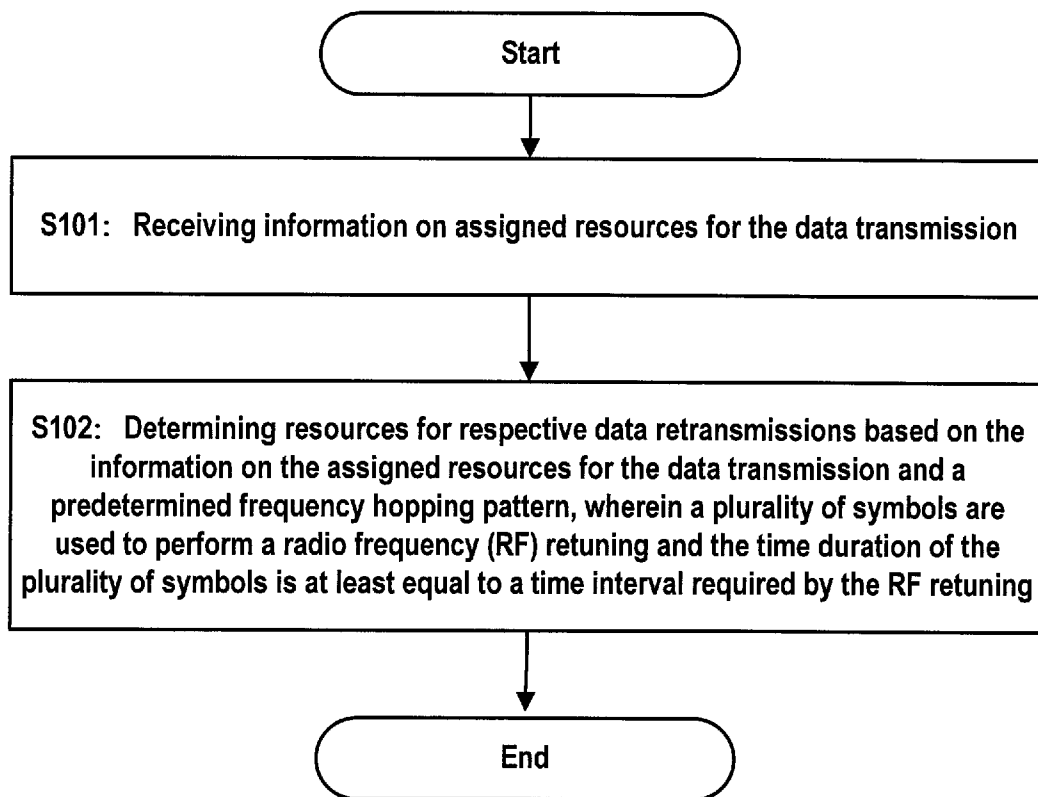


Fig. 1

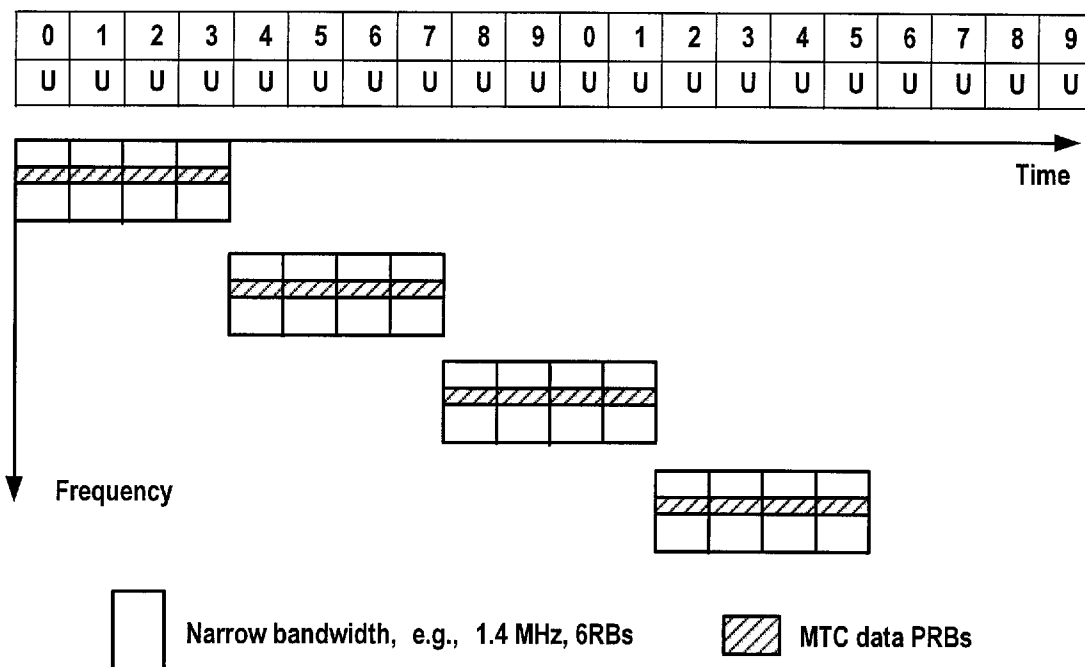


Fig. 2

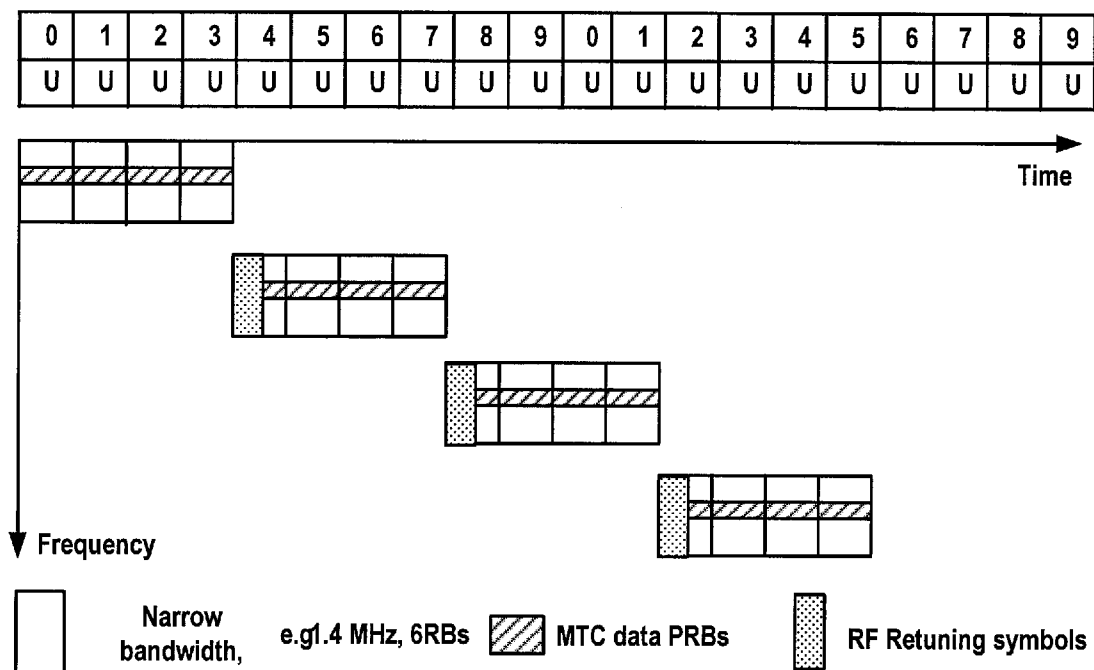


Fig. 3A

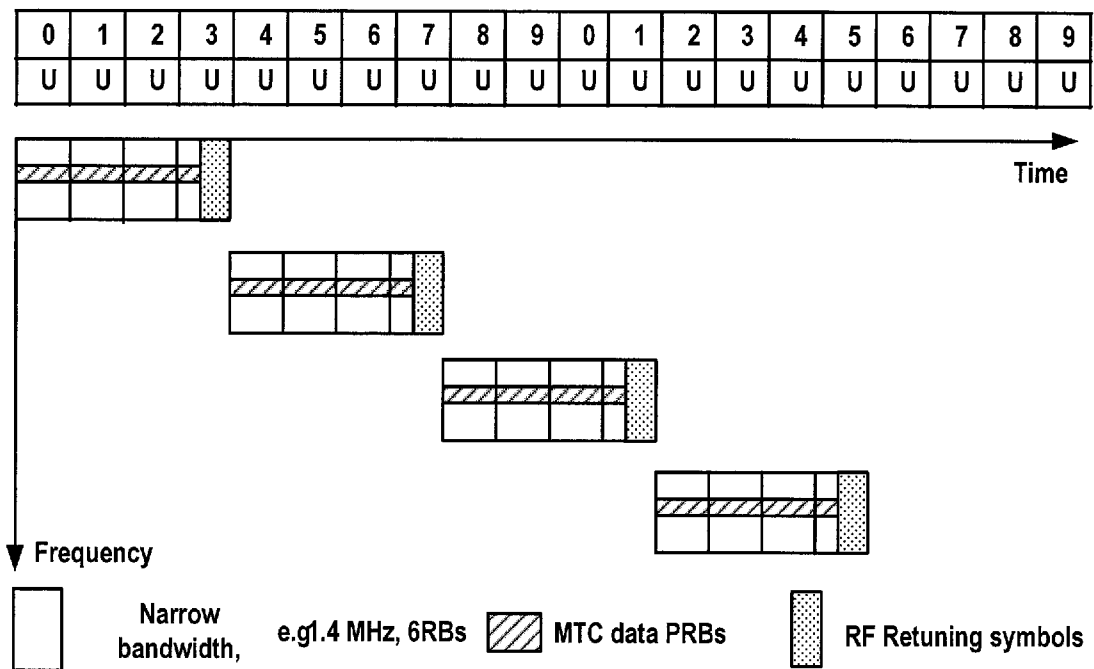


Fig. 3B

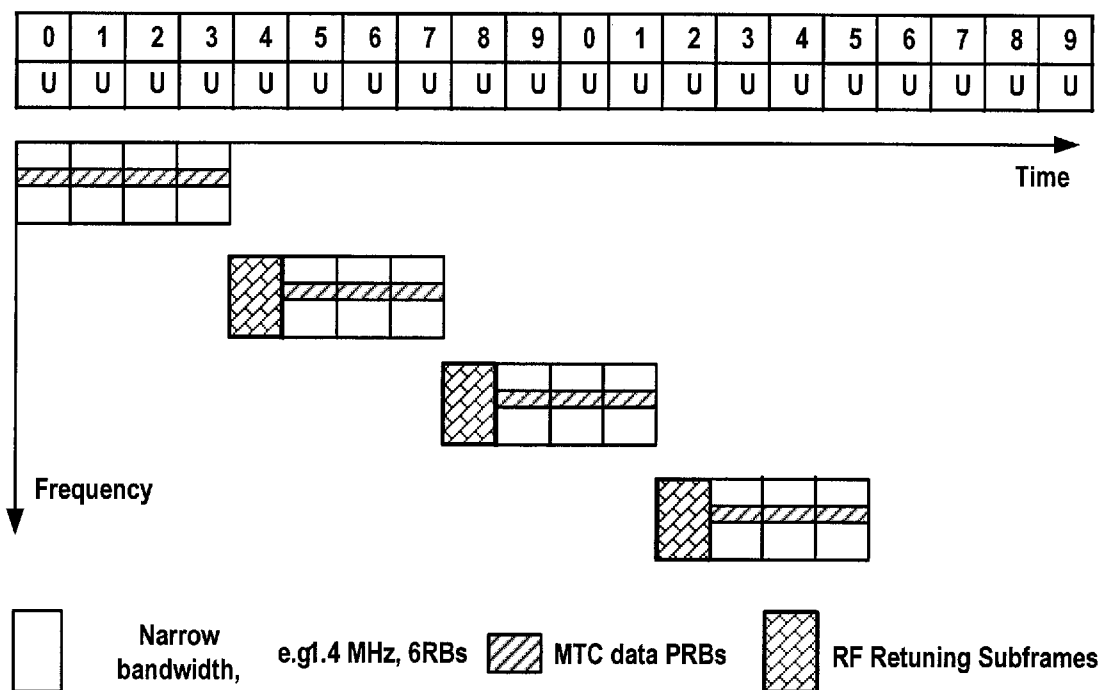


Fig. 4A

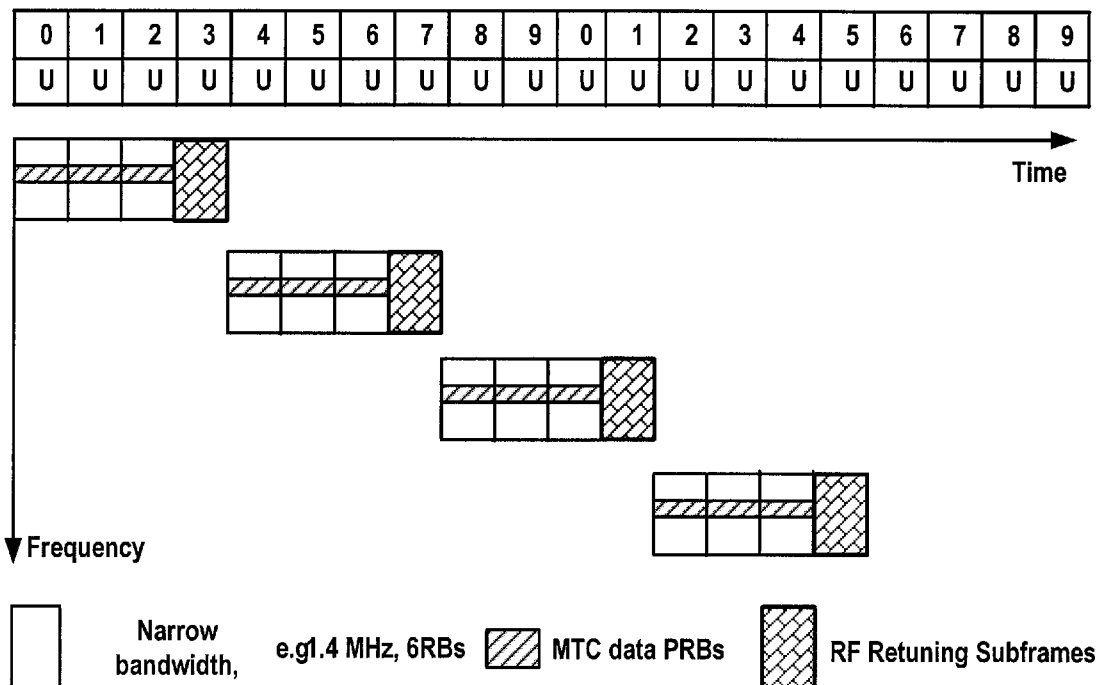


Fig. 4B

UL-DL Configuration	Switching - point periodicity	Subframe number									
		#0	#1	#2	#3	#4	#5	#6	#7	#8	#9
0	5ms	D	S	U	U	U	D	S	U	U	U
1	5ms	D	S	U	U	D	D	S	U	U	D
2	5ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5ms	D	S	U	U	U	D	S	U	U	D

Fig. 5

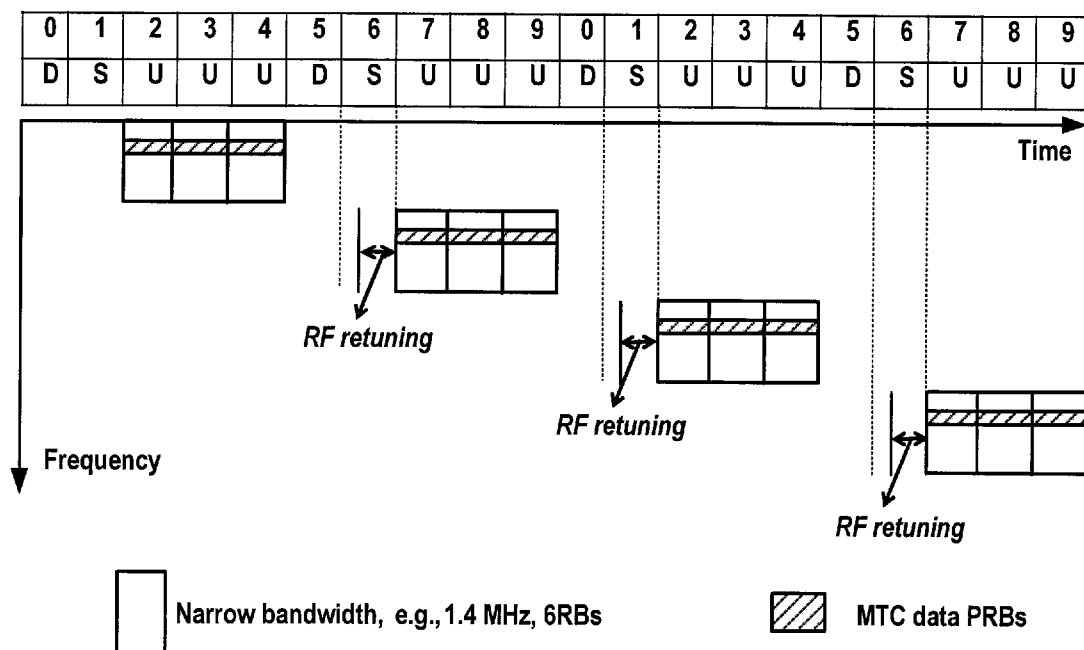


Fig. 6

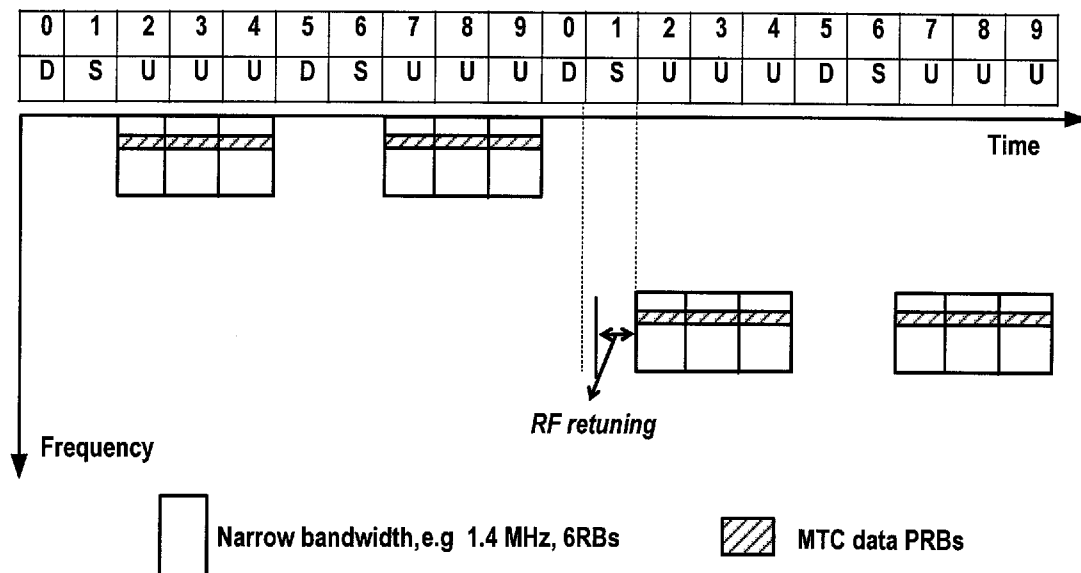


Fig. 7

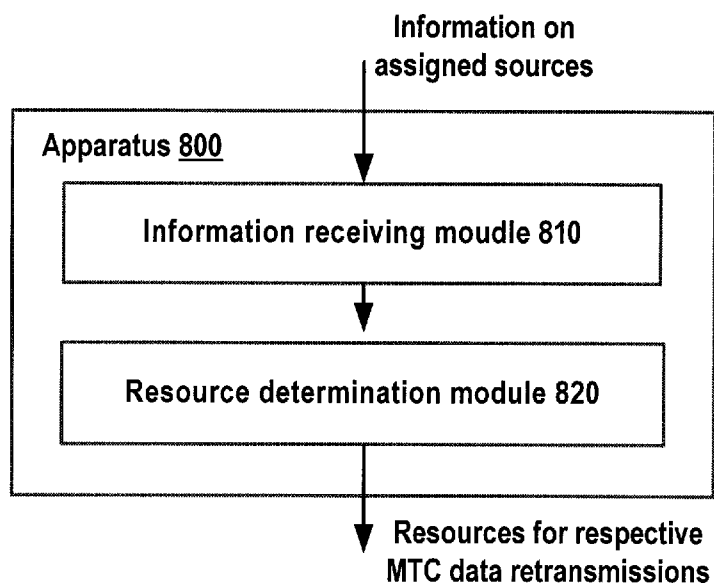


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/075454

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i; H04W 4/00(2009.01)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)

H04W; H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, CNPAT, CNKI: MTC, M2M, machine type communicat+, machine? to machine?, hopping, frequency, RF, tun+, retun+, frame?, subframe?, symbol?, retransmi+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012022370 A2 (NOKIA SIEMENS NETWORKS OY ET AL.) 23 February 2012 (2012-02-23) description, page24, line 4-page 26, line 6, page 27, line 21-page 28, line 33, figures 5 and 8	1-20
A	US 2013294399 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 07 November 2013 (2013-11-07) the whole document	1-20
A	US 2013114579 A1 (LG ELECTRONICS INC.) 09 May 2013 (2013-05-09) the whole document	1-20
A	WO 2014027851 A1 (SAMSUNG ELECTRONICS CO., LTD.) 20 February 2014 (2014-02-20) the whole document	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“E” earlier application or patent but published on or after the international filing date

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

19 November 2015

Date of mailing of the international search report

31 December 2015

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/075454

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2012022370	A2	23 February 2012	None			
US	2013294399	A1	07 November 2013	KR	20130119867	A	01 November 2013
US	2013114579	A1	09 May 2013	WO	2012008691	A2	19 January 2012
				EP	2594026	A2	22 May 2013
WO	2014027851	A1	20 February 2014	US	2015181560	A1	25 June 2015
				KR	20150046122	A	29 April 2015