IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Inventor Name:	Anpeng Huang
Title:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
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PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Prior to examination of the present application, it is respectfully requested that the application be amended as follows.

Amendments to the Specification begin on page 2 of this document.

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this document.

Remarks/Arguments begin on page 9 of this document.

Please amend the application as follows.

Amendments to the Specification:

Please insert the following heading and paragraph after the Title and before the "BACKGROUND" section of the application.

-- CROSS-REFERENCE TO RELATED APPLICATION--

The present application is a U.S. National Stage filing under 35 U.S.C. § 371 of International Application Serial No. PCT/CN2014/083578, filed on August 01, 2014.

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application.

1. (Currently Amended) A method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, the method comprising:

determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink channel or a downlink channel;

assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource;

scheduling a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel based on an initial directional allocation of communication resources for the base station;

after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and

selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

2. (Currently Amended) The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool based on the determined quality status of the first frequency spectrum resource comprises assigning the first frequency spectrum resource to the shared resource pool according to the

first frequency spectrum ~~resources~~resource being:

less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and

less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

3. (Original) The method of claim 2, wherein the first frequency spectrum resource is less suitable for the downlink channel than the third frequency spectrum resource in response to a channel quality indicator (CQI) of the first frequency spectrum resource being less than a CQI of the third frequency spectrum resource.

4. (Original) The method of claim 2, wherein the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource in response to a received interference power (RIP) of the first frequency spectrum resource being greater than an RIP of the third frequency spectrum resource.

5. (Original) The method of claim 1, further comprising:

determining a quality status of the second frequency spectrum resource; and

based on the determined quality status of the second frequency spectrum resource, assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool,

wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises determining a quality status of the second frequency spectrum resource.

6. (Original) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource

pool comprises:

assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the uplink channel, and

assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the downlink channel.

7. (Currently Amended)The method of claim 5, wherein determining the quality status of the second frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI)[[CQI]] and a received interference power (RIP)[[RIP]] of the second frequency spectrum resource.

8. (Original) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool based on the quality status of the second frequency spectrum resource.

9. (Currently Amended)The method of claim 1, wherein determining the quality status of the first frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI)[[CQI]] and a received interference power (RIP)[[RIP]] of the first frequency spectrum resource.

10. (Original) The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements

associated with each of the multiple subcarriers to the shared resource pool.

11. (Currently Amended) A wireless base station for a wireless communication network, the wireless base station comprising:

a quality status module configured to determine a quality status of a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for [[an]]the uplink channel or the downlink channel;

a processor module coupled to the quality status module and configured to assign the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource; and

a scheduler module coupled to the processor module and configured to schedule the second frequency spectrum resource for [[an]]the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

12. (Currently Amended) The wireless base station of claim 11, wherein the processor module is further configured to determine the updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for [[an]]the uplink channel or the downlink channel.

13. (Original) The wireless base station of claim 11, further comprising a

memory coupled to the processor module and configured to store the shared resource pool, wherein the processor module is further configured to assign the second frequency spectrum resource to one of an uplink resource pool stored in the memory or a downlink resource pool stored in the memory based on the determined quality status of the second frequency spectrum resource.

14. (Canceled)

15. (Original) The wireless base station of claim 13, wherein the updated directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, on current resource requests from the wireless base station, on a number of frequency spectrum resources scheduled from the uplink resource pool for uplink channels, and on a number of frequency spectrum resources scheduled from the downlink resource pool for downlink channels.

16. (Original) The wireless base station of claim 11, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station and from the wireless base station.

17. (Currently Amended) The wireless base station of claim 11, wherein the quality status module is configured to determine the quality status of the first frequency spectrum resource by determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

18. (Original) The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum resource to the shared resource pool by assignment of a physical resource block that includes multiple

subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

19. (Currently Amended) The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum resource to the shared resource pool[[by]] in response to the first frequency spectrum resource being less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the wireless base station, and being less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the wireless base station.

20. (Currently Amended) A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of the method of ~~any of claims 1-11~~ claim 1.

REMARKS

It is respectfully requested that the foregoing amendments be made prior to examination of the present application.

Amendments to the Specification

The specification is amended to include a cross-reference to related application paragraph as the first paragraph. No new matter is added.

Amendments to the Claims

By the present communication, claims 1, 2, 7, 9, 11, 12, 17, 19, and 20 are amended, and claim 14 is canceled without prejudice or disclaimer thereof.

The claim amendments add no new matter, and entry and examination of the amended claims is respectfully requested. Upon entry of this amendment, claims 1-13 and 15-20 will be pending and under examination in this application.

Conclusion

Favorable consideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance prosecution.

Dated this 31st day of January, 2017.

Respectfully submitted,

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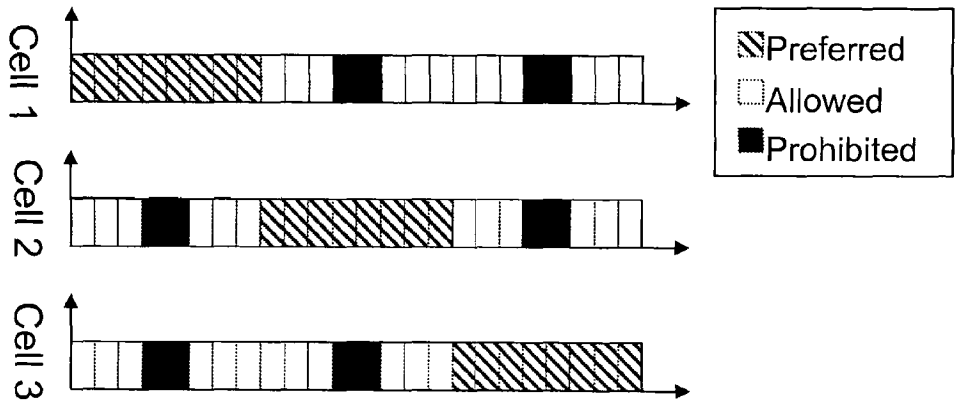
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(54) Title: METHOD IN A SCHEDULER FOR REDUCING INTER-CELL INTERFERENCE



(57) Abstract: The present invention relates to a method for reducing inter-cell interference in a cellular radio system in which said scheduler (111) controls a set of shared radio resources. The method comprises the steps of - assigning cell specific resource priority weights (RPW) to the different radio resources of a cell (11), said assignment differs from the assignment of the same radio resources in at least one neighboring cell (12a-f); - utilizing the resource priority weights for selection of radio resources. The resource priority weights can furthermore be combined with channel quality indication reports (CQI) to form weighted quality indexes (WCQI) for the radio resources that are available to the scheduler (111). The invention also relates to a scheduler performing said method and a radio network node comprising such scheduler.

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Method in a scheduler for reducing inter-cell interference.

FIELD OF THE INVENTION

The present invention relates to methods and arrangements in cellular mobile communication systems, in particular to the inter-cell interference management in cells.

BACKGROUND

In cellular radio systems it is desirable to achieve high data rates for users also at the cell edges that typically have poor radio conditions. Traditionally, radio resources are therefore divided into different sets that are assigned to neighboring cells to make it possible to reduce the interference level for the cell edge users, thus allowing them to communicate with higher data rates, but at the cost of a reduced cell capacity. Other, more advanced methods like soft frequency reuse (sometimes also referred to as power planning) in OFDM systems or fractional frequency reuse also aim to provide users at the cell edges with higher data rates. These methods provide good ways of controlling the trade-off between cell edge data rate and cell capacity.

Previous solutions to provide high data rates to users at cell edges suffer from the disadvantage that they imply a trade-off between cell edge data rate and cell capacity. Furthermore, in many packet data systems where packets of different sizes originating from different sources, e.g. Voice over IP, web traffic etc, are transmitted from different locations in the cells in each transmission time interval, the traffic load varies significantly in both the

spatial and temporal domains. The traffic variation is independent between the different cells, and the time scale of the load variations is such that the transmissions from different cells cannot be successfully coordinated.

It can thus be concluded that static resource division methods and interference coordination methods that do not take into account and utilize the traffic variations only have a limited potential.

SUMMARY

It is therefore an object of the present invention to avoid this trade-off and instead improve the data rate that is available to users at the cell edge while at the same time maintaining the cell capacity as for a system where all radio resources can be used (i.e. a reuse-1 system). Furthermore, it is an object of the invention to make the inter-cell interference more predictable and thereby allowing the link adaptation to be more exact.

The present invention relates to a method for reducing inter-cell interference and a scheduler performing said method. More specifically, the invention relates to a method in a scheduler for reducing inter-cell interference in a cellular radio system in which said scheduler (111) controls a set of shared radio resources. The method comprises the steps of assigning cell specific resource priority weights (RPW) to the different radio resources available in a cell (11), said assignment differs from the assignment of the same radio resources in at least one neighboring cell, and thereafter utilizing the resource priority weights for selection of radio resources. Hence, the same radio resources will not primarily be selected by

a scheduler of a neighboring cell, thus avoiding inter-cell interference.

The resource priority weights are cell specific since the same resource will be assigned different weights in the respective schedulers of the neighboring cells. The present invention thus provides the advantage that sufficiently high data rates are available to users at the cell edge while at the same time the cell capacity can be maintained as for a system where all available radio resources can be used.

The aspect of the invention described above also implies the advantage that the inter-cell interference becomes more predictable and, when the cell is not fully loaded, can be concentrated to some specific radio resources.

It is another advantage of the present invention that the probability that the same radio resources are selected in neighboring cells is significantly reduced, while avoiding at the same time the cell capacity loss that is associated with traditional frequency reuse schemes.

The invention is equally applicable to transmission in both uplink and downlink. In case of uplink transmission the scheduler aims to assign resources with high resource priority weights to cell edge-users.

The invention furthermore relates to a scheduler controlling a set of shared resources in a cellular radio system, comprising means for performing the method according to the invention.

The invention furthermore relates to a radio network node in a cellular radio system comprising a scheduler, where said scheduler comprises means for performing the method according to the invention.

In one embodiment of the invention, the cell specific resource priority weights are combined with channel quality indication reports, CQI, from the users to form weighted quality indexes, WCQI, for the radio resources that are available to the scheduler. Hereby, the channel quality variations between different users are taken into account and a scheduling gain is achieved.

In yet another embodiment of the invention, the cell specific resource priority weights and/or the weighted quality index is/are combined with one or more usage limitation rules, which may be cell specific and/or user specific and/or resource specific and/or time dependent. Hereby, it is possible to further define which resources that may be used by which users under different conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following detailed description of preferred embodiments as illustrated in the drawings.

Figure 1 illustrates a cellular radio network comprising network units according to the claimed invention;

Figure 2 illustrates an embodiment of the invention, where resources in three cells are categorized into three priority classes;

Figure 3 illustrates another embodiment of the invention, where resources in three cells are prioritized according to a priority list.

Figure 4 shows a flow chart illustrating an embodiment of the method according to the invention.

DESCRIPTION

The present invention relates to cellular radio systems as shown in Figure 1. The base station 1 is provided with a scheduler 111 which owns and controls a set of shared radio resources of cell 11. The radio resources of neighboring cells 12a-f are owned and controlled by their respective schedulers 222a-f. The radio resources may comprise of sets of sub-carriers in an OFDM system, time slots in a TDMA system, or spreading codes in a CDMA system. Further, the respective set of radio resources shall be orthogonal, or near orthogonal, to each other. It is also noted that the benefits of the present invention can be advantageously used when the traffic load in communication system varies significantly in both the spatial and temporal domains. This is a typical behavior in many packet data systems where packets of different sizes originating from different sources, e.g. VoIP, web traffic etc. are transmitted from different locations in the cells in each transmission time interval, TTI. Hereby it is assumed that the traffic variation are independent between the different cells in the system and that the time scale of the load variations is such that we can not successfully coordinate the transmissions from different cells, e.g. by means of a joint scheduling decision in a centralized node or by some distributed scheduling algorithm.

The present invention exploits gains with schemes that adapt to the user traffic in some way. One such scheme is to have an underlying reuse-3 cell planning of preferred resources assigned to each cell. All cells will first use all their preferred resources before any other allowed resources. Only when one cell has a lot of data it will use all allowed resources. It is also possible to have some resources that are prohibited, as in traditional reuse schemes. By this

resource division (preferred, allowed, and possibly also not-allowed resources) the average cell edge SINR (Signal to Interference plus Noise Ratio) can be improved, at low and moderate load at least, while the bandwidth cost of a re-use larger than one is avoided. This is illustrated in Figure 2 showing an example with three cells where resources are categorized as preferred, allowed, and prohibited by assigning separate priority class indexes to the resources, one for each category. The priority class index expresses the order of priority that can be applied to the resources as integers in an indexing vector. Although the example in Figure 2 shows the set of resources as a continuous set, they may also be distributed. Said resource division makes the interference more predictable, thus allowing the link adaptation to be more exact and aggressive.

In a further embodiment of the present invention a priority list is introduced covering each resource in the scheduler, whereby the scheduler always selects the resources with the highest priority. One way of creating appropriate resource priority lists for the schedulers is to assign each scheduler with a starting resource r_0, r_1, r_2 for the schedulers in cell 0, cell 1, and cell 2 respectively and then selecting resources in both directions when they are needed. In such a priority list, each available resource is assigned different priority class indexes where the lowest priority class index is assigned to the starting resource and the subsequently following resources are assigned raising indexes. This is illustrated in Figure 3 showing an example with three cells where the resources are prioritized in order to minimize the inter-cell interference. The resources in a cell i are selected by starting with a resource r_i and then using as many resources as needed from both sides of r_i according to the principle of r_i, r_i-1, r_i+1, r_i-2, r_i+2,… or equivalently,

r_i, r_i+1, r_i-1, r_i+2, r_i-2,…. Not allowed resources are marked in the figure with x. The numbering in the different boxes indicates the priority class indexes, i.e. the order in which the resources will be utilized in the different cells.

In the examples described above, the priority class index (PCI) is associated with a one-to-one mapping to the cell specific resource priority weight (RPW). The resources with the lowest priority class index, i.e. the resources to be used first, will be assigned the highest resource priority weights. The resource with the highest priority class index, i.e. the resources to be used only when all other resources are already occupied, will be assigned the smallest resource priority weight. The priority class index thus indicates the priority order of the resources. The RPW of a resource with index r in the cell with index c may typically be calculated as

$$RPW(c,r) = K1 - K2 \times PCI(c,r),$$

where K1 and K2 are constant values. Alternatively a table can be designed where each priority class index is associated with a corresponding priority class weight.

The resource division as described in the foregoing implies however a reduced scheduling gain since in each cell it is only allowed to select the best resources from the set of preferred resources, while there are still such resources available, and not from all resources. There is thus a trade-off between inter-cell interference levels and predictability versus the single user scheduling gain that can be obtained from having each user transmitting only on the resources with the best quality. These two principles can be combined by adding channel quality indication (CQI) reports from each user to the cell specific resource priority weights (RPW) into a weighted channel quality index (WCQI) as follows:

$$WCQI(c,u,r) = CQI(u,r) + RPW(c,r)$$

In the above expression c denotes the cell index, u denotes the user index, and r denotes the resource index. It is assumed that the CQI values are limited to the range [0, CQI_{max}] and that resources with a WCQI below zero (or some other pre-defined threshold value) are not allowed to be used by the scheduler.

As previously mentioned, the resources can be partitioned into classes represented by the priority class indexes. A scaled value of RPW can furthermore be calculated as e.g., $RPW(c,r) = (PCI_{max} - PCI(c,r)) \times \Delta$ to the resources with index r belonging to the corresponding priority classes in the cell c, where Δ is a constant value representing a scaling factor and PCI_{max} is the maximum value of a PCI. By setting Δ to $(CQI_{max} + 1)$ or larger it can be assured that all resources of a class with a lower priority class index are used before starting to use any resources having a higher priority class index. Setting Δ to CQI_{max} or smaller allows the scheduler to sometimes use a resource with a higher priority class if the channel quality indicator of the corresponding higher-priority-class index resource is sufficiently large.

With reference to Figure 2 we may set $\Delta = (CQI_{max} + 1)$ and the priority class index to 0, 1, and -1 for the respective priority classes denoted preferred, allowed, and prohibited in figure 2. In this example $PCI_{max} = 1$ and the resulting resource priority weights will then become $(CQI_{max} + 1)$, 0, and $-(CQI_{max} + 1)$ for the resources denoted preferred, allowed, and prohibited respectively.

In Figure 3 there is only one resource in each priority class. The resource priority indexes in Figure 3 may thus be used to calculate the resource priority weights as $RPW(c,r) = (PCI_{max} - PCI(c,r)) \times \Delta$, with $PCI_{max} = 20$ and PCI(c,r) is given by the

numbers in the figure, i.e. in accordance to what was previously described by the resource ordering (r_c, r_c-1, r_c+1, r_c-2, r_c+2,...), for each cell c = 1, 2, and 3. Resources marked with an X in Figure 3 will be assigned a resource priority weight of $-(CQI_{max} + 1)$ to ensure that the weighted CQI (WCQI) is always a negative value regardless of the CQI value.

It is thus possible to scale the impact that the RPW and the CQI respectively will have in the calculation of the weighted channel quality index (WCQI).

A further aspect of the invention introduces the possibility to use or not to use the resources of some priority classes under certain conditions. The following is a non-comprehensive list of possible restrictions:

1. Resources with higher resource priority indexes may not be used before any resources with lower priority indexes. This can also be achieved by setting the parameters of the RPW calculation properly.

2. Resources of certain priority classes may not be used unless the buffer fill ratio is above a threshold (different priority classes may have different thresholds).

3. Resources of certain priority classes may not be used unless the packet delay is above a threshold (different priority classes may have different thresholds).

4. Resources of certain priority classes may not be used unless the packet error rate (or some other packet quality measurement like the packet drop rate) is above a threshold.

5. If there is information available of the load in neighboring cells it is possible to restrict certain resources to be used only if the load measurements in the neighboring cells are all below (or above) a threshold.

6. A utilization restriction can be set to some resources, e.g. resources of a certain priority class may be used in a transmission time interval (TTI) only if the utilization of these resources is below a threshold. Utilization may, e.g., be measured as the time and frequency usage count of the resources of this priority class summarized over the previous N TTIs.

7. The resources in a specific priority class may only be used for N_{max} consecutive TTIs.

8. If resources of some specific priority class are used in a transmission time interval TTI(n), then the same resource must not be used in TTI(n+ N_{RTT}) where N_{RTT} is related to the HARQ round-trip time. The reason for this could be to let through a retransmission from a user equipment that in its first transmission was interfered by a user equipment in a neighboring cell that rapidly increased its power, whereby the channel quality for the first UE was deteriorated between measurement and transmission.

Alternatively, when in a transmission time interval TTI(n) the transmitted power on resources of certain priority have increased more than a threshold over a pre-defined time interval, the same resources must not be used in transmission time interval number (n+N_{RTT}) where N_{RTT} is related to the HARQ round-trip time.

9. Any of the restrictions disclosed in sections 2-8 can be combined with a timer. When the threshold is exceeded a timer is started indicating that it is allowed to use the corresponding resource until the timer expires (each priority class may have its own timer value).

10. Any of the restrictions disclosed in sections 2-8 can be combined with a hysteresis for the threshold values. Once the

threshold is exceeded it is allowed to use the corresponding resources until the measurement falls below another threshold (typically lower than the first threshold).

11. The resources of some specific priority classes may only be used by users with a certain premium classification (PLATINUM/GOLD/SILVER) or any combination thereof or, assuming that there are such users, the resources may always be scheduled to such users first.

12. The resources of some specific priority classes may only be used by emergency calls or the resources are always scheduled first to emergency users if such users exist.

The above mentioned thresholds, hysteresis intervals, timers and restriction rules may be applied differently to resources of different priority classes.

The introduction of restrictions, e.g. as disclosed above, can be formalized by expanding the calculation of the WCQI values to also include a time varying restriction rule $RR(c,u,r,t)$ as follows (t is the TTI index):

$$WCQI(c,u,r,t) = CQI(u,r,t) + RPW(c,r) + RR(c,u,r,t)$$

Whenever a certain resource is not allowed because of any combination of usage restrictions like the ones listed above, RR is set to a value less than $-(CQI_{max} + RPW_{max})$ which will assure that the corresponding WCQI value is below zero.

In further embodiments not described herein, additional factors covering aspects of the conditions in the own and neighboring cells other than those described herein could be added in the calculation of the WCQI value.

To summarize, the method according to one aspect of the invention could be carried out as illustrated in Fig. 4:

In step 10, the resources of a cell are assigned cell specific resource priority weights (RPW), expressed e.g. as an indexing vector of integers representing the priority order for each resource. The same radio resources in at least one neighboring cell are assigned different resource priority weights.

Channel quality indication reports are created by measuring at step 20, the Signal to Interference plus Noise Ratio (SINR), and in step 30 converting said measured SINR value into an index value by means of e.g. mapping the measured value to a table of CQI indexing values.

In step 40, a restriction comprising one or several restriction rules is added to the calculation of WCQI in order to further define which resources that can be used under certain condition.

Either one of the RPW or the CQI values could be scaled with a factor in order to increase its impact in the calculation 50 of the weighted channel quality index (WCQI). The choice of scaling can e.g. depend on the cell layout of the network. For example, in an environment with a large number of cells overlapping each other, the inter-cell interference is probably a significant problem, and the impact of the RPW could be scaled to have a relatively large impact, whereas in a different environment, it is more advantageous to give the CQI a greater impact.

In step 60, the scheduler then selects resources in accordance with the calculated weighted channel quality index and any applied restriction rules.

Different resources may be allowed to be used with different power levels. There is nothing that prohibits the use of the present invention together with power limitations on the different resources.

The cell specific resource priority weights can be generated in a central node such as an operational maintenance node and provided to the different base stations (1, 2a-f) from said central node over an open interface. The cell specific resource priority weights can either be generated manually by means of a net planning instrument or automatically in a Radio Resource Management node (RRM) or the like.

The present invention is applicable to both uplink and downlink transmission. In case of uplink transmission the scheduler aims to assign resources with high resource priority weights to cell edge-users. The users are categorized into groups dependent on their geographic position in the cell, and are assigned resources of different priority classes. Such categorization into e.g. cell-edge users and cell-centre users could be based on geometry measurements. Cell-edge users are then assigned to resource with lower priority indexes than cell-centre users. The benefits of this are twofold:

Firstly, a user far from the receiving base station will often be power limited and it is then not able to increase the transmit power in case the interference increases. Hence the only way to improve the performance of this cell-edge user is to reduce the interference on the used resources. If resources with high resource priority weights in one cell are assigned low resource priority weights in an interfering cell there is a high probability that the corresponding resources will be unused in the interfering cell and thus the cell edge

user will experience less inter-cell interference if it is assigned to resources with high resource priority weights.

Secondly, even if the resources assigned to a cell-edge user are used in a neighboring interfering cell they will often be assigned to users close to the base station in the other cell. Such cell-centre users typically have a much smaller path loss compared to cell-edge users and they can therefore often transmit with a power much lower than the maximum possible power. The cell centre-users also have a larger path loss to interfered base stations since they are typically located at a longer distance from interfered base stations. Because of this they will generate less interference for cell-edge users in the neighboring cells.

Also for the downlink it is beneficial to map resources transmitted with high power to resource with high resource priority weights. This ensures that a resource transmitted with low power from one base station will have a low probability of colliding with resources transmitted with high power from a neighboring interfering base station.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but is intended to cover various modifications within the scope of the appended claims.

CLAIMS

1. A method in a scheduler for reducing inter-cell interference in a cellular radio system in which said scheduler (111) controls a set of shared radio resources, characterized by the steps of

- assigning cell specific resource priority weights (RPW) to the different radio resources available in a cell (11), said assignment differs from the assignment of the same radio resources in at least one neighboring cell (12a-f);

- utilizing the resource priority weights for selection of radio resources.

2. The method according to claim 1, comprising categorizing the radio resources of a cell (11) into priority classes, where each class is represented by a priority class index.

3. The method according to claim 1, comprising categorizing users into groups dependent on their geographic position in the cell, and assigning resources of different priority classes to the users of the different groups.

4. The method according to claim 2 comprising categorizing the radio resources into priority classes denoted "preferred", "allowed" and "prohibited", where the "preferred" resources are used first, the "allowed" resources are used only when no more unused "preferred resources" exist, and the "prohibited" resources are never used.

5. The method according to claim 2, comprising creating a priority list according to which each priority class comprises only one resource.

6. The method according to claim 5, comprising assigning the lowest priority class index to a starting

resource (r_i), said starting resource is different from starting resources in neighboring cells, and assigning raising priority class indexes to the resources following the starting resource according to the principle r_i, r_i-1, r_i+1, r_i-2, r_i+2,… from said starting resource.

7. The method according to any of the preceding claims, comprising combining the cell specific resource priority weights with channel quality indication reports (CQI) from the users to form weighted quality indexes (WCQI) for the radio resources that are available to the scheduler (111).

8. The method according to claim 7, comprising creating the channel quality indication reports (CQI) by measuring the Signal to Noise Ratio (SNR) or the Signal to Interference plus Noise Ratio (SINR) and converting said measured value into an index value.

9. The method according to claim 7 or 8, comprising multiplying the CQI or the RPW with a scaling factor, said scaling factor determines the relative influence of the term with which it is multiplied in the calculation of the weighted channel quality index (WCQI).

10. The method according to any of the preceding claims, whereby the cell specific resource priority weights and/or the weighted quality index is combined with one or more usage limitation rules applied to some of radio resources under certain conditions.

11. The method according to claim 10, whereby the usage limitation rules may be cell specific and/or user specific and/or resource specific and/or time dependent.

12. The method according to claim 10 or 11, whereby resources with higher priority indexes may not be used before any resources with lower priority indexes.

13. The method according to claim 10 or 11, comprising applying said usage limitation rules as binary

values, representing compliance or non-compliance with certain conditions, on the cell specific resource priority weights or the weighted channel quality index.

14. The method according to claim 13, whereby resources of certain priority may not be used unless the buffer fill ratio is above a predefined threshold, whereby resources of different priority may have different thresholds.

15. The method according to claim 13, whereby resources of certain priority may not be used unless the packet delay is above a predefined threshold, whereby resources of different priority may have different thresholds.

16. The method according to claim 13, whereby resources of certain priority may not be used unless a packet quality measurement such as packet error rate or packet drop rate is above a predefined threshold.

17. The method according to claim 13, whereby certain resources may be used only if load measurements in neighboring cells are all below (or above) a threshold.

18. The method according to claim 13, whereby certain resources may be used in a certain transmission time interval TTI only if the utilization of these resources is below a threshold.

19. The method according to claim 18, whereby resources of certain priority may only be used for a predetermined number N_{max} of consecutive transmission time intervals TTI.

20. The method according to claim 18 or 19, whereby when resources of certain priority are used in a transmission time interval TTI(n), the same resource must not be used in transmission time interval number $(n+N_{RTT})$ where N_{RTT} is related to the HARQ round-trip time.

21. The method according to claim 18 or 19, whereby when used in a transmission time interval TTI(n) the transmitted power on resources of certain priority have increased more than a threshold over a pre-defined time interval, the same resources must not be used in transmission time interval number $(n+N_{RTT})$ where N_{RTT} is related to the HARQ round-trip time.

22. The method according to any of claims 14 to 21, whereby as the threshold is exceeded, a timer is started whereby a corresponding set of resources is allowed to be used during the time set by the timer, whereby resources of certain priority may have its own timer value.

23. The method according to any of claims 14 to 21, whereby a restriction is combined with a hysteresis in the threshold values, whereby as the threshold is exceeded a corresponding set of resources is allowed to be used until a measurement falls below another threshold, which is preferably lower than the first threshold.

24. The method according to claim 10 or 11, whereby resources of certain priority may only be used by users with a certain classification or the resources are always scheduled to users of such classifications first if such users exist.

25. The method according to claim 10 or 11, whereby resources of certain priority may only be used by emergency calls or the resources are always scheduled first to emergency users if such users exist.

26. The method according to any of the preceding claims, whereby said scheduler is arranged in a base station, and whereby the scheduler receives said cell specific resource priority weights from a central node such as an operational maintenance node.

27. The method according to any of the preceding claims, whereby cell specific power limitations are assigned to different radio resources.

28. A scheduler (111, 222a-f) controlling a set of shared radio resources in a cellular radio system, characterized in means for performing the method according to any of claims 1-27.

29. A radio network node (1, 2a-f) in a cellular radio system, comprising a scheduler, characterized in that said scheduler comprises means for performing the method according to any of claims 1-27.

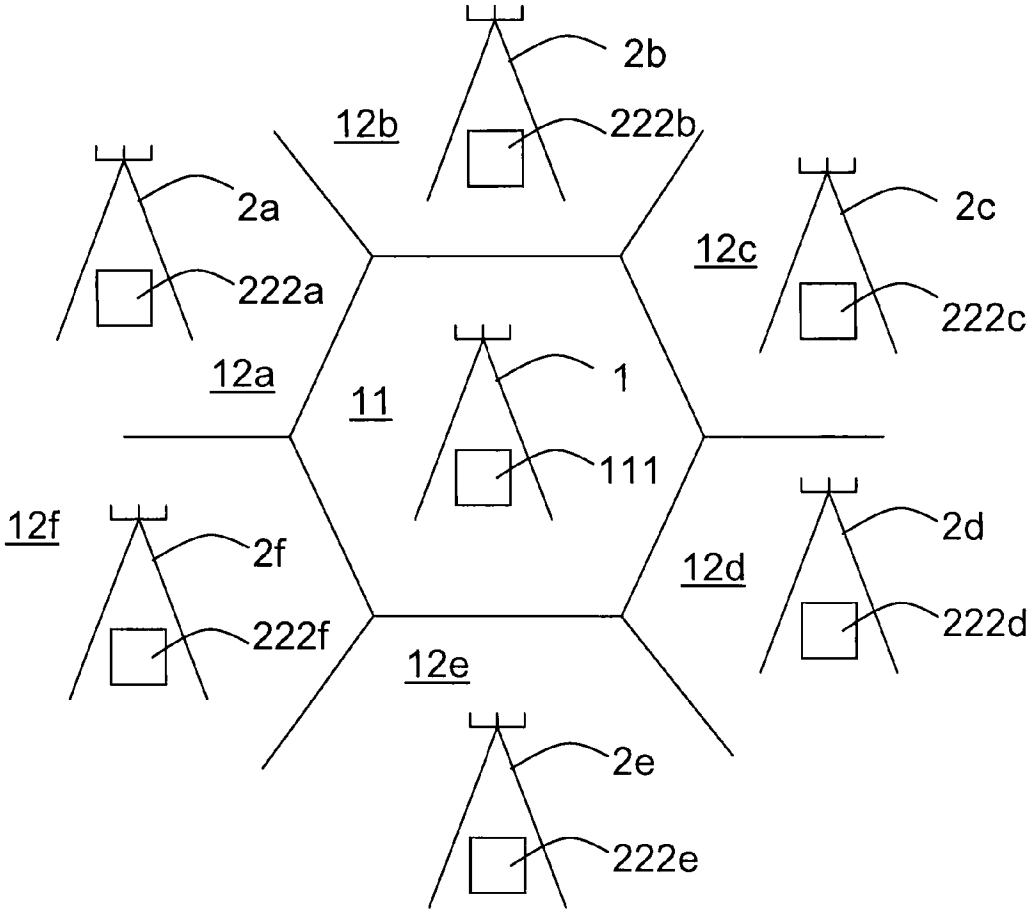

2b
12b
222b
2a
2c
12c
222a
222c
12a
1
11
111
12f
2f
2d
12d
222f
222d
12e
2e
222e

Fig.1

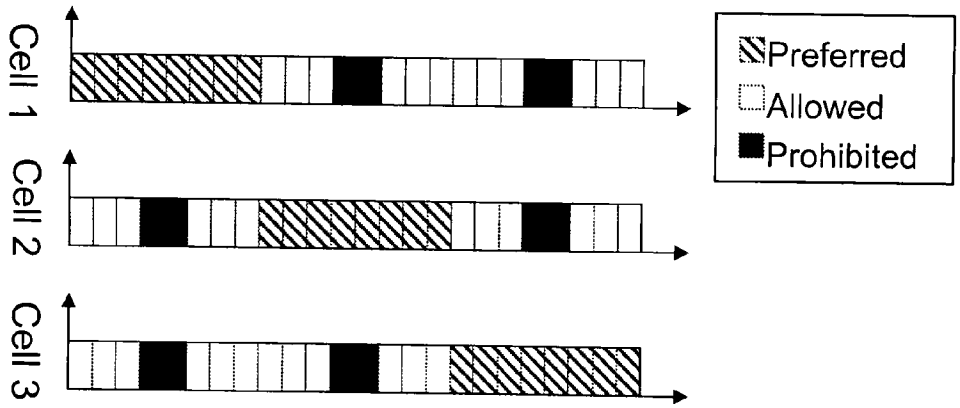

Cell 1
Cell 2
Cell 3
Preferred
Allowed
Prohibited

Fig. 2

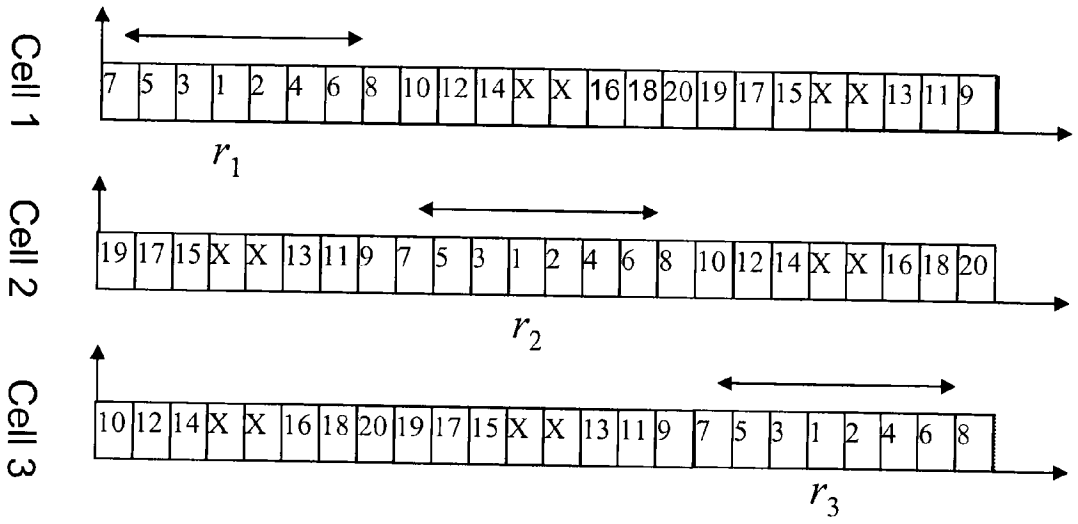

Cell 1
7 5 3 1 2 4 6 8 10 12 14 X X 16 18 20 19 17 15 X X 13 11 9
r_1
Cell 2
19 17 15 X X 13 11 9 7 5 3 1 2 4 6 8 10 12 14 X X 16 18 20
r_2
Cell 3
10 12 14 X X 16 18 20 19 17 15 X X 13 11 9 7 5 3 1 2 4 6 8
r_3

Fig. 3

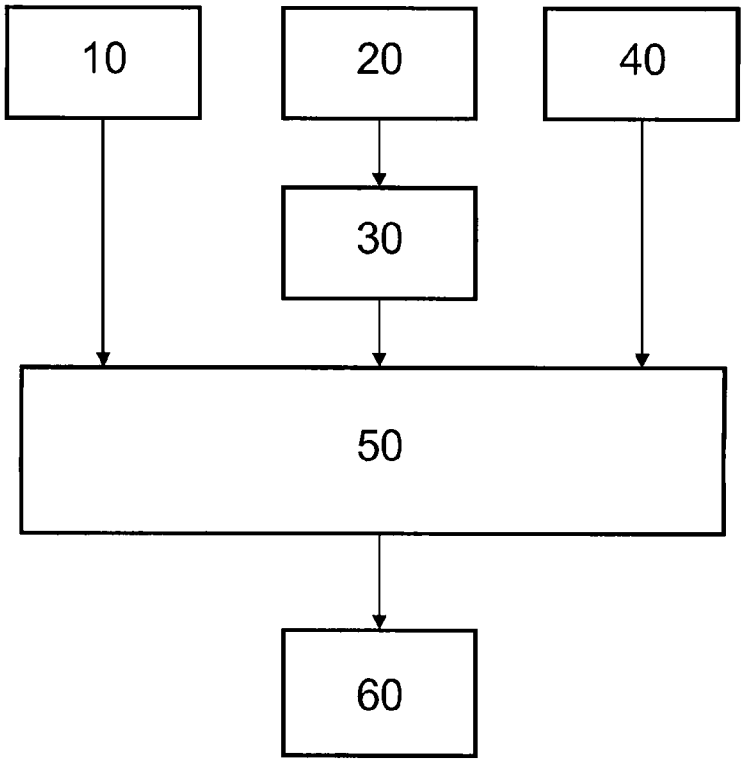


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/050451

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04Q, H04L

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2005046283 A1 (QUALCOMM INCORPORATED), 19 May 2005 (19.05.2005), figures 1-7, claims 1-18, abstract, paragraphs (0005)-(0009),(0032)-(0033), (0048)-(0051),(0082)	1-29
	--	
Y	WO 0163851 A1 (NOKIA NETWORKS OY), 30 August 2001 (30.08.2001), page 6, line 10 - line 23; page 16, line 5 - line 20; page 20, line 18 - line 32, abstract	1-29
	--	
A	WO 2005125263 A1 (QUALCOMM INCORPORATED), 29 December 2005 (29.12.2005), abstract, paragraphs (0007)-(0008),(0034)-(0040)	1-29
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2007	10 -05- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Elisabet Aselius / JA A Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2006012537 A1 (QUALCOMM INCORPORATED), 2 February 2006 (02.02.2006), abstract, paragraphs (0007)-(0010),(0029)-(0030) --	1-29
E	WO 2007029965 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE), 15 March 2007 (15.03.2007), page 5, line 11 - page 9, line 8, abstract -- --------	1-29

International patent classification (IPC)

H04Q 7/38 (2006.01)
H04L 12/56 (2006.01)
H04Q 7/36 (2006.01)

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Use the application number as username.
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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

WO	2005046283	A1	19/05/2005	AU	2004307971	A	19/05/2005
				BR	PI0416047	A	02/01/2007
				CA	2543607	A	19/05/2005
				CN	1902972	A	24/01/2007
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				CN	1248463	C	29/03/2006
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				EP	1258117	A	20/11/2002
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				JP	2003524335	T	12/08/2003
				US	20050276256	A	15/12/2005
WO	2005125263	A1	29/12/2005	AU	2005256063	A	29/12/2005
				CA	2569653	A	29/12/2005
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				US	20060019701	A	26/01/2006
				US	20060159004	A	20/07/2006
WO	2007029965	A1	15/03/2007	NONE			

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

(54) **Title**: METHOD FOR RESOURCE ALLOCATION IN A COMMUNICATION SYSTEM

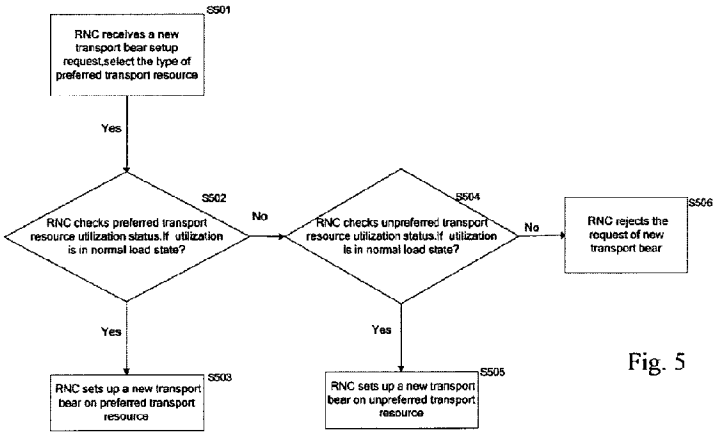


Fig. 5

(57) **Abstract**: The present invention provides a method for resource sharing among different transport resources, comprising the steps of: RNC (101) selecting related preferred transport type, RNC (101) determining availability status of the preferred transport resource, RNC (101) determining utilization status of the preferred transport resource in low load state, and RNC (101) setting up a new transport bearer on the preferred transport resource. With this invention, the overall utilization rate of transport resource can increase and the congestion and overload of specific transport resources can be avoided.

WO 2010/075638 A1

Method for Resource Allocation in a Communication System

TECHNICAL FIELD

This invention relates to telecommunication technology and, more particularly, to a method for resource sharing among different transport resources in UTRAN.

BACKGROUND OF THE INVENTION

Nowadays, there are more and more transport resources introduced into UTRAN (UMTS Terrestrial Radio Access Network), for example, ATM transport and IP transport. With its own specific advantages, IP transport technology is acting as a UTRAN transport solution gradually and will be an alternative to ATM transport technology. Due to current predominant position of ATM transport network and migration issues from ATM transport network to IP transport network, multiple transport technologies will still coexist and interwork in radio access network for a long time. It's necessary to find some ways to assure that UTRAN nodes can communicate with each other which have ATM or IP over different interfaces such as Iu, Iub, Iur interfaces etc in UTRAN networks.

RNC (Radio Network Controller) is required to support dual stack of transport technology (ATM and IP) over Iub interface, so as to support multiple transport resources in UMTS. RBS (Radio Base Station) supports either ATM or IP transport resource or both of them due to different requirement of user service and migration impacts. It's necessary and important that the two transport technologies can coexist and interwork well.

Currently, there're mainly two solutions about interworking between different transport resources. On Iub interface, assume RNC supports dual stack of transport technology (ATM and IP). RNC 101 connects with different kinds of RBS 102 directly as shown in Figure 1.

Under this condition, RNCs 101 have to set up new transport bearers based on the same type of transport resource as that supported by RBS 102. For example, if RBS 102 only supports ATM transport resource, only the ATM transport resources on RNC 101 side are used for new transport bearer establishment over Iub interface. Even RBS 102 also supports dual stack of transport resource (such as ATM and IP), RNC 101 can only set up transport bearer on two type of transport resource respectively where it should be same on both sides. The usages of two different kinds of transport resources are independent.

In order to resolve this issue of communication between different kinds of transport technologies, a new equipment is provided in 3GPP TR 25.933 V5.4.0 and Ericsson patent (patent number: US 2001/0053145 A1). This new equipment

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named as interworking unit (IWU) 103 is defined to implement the transform between different transport technologies as shown in Figure 2. RNC 101 can set up new transport bearers based on different transport resource with that supported in RBS 102 by IWU 103.

For example, RNC 101 has free ATM transport resource on Iub interface. Peer RBS 102 node only supports IP transport technology. When RNC 101 establishes a new transport for user plane transmission, RNC 101 sends ATM transmission address and bind ID with Alcap protocol to IWU 103. When IWU 103 receives the request of transport bearer set up, IWU 103 selects out the corresponding IP address of RBS 102 and sets up transport bearer with RBS 102 by IP Alcap protocol. By this interworking equipment, a transport bearer can be set up successfully between RNC 101 and RBS 102.

This basic procedure is shown in Figure 3. Here, assume that RNC 101 supports dual stack of transport and only ATM transport resource available. RBS 102 only supports IP transport.

However, the transport resource usage in RNC 101 is still irrelevant. This causes unbalanced utilization among different transport resources. In more serious scenarios, one kind of transport resource is highly used even exhausted while another kind of transport resource is extremely free. Thus, a big waste of transport resources may occur due to invalid transport resource usage.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for allocating transport resources in a radio communication network with high resource utilization rate.

It is a further object of the present invention to provide a radio communication network in which the resource utilization rate is high.

According to one aspect of this invention, the present invention provides a method, comprising a first steps of

receiving a request for setting up a transport bearer corresponding to a transport service type, the transport service type being associated with one of the transport resources. If the associated transport resource is in a low load state, the transport bearer is set up on the associated transport resources. If the associated transport resource is not in a low load state and any of the other transport resources is in a low load state, the transport bearer is set up on the any of the other transport resources. If neither of the cases above occur, the request is rejected.

According to another aspect of this invention, the present invention provides a radio communication network, comprising a plurality of radio base stations, and a radio network controller communicating to the plurality of radio base stations.

wherein the radio network controller is configured to allocate transport resources in the following steps. First, a request for setting up a transport bearer corresponding to a transport service type is received from one of the plurality of radio base stations , the transport service type being associated with one of transport resources. Then, if the associated transport resource is in a low load state, the transport bearer is set up on the associated transport resources. If the associated transport resource is not in a low load state and any of the other transport resources is in a low load state, the transport bearer is set up on the any of the other transport resources. If neither of the cases above occur , the request is rejected.

With this invention, it is possible to enable resource sharing between different transport resources and increase the overall utilization rate of transport resource and avoid the congestion and overload of specific transport resources.

This invention also provides a redundancy mechanism among different transport resource .When one kind of transport resource are unavailable in some abnormal condition, the new service can be established on other available transport resource to secure the network accessibility and stability, robustness.

In this invention, the dual threshold of method ensures the accuracy and reliability of utilization status estimation for transport resources.

The strategy of different level of threshold basis on different types of service provides a flexible way for resource sharing between various types of users and increases utilization of transport resource.

BRIEF DESCRIPTION OF THE DRAWINGS

Features as well as advantages of the present invention will become to be more apparent to those skilled in the art from the following detailed description of the preferred embodiments when taking reference to the accompanying figures.

In these figures:

FIG. 1 illustrates an solution for interworking between different transport resources according to the prior art;

FIG. 2 illustrates another solution for interworking between different transport resources according to the prior art;

FIG. 3 illustrates the basic procedure in the interworking according to an existing solution;

FIG. 4 illustrates the architecture for resource sharing among different transport resources;

FIG. 5 illustrates the main flow chart for resource sharing among different

transport resources;

FIG. 6 illustrates the relationship between time and the utilization rate of bandwidth or throughput;

FIG. 7 illustrates an exemplary procedure of the dual threshold method;

FIG. 8 illustrates the different levels for different priorities for different service users;

FIG. 9 illustrates an exemplary procedure of the multi-level protective threshold method.

DETAILED DESCRIPTION OF THE INVENTION

It should be noted that the present invention is described in the no limiting, example context of a universal mobile telecommunication systems (UMTS). The following example will describe transport resource interworking between RNC 101 and RBS 102 in Iub interface.

As shown in Figure 4, in a radio access network of UMTS, assume that RNC 101 supports dual stack (such as ATM/IP) of transport technologies. RNC 101 is connected with different types of RBSs 102 over Iub interface. Some RBSs 102 support IP transport. Some RBSs 102 still support ATM transport. The others support both IP and ATM transport over Iub. The transport resource between RNC 101 and IWU 103 are seen as a resource pool 104 and able to share each other based on the specific method of current invention.

Different service has its preferred transport resource based on its specific quality of service (Qos) and bandwidth utilization requirements. For example, data service is preferred transporting on IP transport resource, while AMR (Adaptive Multi-Rate) service is preferred transporting on ATM transport resource due to sensitivity to transmission delay etc. This relationship between different service and transport resources can be configured on RNC 101 by operators. In the present invention, such preference is always satisfied, if possible.

Figure 5 describes the main procedure of transport resource management between ATM and IP transport technologies in RNC 101. RNC 101 measures the utilization of transport resource in real time and stores related status information (such as user data throughput on IP based transport or utilization rate of physical bandwidth resource on ATM based transport).

When new request of transport bearer comes, RNC 101 will initiate the procedure of transport resource management. At step S501, when a new transport bearer (such as for user plane of R99 PS data RAB) setup request comes, RNC 101 selects related preferred transport type according to configured relationship between service type and transport resource.

At step S502, RNC 101 checks utilization status of the preferred transport resource,

if it is in low (normal) load state, then at step S503, the new transport bearer is set up on the preferred transport resource.

If at step S502, RNC 101 determines the preferred IP transport resource in high load state, then, at step 504, RNC 101 checks utilization status of the unpreferred transport resource, if it is in low load state, the new transport bearer will be set up on the unpreferred ATM transport resource. Otherwise, RNC 101 rejects the request of new transport bearer (step S506). At step 502, preferably, RNC 101 checks availability status of the transport resource before checking utilization status.

This method allows for different transport resource to share each other when one transport resource is unavailable or on highly loaded condition. This can ensure a good utilization rate of transport resource and keep a balance among different transport resources.

In above main procedure, the estimation of utilization status of transport resource and resource sharing are two key parts. The accuracy of estimation of utilization status is a prerequisite of resource adjustment.

Hereafter, two methods are introduced into the estimation of utilization status for transport resources and resource management. The first one is dual threshold detection and hysteresis timer strategy. This method is to ensure that accuracy of estimation and avoid erroneous decision from jitters of transport resource.

The other new method sets multi-level protective threshold of transport resource admission for different types of service users. This method can ensure flexible utilization and management between different transport resources and good quality of service for various users.

In the dual threshold method, dual thresholds (High_Thr and Low_Thr) and a hysteresis timer are configured by operators. Here the load during measurement is for physical bandwidth on ATM transport or average throughput on IP transport, as shown in Figure 6.

The main procedure of the dual threshold method is shown in Figure 7.

At step S701, RNC 101 resides in normal load state of transport resource usage and flag (Load_status_flag) is 0. RNC 101 monitors utilization status on current transport resource. At step S702, RNC 101 checks current average measured utilization rate, if it is more than high threshold (High_Thr), then, at step S703, RNC 101 checks duration under high threshold, if it is longer than hysteresis timer of time, then, at step S704, RNC 101 determines that transport resource in high load state and sets flag (Load_status_flag) as 1.

Then, at step S705, RNC 101 checks current average measured utilization rate, if it is less than low threshold (Low_Thr), then at step S706, RNC 101 checks duration under high threshold, if it is longer than and hysteresis timer of time, then RNC 101 decides the transport resource to return normal load state and sets flag (Load_status_flag) as 0 from 1.

Or, if it is determined current average measured utilization rate is not more than high threshold (High_Thr) (at step S702), or duration under high threshold is not longer than hysteresis timer of time (at step S703), then the process goes back to step S701.

The thresholds and hysteresis timer also can be adjusted dynamically based on specific methods. Furthermore, the method about accumulation and smoothing of multiple samples can be adopted and have better effect on estimation of utilization status.

This method of dual threshold and hysteresis timer can monitor the trend of transport resource utilization and make accurate decision on utilization status of resource usage. This assures a correct precondition for following resource adjustment.

For the burst characteristics of packet data traffic, the fluctuation of its corresponding transport resource is more obvious and intense. Thus, it's recommended that this method is used to monitor utilization status on date service user preferred IP transport resource.

The other method provided by the present invention for the estimation of utilization status for transport resources and resource management defines multiple protective threshold of resource utilization and implements different access priorities of different service users during load sharing among different transport resource.

In this method, admission priorities of transport resource are configured for different service types of users in system by operators based on the type of preferred transport resource and Qos requirements of service.

In below example, assume preferred transport resource for AMR users is ATM bandwidth. Accordingly, the priority of service types is set as below: high priority for incoming AMR users (such as Handover users), medium priority for incoming data users and local AMR users, and low priority for other users.

Different admission thresholds for transport resource are also defined based on different types of users' priority to ensure high transport resource utilization rate and good performance of overall system. Accordingly, three thresholds are defined in Figure 8.

Figure 9 shows the main procedure of resource allocation for users basis when a new transport bearer request comes.

At step S901, when new transport bearer (such as a transport bearer of data user) request comes, RNC 101 will record service type of this new transport bearer and check current the utilization status of allocated ATM bandwidth resource. At step S902, RNC 101 checks utilization rate of bandwidth, if, including the new needed transport resource, it is not less than threshold1, which means utilization rate of transport resource is in high load state, RNC 101 will reject the request of this transport bearer (at step S907).

If, at step S902, RNC 101 determines utilization rate of bandwidth including the new needed transport resource is less than threshold1, then at step S903, RNC 101 checks whether the quest is from incoming AMR users, if not, then, at step S904, RNC 101 checks whether the request is from incoming data users or local AMR users while the utilization rate of bandwidth is less than threshold2, if not, at step S905, RNC 101 checks whether the utilization rate of bandwidth is less than threshold3, if not, then at step S907, the current transport bearer request is rejected..

If, at step S903, S904, or S905, the result of judgment is "yes", then at step S906, RNC 101 allocates free transport resource for new transport bearer.

When multiple new users (such as one AMR user and one data user) access simultaneously, RNC 101 will adopt same method as above single user independently firstly. When the free transport resource is enough only for one user, the preferred user will have higher priority to be allocated the free transport resources. For example, here, the free ATM transport resource will be allocated to its preferred AMR service user and data service user will be put in queues and waiting for free resource.

Another scenario is when a data service user access with high data rate, if the current free preferred and unpreferred transport resource can meet with its requirements of bandwidth. Then RNC 101 can consider to downswitch the data service user to lower data rate, then check if free transport resource is enough for this user according to above method for single user as Figure 9.

On this example, this method is used in the process of service users admission. Meanwhile, during service users holding, the transport resource will vary with the resource release and reallocation. RNC 101 will monitor utilization of all transport resources simultaneously and keep track of fluctuation of load for transport resource. Based on this knowledge, it will adjust different service users to their preferred transport resources dynamically and keep balance of utilization for different transport resource on the whole.

The method of dual thresholds provides a reliable way of estimation for transport resource utilization. The method of multi-level protective threshold gives a strategy on transport resource share based on service user priorities configured by operators. Both together can implement transport resource sharing between different types of transport resource in RNC 101 and IWU 103.

The embodiments of the invention described above are intended to be exemplary only. Those skilled in the art may understand that the provided embodiments can be further varied in many aspects. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

We claim:

1. A method for allocating transport resources in a radio communication node, comprising the steps of:

receiving a request for setting up a transport bearer corresponding to a transport service type, the transport service type being associated with one of the transport resources(S501);

if the associated transport resource is in a low load state(S502), setting up the transport bearer on the associated transport resources(S503),

if the associated transport resource is not in a low load state and any of the other transport resources is in a low load state(S504), setting up the transport bearer on the any of the other transport resources(S505),

otherwise, rejecting the request.

2. The method of claim 1, wherein the transport resources comprise bandwidth or throughput of a channel.

3. The method of claim 2, wherein when the average measured utilization rate of the bandwidth is less than a threshold for a duration longer than a predetermined time interval, the associated transport resource is considered as being in the low load state.

4. The method of claim 2, wherein a plurality of users are assigned to thresholds respectively and for each of the users, when the average measured utilization rate of the bandwidth is less than the assigned threshold for a duration longer than a predetermined time interval, the associated transport resource is considered as being in the low load state.

5. The method of any one of claims 1-5, wherein the node is a radio network controller.

6. A radio communication network, comprising:

a plurality of radio base stations (102); and

a radio network controller (101) communicating to the plurality of radio base stations, wherein the radio network controller (101) is configured to allocate transport resources in the following way:

receive from one of the plurality of radio base stations (102) a request for setting up a transport bearer corresponding to a transport service type, the transport

service type being associated with one of transport resources; and

if the associated transport resource is in a low load state, setting up the transport bearer on the associated transport resources,

if the associated transport resource is not in a low load state and any of the other transport resources is in a low load state, setting up the transport bearer on the any of the other transport resources,

otherwise, rejecting the request.

7. The radio communications network of claim 6, wherein the transport resources comprise bandwidth or throughput of a channel.

8. The radio communications network of claim 7, wherein if the average measured utilization rate of the bandwidth is less than a threshold for a duration longer than a predetermined time interval, the associated transport resource is considered as being in the low load state.

9. The radio communications network of claim 7, wherein a plurality of users are assigned to thresholds respectively and for each of the users, if the average measured utilization rate of the bandwidth is less than the assigned threshold for a duration longer than a predetermined time interval, the associated transport resource is considered as being in the low load state.

10. An apparatus for allocating transport resources in a radio communication network, comprising:

means for receiving a request for setting up a transport bearer corresponding to a transport service type, the transport service type being associated with one of the transport resources;

means for setting up the transport bearer on the associated transport resources if the associated transport resource is in a low load state, or on the other transport resources if the associated transport resource is not in a low load state and the other transport resource is in a low load state.

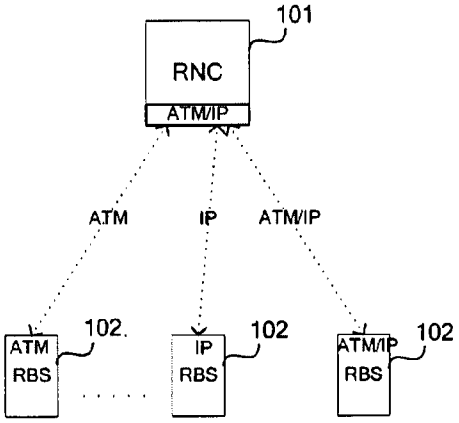


Fig. 1

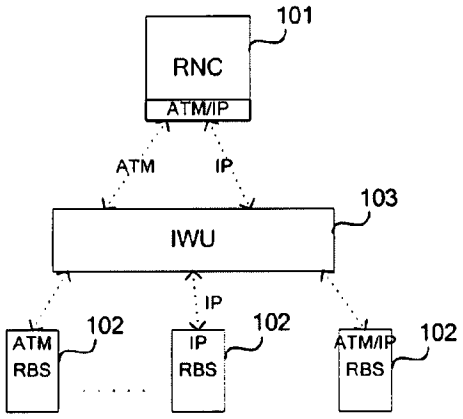

101
RNC
ATM/IP
ATM
IP
103
IWU
IP
102
ATM
RBS
102
IP
RBS
102
ATM/IP
RBS

Fig.2

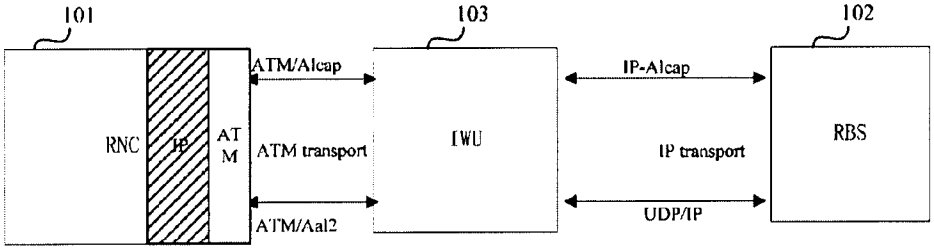

101
103
102
RNC
IP
AT
M
ATM/Alcap
ATM transport
ATM/Aal2
IWU
IP-Alcap
IP transport
UDP/IP
RBS

Fig. 3

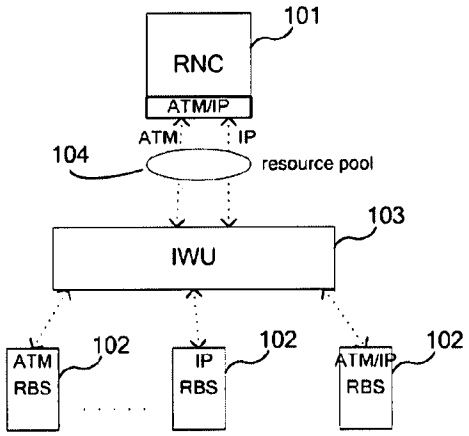

101
RNC
ATM/IP
ATM
IP
104
resource pool
103
IWU
ATM
RBS
102
IP
RBS
102
ATM/IP
RBS
102

Fig. 4

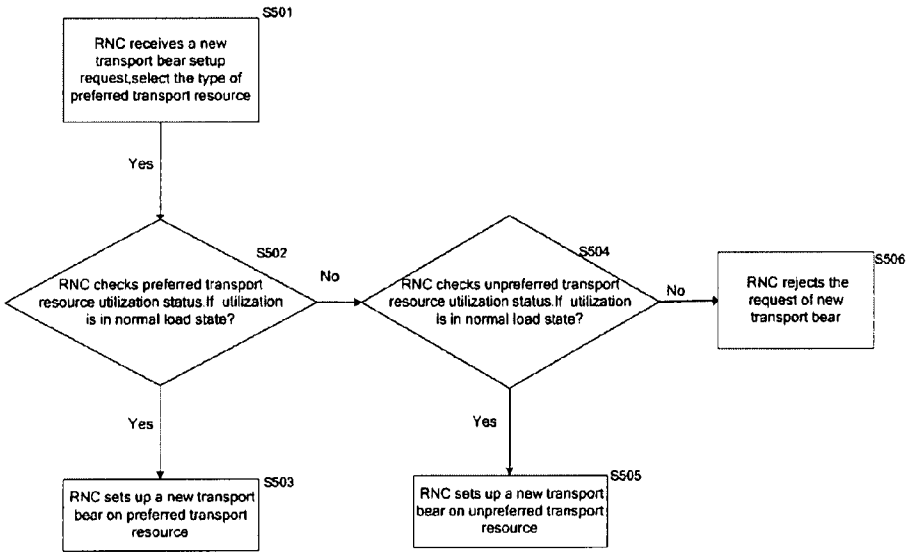

S501
RNC receives a new transport bear setup request,select the type of preferred transport resource
Yes
S502
RNC checks preferred transport resource utilization status.If utilization is in normal load state?
No
S504
RNC checks unpreferred transport resource utilization status.If utilization is in normal load state?
No
S506
RNC rejects the request of new transport bear
Yes
S503
RNC sets up a new transport bear on preferred transport resource
Yes
S505
RNC sets up a new transport bear on unpreferred transport resource

Fig. 5

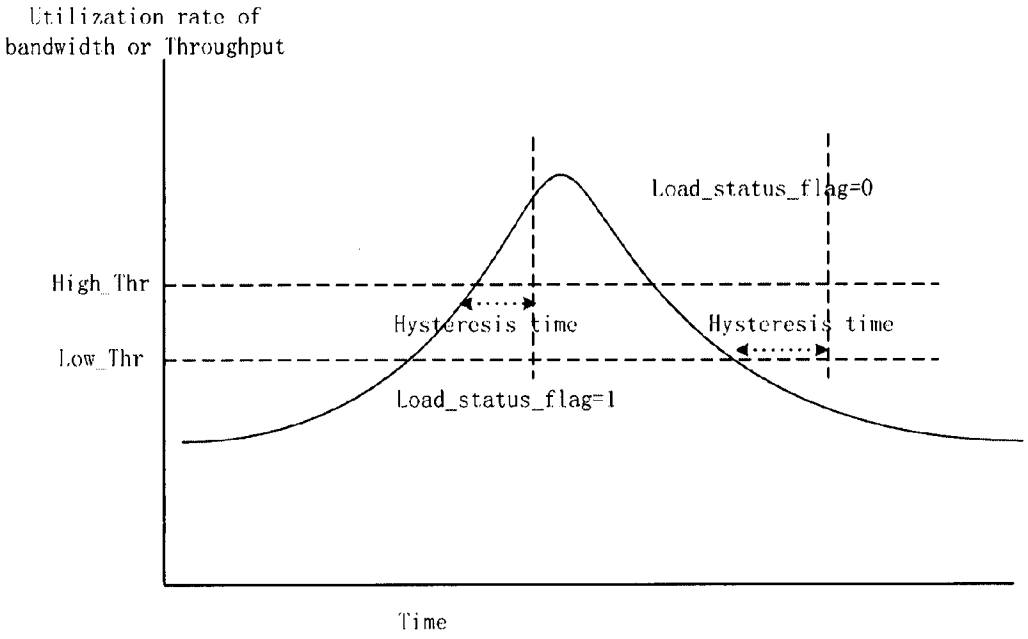

Utilization rate of
bandwidth or Throughput
Load_status_flag=0
High_Thr
Hysteresis time
Hysteresis time
Low_Thr
Load_status_flag=1
Time

Fig. 6

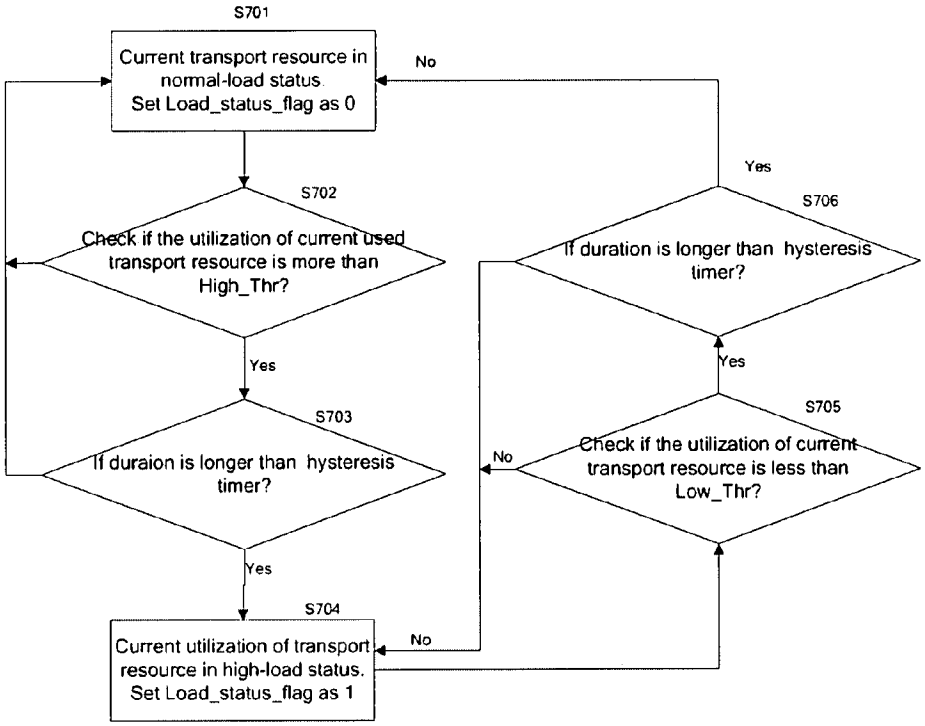

S701
Current transport resource in normal-load status. Set Load_status_flag as 0
No
Yes
S702
Check if the utilization of current used transport resource is more than High_Thr?
S706
If duration is longer than hysteresis timer?
Yes
Yes
S703
If duraion is longer than hysteresis timer?
S705
Check if the utilization of current transport resource is less than Low_Thr?
No
Yes
S704
Current utilization of transport resource in high-load status. Set Load_status_flag as 1
No

Fig. 7

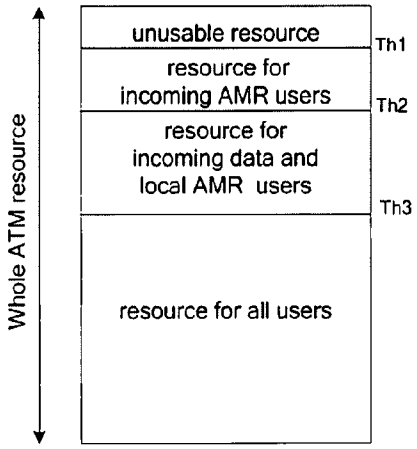

unusable resource
Th1
resource for incoming AMR users
Th2
resource for incoming data and local AMR users
Th3
resource for all users
Whole ATM resource

Fig. 8

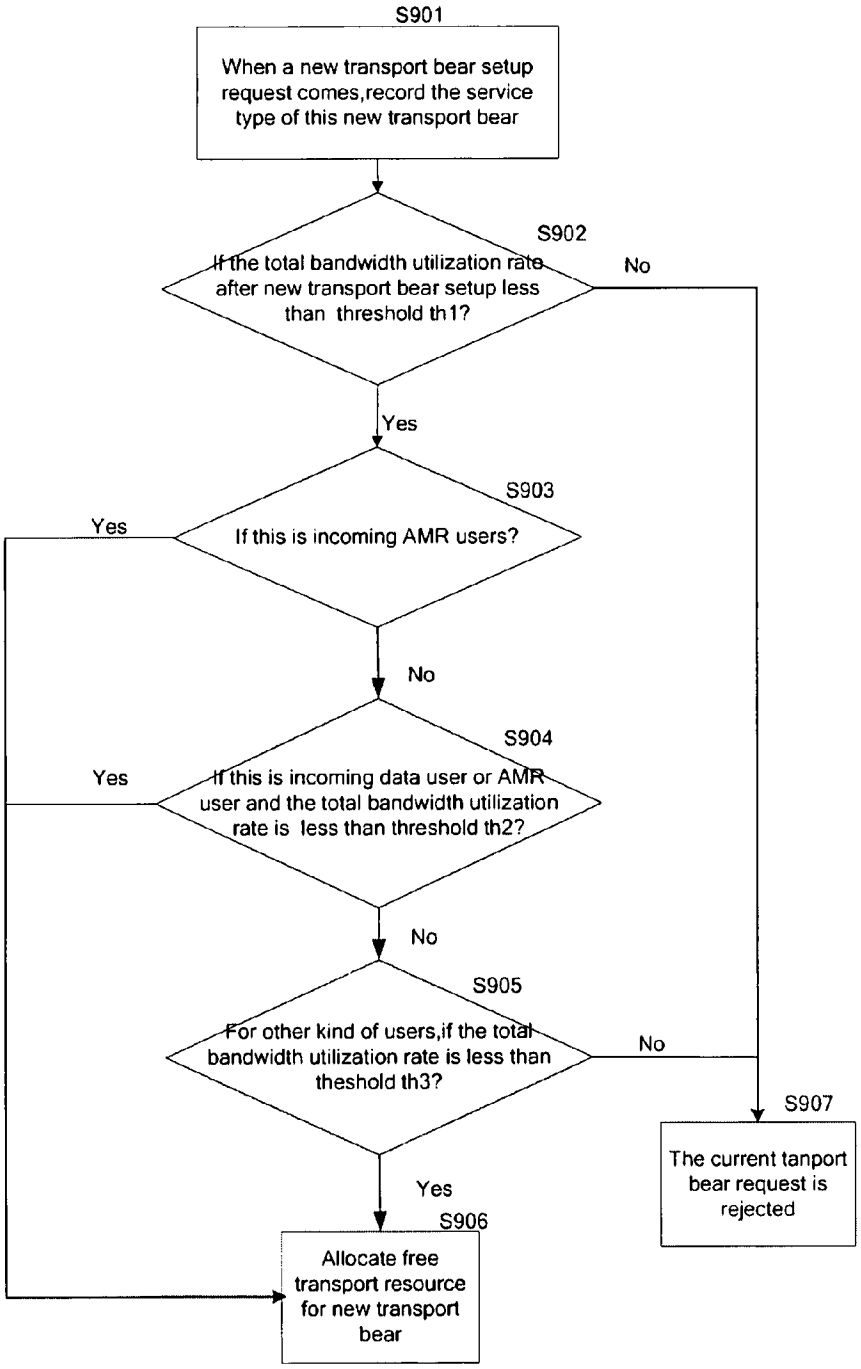

S901
When a new transport bear setup request comes,record the service type of this new transport bear
S902
If the total bandwidth utilization rate after new transport bear setup less than threshold th1?
No
Yes
S903
If this is incoming AMR users?
Yes
No
S904
If this is incoming data user or AMR user and the total bandwidth utilization rate is less than threshold th2?
Yes
No
S905
For other kind of users,if the total bandwidth utilization rate is less than theshold th3?
No
Yes
S906
Allocate free transport resource for new transport bear
S907
The current tanport bear request is rejected

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2008/002144

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04 (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)

IPC: H04L; H04B; H04J; H04Q; H04W

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

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

WPI; EPODOC; PAJ; CNKI; IEEE; CNPAT: resource allocate type service load congestion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US6529497B1 (TELEFONAKTIEBOLAGET LM ERICSSON) 04 Mar. 2003 (04.03.2003) column 5, lines 5 to 6, column 6, line 26 to column 7, line 39 in the description	1-10
A	US5761621A (SPECTRUM INFORMATION TECHNOLOGIES, INC.) 02 Jun. 1998 (02.06.1998) the whole document	1-10
A	EP1677563A1 (LUCENT TECHNOLOGIES INC.) 05 Jul. 2006 (05.07.2006) the whole document	1-10

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 Aug. 2009 (21.08.2009)	**15 Oct. 2009 (15.10.2009)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer MA, Mingyue Telephone No. (86-10)62413406

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2008/002144

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US6529497B1	04.03.2003	WO0120930A1	22.03.2001
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		EP0734636B1	12.10.2005
		EP1622409A2	01.02.2006
		DE69434504E	23.02.2006
		DE69434504T2	18.05.2006
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		CA2573184A1	22.06.1995
		US7386322B2	10.06.2008
EP1677563A1	05.07.2006	US2006142020A1	29.06.2006

Form PCT/ISA/210 (patent family annex) (April 2007)

Espacenet

Bibliographic data: CN101415275 (A) — 2009-04-22

Method and system for inducting outer feedback in TDD aerial interface

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Applicant(s): ZTE CORP [CN] ± (ZTE CORP, ; ZTE CORPORATION)

Classification: **- international:** ***H04J3/16; H04W92/10***
- cooperative:

Application number: CN20071164256 20071017

Priority number(s): CN20071164256 20071017

Also published as: CN101415275 (B)

Abstract of CN101415275 (A)

The invention discloses a method for introducing outer zone feedback into a time division duplex air interface. The method comprises the following processes: an air interface structures a service channel on a first unpaired spectrum which is used in a time-division manner in two directions, and the air interface structures a feedback channel and/or a control channel on a second unpaired spectrum which is used in a time-division manner in two directions. In addition, a system which corresponds to the method is also provided. The air interface has the advantages of reserving the channel reciprocity of TDD, the flexibility of downlink and uplink services and the like; in addition, the air interface has various advantages brought by the low feedback latency of half-duplex FDD.; In particular, when the air interface is applied to the double layer and double frequency wireless access network, the capability of supporting a high-speed mobile terminal of a micro-cell wireless contact can be improved.

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(12)发明专利

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代理人 尚志峰 吴孟秋
(51)Int.Cl.
H04W 92/10(2009.01)
H04J 3/16(2006.01)
(56)对比文件
CN 101026386 A,2007.08.29, 全文.
WO 2007072341 A2,2007.06.28, 全文.
Elena Costa 等.Duplex arrangements for future broadband radio interfaces.《IST-2003-507581 WINNER D2.5 v1.1》.2004,21-28.
审查员 孙洁

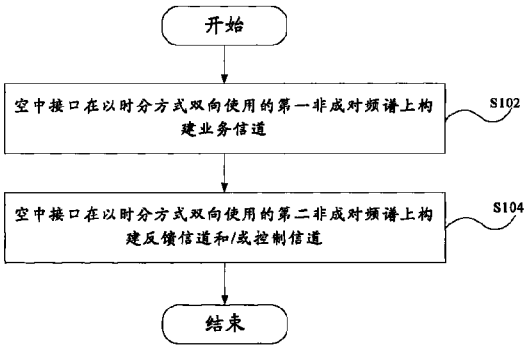
权利要求书1页 说明书8页 附图5页

(54)发明名称

在时分双工空中接口中引入外带反馈的方法及系统

(57)摘要

本发明公开了在时分双工空中接口中引入外带反馈的方法，该方法包括以下处理：空中接口在以时分方式双向使用的第一非成对频谱上构建业务信道；以及空中接口在以时分方式双向使用的第二非成对频谱上构建反馈信道和/或控制信道。此外，本发明还提供了对应于该方法的系统。通过本发明，空中接口除了保留了TDD的信道互易性及上下行业务的灵活性等优点之外，还兼有半双工FDD的低反馈时延带来的各种优点，特别是在应用于双层双频无线接入网时，可以提高微小区无线接点对高速移动终端的支持能力。



CN 101415275 B

1. 一种在时分双工空中接口中引入外带反馈的方法，其特征在于，所述方法包括以下处理：

所述空中接口在以时分方式双向使用的第一非成对频谱上构建业务信道；以及

所述空中接口在以时分方式双向使用的第二非成对频谱上构建所述业务信道的反馈信道和/或所述业务信道的控制信道。

2. 根据权利要求1所述的方法，其特征在于，所述反馈信道和/或控制信道用于承载以下信息中的一种或多种：功控指令、调度指令、重发请求以及信道信息数据。

3. 根据权利要求1所述的方法，其特征在于，在所述第一非成对频谱上构建无线接点至终端的业务信道的方法是使用第一频段上的第一无线帧的下行时隙安排所述业务信道，以及在所述第一非成对频谱上构建终端至无线接点的业务信道的方法是使用所述第一频段上的所述第一无线帧的上行时隙安排所述业务信道；在所述第二非成对频谱上构建无线接点至终端的反馈信道和/或控制信道的方法是使用第二频带上的第二无线帧的下行时隙安排所述反馈信道和/或控制信道，以及在所述第二非成对频带上构建终端至无线接点的反馈信道和/或控制信道的方法是使用所述第二频带上的所述第二无线帧的上行时隙安排所述反馈信道和/或控制信道。

4. 根据权利要求3所述的方法，其特征在于，使用所述无线接点至终端的反馈信道和/或控制信道包括以下步骤：在第一时间区间内，所述终端使用安排在所述第一频带上的业务信道向所述无线接点完成一次数据发射；

在第二时间区间内，所述终端在所述第二频带上的反馈信道和/或控制信道上接收所述无线接点发来的反馈和/或控制数据；

在第三时间区间内，所述终端根据所述反馈和/或控制数据进行必要的工作模式调整；以及

在第四时间区间内，所述终端在安排在所述第一频带上的业务信道进行下一次数据发射。

5. 根据权利要求3所述的方法，其特征在于，使用所述终端至无线接点的反馈信道和/或控制信道包括以下步骤：

在第一时间区间内，所述无线接点使用安排在所述第一频带上的业务信道向所述终端完成一次数据发射；

在第二时间区间内，所述无线接点在所述第二频带上的反馈信道和/或控制信道上接收所述终端发来的反馈和/或控制数据；

在第三时间区间内，所述无线接点根据所述反馈和/或控制数据进行必要的工作模式调整；以及

在第四时间区间内，所述无线接点在安排在所述第一频带上的业务信道进行下一次数据发射。

6. 根据权利要求4或5所述的方法，其特征在于，所述反馈和/或控制数据包括以下信息中的至少一种：发射功率控制信息、动态调度信息、自动重发信息、信道质量信息、以及自适应调制编码信息。

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在时分双工空中接口中引入外带反馈的方法及系统

技术领域

[0001] 本发明涉及无线通信领域，尤其涉及在时分双工空中接口中引入外带反馈的方法及系统。

背景技术

[0002] 双工方式是区分传统无线系统的特征之一，也是决定无线系统基本能力的一个主要因素，系统的诸多性能和其采用的双工方式密切相关，例如，系统对频谱使用的灵活性、终端和基站复杂度、信道信息的使用能力、组网能力、网间互通能力、以及对终端移动速度的支持能力。

[0003] 现有通信系统采用的双工方式主要有三种：纯时分多址(TimeDivision Duplex，简称TDD)方式，例如TD-SCDMA系统；纯频分多址(Frequency Division Duplex，简称FDD)方式，例如WCDMA系统；以及半双工FDD(Half Frequency Division Duplex)方式，例如GSM系统。

[0004] 纯TDD方式的主要优点是：无需成对的频谱，便于频率规划；接收机和发射机通道设计简单；以及便于利用信道互易特性，使得智能天线的设计简单。但其存在以下缺点：覆盖区域过大时频谱使用效率低于FDD方式；以及支持高速移动方面不如FDD方式。

[0005] 纯FDD方式的主要优点是：适合支持高速移动；以及适合大的覆盖区域。但其存在以下缺点：需要成对的频谱，带来频谱规划上的困难；信道互易特性的使用存在困难，使得智能天线的设计难度加大；以及上下行频谱使用在支持非对称业务时不够灵活。

[0006] 半双工FDD和纯FDD比较，其优点是：终端收发分时工作导致终端通道结构简单，成本比较低；以及时分复用的引入导致、测量、切换等功能的实现简便。但上下行频谱使用在支持非对称业务时不够灵活。

[0007] 目前，在研究领域已经对各种双工方式进行了较为全面的评估，如欧盟IST(信息化社会技术)项目中的报告“未来宽带无线接口中双工方式的安排(Duplex arrangements for future broadband radiointerfaces. IST-2003-507581 WINNER D2.5 v1.0)”对7种可能的双工方式进行了评估：纯FDD、纯TDD、半双工FDD(GSM)、FDD上行频谱中引入TDD、FDD下行频谱中引入TDD、频带切换的混合FDD(Band switched FDD Hybrid)、以及使用双TDD频谱的双频带混合双工(Dual band TDD Hybrid)。此外，该报告对码分多址也做了讨论。这些研究的目的在于寻找新的双工方式或者寻找把现有TDD、FDD双工方式进行有效组合的方式，从而达到利用TDD和FDD的优点而避免TDD和FDD的缺点。

[0008] WINNER D2.5 v1.0给出的频带切换的混合FDD(Band switchedFDD Hybrid)使用一对频带A和频带B。在第一个时间段内，在频段A用于上行的同时频段B用于下行，在第一个时间段结束之后及第二个时间段开始之前，无线终端和基站的收发通道在频段A和频段B之间完成切换，第二个时间段内，在频段A用于下行的同时频段B用于上行。在美国专利申请20050243748“全双工无线通信系统中用于相干波束赋型的频带切换(Band switching for coherentbeam forming in full-duplex wireless communication)”中公开了这项技

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术的实施方法。

[0009] WINNER D2.5 v1.0 给出的双频带混合双工 (Dual band TDDHybrid) 使用成对的 TDD 频谱，这种频谱使用方式可能实现的双工方式有纯 TDD 和半双工 (half duplex = (T+F) DD)。

[0010] 在现有的很多专利技术或者专利申请中也出现了和灵活使用 TDD、FDD 双工方式的讨论。

[0011] 题目为“运行一个 TDD/ 虚拟 FDD 分层蜂窝通信系统的方法 (Method of operating a TDD/virtual FDD hierarchical cellulartelecommunication system)”的专利申请 US20050174954 给出了一种在 TDD 系统被 FDD 系统所覆盖的情况下，借用 FDD 的上行频谱中的剩余部分作为终端 FDD 工作方式的上行通道，使用 TDD 频谱作为终端 FDD 工作方式的下行通道，这样就形成一个“虚拟”的 FDD 双工方式。该专利借用 FDD 的上行频谱中的剩余部分得到的主要好处是充分利用了 FDD 的上行频谱中的剩余部分。

[0012] 专利申请“一种综合使用成对和非成对频谱的系统和方法”(申请号：200610003173.4”) 给出的系统包括：将成对的 FDD 频谱和非成对的 TDD 频谱及其对应的处理资源组合起来综合调度的基站，具有多种双工方式的终端。该专利申请给出的对 FDD 频谱和 TDD 频谱综合调度的方法是：高速移动用户以使用成对频谱为主，低速移动用户以使用非成对频谱为主，当成对频谱和非成对频谱无法单独完成业务需求时，就把成对和非成对频谱综合起来提供业务。

[0013] 专利申请“一种提高时分双工系统上行反馈能力的方法”(申请号：200620169883.4) 给出的提高时分双工系统上行能力的系统包括基站、终端以及基站和终端通信使用的双向频谱和下行单向频谱。其中，基站还用于在下行单向频谱向终端发送反馈信息；终端还用于在下行单向频谱上接收基站发送的反馈信息，并且终端在双向频谱上收发信号和在下行单向频谱上接收信号以时分的方式进行。但该发明没有给出使用两个时分双工频谱实现带外反馈的具体方法，也没有给出在分层空口结构下带外反馈的实现方法。

[0014] 专利申请“一种提高时分双工系统下行反馈能力的方法”(申请号：200620171582.5) 给出的提高时分双工系统下行能力的系统包括基站、终端以及基站和终端通信使用的双向频谱和上行单向频谱。终端还用于在上行单向频谱上向基站发送反馈信息；基站还用于在上行单向频谱上接收终端发送的反馈信息，并且终端在双向频谱接收信号和在上行单向频谱上发送信号以时分的方式进行。该发明与专利申请 200620169883.4 具有相同的缺点。

[0015] WINNER D2.5 v1.0 给出的频带切换的混合 FDD 具有以下缺点是：虽然保留了 TDD 的信道互易特性，但不具备 TDD 在支持非对称业务时频谱使用的灵活性。此外，这种双工方式还有如下缺点：会象纯 TDD 那样，在系统失去严格的同步的情况下产生频带间和频带内的干扰；以及会象纯 FDD 那样，要求终端和基站使用复杂的双工器。

[0016] WINNER D2.5 v1.0给出的双频带混合双工 (Dual band TDDHybrid) 虽然可能实现纯 TDD 和半双工 (halfduplex = (T+F)DD)。但其纯 TDD 双工方式存在反馈时延小于无线帧周期的固有缺点；并且其半双工不具备 TDD 在支持非对称业务时频谱使用的灵活性。

[0017] 总之，现有混合双工技术的基本缺点是：要么 TDD 方式帧结构对反馈时延的限制

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依然存在；要么 FDD 在非对称业务的支持能力上的局限性仍然存在。缺少一种既保留 TDD 在信道互易性、上下行业务的灵活性和双工器的简单性，还兼有 FDD 的低反馈时延这样的一种双工方法。

发明内容

[0018] 为了解决现有技术所存在的问题提出本发明。

[0019] 根据本发明的一个方面，提供了一种在时分双工空中接口中引入外带反馈的方法，该方法包括以下处理：空中接口在以时分方式双向使用的第一非成对频谱上构建业务信道；以及空中接口在以时分方式双向使用的第二非成对频谱上构建反馈信道和 / 或控制信道。

[0020] 其中，反馈信道和 / 或控制信道用于承载以下信息中的一种或多种：功控指令、调度指令、重发请求以及信道信息数据。

[0021] 在以时分方式双向使用的第一非成对频谱上构建无线接点至终端的业务信道的方法是使用第一频带上的第一无线帧的下行时隙安排业务信道，以及在第一非成对频谱上构建终端至无线接点的业务信道的方法是使用第一频带上的第一无线帧的上行时隙安排业务信道；在第二非成对频谱上构建无线接点至终端的反馈信道和 / 或控制信道的方法是使用第二频带上的第二无线帧的下行时隙安排反馈信道和 / 或控制信道，以及在第二非成对频谱上构建终端至无线接点的反馈信道和 / 或控制信道的方法是使用第二频带上的第二无线帧的上行时隙安排反馈信道和 / 或控制信道。

[0022] 其中，使用无线接点至终端的反馈信道和 / 或控制信道包括以下步骤：在第一时间区间内，终端使用安排在第一频带上的业务通道向无线接点完成一次数据发射；在第二时间区间内，终端在第二频带上的反馈信道和 / 或控制信道上接收无线接点发来的反馈和 / 和控制数据；在第三时间区间内，终端根据反馈和 / 或控制数据进行必要的工作模式调整；以及在第四时间区间内，终端在安排在第一频带上的业务信道进行下一次数据发射。

[0023] 此外，使用终端至无线接点的反馈信道和 / 或控制信道包括以下步骤：在第一时间区间内，无线接点使用安排在第一频带上的业务通道向终端完成一次数据发射；在第二时间区间内，无线接点在第二频带上的反馈信道和 / 或控制信道上接收终端发来的反馈和 / 和控制数据；在第三时间区间内，无线接点根据反馈和 / 或控制数据进行必要的工作模式调整；以及在第四时间区间内，无线接点在安排在第一频带上的业务信道进行下一次数据发射。

[0024] 反馈和 / 或控制数据包括以下信息中的至少一种：发射功率控制信息、动态调度信息、自动重发信息、信道质量信息、以及自适应调制编码信息。

[0025] 根据本发明的另一方面，提供了一种在时分双工空中接口中引入外带反馈的系统，该系统包括：至少一个第一类无线接点，第一类无线接点工作于第二频带上，并使用第二时分双工无线帧结构；至少一个第二类无线接点，第二类无线接点工作于第一频带上，并使用第一时分双工无线帧结构；至少一个无线终端，用于使用第一频带与第二类无线接点保持连接以及使用第二频带与第一类无线接点保持连接；以及至少一个通信处理与控制单元，与第一类无线接点和第二类无线接点链接，用于实现发射和 / 或接收分集控制。

[0026] 在第一频带上的第一时分双工无线帧结构的下行时隙中建立第二无线接点至终

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端的业务信道，并在第一时分双工无线帧结构的上行时隙中建立终端至第二无线接点的业务信道；以及在第二频带上的第二时分双工无线帧结构的下行时隙中建立第一无线接点至终端的反馈信道和/或控制信道，并在第二时分双工无线帧结构的上行时隙中建立终端至第一无线接点的反馈信道和/或控制信道。

[0027] 无线终端使用第二频带上的反馈信道和/或控制信道实现与第一类无线接点之间的反馈和/或控制，以及无线终端使用第一频带上的业务信道实现与第二类无线接点之间的数据传输。

[0028] 无线终端使用第一频带上的分别属于多个第二类无线接点的业务信道以分集的方式实现数据传输。

[0029] 第二类接点在第一频带和第二频带上工作，无线终端使用多个第二类无线接点在第二频带上以分集方式传送反馈和/或控制信息。

[0030] 第二类无线接点被第一类无线接点覆盖，或者第二类无线接点的覆盖区域与第一类无线接点的覆盖区域存在交叠。

[0031] 第一类无线接点与第二类无线接点之间在时间上同步工作，从而实现发射分集所需要的同步关系。

[0032] 本发明提供了一种既保留 TDD 在信道互易性、上下行业务的灵活性和双工器的简单性，还兼有 FDD 的低反馈时延这样的一种双工方法。通过本发明，时分双工频谱传输的信号的反馈间隔不受无线帧周期的限制，可以在一个无线帧周期内实现多次反馈，从而提高系统的动态性能和吞吐量；可以在双层空口覆盖方式下使微小区无线接点方便地支持高速移动终端；以及易于在现有频谱规划下实现。

[0033] 本发明的其它特征和优点将在随后的说明书中阐述，并且，部分地从说明书中变得显而易见，或者通过实施本发明而了解。本发明的目的和其他优点可通过在所写的说明书、权利要求书、以及附图中所特别指出的结构来实现和获得。

附图说明

[0034] 附图用来提供对本发明的进一步理解，并且构成说明书的一部分，与本发明的实施例一起用于解释本发明，并不构成对本发明的限制。在附图中：

[0035] 图 1 是示出根据本发明的在时分双工空中接口中引入外带反馈的方法的流程图；

[0036] 图 2 是示出根据本发明实施例的引入带外反馈信道的时分双工方法的示意图；

[0037] 图 3 是示出根据本发明实施例的无线接点向无线终端发送带外反馈的方法的流程图；

[0038] 图 4 是示出根据本发明实施例的无线终端向无线接点发送带外反馈的方法的流程图；

[0039] 图 5 是示出根据本发明实施例的使用带外反馈的时分双工无线接入系统的示图；

[0040] 图 6 是示出根据本发明实施例的引入带外反馈信道的双层时分双工无线接入系统的具体实例的示图；以及

[0041] 图 7 是示出带外反馈的时分双工无线接入系统频谱使用方式的实例。

具体实施方式

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[0042] 以下结合附图对本发明的优选实施例进行说明，应当理解，此处所描述的优选实施例仅用于说明和解释本发明，并不用于限定本发明。

[0043] 图 1 是示出根据本发明的在时分双工空中接口中引入外带反馈的方法的流程图。

[0044] 参照图 1，根据本发明的在时分双工空中接口中引入外带反馈的方法，该方法包括以下处理：S102，空中接口在以时分方式双向使用的第一非成对频谱上构建业务信道；以及 S104，空中接口在以时分方式双向使用的第二非成对频谱上构建反馈信道和 / 或控制信道。

[0045] 其中，反馈信道和 / 或控制信道用于承载以下信息中的一种或多种：功控指令、调度指令、重发请求以及信道信息数据。

[0046] 图 2 是示出根据本发明实施例的引入带外反馈信道的时分双工方法的示意图。

[0047] 参照图 2，在以时分方式双向使用的第一非成对频谱（即，f1）上构建无线接点至终端的业务信道的方法是使用频带 f1 上的无线帧 201 的下行时隙 201d 安排业务信道；以及在频带 f1 上构建终端至无线接点的业务信道的方法是使用频带 f1 上的无线帧 201 的上行时隙 201u 安排业务信道。

[0048] 在以时分方式双向使用的第二非成对频谱（即，f2）上构建无线接点至终端的反馈信道和 / 或控制信道的方法是使用频带 f2 上的无线帧 202 时隙 202d 安排反馈信道和 / 或控制信道；以及在频带 f2 上构建终端至无线接点的反馈信道和 / 或控制信道的方法是使用频带 f2 上的无线帧 202 的上行时隙 202u 安排反馈信道和 / 或控制信道。

[0049] 图 3 是示出根据本发明实施例的无线接点向无线终端发送带外反馈的方法的流程图。

[0050] 参照图 3，使用无线接点至终端的反馈信道和 / 或控制信道包括以下步骤：S301，在第一时间区间内，终端使用安排在频带 f1 上的业务通道向无线接点完成一次数据发射；S302，在第二时间区间内，终端在频带 f2 上的反馈信道和 / 或控制信道上接收无线接点发来的反馈和 / 和控制数据；S303，在第三时间区间内，终端根据反馈和 / 或控制数据进行必要的工作模式调整；以及 S304，在第四时间区间内，终端在安排在频带 f1 上的业务信道进行下一次数据发射。

[0051] 图 4 是示出根据本发明实施例的无线终端向无线接点发送带外反馈的方法的流程图。

[0052] 参照图 4，使用终端至无线接点的反馈信道和 / 或控制信道包括以下步骤：S401，在第一时间区间内，无线接点使用安排在频带 f1 上的业务通道向终端完成一次数据发射；S402，在第二时间区间内，无线接点在频带 f2 上的反馈信道和 / 或控制信道上接收终端发来的反馈和 / 和控制数据；S403，在第三时间区间内，无线接点根据反馈和 / 或控制数据进行必要的工作模式调整；以及 S404，在第四时间区间内，无线接点在安排在频带 f1 上的业务信道进行下一次数据发射。

[0053] 反馈和 / 或控制数据包括以下信息中的至少一种：发射功率控制信息、动态调度信息、自动重发信息、信道质量信息、以及自适应调制编码信息。

[0054] 图 5 是示出根据本发明实施例的使用带外反馈的时分双工无线接入系统的示图。

[0055] 参照图 5，根据本发明的在时分双工空中接口中引入外带反馈的系统包括：至少一个第一类无线接点 501，第一类无线接点工作于第二频带（即，f2）上，并使用时分双工

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无线帧结构 202；至少一个第二类无线接点 502，第二类无线接点工作于第一频带（即，f1）上，并使用时分双工无线帧结构 201；至少一个无线终端 503，用于使用频带 f1 与第二类无线 502 接点保持连接以及使用频带 f2 与第一类无线接点 501 保持连接；以及至少一个通信处理与控制单元 504，与第一类无线接点 501 和第二类无线接点 502 链接，用于实现发射和 / 或接收分集控制。

[0056] 第一类无线接点 501 与无线终端 503 之间使用频带 f2 上的时分双工无线帧结构 202 的下行时隙建立无线接点至终端的反馈信道和 / 或控制信道；第一类无线接点 501 与无线终端 503 之间使用频带 f2 上的时分双工无线帧结构 202 的上行时隙建立终端至无线接点的反馈信道和 / 或控制信道。

[0057] 第二类无线接点 502 与无线终端 503 之间使用频带 f_1 上的时分双工无线帧结构 201 的下行时隙建立无线接点至终端的业务信道；第二类无线接点 502 与无线终端 503 之间使用频带 f_1 上的时分双工无线帧结构 202 的上行时隙建立终端至无线接点的业务信道。

[0058] 无线终端 503 具有使用频带 f1 与第二类无线接点 502 保持连接的能力，以及使用频带 f2 与第一类无线节点保持连接的能力。此外，无线终端 503 还具有在第二类无线接点所使用的频带 f1 内探测第二类无线接点的接点识别信号、测量其识别信号功率强度的能力。

[0059] 该系统的基本工作方式是：无线终端 503 使用频带 f2 上的反馈信道和 / 或控制信道实现与第一类无线接点之间的反馈和 / 或控制，以及使用频带 f1 上的业务信道实现与第二类无线接点之间的数据传输。

[0060] 进一步地，无线终端 503 使用频带 f1 上的分别属于多个第二类无线接点（如图 5 中无线接点 502a/502b）的业务信道以分集的方式实现数据传输。

[0061] 进一步地，第二类无线接点 502 可以在频带 f1 和频带 f2 这两个频带上工作。在这种情况下，无线终端 503 除了使用 f2 上的反馈和 / 或控制信道传送反馈和 / 或控制信息外，还使用多个第二类无线接点在频带 f2 上以分集的方式传送反馈和 / 或控制信息。

[0062] 第二类无线节点 502 被第一类无线接点 501 覆盖或者第二类无线接点的覆盖区域 506 与第一类无线接点的覆盖区域 505 存在交叠。

[0063] 第一类无线节点 501 可以是一个完整的基站，也可以是一个只有天线和射频单元的物理实体。第一类无线接点 501 的天线可以是如下天线结构之一种：全向天线、具有固定方向图的天线（如扇区天线）、阵列天线。

[0064] 此外，第二类无线节点 502 可以是一个完整的基站，也可以是一个只有天线和射频单元的物理实体。第二类无线节点 502 的天线可以是如下天线结构之一种、全向天线；具有固定方向图的天线（如扇区天线）、阵列天线。

[0065] 第二类无线节点 502 发送其识别信息，这些信息可以是在广播信道上发送，也可以是在通过导频信道的编码来发送，也可以是以叠加伪随序列的方式发送。

[0066] 第二类无线节点 502 的天线的布设方式可以采用室外布设或室内布设。

[0067] 第一类无线节点 501 与第二类无线接点的空间覆盖关系是：第一类无线接点 501 覆盖若干第二类无线接入点 502，或者存在若干其覆盖区域 506 与第一类无线接入点覆盖范围 505 相交叠的第二类无线接入点 501。

[0068] 第一类无线节点 501 与第二类无线接点 502 的差别是：第一类无线接点 501 相对

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于第二类无线接点 502 具有较大的发射功率；以及第一类无线接点 501 的架设高度大于第二类无线接点 502 的架设高度。

[0069] 第一类无线节点与第二类无线接点之间的链接链路可以是如下之一种：光纤信道、金属信道、以及无线信道。

[0070] 并且第一类无线节点与第二类无线接点之间在时间上同步工作，以便实现发射分集所需要的同步关系，例如，在第一类无线节点与第二类无线接点之间实现单频网分集模式或空分发射分集 (STTD) 所需要同步关系。

[0071] 图 6 是示出根据本发明实施例的引入带外反馈信道的双层时分双工无线接入系统的具体实例的示图。

[0072] 参照图 6，该系统包括：若干个第一类无线接点 501，这里的第一类无线接点 501 采用了阵列天线，该阵列天线可以以波束赋形的方式工作；若干个第二类无线接点 502，这里的第二类无线接点采用的是全向天线；若干个无线终端 503，该终端具有对三类探测集探测的能力：第一类无线接点构成的用于宏小区切换的探测集；第二类无线接点构成的层间发射分集探测集；以及第一类无线接点和第二类无线接点构成的层间发射分集探测集。每个第一类无线接点及若干个第二类无线接点与一个通信处理与控制单元 504 相链接，在通信处理与控制单元 504 内，除了实现第一类无线接点、第二类无线接点所需要的基带处理功能外，还实现了用于第二类无线接点与基带处理器之间通信与控制的节点通信与控制单元 601，更进一步地，在通信处理与控制单元 504 内，实现了发射和或接收分集控制。

[0073] 本实施例中的节点通信处理与控制单元 601 是按照共用公共无线接口规范 CPRI(Common Public Radio Interface)Specification 设计的，可以方便地实现基带处理单元（即 CPRI 规范中的无线电设备控制 (REC) 节点）与第二类无线接点（即 CPRI 规范中的无线电设备控制 (RE) 节点）之间的同步、数据传输、工作模式控制。

[0074] 在本例所述的双层系统中，若干第一类无线接点 501 构成第一层覆盖，其工作频带为 f2，在每一个第一类节点覆盖的区域内存在若干连续覆盖的第二类无线接点 102，其工作频带为 f1，这些第二类无线接点构成双层移动通信系统的第二层覆盖。一个使用频带 f1 上的时分双工数据信道的无线终端使用频带 f2 上的反馈和 / 或控制信道传送反馈和 / 或控制信息。

[0075] 移动终端在通信处理与控制单元 501 的控制下，在频带 f1 上对其附近可能用于分集通信的无线接点 502 进行探测。

[0076] 在移动中断移动到位置 A 处时，通信处理与控制单元 501 进行如下 2 个方面的处理。一方面，通信处理与控制单元 501 根据分集通信活动集内的无线接点的识别号及地址，通过第一类无线接点 501 在频带 f2 上的反馈和 / 或控制信道实现与无线终端之间的控制信息传送，这些控制信息至少包括如下信息之一：自适应编码调制信息、调度信息、功率控制信息、干扰协调信息；另一方面，无线终端 503 通过使用频带 f1 上的时分双工的业务信道与多个第二类无线接点时间以分集的方式进行通信。这里，通信处理与控制单元 501 根据无线终端 503 上报的结果确定该无线终端在位置 A 时的分集通信活动集，位置 A 的活动集包括：第二类无接点 502h、502i、502j。于是，通信处理与控制单元 501 利用无线接点 502h、502i、502j 以单频网分集（活动集内的各个无线接点以时间同步、频率同步、比特同步的方式发送业务数据）分集的方式向无线终端发送业务数据。

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[0077] 无线终端 503 移动到位置 B 处时，通信处理与控制单元 501 进行与位置 A 时相同的处理步骤，但是，此时的分集通信活动集包括：第二类无线接点 502k、5021。

[0078] 本实施例中，所述第二类无线接点利用小灵通 (PHS：PersonalHandy-phone System) 的站址资源进行安装，利用的站址资源包括如下之一种或者多种：基站站址、供电子系统、有线链路、光纤接点。

[0079] 本实施例是以层间和层内实施单频网方式的发射分集为例，按照同样的组网方式和活动集测量方式，也可以实施其他方式的发射分集，如空分发射分集。

[0080] 本实施例是以层间实施开环发射分集为例，按照同样的组网方式和活动集测量方式，也可以实施闭环发射分集。

[0081] 在本实施例中的频段 f1 可以是图 7 中的频段 705 至 709 中的任何一段 TDD 频谱，也可以使用目前划分给地面电视广播的频谱，包括 VHF：174MHz ～ 230MHz、UHF：470MHz ～ 798MHz 中的一部分。频段 f1 也可以是无线局域网使用的免许可频段。

[0082] 通过本发明的技术方案，时分双工频谱传输的信号的反馈间隔不受无线帧周期的限制，可以在一个无线帧周期内实现多次反馈，从而提高系统的动态性能和吞吐量；可以在双层空口覆盖方式下使微小区无线接点方便地支持高速移动终端；以及易于在现有频谱规划下实现。

[0083] 总之，本发明给出的空中接口除了保留了 TDD 的信道互易性及上下行业务的灵活性等优点之外，还兼有半双工 FDD 的低反馈时延带来的各种优点，特别是在应用于双层双频无线接入网时，可以提高微小区无线接点对高速移动终端的支持能力。

[0084] 以上仅为本发明的优选实施例而已，并不用于限制本发明，对于本领域的技术人员来说，本发明可以有各种更改和变化，比如，当第一类无线节点以频分双工方式工作而第二类无线节点以时分双工方式工作时，在第二类无线节点与无线终端之间建立的时分双工业务信道的带外反馈信道可以在第一类无线节点的上行 / 下行频谱上分别构建：第二类无线节点与无线终端之间建立的时分双工业务信道的下行反馈通道（从第一类无线节点向终端发送反馈信息）利用频分双工的下行频谱构建；第二类无线节点与无线终端之间建立的时分双工业务信道的上行反馈通道（从终端向第一类无线节点发送反馈信息）利用频分双工的上行频谱构建。凡在本发明的精神和原则之内，所作的任何修改、等同替换、改进等，均应包含在本发明的保护范围之内。

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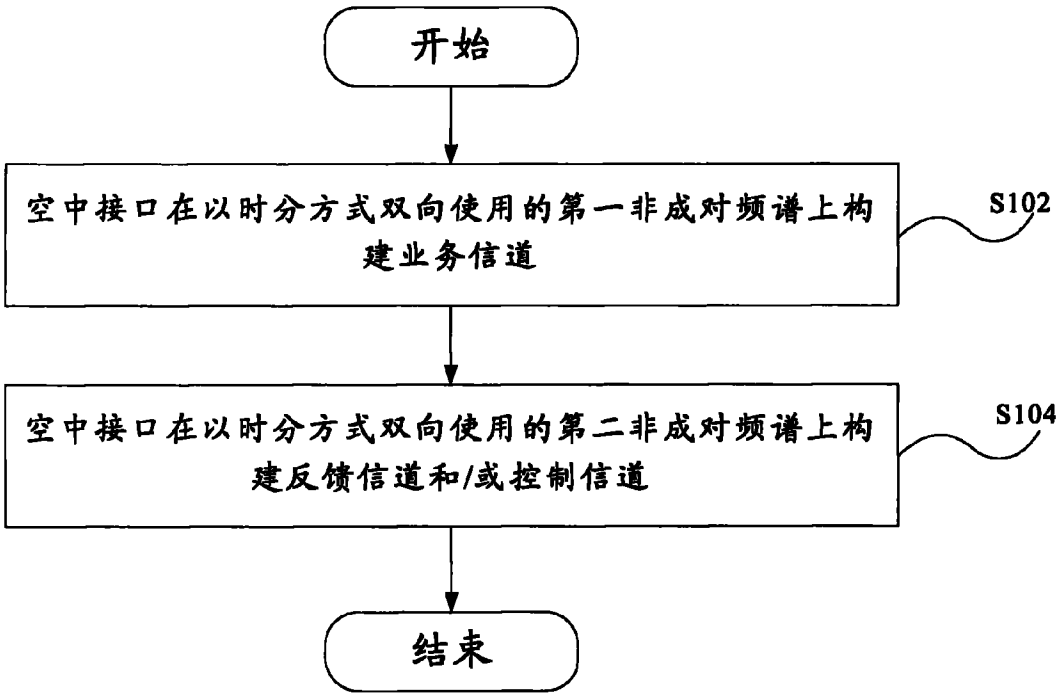


图 1

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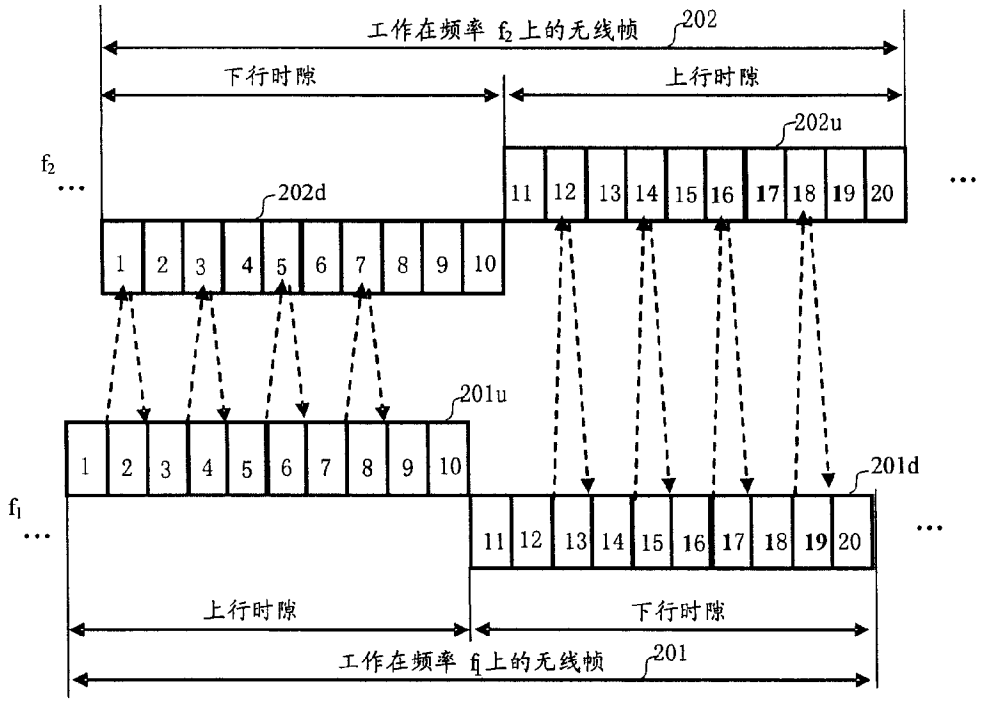


图 2

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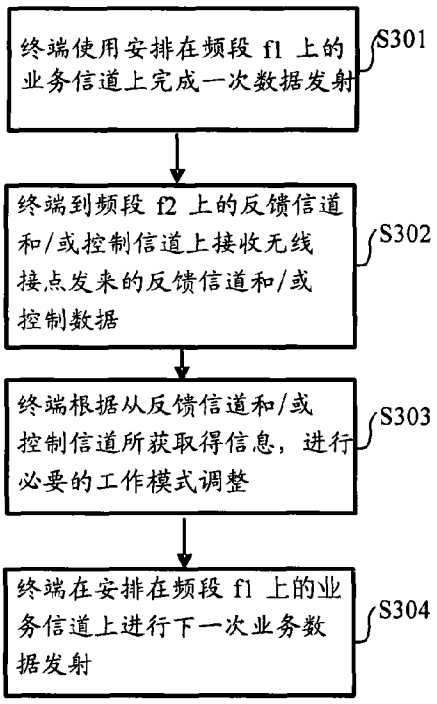


图 3

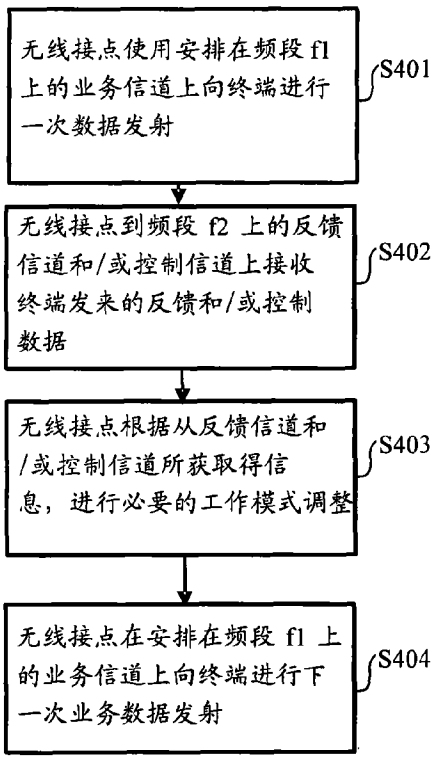


图 4

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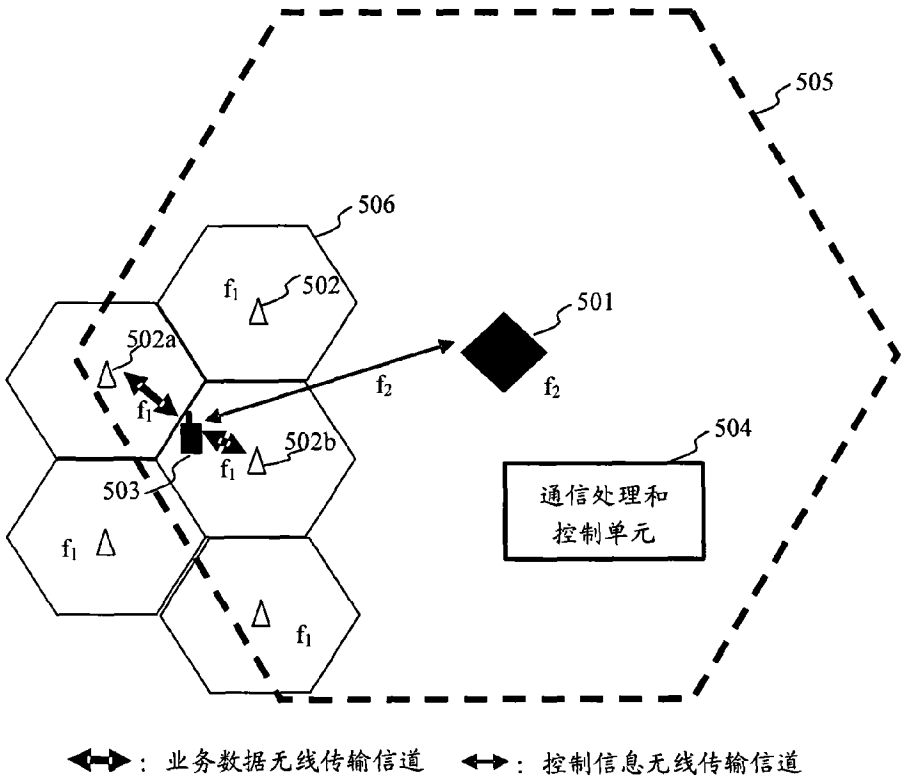


图 5

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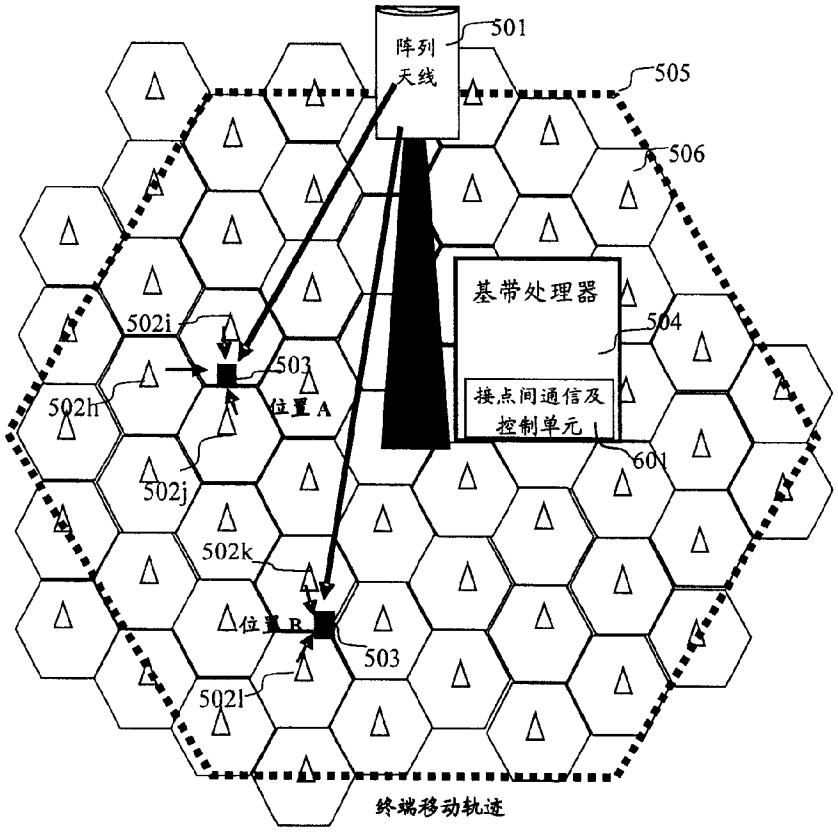


图 6

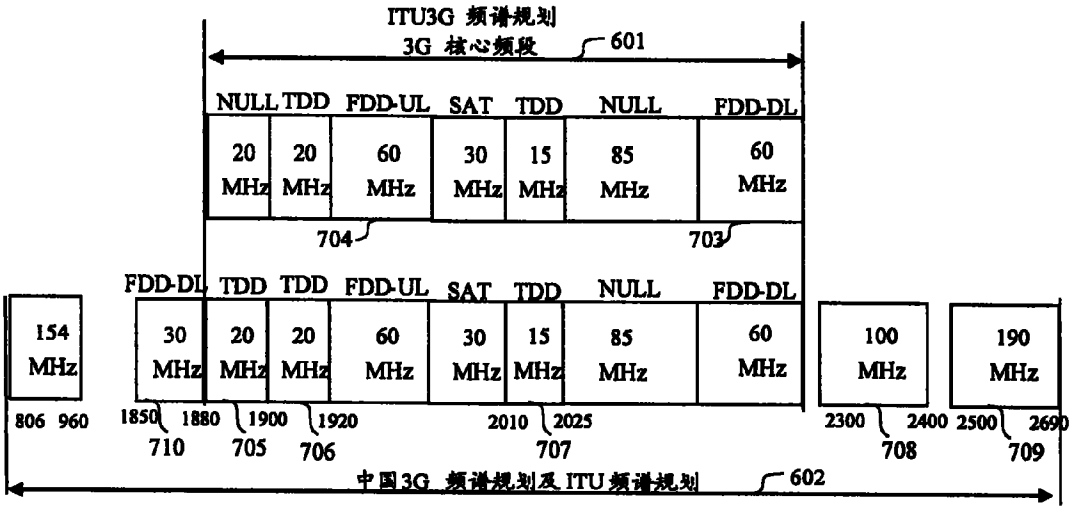


图 7

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Espacenet

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Resource scheduling method and apparatus

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Application number: CN20121540368 20121213 Global Dossier

Priority number(s): CN20121540368 20121213

Abstract of CN103874221 (A)

The invention discloses a resource scheduling method and apparatus. The method comprises the steps of: determining the scheduling priority of each terminal; and successively scheduling resources on the available component carrier for each terminal according to the scheduling priority of each terminal; wherein scheduling resources on the available component carrier for each terminal concretely comprises: determining the scheduling priority of the available component carrier of a terminal; and scheduling carrier resource for the terminal according to the determined scheduling priority of the available component carrier of the terminal. Compared with prior art, the resource scheduling method and apparatus can preferentially schedule the component carrier with higher priority for a terminal, thereby raising terminal communication quality and effectively raising system resource transmission efficiency.

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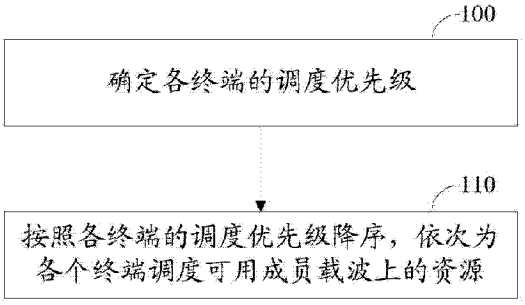
权利要求书3页 说明书6页 附图1页

(54)发明名称

一种资源调度方法及装置

(57)摘要

本发明公开了一种资源调度方法及装置。其方法包括：确定各终端的调度优先级；按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；其中，为一个终端调度可用成员载波上的资源具体包括：确定所述终端可用成员载波的调度优先级；按照确定的所述终端可用成员载波的调度优先级，为所述终端调度载波资源。本发明实施例提供的方法及装置，较之现有技术，能够优先为终端调度对其而言优先级更高的成员载波，从而提高终端的通信质量，且可以有效提高系统资源的传输效率。



CN 103874221 A

1. 一种资源调度方法，其特征在于，包括：

确定各终端的调度优先级；

按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；

其中，为一个终端调度可用成员载波上的资源具体包括：

确定所述终端可用成员载波的调度优先级；

按照确定的所述终端可用成员载波的调度优先级降序，为所述终端调度载波资源。

2. 根据权利要求 1 所述的方法，其特征在于，所述确定各终端的调度优先级，具体包括：

根据各终端在其可用成员载波上的平均信道质量，采用正比公正算法确定各终端的调度优先级；或者，

根据各终端在其可用成员载波上的平均信道质量，采用最大载干比算法确定各终端的调度优先级。

3. 根据权利要求 1 或 2 所述的方法，其特征在于，确定所述终端可用成员载波的调度优先级，具体包括：

从为所述终端配置并激活的成员载波中，选择有可用物理资源块对 PRB 的成员载波作为可用成员载波；

按照所述终端在各个可用成员载波上的平均信道质量排序，确定各个可用成员载波的调度优先级。

4. 根据权利要求 1 或 2 所述的方法，其特征在于，确定所述终端可用成员载波的调度优先级，具体包括：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

按照各个可用成员载波上可用 PRB 的数量排序，确定各个可用成员载波的调度优先级。

5. 根据权利要求 1 或 2 所述的方法，其特征在于，确定所述终端可用成员载波的调度优先级，具体包括：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

根据所述终端在各个可用成员载波上的信道质量和各个成员载波上可用 PRB 数量，确定各个可用成员载波上能够承载的数据量；

按照各个可用成员载波上能够承载的数据量排序，确定各个可用成员载波的调度优先级。

6. 根据权利要求 1 或 2 所述的方法，其特征在于，确定所述终端可用成员载波的调度优先级，具体包括：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

按照所述终端在各个可用成员载波上的平均传输速率排序，确定各个可用成员载波的调度优先级。

7. 根据权利要求 1 或 2 所述的方法，其特征在于，所述按照确定的所述终端可用成员载

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波的调度优先级降序，为所述终端调度载波资源，进一步包括：

根据所述终端在各个成员载波上可用 PRB 数量的上限，为所述终端调度载波资源。

8. 一种资源调度装置，其特征在于，包括：

时域调度单元，用于确定各终端的调度优先级；

频域调度单元，用于按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；

其中，为一个终端调度可用成员载波上的资源时，所述频域调度单元具体用于：

确定所述终端可用成员载波的调度优先级；

按照确定的所述终端可用成员载波的调度优先级降序，为所述终端调度载波资源。

9. 根据权利要求 8 所述的装置，其特征在于，所述时域调度单元具体用于：

根据各终端在其可用成员载波上的平均信道质量，采用正比公正算法确定各终端的调度优先级；或者，

根据各终端在其可用成员载波上的平均信道质量，采用最大载干比算法确定各终端的调度优先级。

10. 根据权利要求 8 或 9 所述的装置，其特征在于，确定所述终端可用成员载波的调度优先级时，所述频域调度单元具体用于：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

按照所述终端在各个可用成员载波上的平均信道质量排序，确定各个可用成员载波的调度优先级。

11. 根据权利要求 8 或 9 所述的装置，其特征在于，确定所述终端可用成员载波的调度优先级时，所述频域调度单元具体用于：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

按照各个可用成员载波上可用 PRB 的数量排序，确定各个可用成员载波的调度优先级。

12. 根据权利要求 8 或 9 所述的装置，其特征在于，确定所述终端可用成员载波的调度优先级时，所述频域调度单元具体用于：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

根据所述终端在各个可用成员载波上的信道质量和各个成员载波上可用 PRB 数量，确定各个可用成员载波上能够承载的数据量；

按照各个可用成员载波上能够承载的数据量排序，确定各个可用成员载波的调度优先级。

13. 根据权利要求 8 或 9 所述的装置，其特征在于，确定所述终端可用成员载波的调度优先级时，所述频域调度单元具体用于：

从为所述终端配置并激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

按照所述终端在各个可用成员载波上的平均传输速率排序，确定各个可用成员载波的

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调度优先级。

14. 根据权利要求 8 或 9 所述的装置，其特征在于，所述频域调度单元进一步用于：

根据所述终端在各个成员载波上可用 PRB 数量的上限，为所述终端调度载波资源。

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一种资源调度方法及装置

技术领域

[0001] 本发明涉及无线通信技术领域，尤其涉及一种资源调度方法及装置。

背景技术

[0002] 长期演进(LTE，Long Term Evolution)/增强的长期演进(LTE-A，Long TermEvolution Advanced)系统采用共享信道的机制，通过动态调度来合理的利用系统的无线资源。资源分配的过程也称为调度。在LTE/LTE-A系统中，可分配的最小物理资源单位为物理资源块(PRB，Physical Resource Block)，一个时隙中频域上宽度为180kHz的连续物理资源称为一个PRB。

[0003] LTE-A引入了载波聚合(CA，Carrier Aggregation)技术，以LTE成员载波带宽为基本单位，通过将多个小带宽的成员载波聚合在一起的方式获得更大的传输带宽，因此，系统内可用的共享资源将随着聚合载波数目的增多而增加。其中，每个参与聚合的载波称为成员载波(CC，Component Carrier)。参与聚合的每个CC带宽可以相同，也可以不相同。

[0004] 在CA系统中，用户设备(UE，User Equipment，又称终端)可能同时存在多个服务小区，UE的服务小区分为主服务小区(PCell，Primary Cell)和辅服务小区(SCell，Secondary Cell)两类，其中PCell是一定存在的，其继承了LTE中服务小区的性质，每个UE只有一个PCell；而SCell仅被作为附加的资源，承担数据传输功能，基站可以根据UE的实际需要为UE配置一个或多个SCell。相应的，PCell对应的成员载波称为主成员载波(PCC，PrimaryCompoment Carrier)，SCell对应的成员载波称为辅成员载波(SCC，SecondaryComponent Carrier)。版本10(Rel-10)中规定，对于配置给用户的每个SCell，需要激活才能使用。PCell始终保持激活状态，而SCell可以根据服务情况保持激活或去激活状态，只有处于激活状态时才能用来传输数据。

[0005] 在CA系统中，对于配置并激活了多个SCell的UE，其可以同时在多个服务小区上进行数据的发送和接收。UE在各个服务小区上的信道环境通常是不一样的，而且同一UE在各个服务小区上可以采用不同的传输模式、及资源分配类型。

[0006] 在CA系统中，为了更好的管理和高效利用各用户共享的空口无线资源，需要设计合理的调度方法，实现多个成员载波的共享信道资源在用户之间进行合理的分配，能够适应无线传播环境的动态变化，满足不同用户对于各种业务的QoS需求，同时提高系统频谱效率和吞吐量性能。

[0007] 对于CA系统，目前公开的调度方案采用的是串行调度各个成员载波的资源的方法。即：先对系统的各个CC进行排序，然后按照排序结果依次在各个CC上对UE进行优先级排队和资源分配。每完成一个CC上的调度，根据前面的资源分配情况确定需要参与下一个CC调度的UE。再对这些UE在第2个CC上进行优先级排序和资源分配，以此类推。该方法无法保证将对终端而言优先级更高的成员载波优先调度给该终端，且对系统资源的传输效率较低。

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发明内容

[0008] 本发明的目的是提供一种资源调度方法及装置，以解决无法针对终端为其优先调度优先级更高的成员载波、以及对系统资源的传输效率较低的问题。

[0009] 本发明的目的是通过以下技术方案实现的：

[0010] 一种资源调度方法，包括：

[0011] 确定各终端的调度优先级；

[0012] 按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；

[0013] 其中，为一个终端调度可用成员载波上的资源具体包括：

[0014] 确定所述终端可用成员载波的调度优先级；

[0015] 按照确定的所述终端可用成员载波的调度优先级降序，为所述终端调度载波资源。

[0016] 一种资源调度装置，包括：

[0017] 时域调度单元，用于确定各终端的调度优先级；

[0018] 频域调度单元，用于按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；

[0019] 其中，为一个终端调度可用成员载波上的资源时，所述频域调度单元具体用于：

[0020] 确定所述终端可用成员载波的调度优先级；

[0021] 按照确定的所述终端可用成员载波的调度优先级降序，为所述终端调度载波资源。

[0022] 本发明实施例提供的方法及装置，首先为参与调度的各个终端确定调度优先级，然后按照该调度优先级依次对各个终端调度可用成员载波上的资源。针对每个终端进行调度时，将其可用成员载波作为一个整体进行调度，即先确定可用成员载波进行调度优先级，然后据此为终端调度载波资源。较之现有技术，能够优先为终端调度对其而言优先级更高的成员载波，从而提高终端的通信质量。另外，为终端调度对其而言优先级更高的成员载波，该成员载波上可以承载的数据量更高，从而可以有效提高系统资源的传输效率。

附图说明

[0023] 图 1 为本发明实施例提供的一种方法流程图；

[0024] 图 2 为本发明实施例提供的另一种方法流程图；

[0025] 图 3 为本发明实施例提供的装置结构示意图。

具体实施方式

[0026] 本发明实施例提供一种资源调度方法，应用于 CA 系统。该方法中，首先为参与调度的各个 UE 确定调度优先级，然后按照该调度优先级依次对各个 UE 调度可用 CC 上的资源。针对每个 UE 进行调度时，将其可用 CC 作为一个整体进行调度，即先确定可用 CC 进行调度优先级，然后据此为 UE 调度载波资源。较之现有技术，能够优先为 UE 调度对其而言优先级更高的 CC，从而提高 UE 的通信质量，且可以有效提高系统资源的传输效率。

[0027] 下面将结合附图，对本发明实施例提供的技术方案进行详细说明。

[0028] 本发明实施例提供了一种资源调度方法，其实现方式如图 1 所示，具体实现方式

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如下：

[0029] 步骤 100、确定各 UE 的调度优先级。

[0030] 以针对一个子帧的调度为例，步骤 100 中，具体是确定参与当前子帧调度的各个 UE 的调度优先级。

[0031] 本发明实施例中，步骤 100 的具体实现方式有多种。例如，可以根据各 UE 在其可用 CC 上的平均信道质量，采用正比公正（PF，Propotional Fair）算法确定各 UE 的调度优先级。也可以根据各 UE 在其可用 CC 上的平均信道质量，采用最大载干比（MAX C/I）算法确定各 UE 的调度优先级。还可以采用轮询（RR，Round Robin）等等算法确定各 UE 的调度优先级。

[0032] 其中，如果采用 PF 或者 MAX C/I 算法确定各 UE 的调度优先级，则需要用到各 UE 在其可用 CC 上的平均信道质量。具体的，可以将 UE 在其各个可用 CC 的可用物理资源块对（PRB）上的信道质量进行拟合得到等效信噪比，该等效信噪比即该 UE 在其可用 CC 上的平均信道质量。

[0033] 步骤 110、按照各 UE 的调度优先级降序，依次为各个 UE 调度可用 CC 上的资源。

[0034] 本发明实施例中，所谓 UE 可用成员载波是指，该 UE 的 PCC 和为该 UE 配置且激活的所有 SCC 中，有可用 PRB 的 CC。

[0035] 其中，为一个 UE 调度可用 CC 上的资源的具体实现方式如下：

[0036] 确定该 UE 可用 CC 的调度优先级；

[0037] 按照确定的该 UE 可用 CC 的调度优先级降序，为该 UE 调度载波资源。

[0038] UE 在各个 CC 上的所采用的资源分配类型可能有所不同，对于不同的资源分配类型，需要遵循不同的资源分配规则。另外，由于每个 CC 上的资源分配都分别对应一条调度信令。为了使用较少的资源分配规则，减少信令开销，从而节省物理下行控制信道（PDCCH）资源开销。在为 UE 调度载波资源时，较佳地，按照该 UE 可用 CC 的调度优先级降序，依次为该 UE 调度各个 CC 上的资源，直到满足资源调度需求或者遍历该 UE 所有可用 CC。

[0039] 应当指出的是，在调度优先级较高的 CC 上为 UE 分配资源，如果需要继续为 UE 调度资源，则按照 UE 可用 CC 的调度优先级降序，在下一个 CC 上为 UE 分配资源。这只是一种较佳地实现方式，而不是对本发明实施例的限定。当然，也可以在 UE 所有可用 CC 上作统一的资源调度。

[0040] 上述本发明方法实施例中，确定所述 UE 可用 CC 的调度优先级的具体实现方式有多种。本发明实施例仅例举如下几种：

[0041] 确定所述 UE 可用 CC 的调度优先级的第一种实现方式：

[0042] 从为 UE 配置且激活的 CC 中，选择有可用 PRB 的 CC 作为可用 CC；

[0043] 按照该 UE 在各个可用 CC 上的平均信道质量（如宽带 CQI 等）排序，确定各个可用 CC 的调度优先级。

[0044] 即，UE 在 CC 上的平均信道质量越高，则该 CC 的调度优先级越高。

[0045] 本发明实施例中，UE 在 CC 上的平均信道质量是指，UE 在该 CC 的各个 PRB 上的信道质量均值。

[0046] 确定所述 UE 可用 CC 的调度优先级的第二种实现方式：

[0047] 从为 UE 配置且激活的 CC 中，选择有可用 PRB 的 CC 作为可用 CC；

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[0048] 按照各个可用 CC 上可用 PRB 的数量排序，确定各个可用 CC 的调度优先级。

[0049] 即，各个可用 CC 上可用 PRB 的数量越多，该 CC 的调度优先级越高。

[0050] 确定所述 UE 可用 CC 的调度优先级的第三种实现方式：

[0051] 从为 UE 配置且激活的 CC 中，选择有可用 PRB 的 CC 作为可用 CC；

[0052] 根据该 UE 在各个可用 CC 上的信道质量和各个 CC 上可用 PRB 数量，确定各个可用 CC 上能够承载的数据量；

[0053] 按照各个可用 CC 上能够承载的数据量排序，确定各个可用 CC 的调度优先级。

[0054] 即，CC 上能够承载的数据量越大，该 CC 的调度优先级越高。

[0055] 确定所述 UE 可用 CC 的调度优先级的第四种实现方式：

[0056] 从为 UE 配置且激活的 CC 中，选择有可用 PRB 的成员载波作为可用 CC；

[0057] 按照该 UE 在各个可用 CC 上的平均传输速率排序，确定各个可用 CC 的调度优先级。

[0058] 即，UE 在 CC 上的平均传输速率越大，则该 CC 的调度优先级越高。

[0059] 其中，可以基于一定的时间窗统计 UE 在各个可用 CC 上的平均传输速率，也可以采用遗忘因子滤波的方式统计 UE 在各个可用 CC 上的平均传输速率。对于初始接入的 UE，可以将该 UE 各个可用 CC 上其他 UE 进行数据传输的平均传输速率作为该 UE 在各个可用 CC 上的平均传输速率初始值。对于为 UE 初始激活的 SCC，可以将该 UE 在其他可用 CC 上的平均传输速率作为该 UE 在该 SCC 上的平均传输速率初始值。

[0060] 本发明实施例中，具体可以根据当前调度周期已完成调度的 UE 资源分配情况，确定当前调度的 UE 在其为其配置且激活的 CC 上是否有可用 PRB。以在子帧上进行调度为例。假设某 CC 是为当前调度 UE 配置且激活的 CC，但该 CC 上的 PRB 已经分配给其他 UE，则该 CC 上没有该 UE 可用的 PRB，无法将其作为可用 CC。

[0061] 在上述任意实施例的基础上，为了保证 UE 的通信质量，兼顾各 UE 之间的公平性，可以设置每个 UE 每次在每个 CC 上可用 PRB 数量的上限。则按照确定的 UE 可用 CC 的调度优先级降序，为该 UE 调度载波资源时，具体根据该 UE 在各个 CC 上可用 PRB 数量的上限，为该 UE 调度载波资源。保证在每个 CC 上为该 UE 分配的 PRB 数量不超过设置的上限。

[0062] 假设 CA 系统配置了 3 个可用载波，分别记作 CC1、CC2 和 CC3。以下行调度为例，每个下行子帧的共享信道资源调度过程如图 2 所示，具体包括如下操作：

[0063] 步骤 200、确定当前有待发送数据的所有 UE 为参与当前下行子帧调度的 UE。

[0064] 假设有 3 个 UE 参与当前下行子帧调度，分别记作 UE1、UE2、和 UE3。

[0065] 步骤 210、根据各 UE 在其可用 CC 上的平均信道质量，采用 MAX C/I 算法确定各 UE 的调度优先级。

[0066] 假设 UE1 当前配置了一个服务小区，对应 CC1，UE2 当前配置了两个服务小区，分别对应 CC2 和 CC3，UE3 当前配置了三个服务小区，分别对应 CC1、CC2 和 CC3。

[0067] UE1 在 CC1 对应带宽上的平均信道质量，记为 WUE1；UE2 在 CC2 和 CC3 对应带宽上的平均信道质量，记为 WUE2；UE3 在 CC1、CC2 和 CC3 对应带宽上的平均信道质量，记为 WUE3。

[0068] 假设 $W_{UE2}>W_{UE1}>W_{UE3}$，则确定当前下行子帧中，UE 的调度优先级降序为 UE2、UE1、UE3。

[0069] 应当指出的是，本实施例中，以 MAX C/I 算法确定各 UE 的调度优先级仅是一种举例。可选的，还可以采用 PF 算法、RR 算法等等确定各 UE 的调度优先级。

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[0070] 步骤220、确定UE2可用CC的调度优先级，并按照UE2可用CC的调度优先级降序，为UE2调度载波资源。

[0071] 具体的，UE2可用CC为CC2和CC3。采用上述任一实现方式对这两个可用CC进行调度优先级排序，由此确定这两个可用CC的调度优先级为CC2>CC3。则先为UE2分配CC2上的资源，假设在CC2上完成对UE2的资源分配后，UE2仍有待传输数据，此时再为UE2分配CC3上的资源。

[0072] 步骤230、为UE1调度CC1上的载波资源。

[0073] 由于UE1可用CC只有一个，即CC1。因此，可以认为CC1的调度优先级最大，无需进行CC调度优先级排序，直接为UE1分配CC1上的资源。

[0074] 步骤240、确定UE3可用CC的调度优先级，并按照UE3可用CC的调度优先级降序，为UE3调度载波资源。

[0075] 具体的，UE3可用CC为CC1、CC2和CC3。采用上述任一实现方式对这三个可用CC进行调度优先级排序，由此确定这三个CC的调度优先级为CC1>CC3>CC2。先为UE3分配CC1上的资源。假设在CC1上完成对UE3的资源分配后，UE3仍有待传输数据，再为UE3分配CC3上的资源。假设在CC3上为UE3分配的资源能够承载UE3所有剩余的待传输数据，则本次对UE3的资源分配结束，不再在CC2上为UE3分配资源。

[0076] 待完成对UE1、UE2和UE3的资源分配后，当前下行子帧的共享信道资源调度结束。

[0077] 图2所示以下行调度为例对本发明实施例进行说明。应当指出的是，本发明实施例提供的方法同样适用于上行调度，其具体实现方式可以参照下行调度，这里不再赘述。

[0078] 基于与方法同样的发明构思，本发明实施例还提供一种资源调度装置，其结构如图3所示，具体实现结构如下：

[0079] 时域调度单元301，用于确定各终端的调度优先级；

[0080] 频域调度单元302，用于按照各终端的调度优先级降序，依次为各个终端调度可用成员载波上的资源；

[0081] 其中，为一个终端调度可用成员载波上的资源时，所述频域调度单元302具体用于：

[0082] 确定所述终端可用成员载波的调度优先级；

[0083] 按照确定的所述终端可用成员载波的调度优先级降序，为所述终端调度载波资源。

[0084] 较佳地，所述时域调度单元301具体用于：

[0085] 根据各终端在其可用成员载波上的平均信道质量，采用正比公正算法确定各终端的调度优先级；或者，

[0086] 根据各终端在其可用成员载波上的平均信道质量，采用最大载干比算法确定各终端的调度优先级。

[0087] 基于上述任意装置实施例，确定所述终端可用成员载波的调度优先级时，频域调度单元302的具体实现方式有多种，下面例举其中几种：

[0088] (一)频域调度单元302具体用于：

[0089] 从为所述终端配置且激活的成员载波中，选择有可用PRB的成员载波作为可用成员载波；

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[0090] 按照所述终端在各个可用成员载波上的平均信道质量排序，确定各个可用成员载波的调度优先级。

[0091] （二）频域调度单元 302 具体用于：

[0092] 从为所述终端配置且激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

[0093] 按照各个可用成员载波上可用 PRB 的数量排序，确定各个可用成员载波的调度优先级。

[0094] （三）频域调度单元 302 具体用于：

[0095] 从为所述终端配置且激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

[0096] 根据所述终端在各个可用成员载波上的信道质量和各个成员载波上可用 PRB 数量，确定各个可用成员载波上能够承载的数据量；

[0097] 按照各个可用成员载波上能够承载的数据量排序，确定各个可用成员载波的调度优先级。

[0098] （四）频域调度单元 302 具体用于：

[0099] 从为所述终端配置且激活的成员载波中，选择有可用 PRB 的成员载波作为可用成员载波；

[0100] 按照所述终端在各个可用成员载波上的平均传输速率排序，确定各个可用成员载波的调度优先级。

[0101] 基于上述任意实施例所述的装置，较佳地，所述频域调度单元 302 进一步用于：

[0102] 根据所述终端在各个成员载波上可用 PRB 数量的上限，为所述终端调度载波资源。

[0103] 显然，本领域的技术人员可以对本发明进行各种改动和变型而不脱离本发明的精神和范围。这样，倘若本发明的这些修改和变型属于本发明权利要求及其等同技术的范围之内，则本发明也意图包含这些改动和变型在内。

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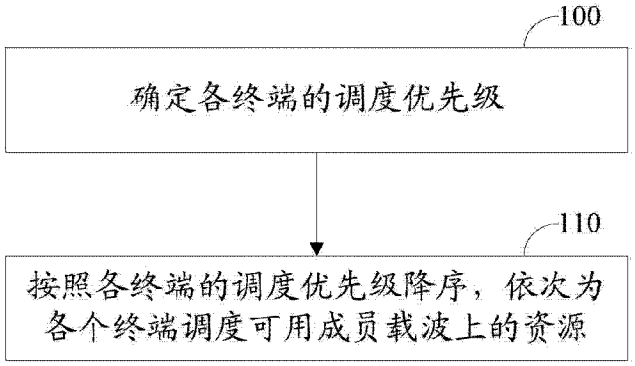


图 1

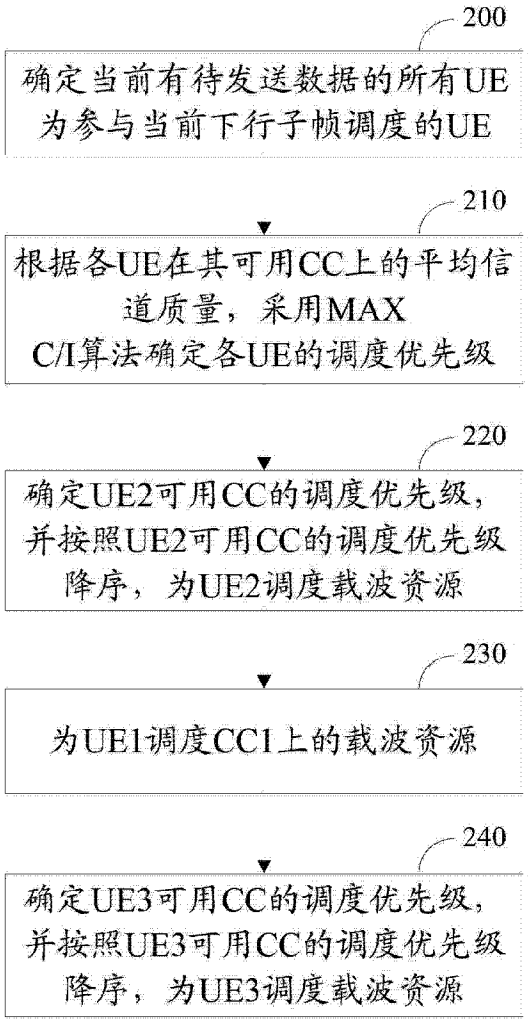


图 2



图 3

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
CPCT-140021		
International application No. PCT/CN2014/083578	International filing date (day/month/year) 01 Aug. 2014 (01. 08. 2014)	(Earliest)Priority date (day/month/year)

Applicant

Empire Technology Development LLC et al

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).

c. ☐ With regard to any **nucleotide and /or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II)

3. ☐ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. The figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant

☐ as selected by this Authority, because the applicant failed to suggest a figure

☐ as selected by this Authority, because this figure better characterizes the invention

b. ☐ none of the figures is to be published with the abstract

中华人民共和国国家知识产权局 专利合作条约

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/083578

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/08(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)
IPC: H04W H04Q

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)
CPRSABS, CNKI, VEN:allot, allocate, assign, distribute, resource, channel, quality, status, interference, share, common, first, priority, preference, precedence, better, high, low, above, below, less

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010075638A1 (ERICSSON TELEFON AB L Met al.) 08 Jul.2010(08.07.2010) description, page 2 line 21 to page 3 line 22	1-20
A	WO 2007145557A1 (ERICSSON TELEFON AB L Met al.) 21 Dec.2007(21.12.2007) the whole document	1-20
A	CN 103874221A (TELECOM TECHNOLOGY ACAD) 18 Jun.2014(18.06.2014) the whole document	1-20

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

Form PCT/ISA /210 (2 sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/083678

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 Apr. 2015(10. 04. 2015)	24 Apr. 2015(24. 04. 2015)

STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN)
6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088
Facsimile No.(86-10)62019451

Authorized officer
CHEN, Hao
Telephone No.: (86-10) 62089471

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/083578

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO2010075638A1	08.07.2010	CN102273297A	07.12.2011
WO2007145557A1	21.12.2007	US8009581B2	30.08.2011
		CN101461267B	13.03.2013
		CN101461267A	17.06.2009
		AR061452A1	27.08.2008
		EP2027734A4	25.04.2012
		EP2027734A1	25.02.2009
		US2009196193A1	06.08.2009
		EP2027734B1	10.04.2013
CN103874221A	18.06.2014	None	

Form PCT/ISA/210(patent family annex)(July 2009)

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PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:

100044

7-8th Floor Tower A, Hundred Island Park, Bei Zhan Bei Jie Street, Xicheng District, Beijing, China

Chang Tsi & Partners

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43 *bis* 1)

Applicant's or agent's file reference CPCT-140021	Date of mailing(*day/month/year*) 24. Apr. 2015 (24. 04. 2015) **FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date(*day/month/year*)	Priority date (*day/month/year*)
PCT/CN2014/083578	01. Aug. 2014 (01. 08. 2014)	

International Patent Classification (IPC) or both national classification and IPC

H04W 72/08(2009. 01)i

Applicant

Empire Technology Development LLC et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No.II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No.VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No.VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA	Date of completion of this opinion	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) 6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 Facsimile No. (86-10) 62019451	16. Apr. 2015 (16. 04. 2015)	CHEN,Hao Telephone No.:(86-10)62089478

Form PCT/ISA/237(cover sheet)(July 2009)

Samsung Ex. 1002, Page 91 of 387

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CN2014/083578

OA7

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into_____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91(Rule 43bis.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application ,this opinion has been established on the basis of a sequence listing filed or furnished :

a. (means):

☐ on paper

☐ in electronic form

b. (time):

☐ in the international application as filed

☐ together with the international application in electronic form

☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CN2014/063578

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement:

Novelty (N)	Claims 1-20	YES
	Claims None	NO
Inventive step (IS)	Claims 1-20	YES
	Claims None	NO
Industrial applicability (IA)	Claims 1-20	YES
	Claims None	NO

2. Citations and explanations

Reference is made to the following documents

D1: WO2010075638 A1 08 July 2010(08.07.2010)

D1 discloses a resource allocation method in a communication system and specifically discloses the following technical features (see description, page 2 line 21 to page 3 line 22): the present invention provides a method, comprising a first step of receiving a request for setting up a transport bearer corresponding to a transport service type, the transport service type being associated with one of the transport resources; if the associated transport resource is in a low load state, the transport bearer is set up on the associated transport resource; if the associated transport resource is not in a low load state and any of the other transport resources is in a low load state, the transport bearer is set up on the any of the other transport resources.

The subject matter of claims 1 and 20 differs from D1 in that: 1) the communication resources are allocated by a base station; 2) the method comprises: assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource, determining an updated directional allocation of communication resources for the base station after scheduling the second frequency spectrum resource, and selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station. The subject matter of claim 20 further differs from D1 in that: a non-transitory computer-readable medium includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of the method. Thus, claims 1 and 20 are novel in the sense of PCT Article 33(2). Accordingly, dependent claims 2-19 are also novel in the sense of PCT Article 33(2).

The subject matter of claim 11 differs from D1 in that: 1) the base station assigns the first frequency spectrum resource to a shared resource pool based on the

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determined quality status of the first frequency spectrum resource, and schedules the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources; 2) the base station comprises a quality status module, a processor module and a scheduler module. Thus, claim 11 is novel in the sense of PCT Article 33(2). Accordingly, dependent claims 12-19 are also novel in the sense of PCT Article 33(2).

The prior art, considered individually or in combination, does not teach or fairly suggest the claimed inventions comprising the methods claimed in claims 1-10, the wireless base stations claimed in claims 11-19 and the non-transitory computer-readable medium claimed in claim 20. Consequently, the subject-matters of the claims 1-20 are not obvious to the skilled in the field and involve inventive steps in the sense of PCT Article 33(3).

The technical solutions of claims 1-20 can be applied in the field of mobile communications and are industrially applicable in the sense of PCT Article 33(4).

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PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Anpeng		HUANG	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Beijing	Country of Residence i	CN

Mailing Address of Inventor:

Address 1	Room 201, Building 6Yi, Yandong Yuan
Address 2	Qinghua South Road, Haidian District

City	Beijing	State/Province	
Postal Code	100084	**Country** i	CN

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	144521		
Email Address	xinova-docket@clairvolex.com	Add Email	Remove Email

Application Information:

Title of the Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK		
Attorney Docket Number	I1013.10213US01	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	**Suggested Figure for Publication (if any)**	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	144521		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/CN2014/083578	2014-08-01

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

PTO/AIA/14 (12-13)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

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In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☒

Organization Name	EMPIRE TECHNOLOGY DEVELOPMENT LLC		
Mailing Address Information For Applicant:			
Address 1	2711 Centerville Road		
Address 2	Suite 400		
City	Wilmington	**State/Province**	DE
Country	US	Postal Code	19808
Phone Number		Fax Number	

PTO/AIA/14 (12-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

Email Address	

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

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Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

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Organization Name	EMPIRE TECHNOLOGY DEVELOPMENT LLC

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	2711 Centerville Road		
Address 2	Suite 400		
City	Wilmington	**State/Province**	DE
Country i	US	Postal Code	19808
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

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Signature	/R. Burns Israelsen Reg. No. 42685/			Date (YYYY-MM-DD)	2017-01-31
First Name	R. Burns	Last Name	Israelsen	Registration Number	42685

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	I1013.10213US01
	Application Number	
Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Anpeng HUANG
Art Unit	
Examiner Name	
Attorney Docket Number	I1013.10213US01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1	2007145557	WO	A1	2007-12-21	TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)		
	2	2010075638	WO	A1	2010-07-08	TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)		
	3	CN101415275	CN	B	2013-05-08	ZTE CORP	See english abstract	X

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Anpeng HUANG
	Art Unit	
	Examiner Name	
	Attorney Docket Number	I1013.10213US01

	4	CN103874221A	CN	A	2014-06-18	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	See english abstract	☒

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	COSTA, E., et al., "Duplex arrangements for future broadband radio interfaces," D2.5 v1.1, in Information Society Technologies, pages 121 (October 30, 2004)	
	2	International Search Report and Written Opinion for International Application No. PCT/CN2014/083578 mailed on April 24, 2015, pages 8	

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Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Anpeng HUANG
	Art Unit	
	Examiner Name	
	Attorney Docket Number	I1013.10213US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/R. Burns Israelsen Reg. No. 42685/	Date (YYYY-MM-DD)	2017-01-31
Name/Print	R. Burns Israelsen	Registration Number	42685

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Filer:	Robert Burns Israelsen/Trisha Rhone
Attorney Docket Number:	I1013.10213US01

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
NATIONAL STAGE FEE	1631	1	280	280
NATL STAGE SEARCH FEE - REPORT PROVIDED	1642	1	480	480
NATIONAL STAGE EXAM - ALL OTHER CASES	1633	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	1480

Electronic Acknowledgement Receipt

EFS ID:	28224308
Application Number:	15500928
International Application Number:	PCT/CN2014/083578
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	144521
Filer:	Robert Burns Israelsen/Trisha Rhone
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	I1013.10213US01
Receipt Date:	31-JAN-2017
Filing Date:	
Time Stamp:	23:27:21
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1480
RAM confirmation Number	020117INTEFSW23283300
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		I1013-10213US01-PCT-App.pdf	3157142 0e83a85cc20263389e158603e7089a55e59f2af7	yes	38

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Documents submitted with 371 Applications	1	1
	Specification	2	23
	Claims	24	28
	Drawings-only black and white line drawings	29	36
	Documents submitted with 371 Applications	37	38

Warnings:

Information:

2	Power of Attorney	I1013-10213US01-POA.pdf	143385 8f39c776b57fe2fa8803c0c5a1bed50c8ab9be48	no	2

Warnings:

Information:

3		I1013-10213US01-Preliminary-Amendment.pdf	278388 2463fd48c15de80224651117c16119b4ffa9d666	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Specification	2	2

	Claims		3		8
	Applicant Arguments/Remarks Made in an Amendment		9		10
Warnings:					
Information:					
4	Foreign Reference	FP1.pdf	1010110 f43ef1cfad0b0239d282d4944e645cf85b8d3051	no	27
Warnings:					
Information:					
5	Foreign Reference	FP2.pdf	720228 d170279812a8ddccc7abafe87926a3b09da6e1ab	no	21
Warnings:					
Information:					
6	Foreign Reference	FP3.pdf	1079421 1fac124c0f6d9a696e34acf71cd169e3d9a4d1f5	no	16
Warnings:					
Information:					
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8	Non Patent Literature	NPL1.pdf	1461357 175c31ec8ac695b2a0952cbc2430271e119436cc	no	121
Warnings:					
Information:					
9	Non Patent Literature	NPL2.pdf	2540007 4b2b10a0871332cfe28ef16f4c74758f7cd1c343	no	8
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10	Application Data Sheet	I1013-10213US01_Application-Data-Sheet.pdf	1561273 757b0cba7cf769ad8a907c33d074c1b53c2e46fd	no	7
Warnings:					
Information:					
11	Information Disclosure Statement (IDS) Form (SB08)	I1013-10213US01-IDS.pdf	1035431 bebfe46710a4988e28f599e596a5444a4be677ee	no	4
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A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
12	Fee Worksheet (SB06)	fee-info.pdf	35330 8c7269ff17eb3f6caa750a21a72baa71f806c874	no	2
Warnings:					
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			Total Files Size (in bytes):	13913594	

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 February 2016 (04.02.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/015345 A1

(51) International Patent Classification:
H04W 72/08 (2009.01)

(21) International Application Number:
PCT/CN2014/083578

(22) International Filing Date:
1 August 2014 (01.08.2014)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **EMPIRE TECHNOLOGY DEVELOPMENT LLC** [US/US]; 2711 Centerville Road, Suite 400, Wilmington, DE 19808 (US).

(72) Inventor; and
(71) Applicant *(for US only)*: **HUANG, Anpeng** [CN/CN]; Room 201, Building 6Yi, Yandong Yuan, Qinghua South Road, Haidian District, Beijing 100084 (CN).

(74) Agent: **CHANG TSI & PARTNERS**; 7-8th Floor Tower A, Hundred Island Park, Bei Zhan Bei Jie Street, Xicheng District, Beijing 100044 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

Published:

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

(54) **Title**: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

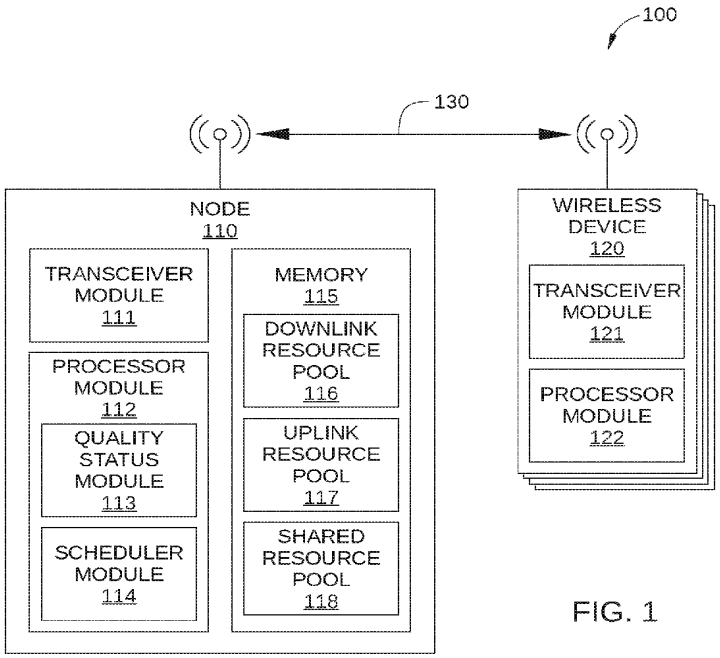


FIG. 1

(57) **Abstract**: Frequency spectrum resources available to a node of a wireless communication network may be allocated for either an uplink or downlink channel by a scheduler module. The scheduler module may schedule a specific frequency spectrum resource based at least in part on whether the frequency spectrum resource has been assigned to a downlink resource pool, an uplink resource pool, or a shared resource pool. Assignment of frequency spectrum resources to the downlink resource pool, the uplink resource pool, or the shared resource pool may be based on suitability of each frequency spectrum resource for uplink channel or downlink channel.

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ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

BACKGROUND

[0001] Unless otherwise indicated herein, the approaches described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0002] In recent years, wireless communication has become increasingly commonplace, with an accompanying improvement in the reliability of such service. However, with the development and ubiquitous use of mobile Internet devices, such as smart phones and the like, there has been explosive growth in the use of mobile Internet services, resulting in wireless traffic levels that may potentially exhaust available bandwidth. According to some forecasts of global mobile data traffic, smart phones represented only approximately 18 percent of total global handsets in use in 2012, but represented approximately 92 percent of total global handset traffic. With the total number of smart phones and other mobile Internet devices continuing to rise, global mobile data traffic in 2020 may be expected to reach approximately 500 to 1000 times that of such traffic in 2013. Consequently, any improvement in the efficient use of available wireless communication spectrum is a potential challenge to be addressed.

SUMMARY

[0003] In accordance with at least some embodiments of the present disclosure, a method for a base station of a wireless network to allocate communication resources between uplink and downlink channels comprises determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel; assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource; scheduling a second frequency spectrum resource that is available for use by the base station for the uplink or downlink channel based on an initial directional allocation of communication resources for the base station; after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

[0004] In accordance with at least some embodiments of the present disclosure, a wireless base station for a wireless communication network comprises a quality status module, a processor module, a scheduler module, and a memory. The quality status module is configured to determine a quality status of a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for an uplink channel or downlink channel. The processor module is coupled to the quality status module and configured to assign the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource. The scheduler module is coupled to the processor module and configured to schedule the second frequency spectrum resource for an uplink channel or downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

[0005] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. These drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope. The disclosure will be described with additional specificity and detail through use of the accompanying drawings.

[0007] FIG. 1 illustrates a wireless mobile network, according to one or more embodiments of the disclosure;

FIG. 2A illustrates an example of a frequency-division duplex allocation scheme applied to a radio frame and a plurality of frequency spectrum resources;

FIG. 2B illustrates an example of a time-division duplex allocation scheme applied to a radio frame and multiple subcarriers;

FIG. 2C illustrates an example of an adaptive radio resource allocation scheme applied to a radio frame and multiple subcarriers, according to at least some embodiments of the present disclosure;

FIG. 3 illustrates example multiple consecutive homogeneous frames, configured according to at least some embodiments of the disclosure;

FIG. 4 sets forth a flowchart of an example method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, according to an embodiment of the disclosure;

FIG. 5 is a block diagram of an illustrative embodiment of a computer program product to implement a method for dynamic resource allocation in a wireless network; and

FIG. 6 is a block diagram illustrating an example computing device, according to at least some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0008] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. The aspects of the disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and made part of this disclosure.

[0009] This disclosure is generally drawn, *inter alia*, to methods, apparatus, systems, devices, and computer program products related to allocating communication resources in a wireless network between uplink and downlink channels.

[0010] As described above, demand for the limited spectrum available for wireless communication may be high and increasing quickly as mobile Internet use becomes part of daily life for more and more consumers. In addition, the wireless traffic currently being

carried by wireless communication networks may be both "bursty" and asymmetric. Bursty traffic may be characterized by unpredictable and sudden increases and decreases in volume. For example, in modern wireless communication networks, a particular cell base station may have widely variable and somewhat random peak hours. This may be due, for example, to approximately 1% of users typically generating more than about 60% of daily network traffic, and less than approximately 10% of users generating about 90% of daily network traffic. Asymmetric traffic may be characterized by a large disparity between total volume associated with uplink channels and downlink channels at a particular time. For example, more than approximately 75% of daily network load may be typically associated with downlink traffic.

[0011] Such bursty and asymmetric wireless traffic can significantly undermine the ability of a node (such as a cell base station) of a wireless mobile network to efficiently utilize available frequency spectrum resources. This may be because duplex communication schemes commonly used in wireless mobile networks, such as time-division duplex (TDD) and frequency-division duplex (FDD) systems, may typically be unable to employ all available frequency spectrum resources when uplink and downlink traffic is constantly changing. Because the transmission signal strength at a node may be orders of magnitude greater than the reception signal strength, a transceiver for the node may typically be constrained to receive or transmit in a particular frequency band rather than transmitting and receiving in the band simultaneously. Consequently, uplink channels (for receiving data) and downlink channels (for transmitting data) of the node may be separated in the frequency and/or the time domain. This static or semi-static allocation of uplink and downlink channels can result in unused or underutilized frequency spectrum resources when uplink and downlink traffic loads change between the node and the mobile stations (e.g., mobile phones or mobile computers using a mobile broadband adapter) serviced by the node. According to some embodiments, a wireless network may be configured to reduce or substantially eliminate unused or underutilized frequency spectrum resources. One such wireless network is illustrated in FIG. 1.

[0012] FIG. 1 illustrates a wireless mobile network 100, according to one or more embodiments of the disclosure. Wireless mobile network 100 may include at least one node 110 and at least one wireless device 120, and may include other components (which are not illustrated herein for purposes of brevity and clarity). Node 110 may be embodied as a cell base station, a base transceiver station (BTS), an evolved node B (eNodeB), or other device that is communicatively coupled to or included in wireless mobile network 100 and is

configured to communicate with wireless device 120. Wireless device 120, also referred to as a mobile station (MS) or as user equipment (UE), may be embodied as a mobile handset, a laptop computer equipped with a mobile broadband adapter, or any other device suitably configured to connect to or otherwise communicate with node 110.

[0013] Node 110 may include a transceiver module 111, a processor module 112, and a memory 115. Transceiver module 111 may be configured to communicate with one or more wireless devices 120 via an air interface 130 using uplink and downlink channels, the allocation of which is described below in conjunction with FIG. 2C. For example, transceiver module 111 may include a transmitter to transmit data to one or more wireless devices 120 via downlink channels established by node 110 and a receiver to receive data from one or more wireless devices 120 via uplink channels established by node 110. Memory 115 may include a downlink resource pool 116, an uplink resource pool 117, and a shared resource pool 118, each of which is described in greater detail below in conjunction with FIG. 2C.

[0014] Processor module 112 may be configured to control and/or perform the operations of node 110. In some embodiments, processor module 112 may include a quality status module 113 configured to determine a quality status of frequency spectrum resources associated with air interface 130 that are available for use by node 110 for an uplink or downlink channel, where air interface 130 may include the radio-based communication link between wireless device 120 and node 110. In such embodiments, quality status module 113 may determine the quality status of each frequency spectrum resources associated with air interface 130 based on channel quality indicator (CQI), received interference power (RIP), and/or any other suitable quality metric or key performance indicator, such as RSSI, acknowledgement/negative acknowledgement (ACK/NACK) frequency, dropping rate, block error rate, bit error rate, signal-to-interference-plus-noise ratio (SINR), etc. In some embodiments, processor module 112 may include a scheduler module 114 configured to schedule frequency spectrum resources associated with air interface 130 based on a target directional allocation of radio resources (e.g., frequency spectrum resources) for node 110. The target directional allocation of such resources may be based at least in part on current resource requests from node 110 (e.g., processor module 111) and from the one or more wireless devices 120 serviced by node 110. Thus, when resource requests for downlink traffic from node 110 are greater than resource requests for uplink traffic from the one or more wireless devices 120 serviced by node 110, scheduler module 114 may allocate frequency spectrum resources between uplink and downlink channels accordingly. According to some embodiments, the allocation of each specific frequency spectrum

resource available to node 110 as either an uplink and downlink channel by scheduler module 114 (i.e., directional allocation of communication resources for the base station) may be based at least in part on whether the specific frequency spectrum resource has been assigned to downlink resource pool 116, uplink resource pool 117, or shared resource pool 118. Such embodiments are described below in conjunction with FIGS. 2C and 4. The various elements of node 110 may be operatively coupled to each other, and may comprise components of hardware, software (or other computer-readable instruction stored on a non-transitory computer-readable medium and executable by one or more processors), or a combination of hardware and software (including firmware).

[0015] Wireless device 120 may include a transceiver module 121 and a processor module 122 operatively coupled to each other. Transceiver module 121 may include hardware, software, and/or firmware components or combinations thereof suitable for communicating with node 110 via uplink and downlink channels established by node 110. Processor module 122 may include software and/or firmware components or combinations thereof that enable wireless device 120 to provide information to node 110 for determining CQI, RIP, and/or any other suitable quality metric of frequency spectrum resources associated with air interface 130.

[0016] FIGS. 2A-2C illustrate examples of the allocation of frequency spectrum resources for nodes of a wireless mobile network, according to various duplex communication schemes. Specifically, FIG. 2A illustrates frequency spectrum resource allocation employing FDD; FIG. 2B illustrates frequency spectrum resource allocation employing TDD; and FIG. 2C illustrates adaptive frequency spectrum resource allocation in wireless mobile network 100 according to at least some embodiments of the present disclosure.

[0017] FIG. 2A illustrates an example of an FDD allocation scheme 210 applied to a radio frame 200 and a plurality of frequency spectrum resources, subcarriers 201-206. Radio frame 200 may be one of a plurality of recurrent data blocks that are associated with a node of a wireless mobile network, where each radio frame 200 corresponds to a time slot of fixed length, for example 10 ms. Radio frame 200 may include a fixed number (for instance, ten) of subframes 207. Each of subframes 207 may occupy a time slot and may be, for example, 1 ms second in duration. Each of subcarriers 201-206 may be a frequency spectrum resource that may be available for use by the node as either an uplink channel or a downlink channel, such as a unique frequency band. Together, radio frame 200 and subcarriers 201-206 may make up an air interface for the portion of the wireless mobile network associated

with the node. It is noted that such air interface may include fewer than six subcarriers 201-206 or many more than six subcarriers 201-206. For example, in long term evolution (LTE) networks, a minimum of 72 subcarriers may be employed at a particular node or base station.

[0018] In FDD allocation scheme 210, the transmitter and the receiver of the node may operate at different carrier frequencies. Stated in another way, the transmitter may use some of subcarriers 201-206 as downlink channels, and the receiver may use other of subcarriers 201-206 as uplink channels. Furthermore, in FDD allocation scheme 210, downlink and uplink channels may usually be operated in paired spectra, in which the same amount of radio resources are reserved for downlink channels and for uplink channels. In the example illustrated in FIG. 2A, the node may employ subcarriers 201-203 for uplink channels and subcarriers 204-206 for downlink channels. Generally, FDD allocation scheme 210 may be more suited to applications like voice calls, whose bidirectional capacity requirements are equal, but is less suitable for Internet applications due to the asymmetric and bursty traffic characterized thereby. To wit, even when downlink traffic from the node to wireless devices greatly exceeds uplink traffic from the wireless devices to the node, in FDD allocation scheme 210, the number of subcarriers 201-206 allocated as uplink channels (e.g., subcarriers 201-203) may remain equal to the number of subcarriers 201-206 that are allocated as downlink channels (e.g., subcarriers 204-206). Therefore, some or most of subcarriers 201-203 may be idle or underutilized at the same time that subcarriers 204-206 cannot satisfy all downlink requests.

[0019] FIG. 2B illustrates an example of a TDD allocation scheme 220 applied to radio frame 200 and subcarriers 201-206. TDD allocation scheme 220 may be based upon using the same frequency spectrum resources (subcarriers 201-206) for both uplink and downlink transmission, where wireless devices and a node do not transmit concurrently. Thus, any one of subcarriers 201-206 may be used for an uplink channel and for a downlink channel during radio frame 200, albeit during different subframes 207. As shown in FIG. 2B, each of subcarriers 201-206 may be used for a downlink channel during subframes 207A and subframes 207F-207J, and for an uplink channel during subframes 207C-207E. When the proportion of uplink and downlink traffic changes, the number of subframes 207 during which subcarriers 201-206 are used for uplink channels and the number of subframes 207 during which subcarriers 201-206 are used for downlink channels can be reconfigured accordingly.

[0020] TDD allocation scheme 220 may be useful for applications with traffic asymmetry, such as when downlink traffic far exceeds uplink traffic (or vice-versa) during a particular radio frame. However, TDD allocation scheme 220 may also have drawbacks. First, there may generally be a limited number of different configurations available, typically seven, for the allocation of subcarriers 201-206 as uplink and downlink channels. So while the proportion of uplink channel capacity and downlink channel capacity for the node can be varied, the granularity of options may be limited. Therefore, some of subcarriers 201-206 may usually be underutilized in each radio frame 200, since the proportion of uplink channel capacity and downlink channel capacity for the node may not be closely matched to the current requirements of the node and the wireless devices.

[0021] Second, in TDD allocation scheme 220 each radio frame 200 may generally include at least one guard period 217, which may expend frequency spectrum resources (subcarriers 201-206) that could otherwise be employed as uplink or downlink channels. Guard period 217, also sometimes referred to as a "guard interval," may be used to ensure that distinct transmissions do not interfere with one another. For example, guard period 217 may prevent downlink transmissions carried by subcarrier 201 in an earlier portion of subframe 207B from interfering with uplink transmissions carried by subcarrier 201 in a later portion of subframe 207B. Thus, during guard period 217, data may generally not be interpreted by the node or the wireless devices. Guard period 217 may be a period of time that could be typically longer than the delay spread associated with uplink and downlink channels available to the node. To avoid data loss and to reduce interference caused by propagation delay between each user timeslot (a contiguous series of subframes used by either the node or the wireless device) and a following user timeslot, one or more guard periods 217 may be used in each radio frame 200. Typically, each user timeslot may end with such a guard period.

[0022] Third, TDD allocation scheme 220 may rely on discontinuous transmission of uplink and downlink traffic to separate uplink and downlink transmission, for example using the above-described guard periods 217. Discontinuous transmission could degrade performance of radio frequency (RF) power amplifiers in transmitters.

[0023] Fourth, implementation of TDD allocation scheme 220 may involve extra signaling overhead. Specifically, for each of the different configurations available for the allocation of subcarriers 201-206 as uplink and downlink channels with respect to subframes 107, configuration information may be transmitted to and/or from the wireless devices and the

node. Such additional signaling overhead may expend frequency spectrum resources (subcarriers 201-206) that could otherwise be employed as uplink or downlink channels.

[0024] FIG. 2C illustrates an example of an adaptive radio resource allocation scheme 230 applied to radio frame 200 and subcarriers 201-206, according to at least some embodiments of the present disclosure. TDD allocation scheme 220 may include dynamic allocation of subcarriers 201-206 in both the time and frequency domains. Consequently, the number of subcarriers 201-206 allocated to uplink channels and to downlink channels can be finely tailored to match the time-varying bandwidth demand associated with the expanded use of mobile Internet services. Thus, even when the proportion of uplink traffic to downlink traffic changes rapidly, subcarriers 201-206 can be effectively exploited, so that none or very few of subcarriers 201-206 are unused or underutilized.

[0025] As shown in FIG. 2C, some of subcarriers 201-206 may be allocated by scheduler module 114 of node 110 for uplink channels for the duration of radio frame 200 (except during guard period 227), while other of subcarriers 201-206 may be allocated by scheduler module 114 for downlink channels for the duration of radio frame 200. In addition, still other of subcarriers 201-206 may be allocated by scheduler module 114 for uplink channels in some subframes 207 of radio frame 200 and allocated by scheduler module 114 for downlink channels in other subframes 207 of radio frame 200. For example, in the scenario depicted in FIG. 2C, subcarrier 201 may be allocated for an uplink channel for the duration of radio frame 200 while subcarrier 206 may be allocated as a downlink channel for the duration of radio frame 200. Concurrently, subcarriers 202, 203, and 205 may be allocated as downlink channels during a first portion 240 of radio frame 200 (subframes 207A-207D and a portion of subframe 207E) and as uplink channels during a second portion 250 of radio frame 200 (a portion of subframe 207E and subframes 207F-207J). Conversely, subcarrier 204 may be allocated for an uplink channel during first portion 240 of radio frame 200 and as a downlink channel during second portion 250 of radio frame 200.

[0026] In some embodiments, in adaptive radio resource allocation scheme 230, radio frame 200 may include guard period 227 when subcarriers 201-206 are reconfigured to have a different direction allocation. As is the case with guard period 217 in FIG. 2B, during guard period 227, data may generally not be interpreted by node 110 or wireless devices 120. Thus, guard period 227 may be used to ensure that a transmission associated with a specific frequency spectrum resource, such as a downlink transmission, does not interfere with a transmission that is subsequently associated with the specific frequency spectrum

resource, such as an uplink transmission. Guard period 227 may be a period of time that is typically longer than the delay spread associated with uplink and downlink channels available to node 110, for example on the order of about 1 microsecond. As shown in FIG. 2C, guard period 227 may be disposed between first portion 240 of radio frame 200 and second portion 250 of radio frame 200, where the direction allocation of subcarriers 201-206 may be constant in first portion 240 and the direction allocation of subcarriers 201-206 may be constant in second portion 250. Thus, guard period 227 may prevent downlink transmissions carried by subcarriers 202, 203, 205, and 206 in first portion 240 of radio frame 200 from interfering with uplink transmissions carried by, respectively, subcarriers 202, 203, 205, and 206 in second portion 250 of radio frame 200. Similarly, guard period 227 may prevent uplink transmissions carried by subcarriers 201 and 204 in first portion 240 of radio frame 200 from interfering with transmissions carried by, respectively, subcarriers 201 and 204 in second portion 250 of radio frame 200.

[0027] While guard period 227 may be in some ways similar to guard period 217 in FIG. 2B, guard period 227 may be fundamentally different from guard period 217 in at least one aspect. Specifically, in adaptive radio resource allocation scheme 230, guard period 227 may be included in a particular radio frame 200 when one "homogeneous frame" ends and another homogeneous frame begins in the particular radio frame 200. A homogeneous frame may be considered to be any consecutive series of subframes 207 in which the direction allocation of subcarriers 201-206 remains unchanged. Thus, first portion 240 of radio frame 200 may be considered as some or all of one homogeneous frame in adaptive radio resource allocation scheme 230, and second portion 250 of radio frame 200 may be considered as some or all of another homogeneous frame. Because guard period 227 may be disposed between different homogeneous frames, and because a homogeneous frame typically may have a duration that includes multiple radio frames 200, in some embodiments, guard periods 227 may occur substantially less frequently than once per radio frame 200. One such embodiment is illustrated in FIG. 3.

[0028] FIG. 3 illustrates example multiple consecutive homogeneous frames 301, 302, and 303, configured according to at least some embodiments of the disclosure. Each of homogeneous frames 301, 302, and 303 may include multiple subframes 207, and in some cases multiple radio frames 200. As shown, homogeneous frame 301 may precede homogeneous frame 302 and may be separated from homogeneous frame 302 by a guard period 227 (described above in conjunction with FIG. 2C). Similarly, homogeneous frame 302 may precede homogeneous frame 303 and may be separated from homogeneous

frame 303 by a guard period 227. It is noted that homogeneous frames 302 and 303 each may include multiple radio frames 200, since in each case, the direction allocation of subcarriers 201-206 may remain unchanged for a period of time longer than a single radio frame 200. Consequently, the total duration of time in which frequency spectrum resources are idle during guard periods 227 in adaptive radio resource allocation scheme 230 may generally be significantly less than the total duration of time in which frequency spectrum resources are idle during guard period 217 in TDD allocation scheme 220.

[0029] In operation, node 110 in FIG. 1 may implement adaptive radio resource allocation scheme 230 according to the following procedure. In some embodiments, the following procedure may be performed once per radio frame 200. In other embodiments, the procedure may be performed more frequently (for example, once every few subframes 207) or less frequently (for example, once every N radio frames, once every second, etc.).

[0030] First, node 110 may obtain the quality status of the current uplink and downlink frequency spectrum resources available (e.g., subcarriers 201-206) using quality status module 113. For example, quality status module 113 may acquire suitability of some or all of subcarriers 201-206 for uplink channels by measurement of RIP for each of subcarriers 201-206. To acquire suitability of some or all of subcarriers 201-206 for downlink channels, node 110 may measure CQI, for example through the measurement of reference signal received power (RSRP) and received signal strength indicator (RSSI). The measurement of RIP and CQI can be based on the particle size of a wavelet or on a smaller particle size, such as physical resource block (PRB), a plurality of which may typically be included in each subframe 207. It is noted that determination of quality status, as described above, can be performed using information typically already measured by LTE and LTE-Advanced wireless communication systems. Consequently, no additional signaling or other procedures may be needed for implementation of the herein-described procedure.

[0031] Second, node 110 may sort the available frequency spectrum resources based on the quality status measured for each. Thus, processor module 112 may assign high-quality resources to downlink resource pool 116 and/or to uplink resource pool 117, and may assign lower-quality frequency spectrum resources to shared resource pool 118. For example, in some embodiments, subcarriers with high CQI, which may indicate that the subcarrier is well-suited for a downlink channel, may be assigned to downlink resource pool 116, and subcarriers with low RIP, which may indicate that the subcarrier is well-suited for an uplink channel, may be assigned to uplink resource pool 117. In such embodiments, the assigned

subcarriers may be ranked in order of suitability, so that during scheduling (described below), the subcarriers assigned to downlink resource pool 116 that are most suitable for uplink channels can be selected first for downlink channels and the subcarriers assigned to uplink resource pool 117 that are most suitable for uplink channels can be selected first for uplink channels. Similarly, in some embodiments, the subcarriers that are assigned to shared resource pool 118 may be ranked in terms suitability for uplink and for downlink channels, for example based on RIP and CQI values, respectively. Furthermore, in some embodiments, one or more frequency spectrum resources may be assigned to both downlink resource pool 116 and uplink resource pool 117, such as when a particular subcarrier has both high CQI and low RIP.

[0032] Third, scheduler module 114 may schedule some or all of the frequency spectrum resources assigned to downlink resource pool 116 for downlink channels for node 110 and some or all of the frequency spectrum resources assigned to uplink resource pool 117 for uplink channels for node 110. In some embodiments, scheduler module 114 may perform such scheduling based on an initial directional allocation of frequency spectrum resources for node 110, where the initial directional allocation of communication resources may indicate current resource requests from wireless devices 120 and from node 110. In this way, the number of frequency spectrum resources scheduled for downlink channels may not exceed the current number of requested downlink channels requested by wireless devices 120, and the number of frequency spectrum resources scheduled for uplink channels may not exceed the current number of requested uplink channels requested by node 110.

[0033] Fourth, processor module 112 may determine an updated directional allocation of frequency spectrum resources for node 110. In some embodiments, the updated directional allocation of frequency spectrum resources may be based on the number of current resource requests from wireless devices 120, on the number of current resource requests from node 110, on the number of frequency spectrum resources scheduled from uplink resource pool 117 for uplink channels, on the number of frequency spectrum resources scheduled from downlink resource pool 116 for downlink channels, and/or on some other factor(s) or combination(s) thereof. Thus, in such embodiments, the updated directional allocation of frequency spectrum resources may be based on the remaining resource requests (for both uplink and downlink channels) that are not yet satisfied after scheduling frequency spectrum resources assigned to downlink resource pool 116 and to uplink resource pool 117.

[0034] Fifth, when there are remaining resource requests for node 110 (for either uplink or downlink channels) that are not yet satisfied, scheduler module 114 may schedule one or more frequency spectrum resources assigned to shared resource pool 118 for uplink and/or downlink channels. In some embodiments, the scheduling of such frequency spectrum resources may be based on the updated directional allocation of frequency spectrum resources described above. Consequently, frequency spectrum resources may be dynamically allocated to satisfy resource requests for node 110, so that very few or no frequency spectrum resources are idle.

[0035] Furthermore, in some embodiments, a particular frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for an uplink or a downlink channel based on suitability of the particular frequency spectrum resource for an uplink or a downlink channel, respectively. For example, a frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for a downlink channel when the frequency spectrum resource has a higher CQI than other frequency spectrum resources assigned to shared resource pool 118. Similarly, a frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for an uplink channel when the frequency spectrum resource has a lower RIP than other frequency spectrum resources assigned to shared resource pool 118. Thus, not only are available frequency spectrum resources efficiently utilized by node 110, these frequency spectrum resources may be scheduled for either uplink or downlink channel based on the current suitability of each resource, which can enhance user experience and system-level performance.

[0036] While assignment and scheduling of frequency spectrum resources is described herein in terms of subcarriers 201-206, the above-described procedure may also be implemented on an individual PRB basis. Thus, each individual PRB (a plurality of which may be associated with each frequency spectrum resource in a single subframe 207) may be assigned to one or more of downlink resource pool 116, uplink resource pool 117, and/or shared resource pool 118, and may be scheduled for an uplink channel or a downlink channel.

[0037] FIG. 4 sets forth a flowchart of an example method 400 for a base station of a wireless network to allocate communication resources between uplink and downlink channels, according to an embodiment of the disclosure. Method 400 may include one or more operations, functions, or actions as illustrated by one or more of blocks 401-405.

Although the blocks are illustrated in a sequential order, these blocks may also be performed in parallel, and/or in a different order than those described herein. Also, the various blocks may be combined into fewer blocks, divided into additional blocks, and/or eliminated based upon the particular implementation. Additional blocks representing other operations, functions, or actions may be provided. Although method 400 is described in conjunction with node 110 of FIG. 1, any suitable computing device configured to perform method 400 is within the scope of this disclosure.

[0038] Method 400 may begin in block 401 ("Determine quality status of a first frequency spectrum"), in which quality status module 113 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may determine a quality status of at least a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel, such as one of subcarriers 201-206. In some embodiments, quality status module 113 may determine this quality status by determining at least one of a channel quality indicator (CQI) value and a received interference power (RIP) of the first frequency spectrum resource. CQI and RIP are each existing channel performance measures that may already typically be in place in wireless networks. Hence, no additional signaling may be required for quality status module 113 to complete block 401.

[0039] In block 402 ("Assign first frequency spectrum resource to shared resource pool based on quality status"), processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may assign the first frequency spectrum resource to shared resource pool 118, based on the quality status of the first frequency spectrum resource determined in block 401. In some embodiments, processor module 112 may assign the first frequency spectrum resource to shared resource pool 118 when it is determined that the first frequency spectrum resource is less suitable for an uplink channel than one or more other frequency spectrum resources available to node 110 and also is less suitable for a downlink channel than one or more frequency spectrum resource that are available to node 110.

[0040] Specifically, the first frequency spectrum resource may be determined by quality status module 113 to be less suitable for a downlink channel in response to a CQI of the first frequency spectrum resource being less than a CQI of one or more other frequency spectrum resources. Similarly, the first frequency spectrum resource may be determined by quality status module 113 to be less suitable for an uplink channel than one or more other frequency spectrum resources in response to an RIP of the first frequency spectrum

resource being greater than an RIP of the one or more other frequency spectrum resources. Thus, because the first frequency spectrum resource is determined by quality status module 113 to currently be a sub-optimal resource for uplink and/or downlink channels, the first frequency spectrum resource may be assigned by processor module 112 to shared resource pool 118. The first frequency spectrum resource may subsequently be scheduled by scheduler module 114 (see block 407) for an uplink or a downlink channel after higher quality frequency spectrum resources are scheduled for use, and if additional radio resources may be needed to satisfy current resource requests by node 110 and/or wireless devices 120.

[0041] In block 403 ("Determine a quality status of a second frequency spectrum resource"), quality status module 113 may determine a quality status of at least a second frequency spectrum resource that is available for use by the base station for an uplink or downlink channel, such as one of subcarriers 201-206. Quality status of the second frequency spectrum resource may be determined using techniques described above in block 401.

[0042] In block 404, ("Assign second frequency spectrum resource to uplink resource pool or downlink resource pool based on quality status"), processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may assign the second frequency spectrum resource to downlink resource pool 116 and/or to uplink resource pool 117 based on the quality status determined in block 403. For example, in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for an uplink channel, processor module 112 may assign the second frequency spectrum resource to uplink resource pool 117. In some embodiments, the second frequency spectrum resource may be "usable for an uplink channel" when the quality status meets or exceeds a particular threshold, such as when an RIP value associated with the second frequency spectrum resource is equal to or less than a specified maximum value or some other value. Similarly, in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for a downlink channel, processor module 112 may assign the second frequency spectrum resource to downlink resource pool 116. In some embodiments, the second frequency spectrum resource may be "usable for a downlink channel" when the quality status meets or exceeds a particular threshold, such as when a CQI value associated with the second frequency spectrum resource is equal to or greater than a specified minimum value or some other value.

[0043] In block 405, ("Schedule second frequency spectrum resource based on initial directional allocation"), scheduler module 114 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may schedule the second frequency spectrum resource for an uplink or a downlink channel based on an initial directional allocation of communication resources for node 110. The initial direction allocation of communication resources may indicate a target number of uplink and downlink channels node 110 should establish to satisfy current uplink and downlink traffic of node 110. For example, an initial direction allocation of communication resources may be based on current resource requests from wireless devices 120 and from node 110. Thus, when the second frequency spectrum resource is determined to be suitable for an uplink channel, and the initial direction allocation of communication resources indicates that node 110 should establish an uplink channel to satisfy current uplink and downlink traffic of node 110, scheduler module 114 may schedule the second frequency spectrum resource for an uplink channel. Similarly, when the second frequency spectrum resource is determined to be suitable for a downlink channel, and the initial direction allocation of communication resources indicates that node 110 should establish a downlink channel to satisfy current uplink and downlink traffic of node 110, scheduler module 114 may schedule the second frequency spectrum resource for a downlink channel.

[0044] In block 406 ("Determine an updated directional allocation of communication resources"), after scheduling the second frequency spectrum resource in block 403, processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may determine an updated directional allocation of communication resources for node 110. Specifically, the updated directional allocation of frequency spectrum resources may be based on current resource requests from wireless devices 120, on current resource requests from node 110, on the number of frequency spectrum resources that are already assigned for uplink channels, on the number of frequency spectrum resources assigned for downlink channels, and/or on other factor(s) or combination(s) thereof. Thus, the updated direction allocation of frequency spectrum resources may indicate, after the second frequency spectrum resource is assigned for one of an uplink or downlink channel, whether any additional uplink or downlink channels should be established by node 110 to satisfy current resource requests from wireless devices 120 and node 110.

[0045] In block 407 ("Schedule first frequency spectrum resource based on the determined updated directional allocation of communication resources"), scheduler module 114 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may select the first

frequency spectrum resource from shared resource pool 118 and may schedule the first spectrum for either an uplink channel or a downlink channel. Scheduler module 114 may schedule the first frequency spectrum resource for either uplink channel or downlink channel based on the updated directional allocation of communication resources determined in block 406. Thus, frequency spectrum resources previously assigned to shared resource pool 118 in block 402 may be scheduled according to what resources node 110 are usable to satisfy current resource requests from wireless devices 120 and node 110 after higher-quality frequency spectrum resources have been scheduled.

[0046] FIG. 5 is a block diagram of an illustrative embodiment of a computer program product 500 to implement a method for dynamic resource allocation in a wireless network. Computer program product 500 may include a signal bearing medium 504. Signal bearing medium 504 may include one or more sets of executable instructions 502 that, in response to execution by, for example, a processor of a computing device, may provide at least the functionality or features described above with respect to FIGS. 1-4.

[0047] In some implementations, signal bearing medium 504 may encompass a non-transitory computer readable medium 508, such as, but not limited to, a hard disk drive, a compact disc (CD), a digital video disk (DVD), a digital tape, memory, etc. In some implementations, signal bearing medium 504 may encompass a recordable medium 510, such as, but not limited to, memory, read/write (R/W) CDs, R/W DVDs, etc. In some implementations, signal bearing medium 504 may encompass a communications medium 506, such as, but not limited to, a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.). Computer program product 500 may be recorded on non-transitory computer readable medium 508 or another similar recordable medium 510.

[0048] FIG. 6 is a block diagram illustrating an example computing device 600, according to at least some embodiments of the present disclosure. In some embodiments, computing device 600 may be used to implement node 110 of FIG. 1. In a very basic configuration 602, computing device 600 typically includes one or more chip multiprocessors 604 and a system memory 606. A memory bus 608 may be used for communicating between processor 604 and system memory 606.

[0049] Chip multiprocessor 604 may be substantially similar in configuration and operation to processor module 112 in FIG. 1. Depending on the desired configuration, processor 604

may be of any type including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. Processor 604 may include one more levels of caching, such as a level one cache 610 and a level two cache 612, a processor core 614, and registers 616. An example processor core 614 may include an arithmetic logic unit (ALU), a floating point unit (FPU), a digital signal processing core (DSP Core), or any combination thereof. An example memory controller 618 may also be used with processor 604, or in some implementations memory controller 618 may be an internal part of processor 604.

[0050] Depending on the desired configuration, system memory 606 (which may be used to implement main memory 170 of FIG. 1) may be of any type including but not limited to volatile memory (such as RAM), non-volatile memory (such as ROM, flash memory, etc.) or any combination thereof. System memory 606 may include an operating system 620, one or more applications 622, and program data 624. Application 622 may be arranged to perform at least the functions and operations as those described with respect processor module 112. Application data 624 may be useful for operation with application 622. In some embodiments, application 622 may be arranged to operate with application data 624 on operating system 620. This described basic configuration 602 is illustrated in Fig. 6 by those components within the inner dashed line.

[0051] Computing device 600 may have additional features or functionality, and additional interfaces to facilitate communications between basic configuration 602 and any required devices and interfaces. For example, a bus/interface controller 630 may be used to facilitate communications between basic configuration 602 and one or more data storage devices 632 via a storage interface bus 634. Data storage devices 632 may be removable storage devices 636, non-removable storage devices 638, or a combination thereof. Examples of removable storage and non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDDs), optical disk drives such as compact disk (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSDs), and tape drives to name a few. Example computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

[0052] System memory 606, removable storage devices 636 and non-removable storage devices 638 are examples of computer storage media. Computer storage media includes,

but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVDs) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which may be used to store the desired information and which may be accessed by computing device 600. Any such computer storage media may be part of computing device 600.

[0053] Computing device 600 may also include an interface bus 640 for facilitating communication from various interface devices (e.g., output devices 642, peripheral interfaces 644, and communication devices 646) to basic configuration 602 via bus/interface controller 630. Example output devices 642 include a graphics processing unit 648 and an audio processing unit 650, which may be configured to communicate to various external devices such as a display or speakers via one or more A/V ports 652. Example peripheral interfaces 644 include a serial interface controller 654 or a parallel interface controller 656, which may be configured to communicate with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports 658. An example communication device 646 includes a network controller 660, which may be arranged to facilitate communications with one or more other computing devices 662 over a network communication link, such as, without limitation, optical fiber, Long Term Evolution (LTE), 3G, WiMax, via one or more communication ports 664.

[0054] The network communication link may be one example of a communication media. Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and may include any information delivery media. A "modulated data signal" may be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), microwave, infrared (IR) and other wireless media. The term computer readable media as used herein may include both storage media and communication media.

[0055] Computing device 600 may be implemented as a portion of a small-form factor portable (or mobile) electronic device such as a cell phone, a personal data assistant (PDA), a personal media player device, a wireless web-watch device, a personal headset device, an application specific device, or a hybrid device that include any of the above functions.

Computing device 600 may also be implemented as a personal computer including both laptop computer and non-laptop computer configurations

[0056] The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, each function and/or operation within such block diagrams, flowcharts, or examples can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described herein may be implemented via application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, some aspects of the embodiments disclosed herein, in whole or in part, can be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and designing the circuitry and/or writing the code for the software and or firmware are possible in light of this disclosure. In addition, the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a compact disc (CD), a digital video disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

[0057] Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein can be integrated into a data processing system via a reasonable amount of experimentation. A typical data processing system generally includes one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating

systems, drivers, graphical user interfaces, and applications programs, one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors (e.g., feedback for sensing position and/or velocity; control motors for moving and/or adjusting components and/or quantities). A typical data processing system may be implemented utilizing any suitable commercially available components, such as those typically found in data computing/communication and/or network computing/communication systems.

[0058] The herein described subject matter sometimes illustrates different components contained within, or connected with, different other components. Such depicted architectures are merely exemplary, and in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0059] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0060] It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such

recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation *is* explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean *at least* the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means *at least* two recitations, or *two or more* recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0061] While various aspects and embodiments have been disclosed herein, other aspects and embodiments are possible. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

I Claim:

1. A method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, the method comprising:
   determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel;
   assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource;
   scheduling a second frequency spectrum resource that is available for use by the base station for the uplink or downlink channel based on an initial directional allocation of communication resources for the base station;
   after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and
   selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

2. The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool based on the determined quality status of the first frequency spectrum resource comprises assigning the first frequency spectrum resource to the shared resource pool according to the first frequency spectrum resources being:
   less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and
   less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

3. The method of claim 2, wherein the first frequency spectrum resource is less suitable for the downlink channel than the third frequency spectrum resource in response to a channel quality indicator (CQI) of the first frequency spectrum resource being less than a CQI of the third frequency spectrum resource.

4. The method of claim 2, wherein the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource in response to a

received interference power (RIP) of the first frequency spectrum resource being greater than an RIP of the third frequency spectrum resource.

5. The method of claim 1, further comprising:
determining a quality status of the second frequency spectrum resource; and
based on the determined quality status of the second frequency spectrum resource, assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool,
wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises determining a quality status of the second frequency spectrum resource.

6. The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises:
assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the uplink channel, and
assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the downlink channel.

7. The method of claim 5, wherein determining the quality status of the second frequency spectrum resource comprises determining at least one of a CQI and a RIP of the second frequency spectrum resource.

8. The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool based on the quality status of the second frequency spectrum resource.

9. The method of claim 1, wherein determining the quality status of the first frequency

spectrum resource comprises determining at least one of a CQI and a RIP of the first frequency spectrum resource.

10. The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

11. A wireless base station for a wireless communication network, the wireless base station comprising:
    a quality status module configured to determine a quality status of a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for an uplink channel or downlink channel;
    a processor module coupled to the quality status module and configured to assign the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource; and
    a scheduler module coupled to the processor module and configured to schedule the second frequency spectrum resource for an uplink channel or downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

12. The wireless base station of claim 11, wherein the processor module is further configured to determine the updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for an uplink or downlink channel.

13. The wireless base station of claim 11, further comprising a memory coupled to the processor module and configured to store the shared resource pool, wherein the processor module is further configured to assign the second frequency spectrum resource to one of an uplink resource pool stored in the memory or a downlink resource

pool stored in the memory based on the determined quality status of the second frequency spectrum resource.

14. The wireless base station of claim 13, wherein the memory is further configured to store the uplink resource pool and the downlink resource pool.

15. The wireless base station of claim 13, wherein the updated directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, on current resource requests from the wireless base station, on a number of frequency spectrum resources scheduled from the uplink resource pool for uplink channels, and on a number of frequency spectrum resources scheduled from the downlink resource pool for downlink channels.

16. The wireless base station of claim 11, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station and from the wireless base station.

17. The wireless base station of claim 11, wherein the quality status module is configured to determine the quality status of the first frequency spectrum by determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

18. The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum resource to the shared resource pool by assignment of a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

19. The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum to the shared resource pool by in response to the first frequency spectrum resource being less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the wireless base station, and being less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the wireless base station.

20. A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of the method of any of claims 1-11.

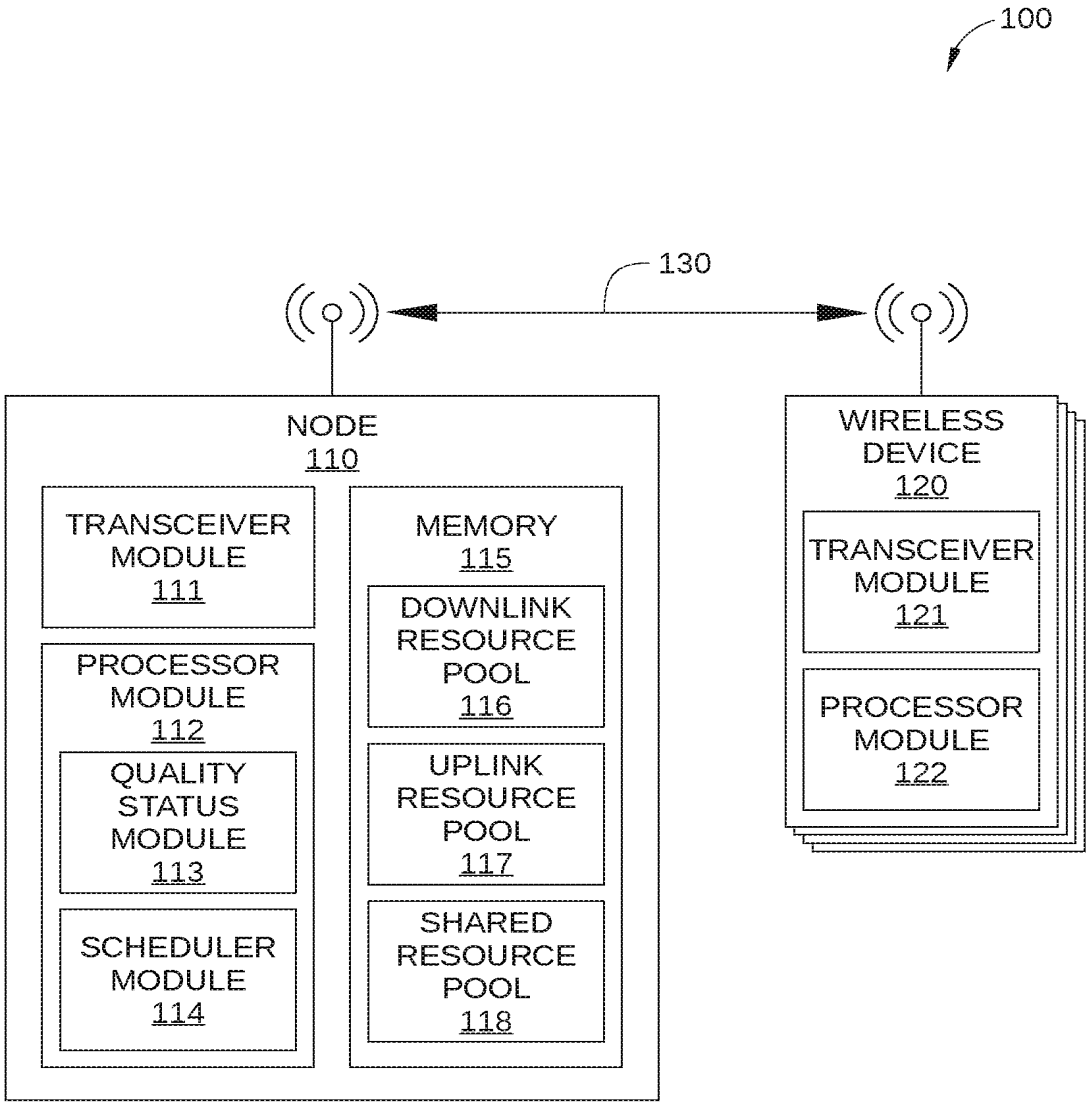

100
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NODE
110
TRANSCEIVER MODULE
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PROCESSOR MODULE
112
QUALITY STATUS MODULE
113
SCHEDULER MODULE
114
MEMORY
115
DOWNLINK RESOURCE POOL
116
UPLINK RESOURCE POOL
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SHARED RESOURCE POOL
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WIRELESS DEVICE
120
TRANSCEIVER MODULE
121
PROCESSOR MODULE
122

FIG. 1

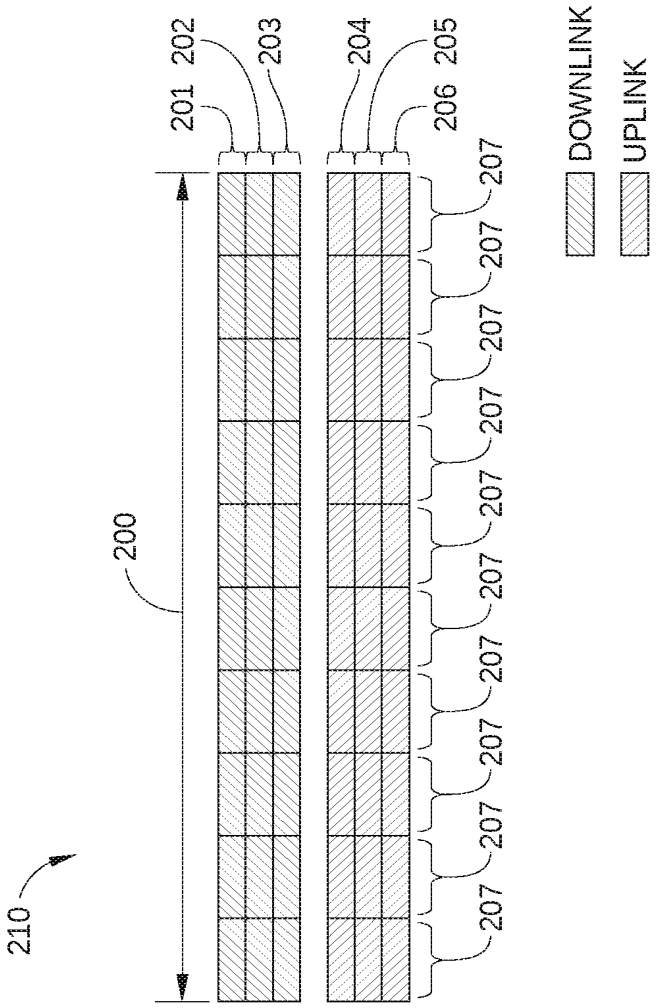


FIG. 2A

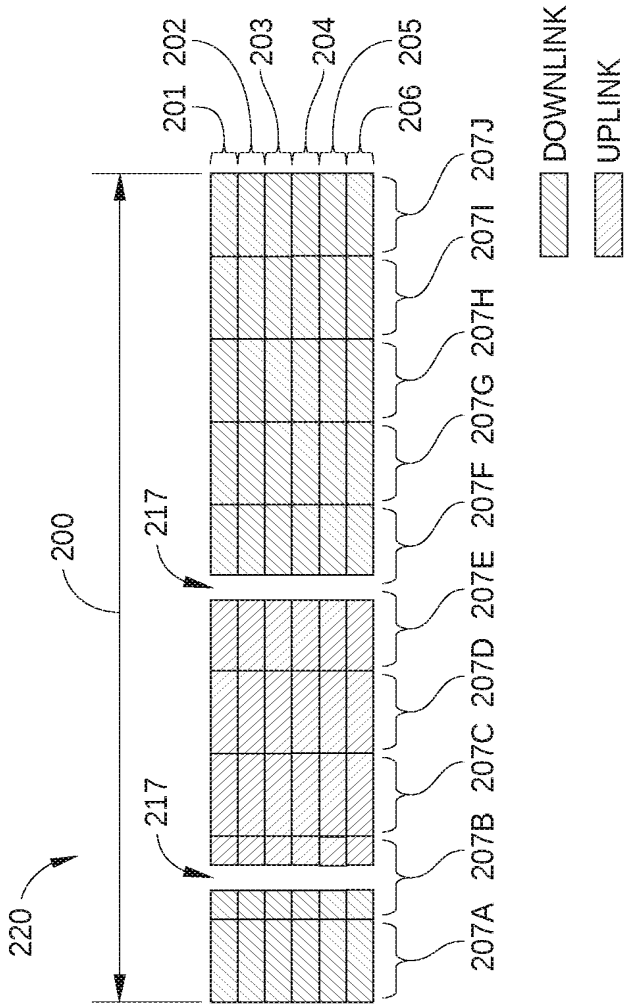

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FIG. 2B

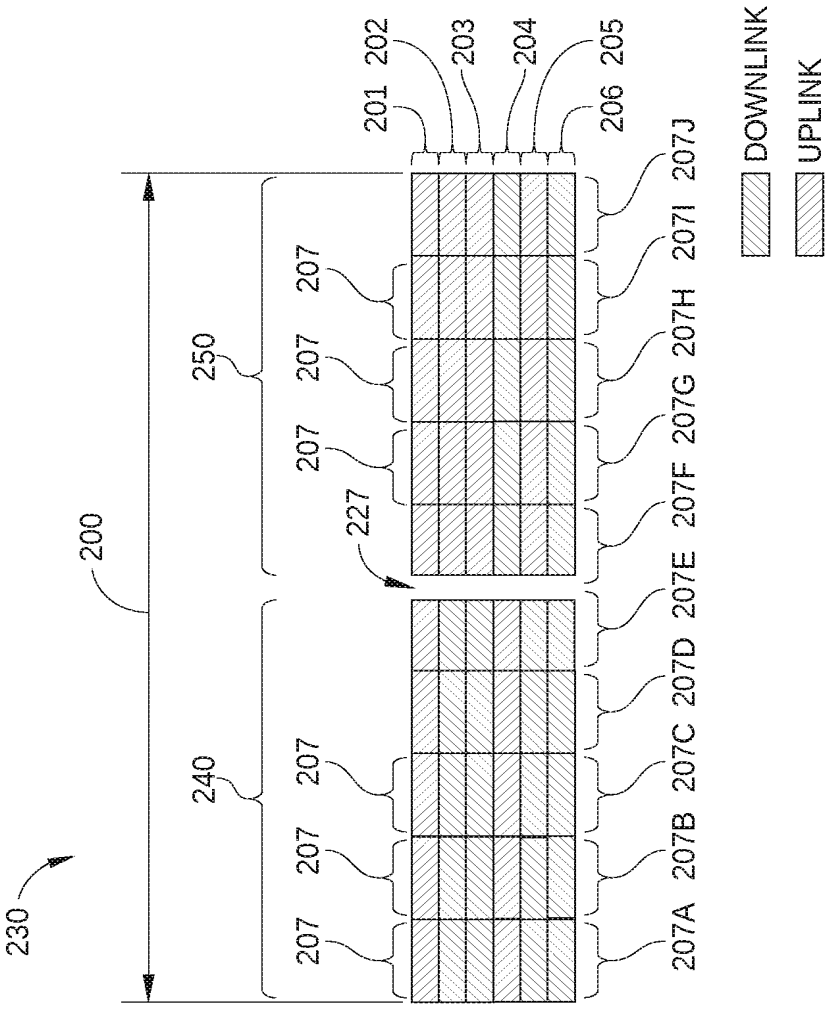

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DOWNLINK
UPLINK

FIG. 2C

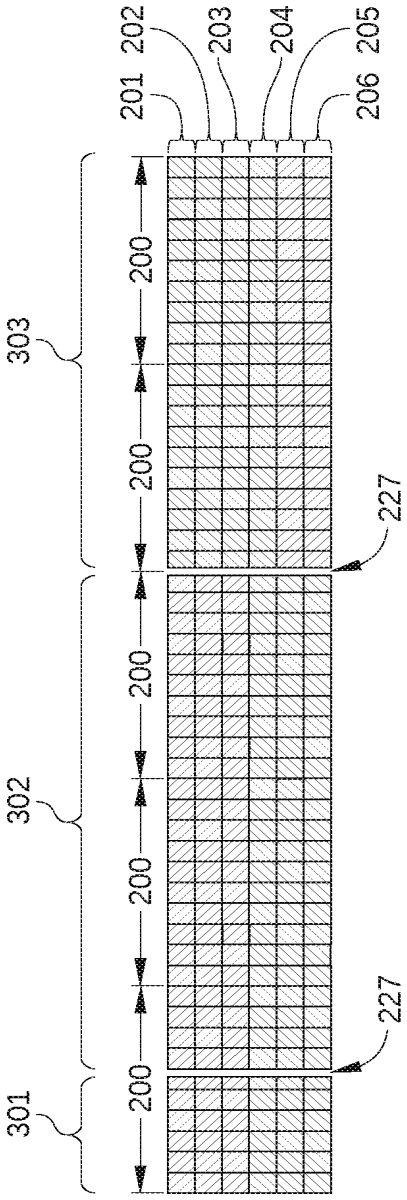


FIG. 3

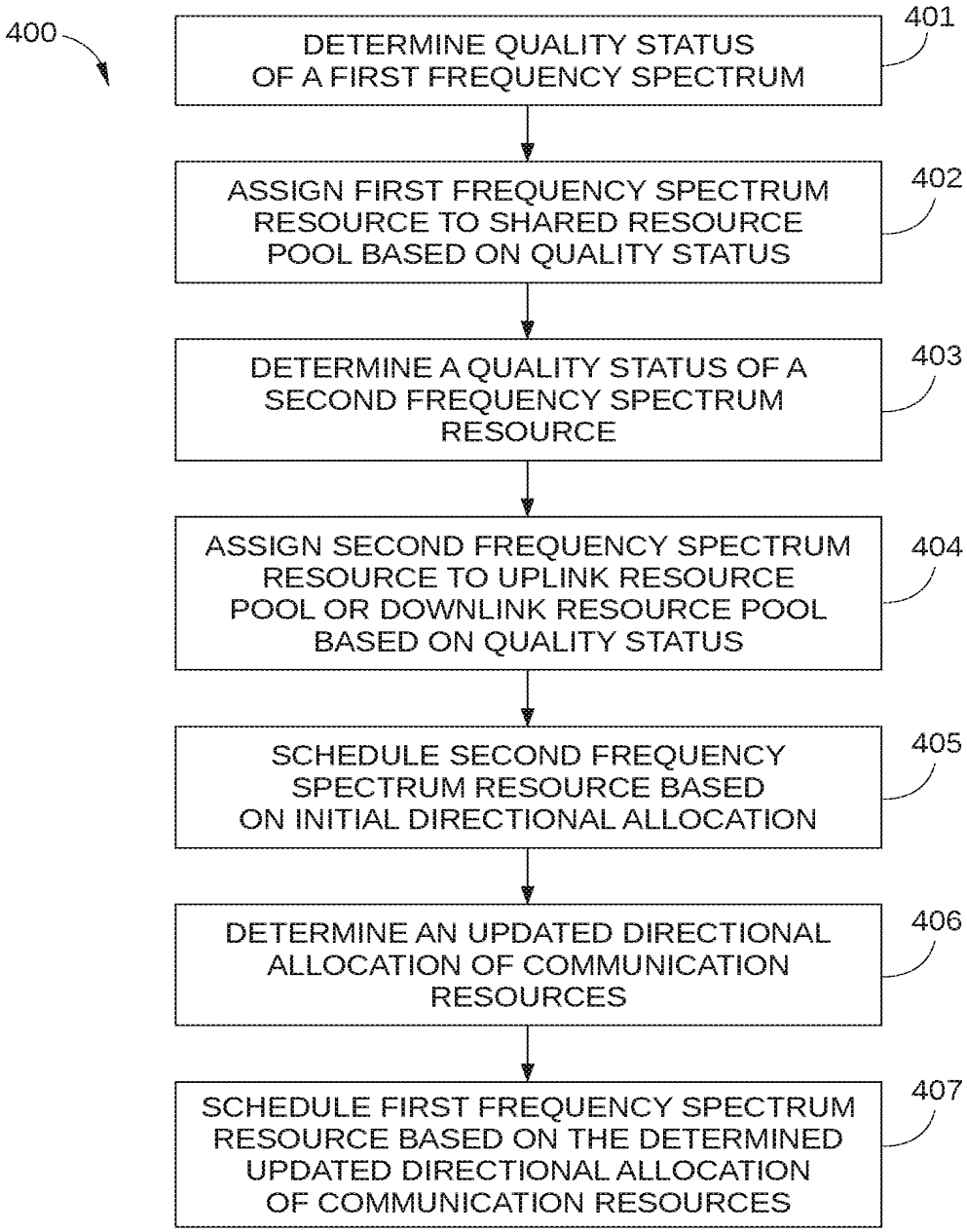

400
DETERMINE QUALITY STATUS OF A FIRST FREQUENCY SPECTRUM
401
ASSIGN FIRST FREQUENCY SPECTRUM RESOURCE TO SHARED RESOURCE POOL BASED ON QUALITY STATUS
402
DETERMINE A QUALITY STATUS OF A SECOND FREQUENCY SPECTRUM RESOURCE
403
ASSIGN SECOND FREQUENCY SPECTRUM RESOURCE TO UPLINK RESOURCE POOL OR DOWNLINK RESOURCE POOL BASED ON QUALITY STATUS
404
SCHEDULE SECOND FREQUENCY SPECTRUM RESOURCE BASED ON INITIAL DIRECTIONAL ALLOCATION
405
DETERMINE AN UPDATED DIRECTIONAL ALLOCATION OF COMMUNICATION RESOURCES
406
SCHEDULE FIRST FREQUENCY SPECTRUM RESOURCE BASED ON THE DETERMINED UPDATED DIRECTIONAL ALLOCATION OF COMMUNICATION RESOURCES
407

FIG. 4

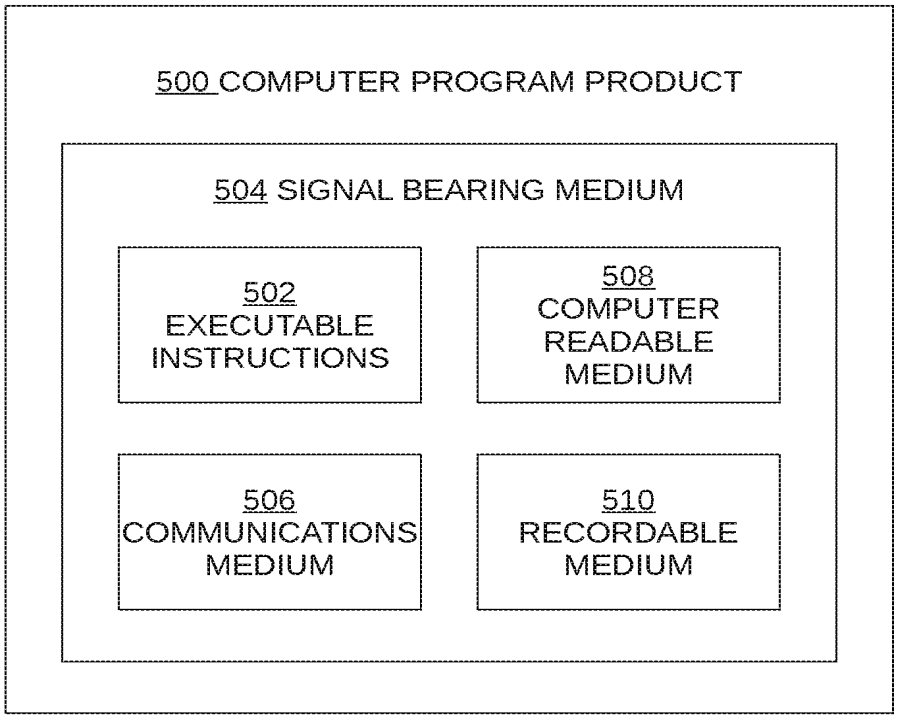

500 COMPUTER PROGRAM PRODUCT
504 SIGNAL BEARING MEDIUM
502 EXECUTABLE INSTRUCTIONS
508 COMPUTER READABLE MEDIUM
506 COMMUNICATIONS MEDIUM
510 RECORDABLE MEDIUM

FIG. 5

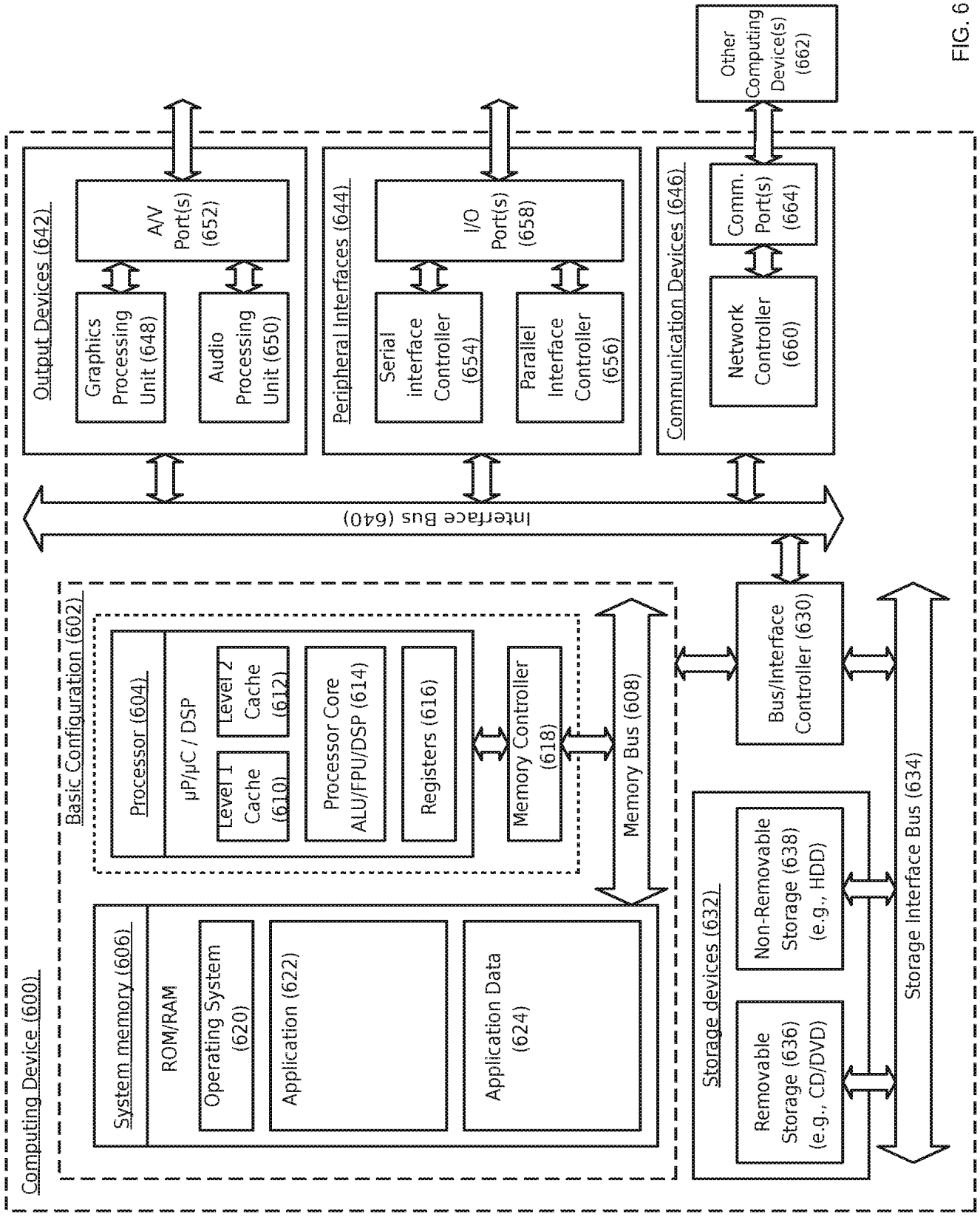

Computing Device (600)
Basic Configuration (602)
Processor (604)
μP/μC / DSP
Level 1 Cache (610)
Level 2 Cache (612)
Processor Core ALU/FPU/DSP (614)
Registers (616)
Memory Controller (618)
System memory (606)
ROM/RAM
Operating System (620)
Application (622)
Application Data (624)
Memory Bus (608)
Output Devices (642)
Graphics Processing Unit (648)
Audio Processing Unit (650)
A/V Port(s) (652)
Peripheral Interfaces (644)
Serial interface Controller (654)
Parallel Interface Controller (656)
I/O Port(s) (658)
Communication Devices (646)
Network Controller (660)
Comm. Port(s) (664)
Other Computing Device(s) (662)
Interface Bus (640)
Bus/Interface Controller (630)
Storage devices (632)
Removable Storage (636) (e.g., CD/DVD)
Non-Removable Storage (638) (e.g., HDD)
Storage Interface Bus (634)

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/083578

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/08(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; H04Q

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)

CPRSABS,CNKI,VEN:allot,allocate,assign,distribute,resource,channel,quality,status,interference,share,common,first,priority, preference,precedence,better,high,low,above,below,less

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010075638 A1 (ERICSSON TELEFON AB L MET AL.) 08 July 2010 (2010-07-08) description, page 2 line 21 to page 3 line 22	1-20
A	WO 2007145557 A1 (ERICSSON TELEFON AB L MET AL.) 21 December 2007 (2007-12-21) the whole document	1-20
A	CN 103874221 A (TELECOM TECHNOLOGY ACAD) 18 June 2014 (2014-06-18) the whole document	1-20

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2015	**24 April 2015**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN)** **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	Authorized officer **CHEN,Hao**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62089471**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/083578

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2010075638	A1	08 July 2010	CN	102273297	A	07 December 2011
WO	2007145557	A1	21 December 2007	US	8009581	B2	30 August 2011
				CN	101461267	B	13 March 2013
				CN	101461267	A	17 June 2009
				AR	061452	A1	27 August 2008
				EP	2027734	A4	25 April 2012
				EP	2027734	A1	25 February 2009
				US	2009196193	A1	06 August 2009
				EP	2027734	B1	10 April 2013
CN	103874221	A	18 June 2014		None		

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number			
Filing Date			
First Named Inventor	Anpeng HUANG		
Title	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK		
Art Unit			
Examiner Name			
Attorney Docket Number	I1013.10213US01		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/R. Burns Israelsen Reg. No. 42685/	**Date**	January 31, 2017
Name	R. Burns Israelsen	**Telephone**	(435) 252-1360
Registration Number	42685		

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PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 97149

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 97149

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Empire Technology Development LLC
2711 Centerville Road, Suite 400
Wilmington, Delaware 19808

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	[signature]	Date	2/9/11
Name	Stacey Rawitta	Telephone	425 691 4005
Title	Authorized Representative		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PCT REQUEST

Print Out (Original in Electronic Form)

0	**For receiving Office use only**	
0-1	International Application No.	PCT/CN2014/083578
0-2	International Filing Date	01 August 2014 (01.08.2014)
0-3	Name of receiving Office and "PCT International Application"	RO/CN

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT-SAFE Version 3.51.061.237 MT/FOP 20140101/0.20.5.21
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	State Intellectual Property Office of the People's Republic of China (RO/CN)
0-7	**Applicant's or agent's file reference**	CPCT-140021
I	**Title of Invention**	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
II-4	Name	Empire Technology Development LLC
II-5	Address	2711 Centerville Road, Suite 400 Wilmington, DE 19808 United States of America
II-6	State of nationality	US
II-7	State of residence	US
III-1	**Applicant and/or inventor**	
III-1-1	This person is	Applicant and inventor
III-1-2	Applicant for	US
III-1-4	Name (LAST, First)	HUANG, Anpeng
III-1-5	Address	Room 201, Building 6Yi, Yandong Yuan, Qinghua South Road Haidian District Beijing 100084 China
III-1-6	State of nationality	CN
III-1-7	State of residence	CN

PCT REQUEST

Print Out (Original in Electronic Form)

IV-1	**Agent or common representative; or address for correspondence**		
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent	
IV-1-1	Name	Chang Tsi & Partners	
IV-1-2	Address	7-8th Floor Tower A, Hundred Island Park Bei Zhan Bei Jie Street Xicheng District Beijing 100044 China	
IV-1-3	Telephone No.	+8610 8836 9999	
IV-1-4	Facsimile No.	+8610 8836 9996	
IV-1-5	e-mail	patent@changtsi.com	
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications	
IV-1-6	Agent's registration No.	11313	
V	**DESIGNATIONS**		
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**		
VI-1	**Priority Claim**	NONE	
VII-1	**International Searching Authority Chosen**	State Intellectual Property Office of the People's Republic of China (ISA/CN)	
VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	

PCT REQUEST

Print Out (Original in Electronic Form)

IX	Check list	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	3	✓
IX-2	Description	22	✓
IX-3	Claims	5	✓
IX-4	Abstract	1	✓
IX-5	Drawings	8	✓
IX-7	TOTAL	39	
	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	–	✓
IX-11	Copy of general power of attorney	–	Reference no. ZW0014073913
IX-18	PCT-SAFE physical media	–	–
IX-20	**Figure of the drawings which should accompany the abstract**	1	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	(PKCS7 Digital Signature)	
X-1-1	Name	Chang Tsi & Partners	
X-1-2	Name of signatory	Martin Meng	
X-1-3	Capacity (if such capacity is not obvious from reading the request)	Agent	

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	01 August 2014 (01.08.2014)
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/CN
10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	**Date of receipt of the record copy by the International Bureau**	

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference CPCT-140021	**FOR FURTHER ACTION** See item 4 below	
International application No. PCT/CN2014/083578	International filing date *(day/month/year)* 01 August 2014 (01.08.2014)	Priority date *(day/month/year)*
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant EMPIRE TECHNOLOGY DEVELOPMENT LLC		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 07 February 2017 (07.02.2017)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Lingfei Bai e-mail: pct.team2@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Chang Tsi & Partners

7-8th Floor Tower A, Hundred Island Park, Bei Zhan Bei Jie Street, Xicheng District, Beijing 100044,
China

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	**24 April 2015**
Applicant's or agent's file reference	**FOR FURTHER ACTION** See paragraph 2 below
CPCT-140021	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CN2014/083578	**01 August 2014**	

International Patent Classification (IPC) or both national classification and IPC
H04W 72/08(2009.01)i

Applicant
Empire Technology Development LLC et al

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/	Date of completion of this opinion	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**16 April 2015**	**CHEN,Hao**
Facsimile No. **(86—10) 62019451**		Telephone No. **(86-10)62089471**

Form PCT/ISA/237 (Cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CN2014/083578

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [✓] the international application in the language in which it was filed.
   - [ ] a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)
      - [ ] on paper
      - [ ] in electronic form

   b. (time)
      - [ ] in the international application as filed
      - [ ] together with the international application in electronic form
      - [ ] subsequently to this Authority for the purposes of search

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/CN2014/083578

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	1-20	YES
	Claims	None	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations :

[1] Reference is made to the following documents

[2] D1: WO2010075638 A1 08 July 2010(08.07.2010)

[3] D1 discloses a resource allocation method in a communication system and specifically discloses the following technical features (see description, page 2 line 21 to page 3 line 22): the present invention provides a method, comprising a first step of receiving a request for setting up a transport bearer corresponding to a transport service type, the transport service type being associated with one of the transport resources; if the associated transport resource is in a low load state, the transport bearer is set up on the associated transport resource; if the associated transport resource is not in a low load state and any of the other transport resources is in a low load state, the transport bearer is set up on the any of the other transport resources.

[4] The subject matter of claims 1 and 20 differs from D1 in that: 1) the communication resources are allocated by a base station; 2) the method comprises: assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource, determining an updated directional allocation of communication resources for the base station after scheduling the second frequency spectrum resource, and selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station. The subject matter of claim 20 further differs from D1 in that: a non-transitory computer-readable medium includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of the method. Thus, claims 1 and 20 are novel in the sense of PCT Article 33(2). Accordingly, dependent claims 2-10 are also novel in the sense of PCT Article 33(2).

[5] The subject matter of claim 11 differs from D1 in that: 1) the base station assigns the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource, and schedules the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources; 2) the base station comprises a quality status module, a processor module and a scheduler module. Thus, claim 11 is novel in the sense of PCT Article 33(2). Accordingly, dependent claims 12-19 are also novel in the sense of PCT Article 33(2).

[6] The prior art, considered individually or in combination, does not teach or fairly suggest the claimed inventions comprising the methods claimed in claims 1-10, the wireless base stations claimed in claims 11-19 and the non-transitory computer-readable medium claimed in claim 20. Consequently, the subject-matters of the claims 1-20 are not obvious to the skilled in the field and involve inventive steps in the sense of PCT Article 33(3).

[7] The technical solutions of claims 1-20 can be applied in the field of mobile communications and are industrially applicable in the sense of PCT Article 33(4).

ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

BACKGROUND

[0001] Unless otherwise indicated herein, the approaches described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0002] In recent years, wireless communication has become increasingly commonplace, with an accompanying improvement in the reliability of such service. However, with the development and ubiquitous use of mobile Internet devices, such as smart phones and the like, there has been explosive growth in the use of mobile Internet services, resulting in wireless traffic levels that may potentially exhaust available bandwidth. According to some forecasts of global mobile data traffic, smart phones represented only approximately 18 percent of total global handsets in use in 2012, but represented approximately 92 percent of total global handset traffic. With the total number of smart phones and other mobile Internet devices continuing to rise, global mobile data traffic in 2020 may be expected to reach approximately 500 to 1000 times that of such traffic in 2013. Consequently, any improvement in the efficient use of available wireless communication spectrum is a potential challenge to be addressed.

SUMMARY

[0003] In accordance with at least some embodiments of the present disclosure, a method for a base station of a wireless network to allocate communication resources between uplink and downlink channels comprises determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel; assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource; scheduling a second frequency spectrum resource that is available for use by the base station for the uplink or downlink channel based on an initial directional allocation of communication resources for the base station; after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

[0004] In accordance with at least some embodiments of the present disclosure, a wireless base station for a wireless communication network comprises a quality status module, a processor module, a scheduler module, and a memory. The quality status module is configured to determine a quality status of a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for an uplink channel or downlink channel. The processor module is coupled to the quality status module and configured to assign the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource. The scheduler module is coupled to the processor module and configured to schedule the second frequency spectrum resource for an uplink channel or downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

[0005] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. These drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope. The disclosure will be described with additional specificity and detail through use of the accompanying drawings.

[0007] FIG. 1 illustrates a wireless mobile network, according to one or more embodiments of the disclosure;

FIG. 2A illustrates an example of a frequency-division duplex allocation scheme applied to a radio frame and a plurality of frequency spectrum resources;

FIG. 2B illustrates an example of a time-division duplex allocation scheme applied to a radio frame and multiple subcarriers;

FIG. 2C illustrates an example of an adaptive radio resource allocation scheme applied to a radio frame and multiple subcarriers, according to at least some embodiments of the present disclosure;

FIG. 3 illustrates example multiple consecutive homogeneous frames, configured according to at least some embodiments of the disclosure;

FIG. 4 sets forth a flowchart of an example method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, according to an embodiment of the disclosure;

FIG. 5 is a block diagram of an illustrative embodiment of a computer program product to implement a method for dynamic resource allocation in a wireless network; and

FIG. 6 is a block diagram illustrating an example computing device, according to at least some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0008] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. The aspects of the disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and made part of this disclosure.

[0009] This disclosure is generally drawn, *inter alia*, to methods, apparatus, systems, devices, and computer program products related to allocating communication resources in a wireless network between uplink and downlink channels.

[0010] As described above, demand for the limited spectrum available for wireless communication may be high and increasing quickly as mobile Internet use becomes part of daily life for more and more consumers. In addition, the wireless traffic currently being

carried by wireless communication networks may be both "bursty" and asymmetric. Bursty traffic may be characterized by unpredictable and sudden increases and decreases in volume. For example, in modern wireless communication networks, a particular cell base station may have widely variable and somewhat random peak hours. This may be due, for example, to approximately 1% of users typically generating more than about 60% of daily network traffic, and less than approximately 10% of users generating about 90% of daily network traffic. Asymmetric traffic may be characterized by a large disparity between total volume associated with uplink channels and downlink channels at a particular time. For example, more than approximately 75% of daily network load may be typically associated with downlink traffic.

[0011] Such bursty and asymmetric wireless traffic can significantly undermine the ability of a node (such as a cell base station) of a wireless mobile network to efficiently utilize available frequency spectrum resources. This may be because duplex communication schemes commonly used in wireless mobile networks, such as time-division duplex (TDD) and frequency-division duplex (FDD) systems, may typically be unable to employ all available frequency spectrum resources when uplink and downlink traffic is constantly changing. Because the transmission signal strength at a node may be orders of magnitude greater than the reception signal strength, a transceiver for the node may typically be constrained to receive or transmit in a particular frequency band rather than transmitting and receiving in the band simultaneously. Consequently, uplink channels (for receiving data) and downlink channels (for transmitting data) of the node may be separated in the frequency and/or the time domain. This static or semi-static allocation of uplink and downlink channels can result in unused or underutilized frequency spectrum resources when uplink and downlink traffic loads change between the node and the mobile stations (e.g., mobile phones or mobile computers using a mobile broadband adapter) serviced by the node. According to some embodiments, a wireless network may be configured to reduce or substantially eliminate unused or underutilized frequency spectrum resources. One such wireless network is illustrated in FIG. 1.

[0012] FIG. 1 illustrates a wireless mobile network 100, according to one or more embodiments of the disclosure. Wireless mobile network 100 may include at least one node 110 and at least one wireless device 120, and may include other components (which are not illustrated herein for purposes of brevity and clarity). Node 110 may be embodied as a cell base station, a base transceiver station (BTS), an evolved node B (eNodeB), or other device that is communicatively coupled to or included in wireless mobile network 100 and is

configured to communicate with wireless device 120. Wireless device 120, also referred to as a mobile station (MS) or as user equipment (UE), may be embodied as a mobile handset, a laptop computer equipped with a mobile broadband adapter, or any other device suitably configured to connect to or otherwise communicate with node 110.

[0013] Node 110 may include a transceiver module 111, a processor module 112, and a memory 115. Transceiver module 111 may be configured to communicate with one or more wireless devices 120 via an air interface 130 using uplink and downlink channels, the allocation of which is described below in conjunction with FIG. 2C. For example, transceiver module 111 may include a transmitter to transmit data to one or more wireless devices 120 via downlink channels established by node 110 and a receiver to receive data from one or more wireless devices 120 via uplink channels established by node 110. Memory 115 may include a downlink resource pool 116, an uplink resource pool 117, and a shared resource pool 118, each of which is described in greater detail below in conjunction with FIG. 2C.

[0014] Processor module 112 may be configured to control and/or perform the operations of node 110. In some embodiments, processor module 112 may include a quality status module 113 configured to determine a quality status of frequency spectrum resources associated with air interface 130 that are available for use by node 110 for an uplink or downlink channel, where air interface 130 may include the radio-based communication link between wireless device 120 and node 110. In such embodiments, quality status module 113 may determine the quality status of each frequency spectrum resources associated with air interface 130 based on channel quality indicator (CQI), received interference power (RIP), and/or any other suitable quality metric or key performance indicator, such as RSSI, acknowledgement/negative acknowledgement (ACK/NACK) frequency, dropping rate, block error rate, bit error rate, signal-to-interference-plus-noise ratio (SINR), etc. In some embodiments, processor module 112 may include a scheduler module 114 configured to schedule frequency spectrum resources associated with air interface 130 based on a target directional allocation of radio resources (e.g., frequency spectrum resources) for node 110. The target directional allocation of such resources may be based at least in part on current resource requests from node 110 (e.g., processor module 111) and from the one or more wireless devices 120 serviced by node 110. Thus, when resource requests for downlink traffic from node 110 are greater than resource requests for uplink traffic from the one or more wireless devices 120 serviced by node 110, scheduler module 114 may allocate frequency spectrum resources between uplink and downlink channels accordingly. According to some embodiments, the allocation of each specific frequency spectrum

resource available to node 110 as either an uplink and downlink channel by scheduler module 114 (i.e., directional allocation of communication resources for the base station) may be based at least in part on whether the specific frequency spectrum resource has been assigned to downlink resource pool 116, uplink resource pool 117, or shared resource pool 118. Such embodiments are described below in conjunction with FIGS. 2C and 4. The various elements of node 110 may be operatively coupled to each other, and may comprise components of hardware, software (or other computer-readable instruction stored on a non-transitory computer-readable medium and executable by one or more processors), or a combination of hardware and software (including firmware).

[0015] Wireless device 120 may include a transceiver module 121 and a processor module 122 operatively coupled to each other. Transceiver module 121 may include hardware, software, and/or firmware components or combinations thereof suitable for communicating with node 110 via uplink and downlink channels established by node 110. Processor module 122 may include software and/or firmware components or combinations thereof that enable wireless device 120 to provide information to node 110 for determining CQI, RIP, and/or any other suitable quality metric of frequency spectrum resources associated with air interface 130.

[0016] FIGS. 2A-2C illustrate examples of the allocation of frequency spectrum resources for nodes of a wireless mobile network, according to various duplex communication schemes. Specifically, FIG. 2A illustrates frequency spectrum resource allocation employing FDD; FIG. 2B illustrates frequency spectrum resource allocation employing TDD; and FIG. 2C illustrates adaptive frequency spectrum resource allocation in wireless mobile network 100 according to at least some embodiments of the present disclosure.

[0017] FIG. 2A illustrates an example of an FDD allocation scheme 210 applied to a radio frame 200 and a plurality of frequency spectrum resources, subcarriers 201-206. Radio frame 200 may be one of a plurality of recurrent data blocks that are associated with a node of a wireless mobile network, where each radio frame 200 corresponds to a time slot of fixed length, for example 10 ms. Radio frame 200 may include a fixed number (for instance, ten) of subframes 207. Each of subframes 207 may occupy a time slot and may be, for example, 1 ms second in duration. Each of subcarriers 201-206 may be a frequency spectrum resource that may be available for use by the node as either an uplink channel or a downlink channel, such as a unique frequency band. Together, radio frame 200 and subcarriers 201-206 may make up an air interface for the portion of the wireless mobile network associated

with the node. It is noted that such air interface may include fewer than six subcarriers 201-206 or many more than six subcarriers 201-206. For example, in long term evolution (LTE) networks, a minimum of 72 subcarriers may be employed at a particular node or base station.

[0018] In FDD allocation scheme 210, the transmitter and the receiver of the node may operate at different carrier frequencies. Stated in another way, the transmitter may use some of subcarriers 201-206 as downlink channels, and the receiver may use other of subcarriers 201-206 as uplink channels. Furthermore, in FDD allocation scheme 210, downlink and uplink channels may usually be operated in paired spectra, in which the same amount of radio resources are reserved for downlink channels and for uplink channels. In the example illustrated in FIG. 2A, the node may employ subcarriers 201-203 for uplink channels and subcarriers 204-206 for downlink channels. Generally, FDD allocation scheme 210 may be more suited to applications like voice calls, whose bidirectional capacity requirements are equal, but is less suitable for Internet applications due to the asymmetric and bursty traffic characterized thereby. To wit, even when downlink traffic from the node to wireless devices greatly exceeds uplink traffic from the wireless devices to the node, in FDD allocation scheme 210, the number of subcarriers 201-206 allocated as uplink channels (e.g., subcarriers 201-203) may remain equal to the number of subcarriers 201-206 that are allocated as downlink channels (e.g., subcarriers 204-206). Therefore, some or most of subcarriers 201-203 may be idle or underutilized at the same time that subcarriers 204-206 cannot satisfy all downlink requests.

[0019] FIG. 2B illustrates an example of a TDD allocation scheme 220 applied to radio frame 200 and subcarriers 201-206. TDD allocation scheme 220 may be based upon using the same frequency spectrum resources (subcarriers 201-206) for both uplink and downlink transmission, where wireless devices and a node do not transmit concurrently. Thus, any one of subcarriers 201-206 may be used for an uplink channel and for a downlink channel during radio frame 200, albeit during different subframes 207. As shown in FIG. 2B, each of subcarriers 201-206 may be used for a downlink channel during subframes 207A and subframes 207F-207J, and for an uplink channel during subframes 207C-207E. When the proportion of uplink and downlink traffic changes, the number of subframes 207 during which subcarriers 201-206 are used for uplink channels and the number of subframes 207 during which subcarriers 201-206 are used for downlink channels can be reconfigured accordingly.

[0020] TDD allocation scheme 220 may be useful for applications with traffic asymmetry, such as when downlink traffic far exceeds uplink traffic (or vice-versa) during a particular radio frame. However, TDD allocation scheme 220 may also have drawbacks. First, there may generally be a limited number of different configurations available, typically seven, for the allocation of subcarriers 201-206 as uplink and downlink channels. So while the proportion of uplink channel capacity and downlink channel capacity for the node can be varied, the granularity of options may be limited. Therefore, some of subcarriers 201-206 may usually be underutilized in each radio frame 200, since the proportion of uplink channel capacity and downlink channel capacity for the node may not be closely matched to the current requirements of the node and the wireless devices.

[0021] Second, in TDD allocation scheme 220 each radio frame 200 may generally include at least one guard period 217, which may expend frequency spectrum resources (subcarriers 201-206) that could otherwise be employed as uplink or downlink channels. Guard period 217, also sometimes referred to as a "guard interval," may be used to ensure that distinct transmissions do not interfere with one another. For example, guard period 217 may prevent downlink transmissions carried by subcarrier 201 in an earlier portion of subframe 207B from interfering with uplink transmissions carried by subcarrier 201 in a later portion of subframe 207B. Thus, during guard period 217, data may generally not be interpreted by the node or the wireless devices. Guard period 217 may be a period of time that could be typically longer than the delay spread associated with uplink and downlink channels available to the node. To avoid data loss and to reduce interference caused by propagation delay between each user timeslot (a contiguous series of subframes used by either the node or the wireless device) and a following user timeslot, one or more guard periods 217 may be used in each radio frame 200. Typically, each user timeslot may end with such a guard period.

[0022] Third, TDD allocation scheme 220 may rely on discontinuous transmission of uplink and downlink traffic to separate uplink and downlink transmission, for example using the above-described guard periods 217. Discontinuous transmission could degrade performance of radio frequency (RF) power amplifiers in transmitters.

[0023] Fourth, implementation of TDD allocation scheme 220 may involve extra signaling overhead. Specifically, for each of the different configurations available for the allocation of subcarriers 201-206 as uplink and downlink channels with respect to subframes 107, configuration information may be transmitted to and/or from the wireless devices and the

node. Such additional signaling overhead may expend frequency spectrum resources (subcarriers 201-206) that could otherwise be employed as uplink or downlink channels.

[0024] FIG. 2C illustrates an example of an adaptive radio resource allocation scheme 230 applied to radio frame 200 and subcarriers 201-206, according to at least some embodiments of the present disclosure. TDD allocation scheme 220 may include dynamic allocation of subcarriers 201-206 in both the time and frequency domains. Consequently, the number of subcarriers 201-206 allocated to uplink channels and to downlink channels can be finely tailored to match the time-varying bandwidth demand associated with the expanded use of mobile Internet services. Thus, even when the proportion of uplink traffic to downlink traffic changes rapidly, subcarriers 201-206 can be effectively exploited, so that none or very few of subcarriers 201-206 are unused or underutilized.

[0025] As shown in FIG. 2C, some of subcarriers 201-206 may be allocated by scheduler module 114 of node 110 for uplink channels for the duration of radio frame 200 (except during guard period 227), while other of subcarriers 201-206 may be allocated by scheduler module 114 for downlink channels for the duration of radio frame 200. In addition, still other of subcarriers 201-206 may be allocated by scheduler module 114 for uplink channels in some subframes 207 of radio frame 200 and allocated by scheduler module 114 for downlink channels in other subframes 207 of radio frame 200. For example, in the scenario depicted in FIG. 2C, subcarrier 201 may be allocated for an uplink channel for the duration of radio frame 200 while subcarrier 206 may be allocated as a downlink channel for the duration of radio frame 200. Concurrently, subcarriers 202, 203, and 205 may be allocated as downlink channels during a first portion 240 of radio frame 200 (subframes 207A-207D and a portion of subframe 207E) and as uplink channels during a second portion 250 of radio frame 200 (a portion of subframe 207E and subframes 207F-207J). Conversely, subcarrier 204 may be allocated for an uplink channel during first portion 240 of radio frame 200 and as a downlink channel during second portion 250 of radio frame 200.

[0026] In some embodiments, in adaptive radio resource allocation scheme 230, radio frame 200 may include guard period 227 when subcarriers 201-206 are reconfigured to have a different direction allocation. As is the case with guard period 217 in FIG. 2B, during guard period 227, data may generally not be interpreted by node 110 or wireless devices 120. Thus, guard period 227 may be used to ensure that a transmission associated with a specific frequency spectrum resource, such as a downlink transmission, does not interfere with a transmission that is subsequently associated with the specific frequency spectrum

resource, such as an uplink transmission. Guard period 227 may be a period of time that is typically longer than the delay spread associated with uplink and downlink channels available to node 110, for example on the order of about 1 microsecond. As shown in FIG. 2C, guard period 227 may be disposed between first portion 240 of radio frame 200 and second portion 250 of radio frame 200, where the direction allocation of subcarriers 201-206 may be constant in first portion 240 and the direction allocation of subcarriers 201-206 may be constant in second portion 250. Thus, guard period 227 may prevent downlink transmissions carried by subcarriers 202, 203, 205, and 206 in first portion 240 of radio frame 200 from interfering with uplink transmissions carried by, respectively, subcarriers 202, 203, 205, and 206 in second portion 250 of radio frame 200. Similarly, guard period 227 may prevent uplink transmissions carried by subcarriers 201 and 204 in first portion 240 of radio frame 200 from interfering with transmissions carried by, respectively, subcarriers 201 and 204 in second portion 250 of radio frame 200.

[0027] While guard period 227 may be in some ways similar to guard period 217 in FIG. 2B, guard period 227 may be fundamentally different from guard period 217 in at least one aspect. Specifically, in adaptive radio resource allocation scheme 230, guard period 227 may be included in a particular radio frame 200 when one "homogeneous frame" ends and another homogeneous frame begins in the particular radio frame 200. A homogeneous frame may be considered to be any consecutive series of subframes 207 in which the direction allocation of subcarriers 201-206 remains unchanged. Thus, first portion 240 of radio frame 200 may be considered as some or all of one homogeneous frame in adaptive radio resource allocation scheme 230, and second portion 250 of radio frame 200 may be considered as some or all of another homogeneous frame. Because guard period 227 may be disposed between different homogeneous frames, and because a homogeneous frame typically may have a duration that includes multiple radio frames 200, in some embodiments, guard periods 227 may occur substantially less frequently than once per radio frame 200. One such embodiment is illustrated in FIG. 3.

[0028] FIG. 3 illustrates example multiple consecutive homogeneous frames 301, 302, and 303, configured according to at least some embodiments of the disclosure. Each of homogeneous frames 301, 302, and 303 may include multiple subframes 207, and in some cases multiple radio frames 200. As shown, homogeneous frame 301 may precede homogeneous frame 302 and may be separated from homogeneous frame 302 by a guard period 227 (described above in conjunction with FIG. 2C). Similarly, homogeneous frame 302 may precede homogeneous frame 303 and may be separated from homogeneous

frame 303 by a guard period 227. It is noted that homogeneous frames 302 and 303 each may include multiple radio frames 200, since in each case, the direction allocation of subcarriers 201-206 may remain unchanged for a period of time longer than a single radio frame 200. Consequently, the total duration of time in which frequency spectrum resources are idle during guard periods 227 in adaptive radio resource allocation scheme 230 may generally be significantly less than the total duration of time in which frequency spectrum resources are idle during guard period 217 in TDD allocation scheme 220.

[0029] In operation, node 110 in FIG. 1 may implement adaptive radio resource allocation scheme 230 according to the following procedure. In some embodiments, the following procedure may be performed once per radio frame 200. In other embodiments, the procedure may be performed more frequently (for example, once every few subframes 207) or less frequently (for example, once every N radio frames, once every second, etc.).

[0030] First, node 110 may obtain the quality status of the current uplink and downlink frequency spectrum resources available (e.g., subcarriers 201-206) using quality status module 113. For example, quality status module 113 may acquire suitability of some or all of subcarriers 201-206 for uplink channels by measurement of RIP for each of subcarriers 201-206. To acquire suitability of some or all of subcarriers 201-206 for downlink channels, node 110 may measure CQI, for example through the measurement of reference signal received power (RSRP) and received signal strength indicator (RSSI). The measurement of RIP and CQI can be based on the particle size of a wavelet or on a smaller particle size, such as physical resource block (PRB), a plurality of which may typically be included in each subframe 207. It is noted that determination of quality status, as described above, can be performed using information typically already measured by LTE and LTE-Advanced wireless communication systems. Consequently, no additional signaling or other procedures may be needed for implementation of the herein-described procedure.

[0031] Second, node 110 may sort the available frequency spectrum resources based on the quality status measured for each. Thus, processor module 112 may assign high-quality resources to downlink resource pool 116 and/or to uplink resource pool 117, and may assign lower-quality frequency spectrum resources to shared resource pool 118. For example, in some embodiments, subcarriers with high CQI, which may indicate that the subcarrier is well-suited for a downlink channel, may be assigned to downlink resource pool 116, and subcarriers with low RIP, which may indicate that the subcarrier is well-suited for an uplink channel, may be assigned to uplink resource pool 117. In such embodiments, the assigned

subcarriers may be ranked in order of suitability, so that during scheduling (described below), the subcarriers assigned to downlink resource pool 116 that are most suitable for uplink channels can be selected first for downlink channels and the subcarriers assigned to uplink resource pool 117 that are most suitable for uplink channels can be selected first for uplink channels. Similarly, in some embodiments, the subcarriers that are assigned to shared resource pool 118 may be ranked in terms suitability for uplink and for downlink channels, for example based on RIP and CQI values, respectively. Furthermore, in some embodiments, one or more frequency spectrum resources may be assigned to both downlink resource pool 116 and uplink resource pool 117, such as when a particular subcarrier has both high CQI and low RIP.

[0032] Third, scheduler module 114 may schedule some or all of the frequency spectrum resources assigned to downlink resource pool 116 for downlink channels for node 110 and some or all of the frequency spectrum resources assigned to uplink resource pool 117 for uplink channels for node 110. In some embodiments, scheduler module 114 may perform such scheduling based on an initial directional allocation of frequency spectrum resources for node 110, where the initial directional allocation of communication resources may indicate current resource requests from wireless devices 120 and from node 110. In this way, the number of frequency spectrum resources scheduled for downlink channels may not exceed the current number of requested downlink channels requested by wireless devices 120, and the number of frequency spectrum resources scheduled for uplink channels may not exceed the current number of requested uplink channels requested by node 110.

[0033] Fourth, processor module 112 may determine an updated directional allocation of frequency spectrum resources for node 110. In some embodiments, the updated directional allocation of frequency spectrum resources may be based on the number of current resource requests from wireless devices 120, on the number of current resource requests from node 110, on the number of frequency spectrum resources scheduled from uplink resource pool 117 for uplink channels, on the number of frequency spectrum resources scheduled from downlink resource pool 116 for downlink channels, and/or on some other factor(s) or combination(s) thereof. Thus, in such embodiments, the updated directional allocation of frequency spectrum resources may be based on the remaining resource requests (for both uplink and downlink channels) that are not yet satisfied after scheduling frequency spectrum resources assigned to downlink resource pool 116 and to uplink resource pool 117.

[0034] Fifth, when there are remaining resource requests for node 110 (for either uplink or downlink channels) that are not yet satisfied, scheduler module 114 may schedule one or more frequency spectrum resources assigned to shared resource pool 118 for uplink and/or downlink channels. In some embodiments, the scheduling of such frequency spectrum resources may be based on the updated directional allocation of frequency spectrum resources described above. Consequently, frequency spectrum resources may be dynamically allocated to satisfy resource requests for node 110, so that very few or no frequency spectrum resources are idle.

[0035] Furthermore, in some embodiments, a particular frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for an uplink or a downlink channel based on suitability of the particular frequency spectrum resource for an uplink or a downlink channel, respectively. For example, a frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for a downlink channel when the frequency spectrum resource has a higher CQI than other frequency spectrum resources assigned to shared resource pool 118. Similarly, a frequency spectrum resource assigned to shared resource pool 118 may be scheduled by scheduler module 114 of node 110 for an uplink channel when the frequency spectrum resource has a lower RIP than other frequency spectrum resources assigned to shared resource pool 118. Thus, not only are available frequency spectrum resources efficiently utilized by node 110, these frequency spectrum resources may be scheduled for either uplink or downlink channel based on the current suitability of each resource, which can enhance user experience and system-level performance.

[0036] While assignment and scheduling of frequency spectrum resources is described herein in terms of subcarriers 201-206, the above-described procedure may also be implemented on an individual PRB basis. Thus, each individual PRB (a plurality of which may be associated with each frequency spectrum resource in a single subframe 207) may be assigned to one or more of downlink resource pool 116, uplink resource pool 117, and/or shared resource pool 118, and may be scheduled for an uplink channel or a downlink channel.

[0037] FIG. 4 sets forth a flowchart of an example method 400 for a base station of a wireless network to allocate communication resources between uplink and downlink channels, according to an embodiment of the disclosure. Method 400 may include one or more operations, functions, or actions as illustrated by one or more of blocks 401-405.

Although the blocks are illustrated in a sequential order, these blocks may also be performed in parallel, and/or in a different order than those described herein. Also, the various blocks may be combined into fewer blocks, divided into additional blocks, and/or eliminated based upon the particular implementation. Additional blocks representing other operations, functions, or actions may be provided. Although method 400 is described in conjunction with node 110 of FIG. 1, any suitable computing device configured to perform method 400 is within the scope of this disclosure.

[0038] Method 400 may begin in block 401 ("Determine quality status of a first frequency spectrum"), in which quality status module 113 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may determine a quality status of at least a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel, such as one of subcarriers 201-206. In some embodiments, quality status module 113 may determine this quality status by determining at least one of a channel quality indicator (CQI) value and a received interference power (RIP) of the first frequency spectrum resource. CQI and RIP are each existing channel performance measures that may already typically be in place in wireless networks. Hence, no additional signaling may be required for quality status module 113 to complete block 401.

[0039] In block 402 ("Assign first frequency spectrum resource to shared resource pool based on quality status"), processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may assign the first frequency spectrum resource to shared resource pool 118, based on the quality status of the first frequency spectrum resource determined in block 401. In some embodiments, processor module 112 may assign the first frequency spectrum resource to shared resource pool 118 when it is determined that the first frequency spectrum resource is less suitable for an uplink channel than one or more other frequency spectrum resources available to node 110 and also is less suitable for a downlink channel than one or more frequency spectrum resource that are available to node 110.

[0040] Specifically, the first frequency spectrum resource may be determined by quality status module 113 to be less suitable for a downlink channel in response to a CQI of the first frequency spectrum resource being less than a CQI of one or more other frequency spectrum resources. Similarly, the first frequency spectrum resource may be determined by quality status module 113 to be less suitable for an uplink channel than one or more other frequency spectrum resources in response to an RIP of the first frequency spectrum

resource being greater than an RIP of the one or more other frequency spectrum resources. Thus, because the first frequency spectrum resource is determined by quality status module 113 to currently be a sub-optimal resource for uplink and/or downlink channels, the first frequency spectrum resource may be assigned by processor module 112 to shared resource pool 118. The first frequency spectrum resource may subsequently be scheduled by scheduler module 114 (see block 407) for an uplink or a downlink channel after higher quality frequency spectrum resources are scheduled for use, and if additional radio resources may be needed to satisfy current resource requests by node 110 and/or wireless devices 120.

[0041] In block 403 ("Determine a quality status of a second frequency spectrum resource"), quality status module 113 may determine a quality status of at least a second frequency spectrum resource that is available for use by the base station for an uplink or downlink channel, such as one of subcarriers 201-206. Quality status of the second frequency spectrum resource may be determined using techniques described above in block 401.

[0042] In block 404, ("Assign second frequency spectrum resource to uplink resource pool or downlink resource pool based on quality status"), processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may assign the second frequency spectrum resource to downlink resource pool 116 and/or to uplink resource pool 117 based on the quality status determined in block 403. For example, in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for an uplink channel, processor module 112 may assign the second frequency spectrum resource to uplink resource pool 117. In some embodiments, the second frequency spectrum resource may be "usable for an uplink channel" when the quality status meets or exceeds a particular threshold, such as when an RIP value associated with the second frequency spectrum resource is equal to or less than a specified maximum value or some other value. Similarly, in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for a downlink channel, processor module 112 may assign the second frequency spectrum resource to downlink resource pool 116. In some embodiments, the second frequency spectrum resource may be "usable for a downlink channel" when the quality status meets or exceeds a particular threshold, such as when a CQI value associated with the second frequency spectrum resource is equal to or greater than a specified minimum value or some other value.

[0043] In block 405, ("Schedule second frequency spectrum resource based on initial directional allocation"), scheduler module 114 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may schedule the second frequency spectrum resource for an uplink or a downlink channel based on an initial directional allocation of communication resources for node 110. The initial direction allocation of communication resources may indicate a target number of uplink and downlink channels node 110 should establish to satisfy current uplink and downlink traffic of node 110. For example, an initial direction allocation of communication resources may be based on current resource requests from wireless devices 120 and from node 110. Thus, when the second frequency spectrum resource is determined to be suitable for an uplink channel, and the initial direction allocation of communication resources indicates that node 110 should establish an uplink channel to satisfy current uplink and downlink traffic of node 110, scheduler module 114 may schedule the second frequency spectrum resource for an uplink channel. Similarly, when the second frequency spectrum resource is determined to be suitable for a downlink channel, and the initial direction allocation of communication resources indicates that node 110 should establish a downlink channel to satisfy current uplink and downlink traffic of node 110, scheduler module 114 may schedule the second frequency spectrum resource for a downlink channel.

[0044] In block 406 ("Determine an updated directional allocation of communication resources"), after scheduling the second frequency spectrum resource in block 403, processor module 112 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may determine an updated directional allocation of communication resources for node 110. Specifically, the updated directional allocation of frequency spectrum resources may be based on current resource requests from wireless devices 120, on current resource requests from node 110, on the number of frequency spectrum resources that are already assigned for uplink channels, on the number of frequency spectrum resources assigned for downlink channels, and/or on other factor(s) or combination(s) thereof. Thus, the updated direction allocation of frequency spectrum resources may indicate, after the second frequency spectrum resource is assigned for one of an uplink or downlink channel, whether any additional uplink or downlink channels should be established by node 110 to satisfy current resource requests from wireless devices 120 and node 110.

[0045] In block 407 ("Schedule first frequency spectrum resource based on the determined updated directional allocation of communication resources"), scheduler module 114 (or any other suitably configured software, firmware, or logic circuit entity, etc.) may select the first

frequency spectrum resource from shared resource pool 118 and may schedule the first spectrum for either an uplink channel or a downlink channel. Scheduler module 114 may schedule the first frequency spectrum resource for either uplink channel or downlink channel based on the updated directional allocation of communication resources determined in block 406. Thus, frequency spectrum resources previously assigned to shared resource pool 118 in block 402 may be scheduled according to what resources node 110 are usable to satisfy current resource requests from wireless devices 120 and node 110 after higher-quality frequency spectrum resources have been scheduled.

[0046] FIG. 5 is a block diagram of an illustrative embodiment of a computer program product 500 to implement a method for dynamic resource allocation in a wireless network. Computer program product 500 may include a signal bearing medium 504. Signal bearing medium 504 may include one or more sets of executable instructions 502 that, in response to execution by, for example, a processor of a computing device, may provide at least the functionality or features described above with respect to FIGS. 1-4.

[0047] In some implementations, signal bearing medium 504 may encompass a non-transitory computer readable medium 508, such as, but not limited to, a hard disk drive, a compact disc (CD), a digital video disk (DVD), a digital tape, memory, etc. In some implementations, signal bearing medium 504 may encompass a recordable medium 510, such as, but not limited to, memory, read/write (R/W) CDs, R/W DVDs, etc. In some implementations, signal bearing medium 504 may encompass a communications medium 506, such as, but not limited to, a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.). Computer program product 500 may be recorded on non-transitory computer readable medium 508 or another similar recordable medium 510.

[0048] FIG. 6 is a block diagram illustrating an example computing device 600, according to at least some embodiments of the present disclosure. In some embodiments, computing device 600 may be used to implement node 110 of FIG. 1. In a very basic configuration 602, computing device 600 typically includes one or more chip multiprocessors 604 and a system memory 606. A memory bus 608 may be used for communicating between processor 604 and system memory 606.

[0049] Chip multiprocessor 604 may be substantially similar in configuration and operation to processor module 112 in FIG. 1. Depending on the desired configuration, processor 604

may be of any type including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. Processor 604 may include one more levels of caching, such as a level one cache 610 and a level two cache 612, a processor core 614, and registers 616. An example processor core 614 may include an arithmetic logic unit (ALU), a floating point unit (FPU), a digital signal processing core (DSP Core), or any combination thereof. An example memory controller 618 may also be used with processor 604, or in some implementations memory controller 618 may be an internal part of processor 604.

[0050] Depending on the desired configuration, system memory 606 (which may be used to implement main memory 170 of FIG. 1) may be of any type including but not limited to volatile memory (such as RAM), non-volatile memory (such as ROM, flash memory, etc.) or any combination thereof. System memory 606 may include an operating system 620, one or more applications 622, and program data 624. Application 622 may be arranged to perform at least the functions and operations as those described with respect processor module 112. Application data 624 may be useful for operation with application 622. In some embodiments, application 622 may be arranged to operate with application data 624 on operating system 620. This described basic configuration 602 is illustrated in Fig. 6 by those components within the inner dashed line.

[0051] Computing device 600 may have additional features or functionality, and additional interfaces to facilitate communications between basic configuration 602 and any required devices and interfaces. For example, a bus/interface controller 630 may be used to facilitate communications between basic configuration 602 and one or more data storage devices 632 via a storage interface bus 634. Data storage devices 632 may be removable storage devices 636, non-removable storage devices 638, or a combination thereof. Examples of removable storage and non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDDs), optical disk drives such as compact disk (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSDs), and tape drives to name a few. Example computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

[0052] System memory 606, removable storage devices 636 and non-removable storage devices 638 are examples of computer storage media. Computer storage media includes,

but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVDs) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which may be used to store the desired information and which may be accessed by computing device 600. Any such computer storage media may be part of computing device 600.

[0053] Computing device 600 may also include an interface bus 640 for facilitating communication from various interface devices (e.g., output devices 642, peripheral interfaces 644, and communication devices 646) to basic configuration 602 via bus/interface controller 630. Example output devices 642 include a graphics processing unit 648 and an audio processing unit 650, which may be configured to communicate to various external devices such as a display or speakers via one or more A/V ports 652. Example peripheral interfaces 644 include a serial interface controller 654 or a parallel interface controller 656, which may be configured to communicate with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports 658. An example communication device 646 includes a network controller 660, which may be arranged to facilitate communications with one or more other computing devices 662 over a network communication link, such as, without limitation, optical fiber, Long Term Evolution (LTE), 3G, WiMax, via one or more communication ports 664.

[0054] The network communication link may be one example of a communication media. Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and may include any information delivery media. A "modulated data signal" may be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), microwave, infrared (IR) and other wireless media. The term computer readable media as used herein may include both storage media and communication media.

[0055] Computing device 600 may be implemented as a portion of a small-form factor portable (or mobile) electronic device such as a cell phone, a personal data assistant (PDA), a personal media player device, a wireless web-watch device, a personal headset device, an application specific device, or a hybrid device that include any of the above functions.

Computing device 600 may also be implemented as a personal computer including both laptop computer and non-laptop computer configurations

[0056] The foregoing detailed description has set forth various embodiments of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, each function and/or operation within such block diagrams, flowcharts, or examples can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described herein may be implemented via application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, some aspects of the embodiments disclosed herein, in whole or in part, can be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and designing the circuitry and/or writing the code for the software and or firmware are possible in light of this disclosure. In addition, the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a compact disc (CD), a digital video disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

[0057] Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems. That is, at least a portion of the devices and/or processes described herein can be integrated into a data processing system via a reasonable amount of experimentation. A typical data processing system generally includes one or more of a system unit housing, a video display device, a memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating

systems, drivers, graphical user interfaces, and applications programs, one or more interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors (e.g., feedback for sensing position and/or velocity; control motors for moving and/or adjusting components and/or quantities). A typical data processing system may be implemented utilizing any suitable commercially available components, such as those typically found in data computing/communication and/or network computing/communication systems.

[0058] The herein described subject matter sometimes illustrates different components contained within, or connected with, different other components. Such depicted architectures are merely exemplary, and in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0059] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0060] It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such

recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation *is* explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean *at least* the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means *at least* two recitations, or *two or more* recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0061] While various aspects and embodiments have been disclosed herein, other aspects and embodiments are possible. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

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Published:

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(54) **Title**: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

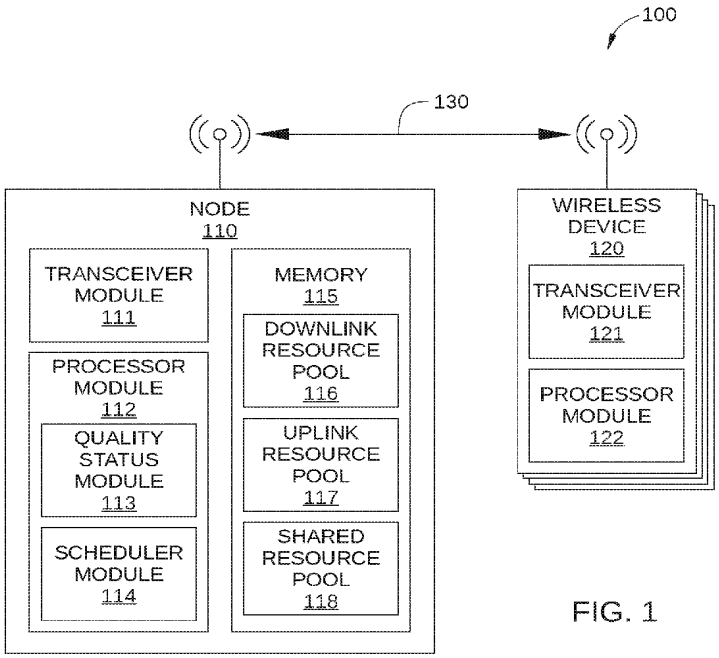


FIG. 1

(57) **Abstract**: Frequency spectrum resources available to a node of a wireless communication network may be allocated for either an uplink or downlink channel by a scheduler module. The scheduler module may schedule a specific frequency spectrum resource based at least in part on whether the frequency spectrum resource has been assigned to a downlink resource pool, an uplink resource pool, or a shared resource pool. Assignment of frequency spectrum resources to the downlink resource pool, the uplink resource pool, or the shared resource pool may be based on suitability of each frequency spectrum resource for uplink channel or downlink channel.

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I Claim:

1. A method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, the method comprising:

determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink or downlink channel;

assigning the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource;

scheduling a second frequency spectrum resource that is available for use by the base station for the uplink or downlink channel based on an initial directional allocation of communication resources for the base station;

after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and

selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

2. The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool based on the determined quality status of the first frequency spectrum resource comprises assigning the first frequency spectrum resource to the shared resource pool according to the first frequency spectrum resources being:

less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and

less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

3. The method of claim 2, wherein the first frequency spectrum resource is less suitable for the downlink channel than the third frequency spectrum resource in response to a channel quality indicator (CQI) of the first frequency spectrum resource being less than a CQI of the third frequency spectrum resource.

4. The method of claim 2, wherein the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource in response to a

received interference power (RIP) of the first frequency spectrum resource being greater than an RIP of the third frequency spectrum resource.

5. The method of claim 1, further comprising:
   determining a quality status of the second frequency spectrum resource; and
   based on the determined quality status of the second frequency spectrum resource, assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool,
   wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises determining a quality status of the second frequency spectrum resource.

6. The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises:
   assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the uplink channel, and
   assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the downlink channel.

7. The method of claim 5, wherein determining the quality status of the second frequency spectrum resource comprises determining at least one of a CQI and a RIP of the second frequency spectrum resource.

8. The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool based on the quality status of the second frequency spectrum resource.

9. The method of claim 1, wherein determining the quality status of the first frequency

spectrum resource comprises determining at least one of a CQI and a RIP of the first frequency spectrum resource.

10. The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

11. A wireless base station for a wireless communication network, the wireless base station comprising:
    a quality status module configured to determine a quality status of a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for an uplink channel or downlink channel;
    a processor module coupled to the quality status module and configured to assign the first frequency spectrum resource to a shared resource pool based on the determined quality status of the first frequency spectrum resource; and
    a scheduler module coupled to the processor module and configured to schedule the second frequency spectrum resource for an uplink channel or downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

12. The wireless base station of claim 11, wherein the processor module is further configured to determine the updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for an uplink or downlink channel.

13. The wireless base station of claim 11, further comprising a memory coupled to the processor module and configured to store the shared resource pool, wherein the processor module is further configured to assign the second frequency spectrum resource to one of an uplink resource pool stored in the memory or a downlink resource

pool stored in the memory based on the determined quality status of the second frequency spectrum resource.

14. The wireless base station of claim 13, wherein the memory is further configured to store the uplink resource pool and the downlink resource pool.

15. The wireless base station of claim 13, wherein the updated directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, on current resource requests from the wireless base station, on a number of frequency spectrum resources scheduled from the uplink resource pool for uplink channels, and on a number of frequency spectrum resources scheduled from the downlink resource pool for downlink channels.

16. The wireless base station of claim 11, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station and from the wireless base station.

17. The wireless base station of claim 11, wherein the quality status module is configured to determine the quality status of the first frequency spectrum by determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

18. The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum resource to the shared resource pool by assignment of a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

19. The wireless base station of claim 11, wherein the processor module is configured to assign the first frequency spectrum to the shared resource pool by in response to the first frequency spectrum resource being less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the wireless base station, and being less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the wireless base station.

20. A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of the method of any of claims 1-11.

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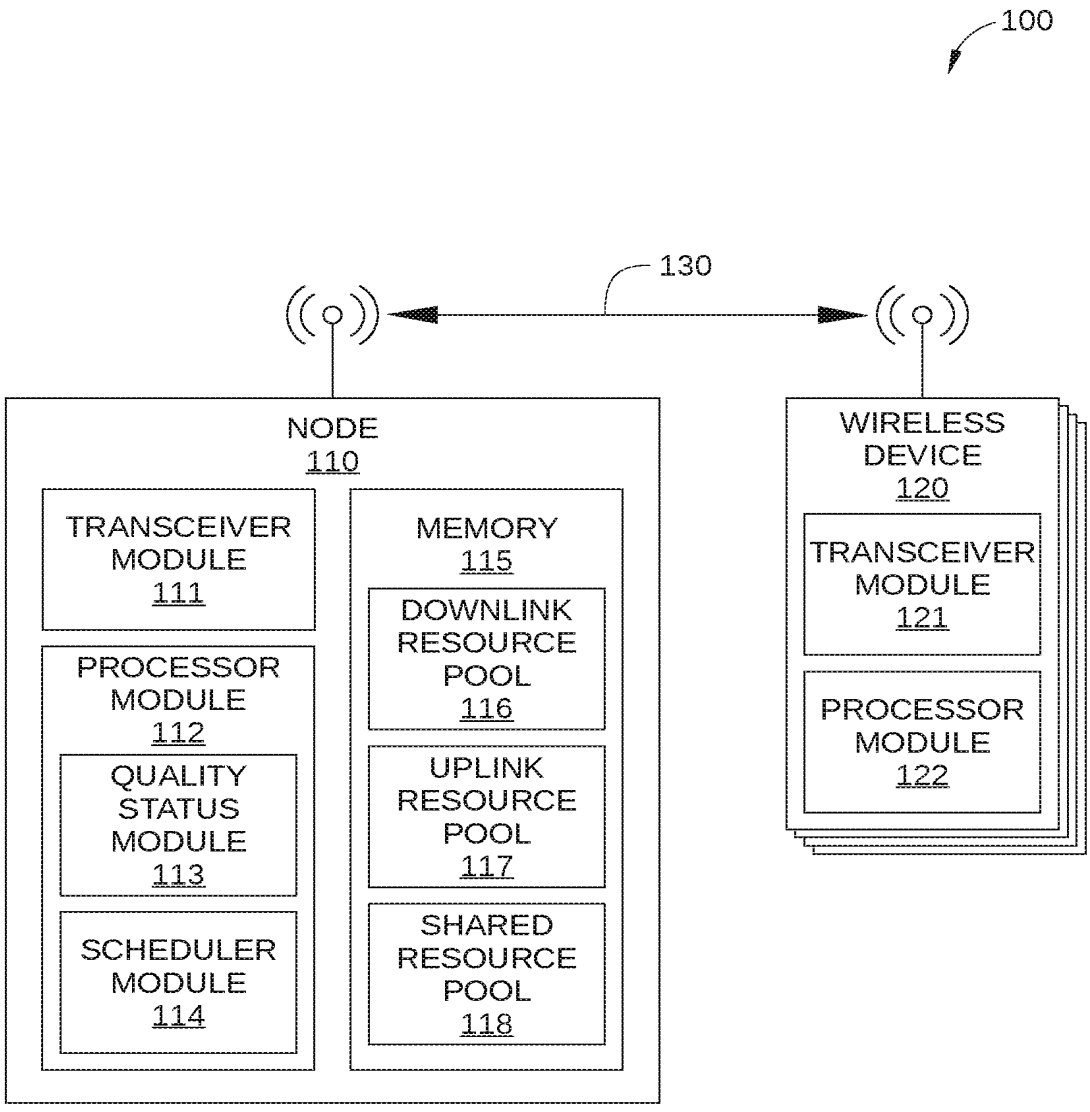

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NODE
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PROCESSOR MODULE
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QUALITY STATUS MODULE
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SCHEDULER MODULE
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MEMORY
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DOWNLINK RESOURCE POOL
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UPLINK RESOURCE POOL
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SHARED RESOURCE POOL
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WIRELESS DEVICE
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TRANSCEIVER MODULE
121
PROCESSOR MODULE
122

FIG. 1

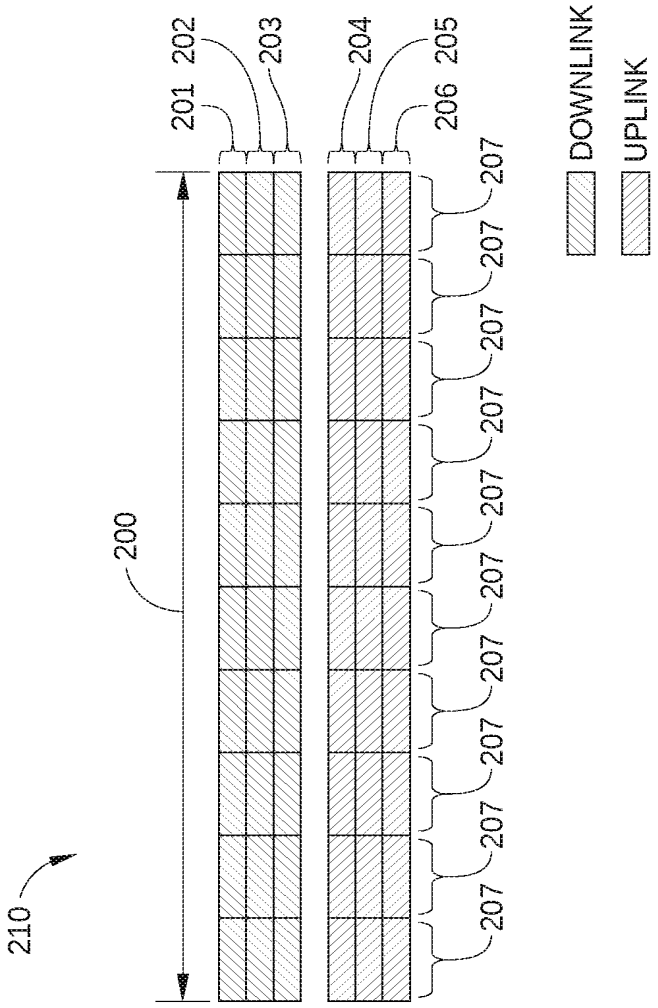


FIG. 2A

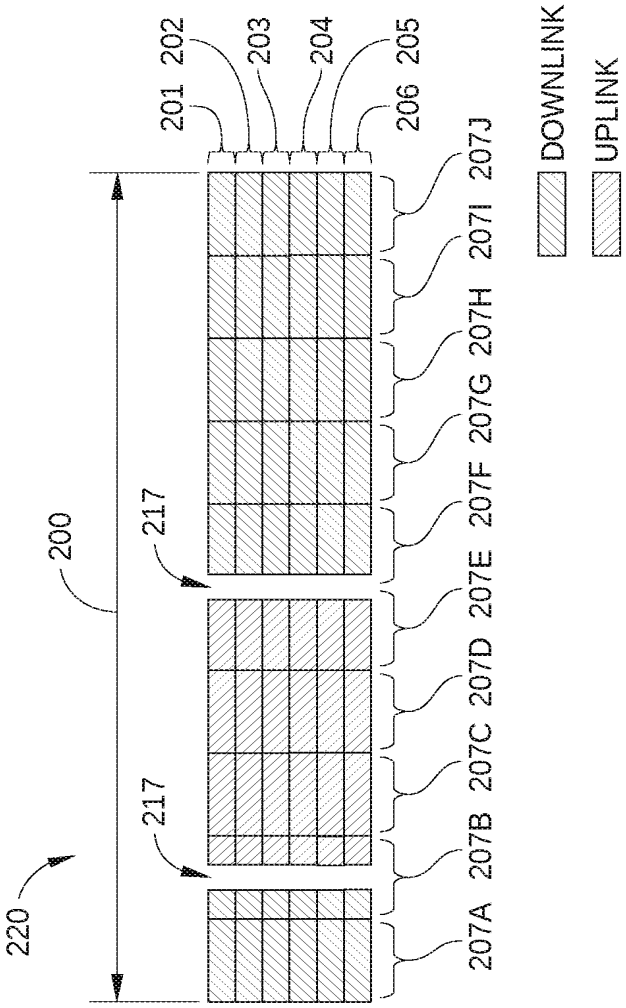

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FIG. 2B

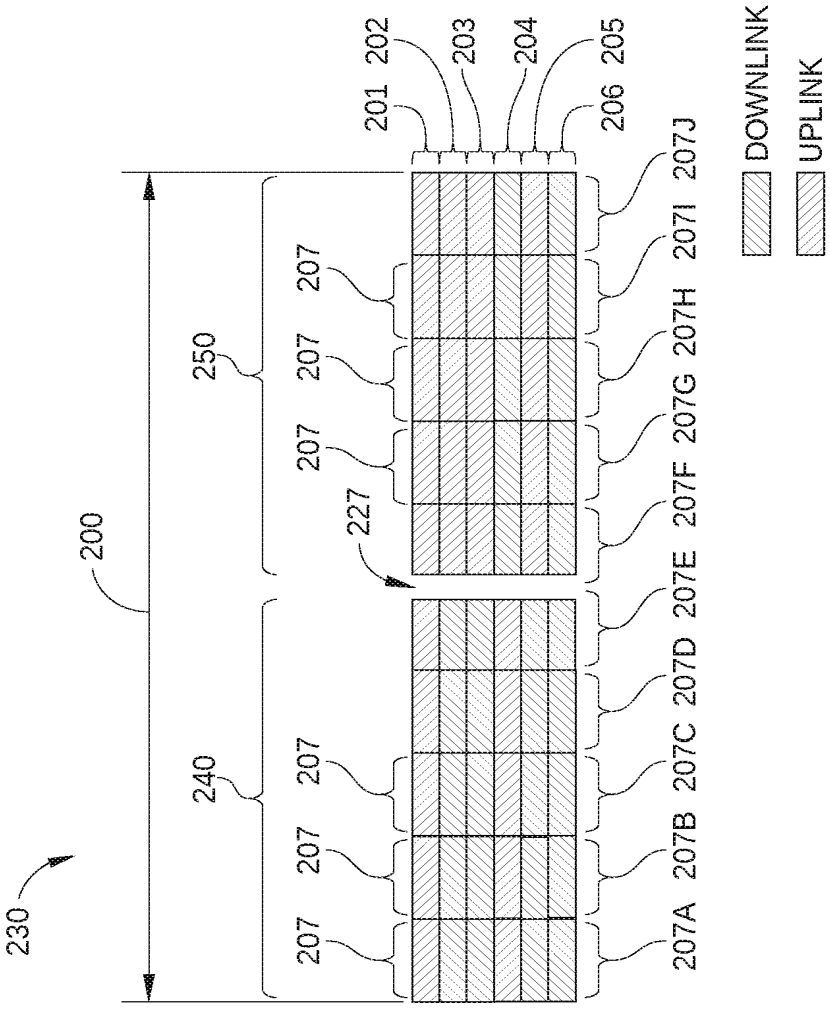

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DOWNLINK
UPLINK

FIG. 2C

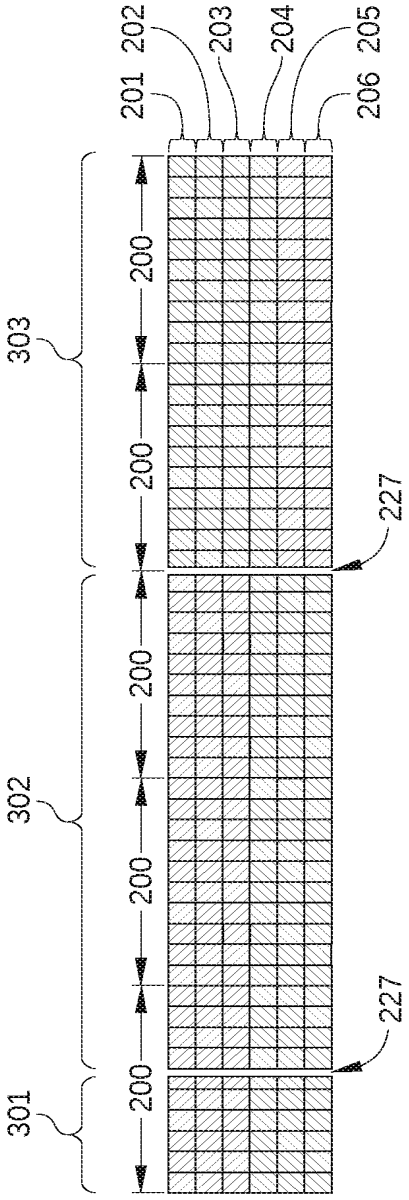


FIG. 3

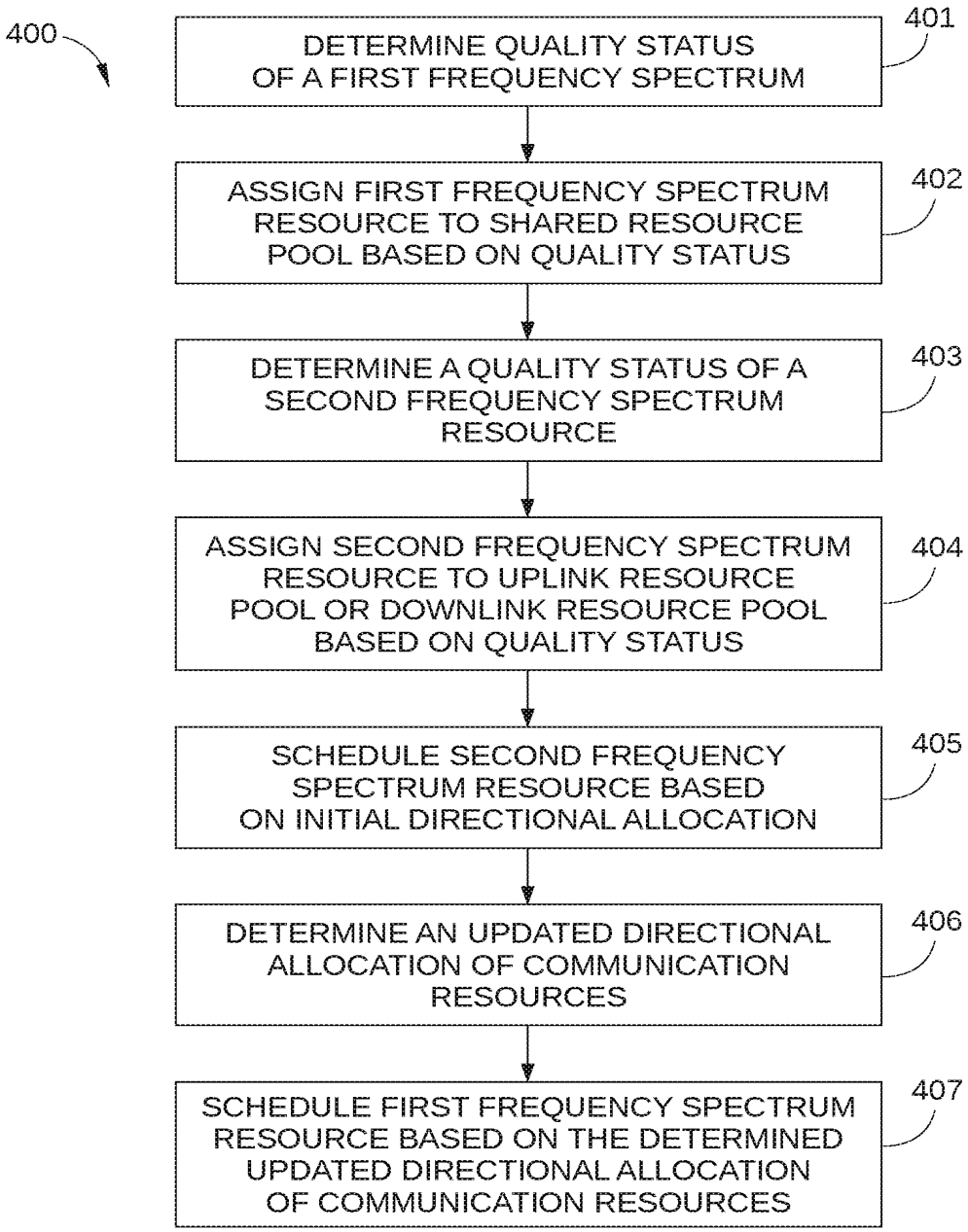

400
DETERMINE QUALITY STATUS OF A FIRST FREQUENCY SPECTRUM
401
ASSIGN FIRST FREQUENCY SPECTRUM RESOURCE TO SHARED RESOURCE POOL BASED ON QUALITY STATUS
402
DETERMINE A QUALITY STATUS OF A SECOND FREQUENCY SPECTRUM RESOURCE
403
ASSIGN SECOND FREQUENCY SPECTRUM RESOURCE TO UPLINK RESOURCE POOL OR DOWNLINK RESOURCE POOL BASED ON QUALITY STATUS
404
SCHEDULE SECOND FREQUENCY SPECTRUM RESOURCE BASED ON INITIAL DIRECTIONAL ALLOCATION
405
DETERMINE AN UPDATED DIRECTIONAL ALLOCATION OF COMMUNICATION RESOURCES
406
SCHEDULE FIRST FREQUENCY SPECTRUM RESOURCE BASED ON THE DETERMINED UPDATED DIRECTIONAL ALLOCATION OF COMMUNICATION RESOURCES
407

FIG. 4

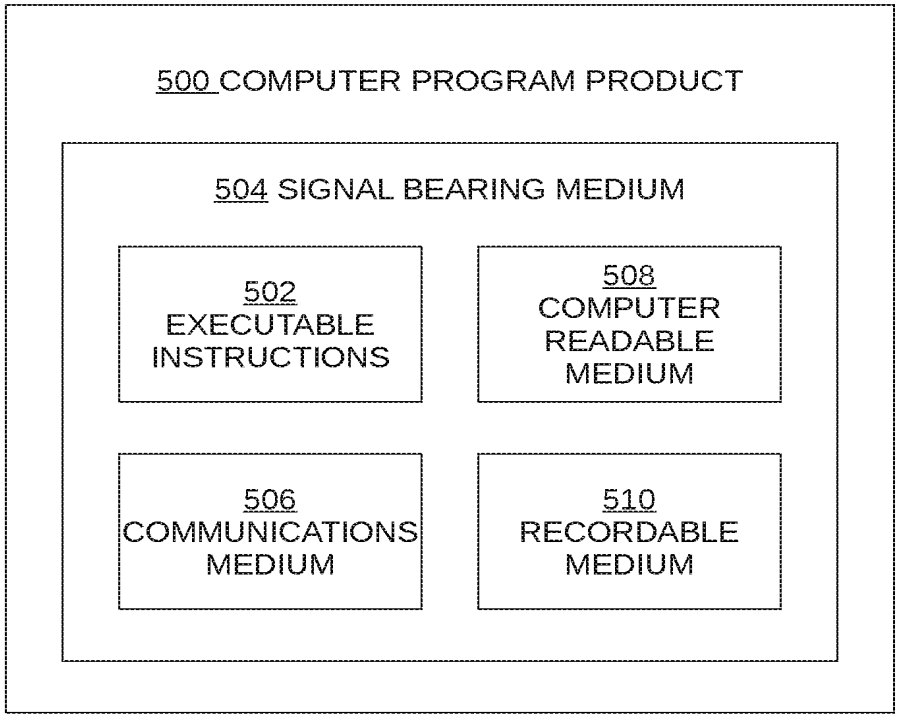

500 COMPUTER PROGRAM PRODUCT
504 SIGNAL BEARING MEDIUM
502 EXECUTABLE INSTRUCTIONS
508 COMPUTER READABLE MEDIUM
506 COMMUNICATIONS MEDIUM
510 RECORDABLE MEDIUM

FIG. 5

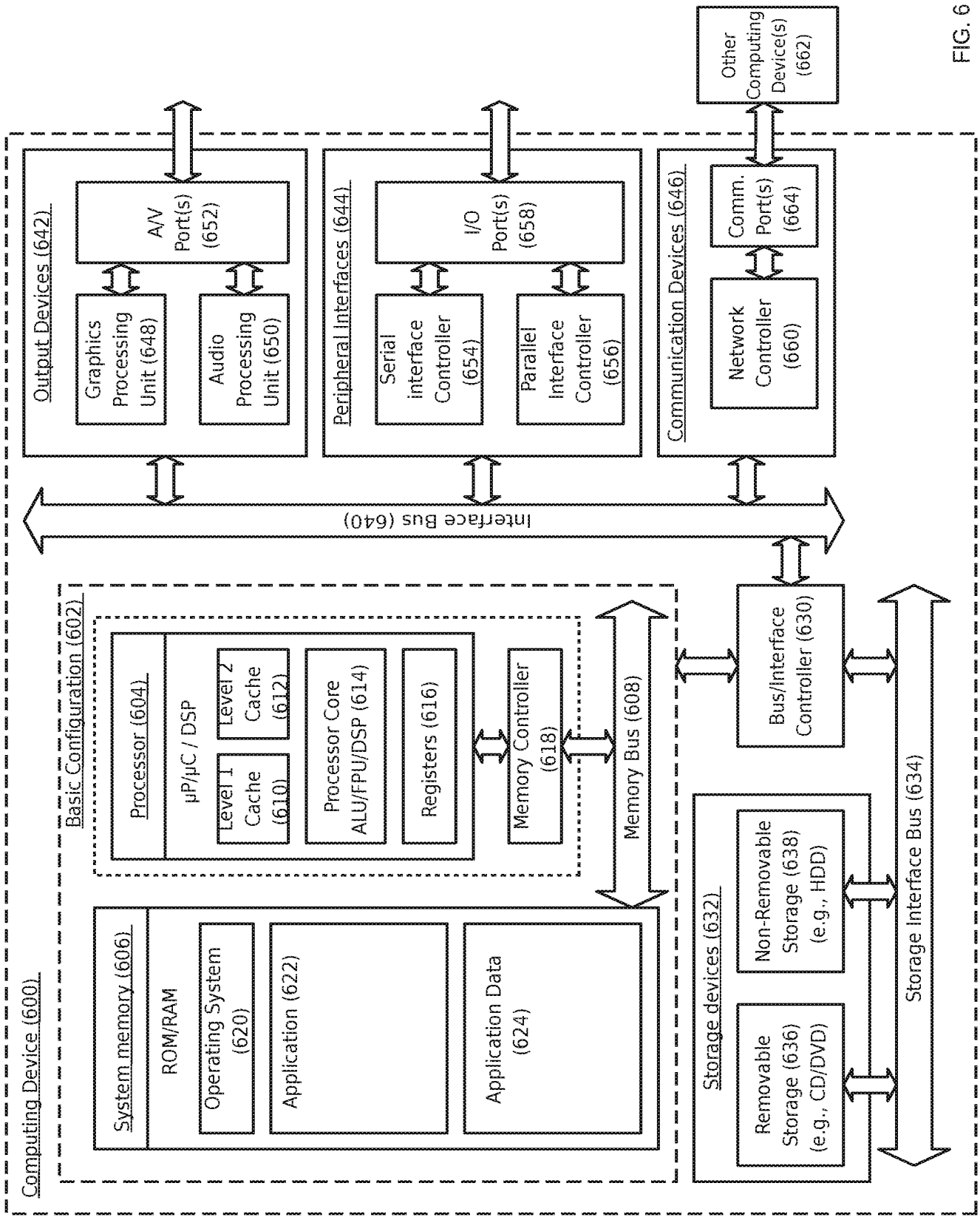

Computing Device (600)
Basic Configuration (602)
Processor (604)
μP/μC / DSP
Level 1 Cache (610)
Level 2 Cache (612)
Processor Core ALU/FPU/DSP (614)
Registers (616)
Memory Controller (618)
System memory (606)
ROM/RAM
Operating System (620)
Application (622)
Application Data (624)
Memory Bus (608)
Output Devices (642)
Graphics Processing Unit (648)
Audio Processing Unit (650)
A/V Port(s) (652)
Peripheral Interfaces (644)
Serial interface Controller (654)
Parallel Interface Controller (656)
I/O Port(s) (658)
Communication Devices (646)
Network Controller (660)
Comm. Port(s) (664)
Other Computing Device(s) (662)
Interface Bus (640)
Bus/Interface Controller (630)
Storage devices (632)
Removable Storage (636) (e.g., CD/DVD)
Non-Removable Storage (638) (e.g., HDD)
Storage Interface Bus (634)

FIG. 6

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CONFIRMATION NO. 4629

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Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

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Date Mailed: 04/27/2017

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Power of Attorney: The patent practitioners associated with Customer Number 97149

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This application is a 371 of PCT/CN2014/083578 08/01/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/500,928**

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Early Publication Request: No
Title

ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/500,928

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	480
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1480

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
15/500,928	Anpeng HUANG	I1013.10213US01

97149
Maschoff Brennan
1389 Center Drive, Suite 300
Park City, UT 84098

INTERNATIONAL APPLICATION NO.	
PCT/CN2014/083578	
I.A. FILING DATE	PRIORITY DATE
08/01/2014	

CONFIRMATION NO. 4629
371 FORMALITIES LETTER

OC000000090931913

Date Mailed: 04/27/2017

Notification of Insufficiency Under 37 CFR 1.492 and/or 1.495 (DO/EO/US)

The following items have been submitted by the applicant or the International Bureau to the United States Patent and Trademark Office as a Designated / Elected Office (37 CFR 1.495).

- Copy of the International Application filed on 01/31/2017
- Copy of the International Search Report filed on 01/31/2017
- Preliminary Amendments filed on 01/31/2017
- Information Disclosure Statements filed on 01/31/2017
- U.S. Basic National Fees filed on 01/31/2017
- Power of Attorney filed on 01/31/2017
- Specification filed on 01/31/2017
- Claims filed on 01/31/2017
- Abstracts filed on 01/31/2017
- Drawings filed on 01/31/2017
- Authorization to Permit Access filed on 01/31/2017
- Application Data Sheet (37 CFR 1.76) filed on 01/31/2017

The following items **MUST** be furnished within the period set forth below:

- To avoid abandonment, a surcharge (for late submission of search fee, examination fee or inventor's oath or declaration) as set forth in 37 CFR 1.492(h) of $140 for an undiscounted entity , must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fees required for this application is $**140** for an Undiscounted Entity:

- $**140** Surcharge.

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.495(c).

- Properly executed inventor's oath or declaration for the following inventor(s) has not been submitted: **Anpeng HUANG**

ALL OF THE ITEMS SET FORTH ABOVE MUST BE SUBMITTED WITHIN TWO (2) MONTHS FROM THE DATE OF THIS NOTICE. FAILURE TO PROPERLY RESPOND WILL RESULT IN ABANDONMENT.

FORM PCT/DO/EO/923 (371 Formalities Notice)

The time period set above may be extended by filing a petition and fee for extension of time under the provisions of 37 CFR 1.136(a).

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

RODERICK M JONES

Telephone: (571) 272-9083

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
15500928	

Applicant(s) Anpeng HUANG

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT			*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend		Indep	Depend	Indep	Depend	Indep	Depend
1	1		1				51						
2		1		1			52						
3		1		1			53						
4		1		1			54						
5		1		1			55						
6		1		1			56						
7		1		1			57						
8		1		1			58						
9		1		1			59						
10		1		1			60						
11	1		1				61						
12		1		1			62						
13		1		1			63						
14		1	---	---			64						
15		1		1			65						
16		1		1			66						
17		1		1			67						
18		1		1			68						
19		1		1			69						
20		11		1			70						
21							71						
22							72						
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41							91						
42							92						
43							93						
44							94						
45							95						
46							96						
47							97						
48							98						
49							99						
50							100						
Total Indep	2		2		0								
Total Depend	28	↵	17	↵	0	↵							
Total Claims	30		19		0								

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/CN2014/083578 filed on August 1, 2014.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Anpeng HUANG Date (Optional): May 5 2017

Signature: Anpeng Huang

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	15500928
Filing Date:	31-Jan-2017
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Filer:	Robert Burns Israelsen/Vanessa Mangum
Attorney Docket Number:	I1013.10213US01

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
OATH/DECL > 30 MOS FROM 371 COMMENCEMENT	1617	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**140**

Electronic Acknowledgement Receipt

EFS ID:	29165844
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	97149
Filer:	Robert Burns Israelsen/Vanessa Mangum
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	I1013.10213US01
Receipt Date:	11-MAY-2017
Filing Date:	31-JAN-2017
Time Stamp:	12:27:09
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$140
RAM confirmation Number	051117INTEFSW12281500
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	I1013-10213US01_Declaration.pdf	362660 ce5ac72a0328e90b219574af98198df65764bffc	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30886 9a5bb406337cbc694edcf9fa5a4f4826d4d74b5c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	393546		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
15/500,928		2414	40037

PAIR Correspondence Address/Fee Address Change

The following fields have been changed to Customer Number 144521 on 05/17/2017 via Private PAIR in view of the certification copied below that authorized the change.

- Maintenance Fee Address

The address for Customer Number 144521 is:
144521
Xinova, LLC
701 5th AVE
Suite 4100
Seattle, WA 98104

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/R. Burns Israelsen/
Name:	R. Burns Israelsen
Registration Number:	42685

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	REQUEST ID
15/500,928		2414	40037

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- Correspondence Address

The address for Customer Number 144521 is:
144521
Xinova, LLC
701 5th AVE
Suite 4100
Seattle, WA 98104

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature:	/R. Burns Israelsen/
Name:	R. Burns Israelsen
Registration Number:	42685

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/500,928	01/31/2017	Anpeng HUANG	I1013.10213US01

CONFIRMATION NO. 4629

144521
Xinova, LLC
701 5th AVE
Suite 4100
Seattle, WA 98104

PUBLICATION NOTICE

OC000000093219122

Title:ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

Publication No.US-2017-0223719-A1
Publication Date:08/03/2017

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/500,928	01/31/2017	2414	1620	I1013.10213US01	19	2

CONFIRMATION NO. 4629

UPDATED FILING RECEIPT

144521
Maschoff Brennan/Allied Inventors
111 East Broadway, Suite 725
Salt Lake City, UT 84111

OC000000098527100

Date Mailed: 01/09/2018

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
Anpeng HUANG, Beijing, CHINA;

Applicant(s)
EMPIRE TECHNOLOGY DEVELOPMENT LLC, Wilmington, DE;
Anpeng HUANG, Beijing, CHINA

Assignment For Published Patent Application
EMPIRE TECHNOLOGY DEVELOPMENT LLC, Wilmington, DE

Power of Attorney: The patent practitioners associated with Customer Number 97149

Domestic Priority data as claimed by applicant
This application is a 371 of PCT/CN2014/083578 08/01/2014

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 04/26/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/500,928**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

Preliminary Class

370

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/500,928

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	480
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1480

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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United States Patent and Trademark Office
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P.O. Box 1450
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U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
15/500,928	Anpeng HUANG	I1013.10213US01

144521
Maschoff Brennan/Allied Inventors
111 East Broadway, Suite 725
Salt Lake City, UT 84111

INTERNATIONAL APPLICATION NO.	
PCT/CN2014/083578	
I.A. FILING DATE	PRIORITY DATE
08/01/2014	

CONFIRMATION NO. 4629
371 ACCEPTANCE LETTER

OC000000096527101

Date Mailed: 01/09/2018

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

01/31/2017
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Copy of the International Application filed on 01/31/2017
- Copy of the International Search Report filed on 01/31/2017
- Preliminary Amendments filed on 01/31/2017
- Information Disclosure Statements filed on 01/31/2017
- Inventor's Oath or Declaration filed on 05/11/2017
- U.S. Basic National Fees filed on 01/31/2017
- Power of Attorney filed on 01/31/2017
- Specification filed on 01/31/2017
- Claims filed on 01/31/2017
- Abstracts filed on 01/31/2017
- Drawings filed on 01/31/2017
- Authorization to Permit Access filed on 01/31/2017
- Application Data Sheet (37 CFR 1.76) filed on 01/31/2017

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

RODERICK M JONES

Telephone: (571) 272-9083

FORM PCT/DO/EO/903 (371 Acceptance Notice)

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15500928
Filing Date	2017-01-31
First Named Inventor	Anpeng HUANG
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	I1013.10213US01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2013170426	WO	A1	2013-11-21	NOKIA CORPORATION		
	2	3142434	EP	A1	2017-03-15	Yulong Computer Telecommunication Scientific		

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NON-PATENT LITERATURE DOCUMENTS Remove

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15500928
	Filing Date	2017-01-31
	First Named Inventor	Anpeng HUANG
	Art Unit	2464
	Examiner Name	Ricky Quoc Ngo
	Attorney Docket Number	I1013.10213US01

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	CHEN, L., et al., "Dynamic timeslot allocation algorithms suitable for asynmetric traffic in multimedia TOMA/TDD cellular radio," 48th IEEE Vehicular Technology Conference, Vol. 02, pp. 1424-1428 (May 18, 1998)	
	2	Extended European Search Report for European Patent Application No. EP14899031.0 mailed on February 16, 2018, Pages 11	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15500928
Filing Date	2017-01-31
First Named Inventor	Anpeng HUANG
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	I1013.10213US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/R. Burns Israelsen, Reg. No. 42685/	Date (YYYY-MM-DD)	2018-03-02
Name/Print	R. Burns Israelsen	Registration Number	42685

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	31917636
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	144521
Filer:	Robert Burns Israelsen/Claire Rigby
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	I1013.10213US01
Receipt Date:	02-MAR-2018
Filing Date:	31-JAN-2017
Time Stamp:	11:10:03
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	CN-879177-02-US-NAT_FP1.pdf	1139993 4e186579a5db26a9f1f5ef950e7fd79a99470823	no	29

Warnings:

Information:					
2	Foreign Reference	CN-879177-02-US-NAT_FP2.pdf	1223422 a8ede4aaafc11cd4d406a0c3117c5bf2bd364ac0	no	16
Warnings:					
Information:					
3	Non Patent Literature	CN-879177-02-US-NAT_NPL1.pdf	282207 f1c79f995d7f107c75c897344bd02688cdcefe8e	no	5
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The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
4	Non Patent Literature	CN-879177-02-US-NAT_NPL2.pdf	416361 f0e57b8ea847088b0c5b9d8778db2e245e447dbe	no	11
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	CN-879177-02-US-NAT_IDS.PDF	1035332 21e0dd790564c73bef1d964edec0cf1a1000a0cb	no	4
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A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 November 2013 (21.11.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/170426 A1

(51) International Patent Classification:
H04W 72/04 (2009.01)

(21) International Application Number:
PCT/CN2012/075466

(22) International Filing Date:
14 May 2012 (14.05.2012)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FI-02150 Espoo (FI).

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[Continued on next page]

(54) Title: METHOD FOR TIME DIVISION DUPLEX UPLINK-DOWNLINK CONFIGURATION INDICATION

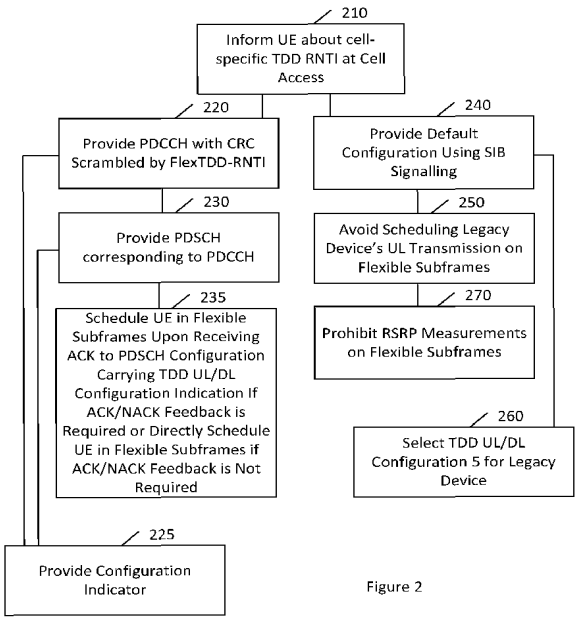


Figure 2

(57) Abstract: Communication systems, such as the long term evolution (LTE) advanced (LTE-A) of the third generation partnership project (3 GPP) may benefit from various enhancements. These enhancements can include LTE time division duplex (TDD) enhancements for traffic adaptation and uplink (UL) - downlink (DL) configuration indication. A method can include informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access. The method can also include providing a downlink control channel having a cyclic redundancy check scrambled by the identifier. The method can further include providing a configuration indicator.

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METHOD FOR TIME DIVISION DUPLEX UPLINK-DOWNLINK CONFIGURATION INDICATION

BACKGROUND:

Field:

[0001] Communication systems, such as the long term evolution (LTE) advanced (LTE-A) of the third generation partnership project (3GPP) may benefit from various enhancements. These enhancements can include LTE time division duplex (TDD) enhancements for traffic adaptation and uplink (UL) – downlink (DL) configuration indication.

Description of the Related Art:

[0002] Currently, LTE TDD allows for asymmetric UL-DL allocations by providing seven different semi-statically configured TDD UL-DL configurations shown in Figure 1. These allocations can provide between 40% and 90% DL subframes. The current mechanism for adapting UL-DL allocation is based on the system information change procedure with a 640ms period. The concrete TDD UL/DL configuration is semi-statically informed by system information block, type 1 (SIB-1) signaling.

[0003] As shown in Figure 1, the various UL-DL allocations can have either 5 ms or 10 ms switching point periodicity. Moreover, the allocations can include allocations for downlink, D, uplink U, and special S. The special subframes can be, for example, a guard period.

[0004] TDD UL/DL configuration indication in LTE is currently based on the system information change procedure with a 640 ms period. The concrete TDD UL/DL configuration is semi-statically informed by SIB-1 signaling.

[0005] In addition to the explicit TDD UL/DL configuration indication, there is another mode for dynamic TDD UL/DL reconfiguration called transparent mode. In this mode, UE does not need to know the actual TDD UL/DL configuration and the transmission or receiving on the flexible subframe, for example subframe 3, 4, 7, 8 or 9, is completely dependent on eNB scheduling. In this case, UE will have no behavior unless eNB sends scheduling signaling.

However, the UE may not know which subframe can be used for ACK/NACK feedback due to not being aware of a concrete TDD UL/DL configuration.

[0006] Moreover, it may be valuable to set a TDD reconfiguration period to be 10ms, as opposed to a longer period such as 200 ms or 640 ms. The current semi-static mechanism for TDD UL/DL configuration indication, namely via SIB-1 signaling in a period of 640 ms, cannot adapt to fast TDD UL/DL reconfiguration, no matter what TDD reconfiguration switching scale is used: 10ms, 30ms, 200ms or any other scale less than 640ms.

SUMMARY:

[0007] According to certain embodiments, a method includes informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access stage. The method also includes providing a downlink control channel having a cyclic redundancy check scrambled by the identifier. The method further includes providing a configuration indicator.

[0008] In certain embodiments, a method includes determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage. The method also includes decoding downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

[0009] An apparatus, according to certain embodiments, includes at least one processor and at least one memory including computer program code. The at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to inform a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access. The at least one memory and the computer program code are also configured to, with the at least one processor, cause the apparatus at least to provide a downlink control channel having a cyclic redundancy check scrambled by the identifier. The at least one memory and the computer program code are further configured to, with the at least one processor, cause the

apparatus at least to provide a configuration indicator.

[0010] An apparatus, in certain embodiments, includes at least one processor and at least one memory including computer program code. The at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to determine that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage. The at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to decode downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

[0011] According to certain embodiments, an apparatus includes informing means for informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access. The apparatus also includes control means for providing a downlink control channel having a cyclic redundancy check scrambled by the identifier. The apparatus further includes sharing means for providing a configuration indicator.

[0012] In certain embodiments, an apparatus includes determining means for determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage. The apparatus also includes decoding means for decoding downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

[0013] A non-transitory computer-readable medium is, according to certain embodiments, encoded with instructions that, when executed in hardware, perform a process. The process includes informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access. The process also includes providing a downlink control channel having a cyclic redundancy check scrambled by the identifier. The process further includes providing a configuration indicator.

[0014] A non-transitory computer-readable medium is, in certain embodiments,

encoded with instructions that, when executed in hardware, perform a process. The process includes determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage. The process also includes decoding downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0015] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0016] Figure 1 illustrates seven current kinds of TDD UL/DL configurations.

[0017] Figure 2 illustrates a method according to certain embodiments.

[0018] Figure 3 illustrates another method according to certain embodiments.

[0019] Figure 4 illustrates a system according to certain embodiments.

DETAILED DESCRIPTION:

[0020] Certain embodiments enhance current time division duplex (TDD) configuration indication mechanisms for fast TDD uplink (UL)/ downlink (DL) reconfiguration and provide new TDD UL/DL configuration indication mechanisms. Moreover, certain embodiments provide for fast and reliable TDD UL/DL configuration indication. For example, certain embodiments provide a fast TDD UL/DL configuration indication mechanism for dynamic TDD UL/DL configuration, which can facilitate quick TDD reconfiguration switching, for example, on a scale of 10 ms, 30 ms, 200 ms, or any other scale less than 640 ms. In certain embodiments, this is obtained through the use of L2 control.

[0021] In certain embodiments, the base station, access point or eNode B (eNB) can inform a dynamic TDD-capable user equipment (UE) of the cell-specific flexible TDD radio network temporary identifier (FlexTDD-RNTI) at the cell access stage.

[0022] Medium access control (MAC) signaling can be used to indicate the

cell-specific TDD UL/DL configuration after the TDD UL/DL configuration is determined by eNB. One physical downlink control channel (PDCCH) with cyclic redundancy check (CRC) scrambled by FlexTDD-RNTI can be decoded by all the capable UEs. The corresponding physical downlink shared channel (PDSCH) can carry the MAC signaling to indicate the current TDD UL/DL configuration or the TDD UL/DL configuration to be used for next radio frame, which may be dependent on eNB configuration.

[0023] The PDCCH with CRC scrambled by FlexTDD-RNTI can be transmitted in DL subframes with a fixed subframe index and with the period configured by eNB. A dynamic TDD-capable UE can be configured by higher layers to decode PDCCH with CRC scrambled by FlexTDD-RNTI in DL subframes with fixed subframe index with the period configured by eNB.

[0024] After detecting this radio network temporary identifier (RNTI), the UE can decode the PDCCH and the corresponding PDSCH in the same DL subframe and feed back an acknowledgment (ACK)/ negative acknowledgment (NACK) to the eNB for confirmation.

[0025] In detail, if the UE correctly decodes this PDSCH and gets the current TDD UL/DL configuration or next radio frame configuration which depends on eNB configuration, then the UE can feed back ACK to eNB. If UE does not correctly decode this PDSCH then the UE can feed back NACK to eNB. If the UE does not detect this RNTI, the UE can avoid feeding back to the eNB at all.

[0026] Additionally, physical layer signaling can also be used to indicate the cell-specific TDD UL/DL configuration after the TDD UL/DL configuration is determined by the eNB. One physical downlink control channel (PDCCH) with cyclic redundancy check (CRC) scrambled by FlexTDD-RNTI can be decoded by all the capable UEs. The PDCCH can contain several bits to indicate the current TDD UL/DL configuration or the TDD UL/DL configuration to be used for next radio frame, which may be dependent on the eNB configuration.

[0027] The PDCCH with CRC scrambled by FlexTDD-RNTI can be transmitted in DL subframes with a fixed subframe index and with a period configured by the eNB. A dynamic TDD-capable UE can be configured by

higher layers to decode PDCCH with CRC scrambled by FlexTDD-RNTI in DL subframes with a fixed subframe index with the period configured by the eNB. After detecting this radio network temporary identifier (RNTI), the UE can decode the PDCCH and feed back an acknowledgment (ACK) to the eNB for confirmation. After receiving the ACK corresponding to the PDCCH carrying TDD UL/DL configuration indication, the eNB can know the UE has correctly obtained the knowledge of the current TDD UL/DL configuration and can schedule the UE in the flexible subframes.

[0028] Certain embodiments, therefore, can avoid false alarm issues. Thus, benefits of dynamic TDD reconfiguration can be achieved. For example, a fast and reliable TDD UL/DL configuration indication mechanism can be used for dynamic TDD UL/DL configuration, which can avoid false alarm issues and guarantee the reliability of TDD UL/DL configuration indication.

[0029] According to certain embodiments, a user equipment can initially report its capability of supporting dynamic TDD UL/DL reconfiguration to an eNB. Moreover, the UE can be configured by higher layer signaling to decode PDCCH with CRC scrambled by FlexTDD-RNTI in, for example, DL subframe 0 with eNB configured periodicity, such as 10 ms, 30 ms, or the like.

[0030] The eNB can select the most appropriate TDD UL/DL configuration according to traffic fluctuation in UL and DL. Moreover, the eNB can send MAC signaling to the UE supporting the feature of dynamic TDD UL/DL reconfiguration, to indicate the current TDD UL/DL configuration. One PDCCH with CRC scrambled by FlexTDD-RNTI can be decoded by all the capable UEs.

[0031] After detecting FlexTDD-RNTI, a capable UE can decode the PDCCH and the corresponding PDSCH carrying MAC signaling and feed back ACK/NACK to eNB for confirmation. For example, as mentioned above, if the UE correctly decodes this PDSCH then UE can feed back ACK to eNB, but if the UE does not correctly decode this PDSCH then the UE can feed back NACK to eNB. On the other hand, the UE does not need to provide any feedback if the UE is not able to detect the RNTI. The UEs that lack the

capabilities described herein can simply ignore the PDCCH with CRC scrambled by FlexTDD-RNTI.

[0032] After receiving the ACK/NACK corresponding to the TDD UL/DL configuration indication, the eNB can know the UE has correctly obtained the knowledge of the current TDD UL/DL configuration and can schedule the UE in the flexible subframes.

[0033] For detailed implementation, the TDD UL/DL configuration can be indicated by 3 bits indexed from 0 to 6 corresponding to current TDD UL/DL configurations 0 to 6. Then these 3 bits can be added in a MAC packet data unit (PDU), together with the MAC header. After that, this MAC packet can be sent to physical layer and transmitted on the PDSCH.

[0034] Additionally, if eNB supporting dynamic TDD UL/DL reconfiguration only selects the TDD UL/DL configurations with 5 ms switching point, such as TDD UL/DL configuration 0, 1, 2 and 6 or the configurations with 10 ms switching point, such as TDD UL/DL configuration 3, 4 and 5 to simplify the HARQ timing or PUSCH timing issues. In that case, the TDD UL/DL configuration can be indicated by 2 bits indexed from 0 to 3 corresponding to TDD UL/DL configuration 0, 1, 2 and 6 or indexed from 0 to 2 corresponding to TDD UL/DL configuration 3, 4 and 5.Then the 2 bits can be added in a MAC packet data unit together with the MAC header and transmitted on PDSCH.

[0035] The PDCCH with downlink control information (DCI) format 1C can be transmitted in common search space and used for very compact scheduling of one PDSCH codeword. In this example, DCI format 1C in common search space is used to schedule the PDSCH carrying TDD UL/DL configuration in MAC layer. DCI format 1C can be transmitted with CRC scrambled by FlexTDD-RNTI. This RNTI can have the same length as the CRC. For example, it can be a pseudo-random sequence of 16 bits length.

[0036] After detecting this DCI with CRC scrambled by FlexTDD-RNTI, the UE can decode the PDCCH and the corresponding PDSCH and feed back ACK/NACK to eNB for confirmation.

[0037] On the other hand, TDD UL/DL configuration indication can be

specified in one or more fixed DL subframes, such as subframe 0, 1, 5 or 6. The UE can detect this DCI with CRC scrambled by FlexTDD-RNTI in the specified subframe, which may decrease the number of blind detections.

[0038] In one implementation, the UE is assumed to read PDCCH with CRC scrambled by FlexTDD-RNTI in every subframe 0, in order to enable timely change for TDD UL/DL configuration. In this implementation, the UE does not need to feed back ACK/NACK in order to enable timely changes in this same subframe and reduce the signaling overhead. The ACK/NACK feedback may take several ms in a frame. Since the configuration can be informed every 10ms, and can repeatedly contain similar information if the configuration does not change rapidly, it may be acceptable for the UE to miss one detection or for a DRX UE to miss the change information.

[0039] Allowing for backward compatibility of the dynamic TDD UL/DL reconfiguration for legacy UEs, SIB-1 signaling can also be used for TDD UL/DL configuration indication. For example, TDD UL/DL configuration 5 can be indicated to legacy UE and eNB can avoid scheduling a legacy UE's uplink transmission in subframe 3, 4, 7, 8 or 9. In this way, backward compatibility can be guaranteed with a predictable amount of UL throughput loss.

[0040] Considering the reference signal received power (RSRP) measurement for legacy UEs, RSRP measurement on flexible subframes can be prohibited. Alternatively, the eNB can indicate to the legacy UE that the flexible subframes are configured as almost blank subframe (ABSF).

[0041] Certain embodiments of a flexible TDD UL/DL configuration indication procedure for dynamic TDD can have various components. The components can includes PDCCH with CRC scrambled by "FlexTDD-RNTI"; MAC signaling of a UL/DL configuration; ACK/NACK feedback for the configuration, which acknowledgment process can be disabled by a base station (BS); and RRC signaling on capable UE access procedure to let capable UE override the TDD UL/DL configuration indicated by the SIB-1 signaling and get knowledge of the "FlexTDD-RNTI" and change period, and the like

features described herein.

[0042] As such, certain embodiments involve a combination of features. For example, the RRC signaling and MAC signaling may only be visible for a capable UE, and a legacy UE can still follow the SIB1 information.

[0043] For example, in certain embodiments, a MAC signaling can indicate the cell-specific TDD UL/DL configuration for a capable UE to override the current UL/DL configuration indicated from SIB-1. The configurations can be directly indicated by different RNTIs, or a single RNTI can be used for all configurations.

[0044] The legacy UE cannot read the MAC signaling, and consequently will still follow SIB-1. The TDD UL/DL configuration 5, or another DL heavy configuration, can be indicated to the legacy UE before the eNB decides to use frequently dynamic UL/DL configuration change. The eNB can avoid scheduling a legacy UE's uplink transmission in subframe 3, 4, 7, 8 or 9. In this way, backward compatibility can be accomplished while sacrificing a predetermined amount of uplink throughput.

[0045] FlexTDD-RNTI can be used to indicate to compatible UEs whether a current subframe contains the TDD UL/DL configuration indication signaling. The PDCCH with CRC scrambled by FlexTDD-RNTI can be transmitted in DL subframes with fixed subframe index with a period configured by the eNB.

[0046] A flexible ACK/NACK procedure for TDD UL/DL configuration can be used. For a slower TDD UL/DL configuration period, the ACK/NACK procedure can be used for TDD configuration indication without inducing significant delay, and the dynamic UL/DL configuration changes can be assumed only for small cell, which will not attach too many UEs, thus creating no blocking due to these feedbacks. For faster TDD UL/DL configuration period, a simple procedure can be used to avoid the delay of ACK/NACK confirmation.

[0047] The FlexTDD-RNTI can be cell-specific. In implementation, one PDCCH with CRC scrambled by FlexTDD-RNTI can be decoded by all the capable UEs. A corresponding PDSCH can carry the UL/DL configuration

indication, which can also be cell specific.

[0048] A higher layer configuration for capable UE can allow capable UE to decode PDCCH with CRC scrambled by "FlexTDD-RNTI" in DL subframes with fixed subframe index with the period configured by eNB to get the new UL/DL configuration in relevant PDSCH, and then override the DL/UL configuration information from SIB-1 signaling. With this, the capable UE can get the FlexTDD-RNTI of this cell, and know the fixed subframe and period. By default, the fixed subframe can be subframe (SF) #0 and the period can be 10ms. The UE may or may not need to feed back the ACK/NACK. This procedure can occur in an attach procedure.

[0049] A legacy UE does not need to know the FlexTDD-RNTI, and SIB-1 signaling can still be used for TDD UL/DL configuration indication. The eNB can indicate TDD UL/DL configuration 5, or another DL heavy configuration, to the legacy UE before the eNB decides to use frequently dynamic UL/DL configuration changes. The eNB, in such cases, can avoid scheduling a legacy UE's uplink transmission in subframe 3, 4, 7, 8 or 9. As mentioned above, this may provide a balance between backward compatibility and throughput.

[0050] The UL/DL configuration changes may be used, for example, in a small cell that may not attach very many UEs. Thus, no significant blocking due to feedback for the feedback procedure may occur. However, in another implementation the UEs do not need to feed back ACK/NACK.

[0051] Certain embodiments may provide benefit from dynamic TDD UL/DL reconfiguration. Moreover, certain embodiments may provide this benefit without requiring a special PDCCH format. Certain embodiments also permit an explicit TDD UL/DL configuration indication for UE. Furthermore, certain embodiments can guarantee the reliability of the TDD UL/DL configuration indication. Moreover, certain embodiments can avoid false alarm due to dynamic TDD UL/DL reconfiguration.

[0052] Figure 2 illustrates a method according to certain embodiments. The method of Figure 2 can be performed by, for example, a base station such as an eNode B. As shown in Figure 2, a method can include, at 210, informing a user

equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access. The informing can include medium access control or higher layer signaling, which also contains the fixed subframe index for configuration indication, period and/or require acknowledgment or not.

[0053] The method can also include, at 220, providing a downlink control channel having a cyclic redundancy check scrambled by the identifier. The downlink control channel can be transmitted in downlink subframes with a fixed subframe index and with the period configured by a base station.

[0054] The method can also include, at 225, providing a configuration indicator. The method can further, at 230, include providing a downlink shared channel corresponding to the downlink control channel. The method can also include, at 235, scheduling the user equipment in flexible subframes in which the transmission direction may change according to the time division duplex uplink-downlink configuration, upon receiving an acknowledgment in response to a configuration provided on the physical downlink shared channel if the cell requires acknowledgement, or directly if the cell does not require acknowledgment.

[0055] A configuration indicator provided by the downlink control channel or its corresponding downlink shared channel can indicate a current time division duplex uplink-downlink configuration, a time division duplex uplink-downlink configuration to be used for a next radio frame, or both. The configuration indicator on the downlink control channel can be provided via a new PDCCH format. The configuration indicator on the downlink shared channel can be provided by, for example, MAC signaling or punctured bits on fixed position.

[0056] The method can further include, at 240, providing a default configuration using system information block signaling. The method additionally include, at 250, avoiding scheduling a device with uplink transmission in subframe 3, 4, 7, 8, or 9 which are used for flexible subframes and thus conflict with the default configuration, when the device does not support flexible time division duplex configuration, for example a legacy device.

[0057] The method can also include, at 260, selecting time division duplex uplink-downlink configuration 5 for a device when the device does not support flexible time division duplex configuration, such as a legacy device. The method can further include, at 270, prohibiting reference signal received power measurement on flexible subframes.

[0058] Figure 3 illustrates another method according to certain embodiments. The method of Figure 3 may be performed by, for example, a user equipment. The method can include, at 305, reporting capability of supporting flexible time division duplex configuration to a base station. In other words, the device can report that it is capable of handling the very dynamic TDD UL/DL configuration approach described above. The method can also include, at 310, determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage. The method can further include, at 320, decoding physical downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier. The decoding can include decoding the physical downlink control channel in downlink subframes with fixed subframe index with the period configured by a base station.

[0059] The method can additionally include, at 330, decoding a physical downlink shared channel corresponding to the physical downlink control channel. The downlink shared channel can indicate a current time division duplex uplink-downlink configuration or a time division duplex uplink-downlink configuration to be used for a next radio frame.

[0060] The method can also include, at 340, feeding back an acknowledgment or negative acknowledgment to a base station regarding decoding of the physical downlink control channel. The method can additionally, include at 350, feeding back ACK when ACK/NACK feedback required, or decoding the downlink control channel without acknowledgment, when the cell does not require acknowledgment.

[0061] Figure 4 illustrates a system according to certain embodiments of the

invention. In one embodiment, a system may include two devices, such as, for example, UE 410 and eNB 420. Each of these devices may include at least one processor, respectively indicated as 414 and 424. At least one memory is provided in each device, and indicated as 415 and 425, respectively. The memory may include computer program instructions or computer code contained therein. Transceivers 416 and 426 are provided, and each device may also include an antenna, respectively illustrated as 417 and 427. Other configurations of these devices, for example, may be provided. For example, UE 410 and eNB 420 may be configured for wired communication, rather than wireless communication, and in such a case antennas 417 and 427 would illustrate any form of communication hardware, without requiring a conventional antenna.

[0062] Transceivers 416 and 426 can each, independently, be a transmitter, a receiver, or both a transmitter and a receiver, or a unit or device that is configured both for transmission and reception.

[0063] Processors 414 and 424 can be embodied by any computational or data processing device, such as a central processing unit (CPU), application specific integrated circuit (ASIC), or comparable device. The processors can be implemented as a single controller, or a plurality of controllers or processors.

[0064] Memories 415 and 425 can independently be any suitable storage device, such as a non-transitory computer-readable medium. A hard disk drive (HDD), random access memory (RAM), flash memory, or other suitable memory can be used. The memories can be combined on a single integrated circuit as the processor, or may be separate therefrom. Furthermore, the computer program instructions stored in the memory and which may be processed by the processors can be any suitable form of computer program code, for example, a compiled or interpreted computer program written in any suitable programming language.

[0065] The memory and the computer program instructions can be configured, with the processor for the particular device, to cause a hardware apparatus such as UE 410 and eNB 420, to perform any of the processes described above (see,

for example, Figures 2 and 3). Therefore, in certain embodiments, a non-transitory computer-readable medium can be encoded with computer instructions that, when executed in hardware, perform a process such as one of the processes described herein. Alternatively, certain embodiments of the invention can be performed entirely in hardware.

[0066] Furthermore, although Figure 4 illustrates a system including a UE and an eNB, embodiments of the invention may be applicable to other configurations, and configurations involving additional elements, as discussed herein. For example, the system can include both users that are capable of flexible TDD reconfiguration and also legacy UEs.

[0067] One having ordinary skill in the art will readily understand that the invention as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although the invention has been described based upon these preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of the invention. In order to determine the metes and bounds of the invention, therefore, reference should be made to the appended claims.

[0068] Glossary of Abbreviations

[0069] LTE Long term evolution

[0070] DCI Downlink control information

[0071] ABSF Almost blank subframe

[0072] DL Downlink

[0073] eNB evolved Node B

[0074] PDCCH Physical downlink control channel

[0075] PDSCH Physical downlink shared channel

[0076] PUCCH Physical uplink control channel

[0077] PUSCH Physical uplink shared channel

[0078] RRC Radio resource control

[0079] UE User equipment

[0080] UL Uplink

WHAT IS CLAIMED IS:

1. A method, comprising:

informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access;

providing a downlink control channel having a cyclic redundancy check scrambled by the identifier; and

providing a configuration indicator.

2. The method of claim 1, wherein the configuration indicator provided by downlink control channel or its corresponding downlink shared channel indicate a current time division duplex uplink-downlink configuration or a time division duplex uplink-downlink configuration to be used for the next radio frames.

3. The method of claim 1, wherein the informing comprises high layer signaling, which also contains the fixed subframe index for configuration indication, period and/or require acknowledgment or not.

4. The method of claim 1, wherein the downlink control channel is transmitted in downlink subframes with a fixed subframe index and with the period configured by a base station.

5. The method of claim 1, further comprising:

scheduling the user equipment in flexible subframes in which the transmission direction may change according to the time division duplex uplink-downlink configuration, upon receiving an acknowledgment in response to a configuration provided on the downlink control channel or downlink shared channel if the cell requires acknowledgement, or directly if the cell does not require acknowledgment.

6. The method of claim 1, further comprising:

providing a default configuration using system information block signaling.

7. The method of claim 1, further comprising:

avoiding scheduling a device with uplink transmission in subframe 3, 4, 7, 8, or 9 which are used for flexible subframes and thus conflict with the default configuration, when the device does not support flexible time division duplex configuration.

8. The method of claim 1, further comprising:

selecting time division duplex uplink-downlink configuration 5 for a device when the device does not support flexible time division duplex configuration.

9. The method of claim 1, further comprising:

prohibiting reference signal received power measurement on flexible subframes.

10. A method, comprising:

determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage; and

decoding a downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

11. The method of claim 10, further comprising:

reporting capability of supporting flexible time division duplex configuration to a base station.

12. The method of claim 10, further comprising:

decoding a configuration indicator provided by downlink control channel or a downlink shared channel corresponding to the downlink control channel, wherein the indicator indicates a current time division duplex uplink-downlink configuration or a time division duplex uplink-downlink configuration to be used for next radio frames.

13. The method of claim 10, further comprising:

feeding back an acknowledgment or negative acknowledgment to a base station regarding decoding of a configuration indicator provided by downlink control channel or downlink shared channel.

14. The method of claim 10, wherein the decoding comprises decoding the downlink control channel in downlink subframes with fixed subframe index with the period configured by a base station.

15. The method of claim 10, further comprising:

decoding a configuration indicator provided by downlink control channel or downlink shared channel without acknowledgment, when the cell does not require acknowledgment.

16. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to

inform a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access;

provide a downlink control channel having a cyclic redundancy check scrambled by the identifier; and

provide a configuration indicator.

17. The apparatus of claim 16, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to schedule the user equipment in flexible subframes upon receiving an acknowledgment in response to a configuration provided on the downlink shared channel.

18. The apparatus of claim 16, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to provide a default configuration using system information block signaling.

19. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to

determine that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage,

decode downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier, and

feed back an acknowledgment in response to a configuration indicator received.

20. The apparatus of claim 19, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to report capability of supporting flexible time division duplex configuration to a base station.

21. The apparatus of claim 19, wherein the at least one memory and the

computer program code are configured to, with the at least one processor, cause the apparatus at least to decode a configuration indication provided by downlink control channel or the downlink shared channel corresponding to the downlink control channel, wherein the configuration indication indicates a current time division duplex uplink-downlink configuration or a time division duplex uplink-downlink configuration to be used for next radio frames.

22. An apparatus, comprising:

informing means for informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access;

control means for providing a downlink control channel having a cyclic redundancy check scrambled by the identifier; and

sharing means for providing a configuration indicator.

23. An apparatus, comprising:

determining means for determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage; and

decoding means for decoding downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

24. A non-transitory computer-readable medium encoded with instructions that, when executed in hardware, perform a process, the process comprising:

informing a user equipment about a cell-specific flexible time division duplex radio network temporary identifier at cell access, as well as the fixed subframe index for configuration indication, period and/or require acknowledgment or not;

providing a downlink control channel having a cyclic redundancy check scrambled by the identifier; and

providing a configuration indicator.

25. A non-transitory computer-readable medium encoded with instructions that, when executed in hardware, perform a process, the process comprising:

determining that a cell supports flexible time division duplex configuration based on a cell-specific flexible time division duplex radio network temporary identifier at a cell access stage; and

decoding downlink control channel with cyclic redundancy check scrambled by the flexible time division duplex radio network temporary identifier.

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

Figure 1

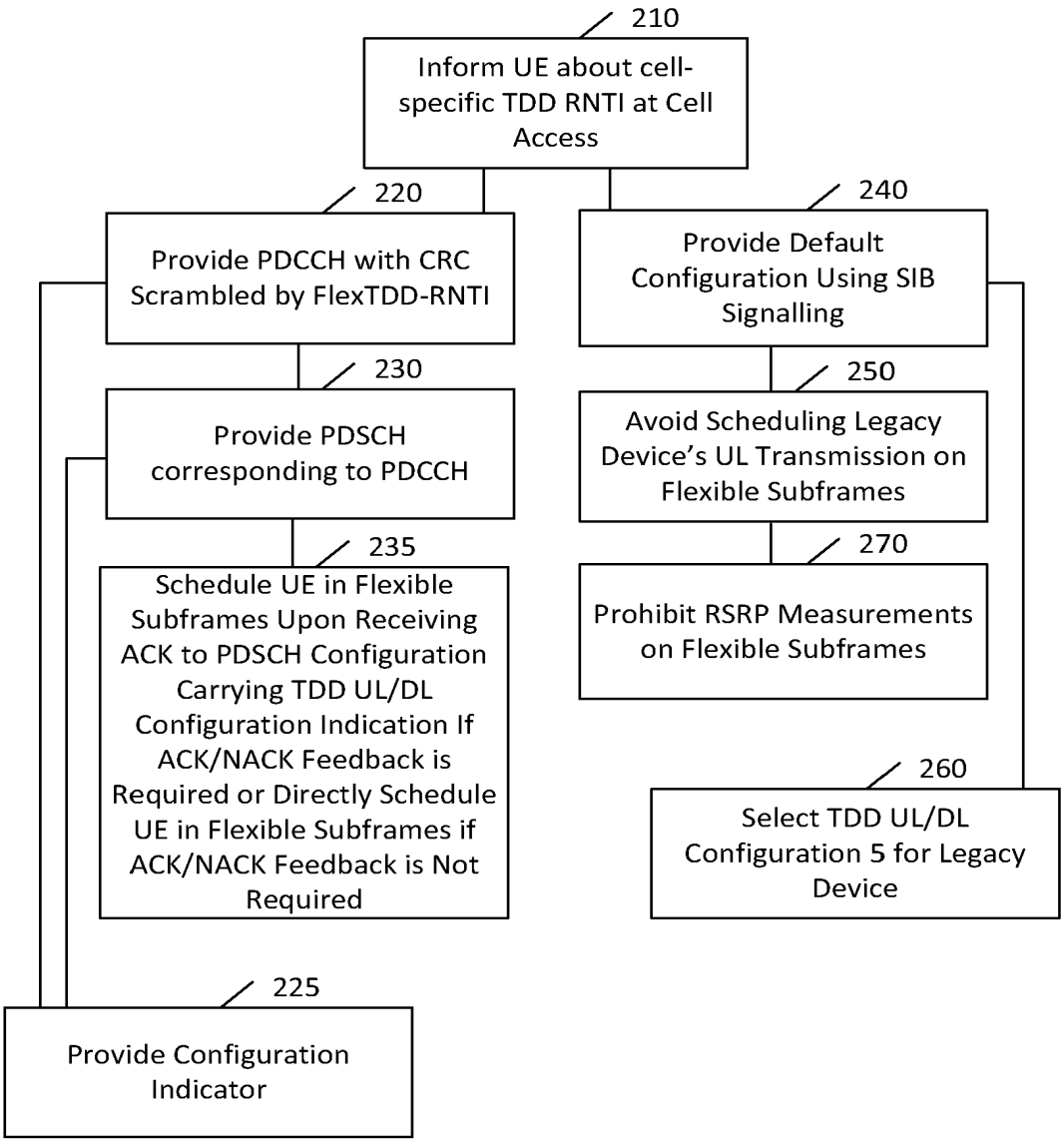

210
Inform UE about cell-specific TDD RNTI at Cell Access
220
Provide PDCCH with CRC Scrambled by FlexTDD-RNTI
230
Provide PDSCH corresponding to PDCCH
235
Schedule UE in Flexible Subframes Upon Receiving ACK to PDSCH Configuration Carrying TDD UL/DL Configuration Indication If ACK/NACK Feedback is Required or Directly Schedule UE in Flexible Subframes if ACK/NACK Feedback is Not Required
225
Provide Configuration Indicator
240
Provide Default Configuration Using SIB Signalling
250
Avoid Scheduling Legacy Device's UL Transmission on Flexible Subframes
270
Prohibit RSRP Measurements on Flexible Subframes
260
Select TDD UL/DL Configuration 5 for Legacy Device

Figure 2

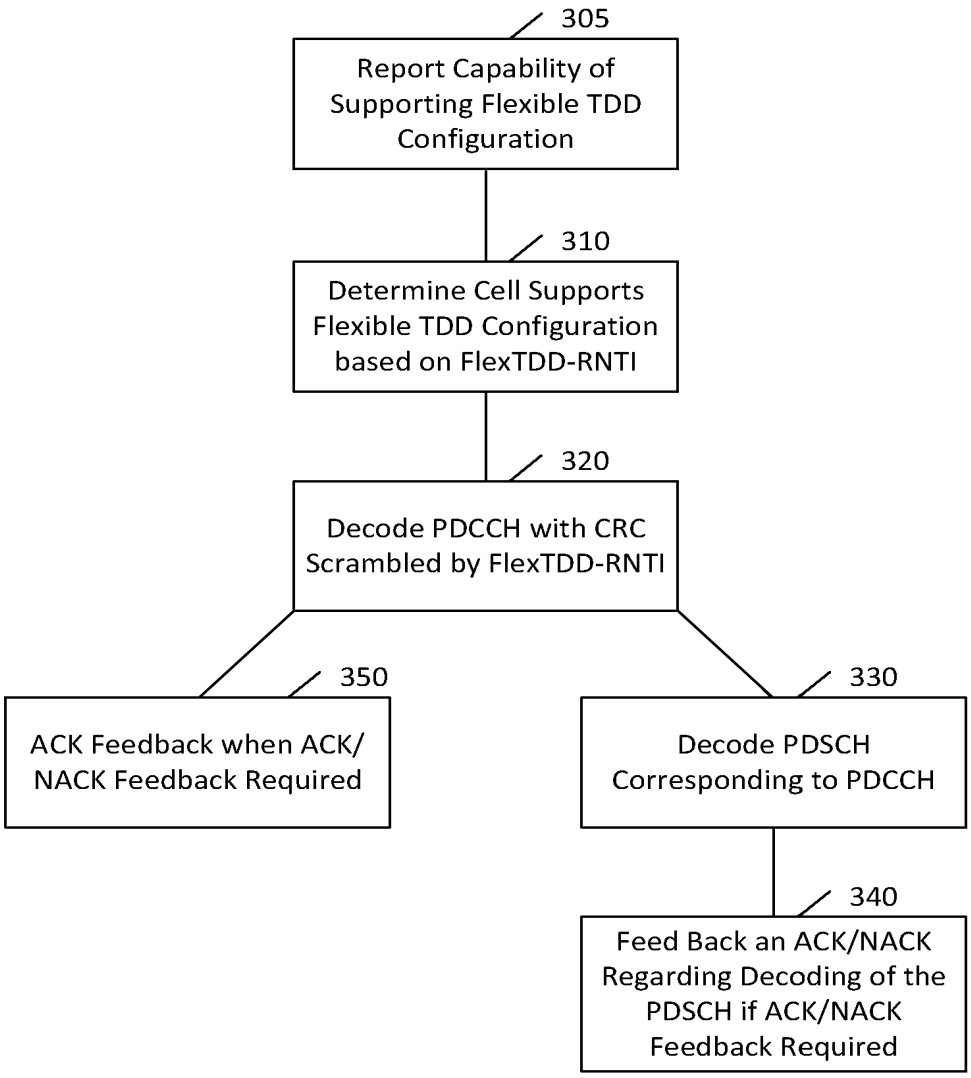

305
Report Capability of Supporting Flexible TDD Configuration
310
Determine Cell Supports Flexible TDD Configuration based on FlexTDD-RNTI
320
Decode PDCCH with CRC Scrambled by FlexTDD-RNTI
350
ACK Feedback when ACK/ NACK Feedback Required
330
Decode PDSCH Corresponding to PDCCH
340
Feed Back an ACK/NACK Regarding Decoding of the PDSCH if ACK/NACK Feedback Required

Figure 3

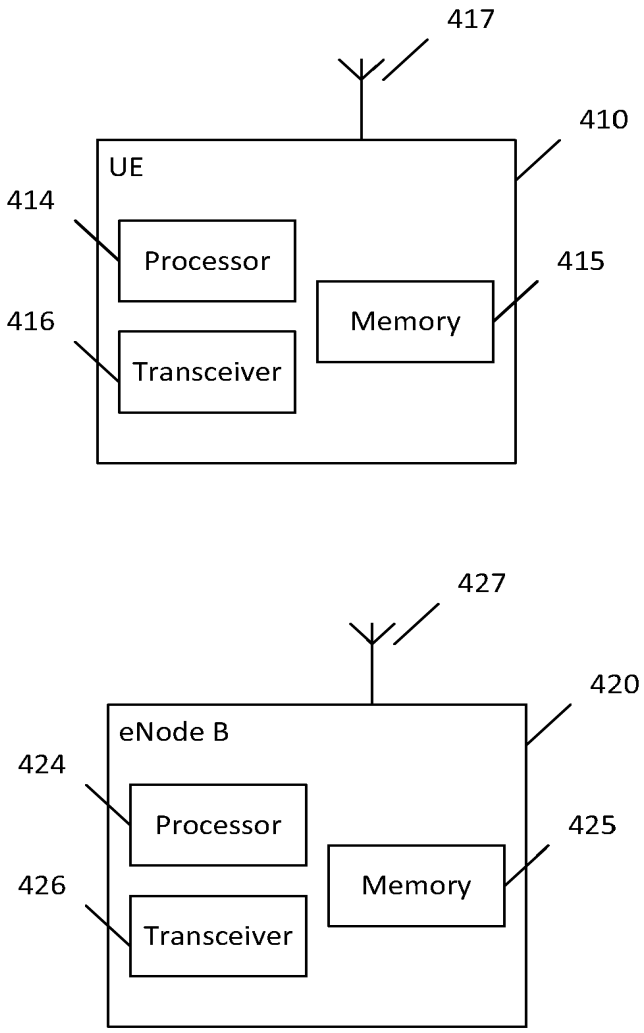

417
410
UE
414
Processor
415
Memory
416
Transceiver
427
420
eNode B
424
Processor
425
Memory
426
Transceiver

Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/075466

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04 (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)

IPC: H04W

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

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

CNABS, CNTXT, CNKI, VEN, 3GPP, USTXT: TDD, 时分复用, RNTI, 无线网络临时标识, 灵活, 动态, 配置, 重配置, 下行, DCH, PDCCH, 加扰, flexible, dynamic, configuration, reconfiguration, identifier, radio network temporary identifier, downlink, DL, CRC, scramble+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	R1-122267. 3GPP TSG RAN WG1 Meeting #69. Prague, Czech Republic 21st -25th May 2012. Dynamic reconfiguration of TDD UL-DL configuration. 12 May 2012(12.05.2012) Section 2	1-25
A	R1-122363. 3GPP TSG RAN WG1 Meeting #69. Prague, Czech Republic 21st -25th May 2012. Discussion on enhancements for Dynamic TDD UL-DL configuration. 12 May 2012(12.05.2012) the whole document	1-25
A	CN102036297A (DATANG MOBILE COMMUNICATION EQUIP CO LTD) 27 April 2011(27.04.2011) the whole document	1-25
A	WO2010068011A2(LG ELECTRONIC INC.) 17 June 2010(17.06.2010) the whole document	1-25

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 Jan. 2013(24.01.2013)	**07 Feb. 2013 (07.02.2013)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer Su, Yulei Telephone No. (86-10)62411515

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/075466

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN102036297A	27.04.2011	WO2012083766A1	28.06.2012
WO2010068011A2	17.06.2010	WO2010068011A3	16.09.2010
		US2011222501A1	15.09.2011

Form PCT/ISA /210 (patent family annex) (July 2009)

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(54) RESOURCE ALLOCATION METHOD AND RESOURCE ALLOCATION DEVICE

(57) Provided are a resource allocation method and a resource allocation device, which are used for a frequency division duplexing system. The resource allocation method comprises: setting a shared frequency band; and according to resource demands for an original uplink frequency band and an original downlink frequency band in a network service, allocating the shared frequency band to the original uplink frequency band and/or the original downlink frequency band. By means of the technical solution of the present invention, a flexible duplexing solution of a FDD system can be realized, so that the allocation proportion of an uplink resource to a downlink resource is matched with the proportion of an actual uplink load to an actual downlink load, thereby achieving the purpose of rationally using resources.

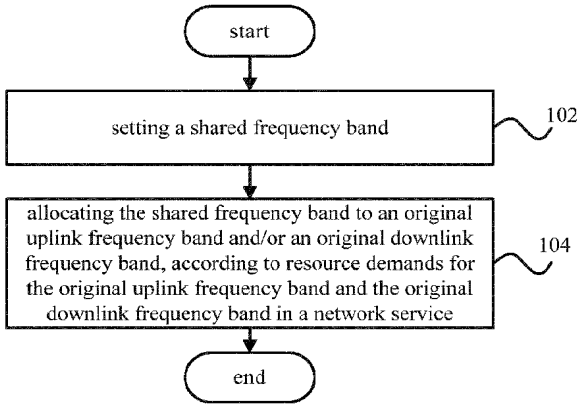


Fig. 1

EP 3 142 434 A1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of resource allocation, specifically, relates to a resource allocation method and a resource allocation device.

BACKGROUND

[0002] With the continuous development of the LTE technology as well as the subsequent 5G pre-research project, spectrum is becoming quite insufficient, and thus a new generation of mobile communication technology is required to further improve spectrum efficiency than prior art. Studies found that generation of data service is closely related to user behavior. Furthermore, the generation of the data service is closely related to time and locations, and the service data has a serious asymmetry between uplinks and downlinks.

[0003] To this end, in the mobile communication technology in the prior art, eIMTA (enhanced Interference Mitigation and Traffic Adaptation) (dynamic TDD technology) is introduced. This technology flexibly adjusts proportion of an uplink resource to a downlink resource, such that the resource allocation is matched with proportion of an actual uplink load to an actual downlink load, thereby achieving the purpose of rationally using resources. However, this technology is merely applicable in a TDD (Time Division Duplexing) system, and could not be applicable in a FDD (Frequency Division Duplexing) system. The uplink resource and the downlink resource of the FDD system are allocated to an uplink dedicated frequency and a download dedicated frequency, respectively. Thus, the eIMTA technology could not adjust the proportion of the uplink resource to the downlink resource according to actual service demands.

[0004] Therefore, a new technology is required to realize a flexible duplexing solution of a FDD system, that is to say, flexibly adjust the uplink resource and the downlink resource of the FDD system according to actual network service demands.

SUMMARY

[0005] The present invention is addressed to the above problem, and provides a new technical solution which may flexibly adjust the uplink resource and the downlink resource of the FDD system, and achieve the purpose of rationally using the uplink resource and the downlink resource.

[0006] To this end, the present invention provides a resource allocation method, comprising: setting a shared frequency band; and allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

[0007] In this technical solution, firstly, one shared frequency band is set for the uplink frequency band and the downlink frequency band, such that when service demands are changed, the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted so as to meet the service demands. For example, in the original network service, the original uplink frequency bandwidth and the original downlink frequency bandwidth are both 10MHz, while the shared frequency bandwidth is 5MHz, and if after a period of time t, demands of users for the uplink frequency band are increased to 12MHz, the uplink frequency bandwidth may be increased by means of utilizing the shared frequency band, i.e., 2MHz is allocated from the shared frequency band which is 5MHz to serve as the uplink resource, so as to meet the service demands. Thus, by means of the present technical solution, the uplink frequency bandwidth and the downlink frequency bandwidth of the FDD system may be adjusted in real time by fully utilizing the shared frequency band, so as to meet different network service demands and improve user experience.

[0008] In the above technical solution, it is preferable to further comprise: when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

[0009] In this technical solution, the FDD system is a duplexing system having two channels (specifically, one uplink frequency band and one downlink frequency band). One channel is used to transmit downlink information, and the other channel is used to transmit uplink information. The information transmissions in these two channels are in opposite directions, and a transmitter and a receiver are disposed at two ends of each channel, respectively. Thus, by setting a certain isolation bandwidth between the channels (the uplink frequency band and the downlink frequency band), out-of-band interference (radiation) may be prevented and mutual interference between the adjacent transmitter and receiver may also be prevented. Furthermore, the shared frequency band may also be divided into portions for uplink transmission and portions for downlink transmission by time slots. The shared frequency band is divided into a plurality of uplink sub-frames and downlink sub-frames, and protective time slots are disposed between the uplink sub-frames and the downlink sub-frames, such that not only the interference may be prevented, but also the times for switching from the uplink to the downlink or from the downlink to the uplink are provided.

[0010] Meanwhile, prior wireless communication sys-

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tems (such as LTE systems) may merely use continuously distributed and standardized broadband resources, such as 10MHz, 20MHz, and may not use frequency band resources which are non-continuous or have a non-standardized width. Thus, the share frequency band may not be directly used after being allocated to the uplink frequency band and the downlink frequency band, and may be used only by means of dispatching the shared frequency band which is non-continuous or has a non-standardized width with prior CA (Carrier Aggregation) or NCT (New Carrier Type) technology.

[0011] In the above technical solution, it is preferable to further comprise: dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band on the basis of the proportion of current network service.

[0012] In this technical solution, when allocating the shared bandwidth of the shared frequency band to the original uplink frequency band and the original downlink frequency band after dividing the bandwidth into a plurality of dispatched units on the basis of preset frequency width or time width, the required dispatched units may be quantified. Thus, by means of the present technical solution, the shared frequency spectrum may be effectively and accurately allocated on the basis of specific proportion of the uplink service to the downlink service, thereby improving the utilization rate of the shared frequency spectrum.

[0013] In the above technical solution, preferably, the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

[0014] In this technical solution, the shared frequency band may be constituted by a dedicated band, however, with the increase of the service, if the shared frequency band is merely the dedicated band, the bandwidth demands of users may be far from met. Meanwhile, the demands of users for the uplink resource and the downlink resource are different, and sometimes, the uplink (downlink) resource may be too much while the downlink (uplink) resource may be not sufficient. At this moment, the uplink (downlink) frequency band in the idle state may be allocated as a shared frequency band to the downlink (uplink) frequency band, thereby increasing the downlink (uplink) resource to meet the network demands of users. Thus, by means of the present technical solution, the shared frequency band resource may be increased, and the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted, which is advantageous for improving the utilization rate of the uplink frequency band and the download frequency band and meeting the real-time requirements of users.

[0015] In the above technical solution, preferably, when the shared frequency band is constituted by the original uplink frequency band, an allocation unit may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission; when the shared frequency band is constituted by the original downlink frequency band, the allocation unit may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

[0016] In this technical solution, when the shared frequency band is constituted by the original uplink (downlink) frequency band, the allocation unit may not allocate all the shared frequency band to the downlink (uplink) frequency band, since a part of the original uplink (downlink) frequency band merely serves as the uplink (downlink) frequency band transmitting resource, and may not transmit the downlink (uplink) data.

[0017] In the above technical solution, preferably, the shared frequency band is constituted by unlicensed public frequency spectrum resources.

[0018] In this technical solution, with the increase of the network service for users, the shared frequency band constituted by a dedicated band, or constituted by the original uplink frequency band or the original downlink frequency band in the idle state is still quite limited, and the demands of users may not be effectively met. Furthermore, operators, in order to meet the demands of users, often need to buy these licensed frequency spectrum resources, however, it usually lead to a large expense to buy these licensed frequency spectrum resources. Thus, by means of the present technical solution, sources for the shared frequency band may be further increased, thereby meeting the network demands of users, improving user experience and reducing the economic cost of deploying the dedicated "shared frequency band" by operators.

[0019] In the above technical solution, preferably, when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, the method further comprises: performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

[0020] In this technical solution, the unlicensed public frequency spectrum resources may generally include much interference from other systems, such as Wi-Fi and so on. Thus, when being used, the interference detection should be performed with interference detection technology, in order to determine whether to serve as a shared frequency band. Therefore, by means of the present technical solution, it is ensured that the unlicensed shared frequency band has a high quality, such that users may smoothly use the network service.

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[0021] When detecting the strength of the interference with the unlicensed public frequency spectrum, some prior interference detection technologies, such as cognitive radio technology may be utilized.

[0022] According to another aspect of the present invention, a resource allocation device is provided, comprises: a setting unit for setting a shared frequency band; and an allocation unit for allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

[0023] In this technical solution, firstly, one shared frequency band is set for the uplink frequency band and the downlink frequency band, such that when service demands are changed, the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted so as to meet the service demands. For example, in the original network service, the original uplink frequency bandwidth and the original downlink frequency bandwidth are both 10MHz, while the shared frequency bandwidth is 5MHz, and if after a period of time t, demands of users for the uplink frequency band are increased to 12MHz, the uplink frequency bandwidth may be increased by means of utilizing the shared frequency band, i.e., 2MHz is allocated from the shared frequency band which is 5MHz to serve as the uplink resource, so as to meet the service demands. Thus, by means of the present technical solution, the uplink frequency bandwidth and the downlink frequency bandwidth of the FDD system may be adjusted in real time by fully utilizing the shared frequency band, so as to meet different network service demands and improve user experience.

[0024] In the above technical solution, preferably, the setting unit is further for, when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

[0025] In this technical solution, the FDD system is a duplexing system having two channels (specifically, one uplink frequency band and one downlink frequency band). One channel is used to transmit downlink information, and the other channel is used to transmit uplink information. The information transmissions in these two channels are in opposite directions, and a transmitter and a receiver are disposed at two ends of each channel, respectively. Thus, by setting a certain isolation bandwidth between the channels (the uplink frequency band and the downlink frequency band), out-of-band interference (radiation) may be prevented, and mutual interference between the adjacent transmitter and receiver may also be prevented. Furthermore, the shared frequency band may also be divided into portions for uplink transmission and portions for downlink transmission by time slots. The shared frequency band is divided into a plurality of uplink sub-frames and downlink sub-frames, and protective time slots are disposed between the uplink sub-frames and the downlink sub-frames, such that not only interference may be prevented, but also times for switching from the uplink to the downlink or from the downlink to the uplink are provided.

[0026] Meanwhile, prior wireless communication systems (such as LTE systems) may only use continuously distributed and standardized broadband resources, such as 10MHz, 20MHz, and may not use frequency band resources which are non-continuous or have a non-standardized width. Thus, the share frequency band may not be directly used after being allocated to the uplink frequency band and the downlink frequency band, and may be used only by means of dispatching the shared frequency band which is non-continuous or has a non-standardized width with prior CA (Carrier Aggregation) or NCT (New Carrier Type) technology.

[0027] In the above technical solution, preferably, the resource allocation device further comprises: a dividing unit for dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band on the basis of the proportion of network service processed in the original uplink frequency band to network service processed in the original downlink frequency band.

[0028] In this technical solution, when allocating the shared bandwidth of the shared frequency band to the original uplink frequency band and the original downlink frequency band after dividing the bandwidth into a plurality of dispatched units on the basis of preset frequency width or time width, the required dispatched units may be quantified. Thus, by means of the present technical solution, the shared frequency spectrum may be effectively and accurately allocated on the basis of specific proportion of the uplink service to the downlink service, thereby improving the utilization rate of the shared frequency spectrum.

[0029] In the above technical solution, preferably, the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

[0030] In this technical solution, the shared frequency band may be constituted by a dedicated band, however, with the increase of the service, if the shared frequency band is merely the dedicated band, the bandwidth demands of users may be far from met. Meanwhile, the demands of users for the uplink resource and the downlink resource are different, and sometimes, the uplink (downlink) resource may be too much while the downlink

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(uplink) resource may be not sufficient. At this moment, the uplink (downlink) frequency band in the idle state may be allocated as a shared frequency band to the downlink (uplink) frequency band, thereby increasing the downlink (uplink) resource to meet the network demands of users. Thus, by means of the present technical solution, the shared frequency band resource may be increased, and the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted, which is advantageous for improving the utilization rate of the uplink frequency band and the download frequency band and meeting the real-time requirements of users.

[0031] In the above technical solution, preferably, when the shared frequency band is constituted by the original uplink frequency band, the allocation unit may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission; when the shared frequency band is constituted by the original downlink frequency band, the allocation unit may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

[0032] In this technical solution, when the shared frequency band is constituted by the original uplink (downlink) frequency band, the allocation unit may not allocate all the shared frequency band to the downlink (uplink) frequency band, since a part of the original uplink (downlink) frequency band merely serves as the uplink (downlink) frequency band transmitting resource, and may not transmit the downlink (uplink) data.

[0033] In the above technical solution, preferably, the shared frequency band is constituted by unlicensed public frequency spectrum resources.

[0034] In this technical solution, with the increase of the network service for users, the shared frequency band constituted by a dedicated band, or constituted by the original uplink frequency band or the original downlink frequency band in the idle state is still quite limited, and the demands of users may not be effectively met. Furthermore, operators, in order to meet the demands of users, often need to buy these licensed frequency spectrum resources, however, it usually lead to a large expense to buy these licensed frequency spectrum resources. Thus, by means of the present technical solution, sources for the shared frequency band may be further increased, thereby meeting the network demands of users, improving user experience and reducing the economic cost of deploying the dedicated "shared frequency band" by operators.

[0035] In the above technical solution, preferably, when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, the device is further for performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

[0036] In this technical solution, the unlicensed public frequency spectrum resources may generally include much interference from other systems, such as Wi-Fi and so on. Thus, when being used, the interference detection should be performed with interference detection technology, in order to determine whether to serve as a shared frequency band. Therefore, by means of the present technical solution, it is ensured that the unlicensed shared frequency band has a high quality, such that users may smoothly use the network service.

[0037] When detecting the strength of the interference with the unlicensed public frequency spectrum, some prior interference detection technologies, such as cognitive radio technology may be utilized.

[0038] By means of the technical solution of the present invention, the uplink resource and the downlink resource of the FDD system may be flexibly adjusted on the basis of actual service proportion, such that the allocation proportion of the uplink resource to the downlink resource is matched with the proportion of an actual uplink load to an actual downlink load, thereby achieving the purpose of rationally using resources.

BRIEF DESCRIPTION OF DRAWINGS

[0039]

Fig. 1 shows a flowchart of a resource allocation method according to an embodiment of the present disclosure;

Fig. 2 shows a schematic structural diagram of a resource allocation device according to an embodiment of the present disclosure;

Fig. 3A and 3B show schematic diagrams of allocating a non-dedicated "shared frequency band" according to an embodiment of the present disclosure;

Fig. 4 shows a schematic diagram of a specific setting mode of a isolation bandwidth according to an embodiment of the present disclosure;

Fig. 5 shows a schematic diagram of dividing a shared bandwidth into dispatched units on the basis of frequency width according to an embodiment of the present disclosure;

Fig. 6 shows a schematic diagram of a specific mode of allocating resource by an allocation unit to an uplink and a downlink according to an embodiment of the present disclosure;

Fig. 7 shows a schematic diagram of a specific mode of allocating resource by an allocation unit to an uplink and a downlink according to another embodiment of the present disclosure.

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DETAILED DESCRIPTION

[0040] The present disclosure is further described in detail hereinafter with reference to the accompanying drawings and embodiments, in order to more fully understand the above-mentioned purposes, features and advantages of the present disclosure. It should be noted that, when not conflicting, the embodiments of the present application and features in the embodiments could be combined mutually.

[0041] A lot of details are set forth in the below description so as to fully understand the present disclosure, however, the present disclosure may also be implemented by adopting other embodiments different from those as described herein, and therefore, the protection scope of the present disclosure is not limited by the embodiments disclosed below.

[0042] Fig. 1 shows a flowchart of a resource allocation method according to an embodiment of the present disclosure.

[0043] As shown in Fig. 1, a resource allocation method according to an embodiment of the present disclosure, comprises: a step 102 of setting a shared frequency band; and a step 104 of allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

[0044] In this technical solution, firstly, one shared frequency band is set for the uplink frequency band and the downlink frequency band, such that when service demands are changed, the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted so as to meet the service demands. For example, in the original network service, the original uplink frequency bandwidth and the original downlink frequency bandwidth are both 10MHz, while the shared frequency bandwidth is 5MHz, and if after a period of time t, demands of users for the uplink frequency band are increased to 12MHz, the uplink frequency bandwidth may be increased by means of utilizing the shared frequency band, i.e., 2MHz is allocated from the shared frequency band which is 5MHz to serve as the uplink resource, so as to meet the service demands. Thus, by means of the present technical solution, the uplink frequency bandwidth and the downlink frequency bandwidth of the FDD system may be adjusted in real time by fully utilizing the shared frequency band, so as to meet different network service demands and improve user experience.

[0045] In the above technical solution, it is preferable to further comprise: when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

[0046] In this technical solution, the FDD system is a duplexing system having two channels (specifically, one uplink frequency band and one downlink frequency band). One channel is used to transmit downlink information, and the other channel is used to transmit uplink information. The information transmissions in these two channels are in opposite directions, and a transmitter and a receiver are disposed at two ends of each channel, respectively. Thus, by setting a certain isolation bandwidth between the channels (the uplink frequency band and the downlink frequency band), out-of-band interference (radiation) may be prevented and mutual interference between the adjacent transmitter and receiver may also be prevented. The specific setting mode of the isolation bandwidth is as shown in Fig. 4.

[0047] Furthermore, the shared frequency band may also be divided into portions for uplink transmission and portions for downlink transmission by time slots. The shared frequency band is divided into a plurality of uplink sub-frames and downlink sub-frames, and protective time slots are disposed between the uplink sub-frames and the downlink sub-frames, such that not only the interference may be prevented, but also the times for switching from the uplink to the downlink or from the downlink to the uplink are provided. The specific setting mode of the protective time slots is as shown in Fig. 7.

[0048] Meanwhile, prior wireless communication systems (such as LTE systems) may merely use continuously distributed and standardized broadband resources, such as 10MHz, 20MHz, and may not use frequency band resources which are non-continuous or have a non-standardized width. Thus, the share frequency band may not be directly used after being allocated to the uplink frequency band and the downlink frequency band, and may be used only by means of dispatching the shared frequency band which is non-continuous or has a non-standardized width with prior CA (Carrier Aggregation) or NCT (New Carrier Type) technology.

[0049] In the above technical solution, it is preferable to further comprise: dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band on the basis of the proportion of current network service.

[0050] In this technical solution, when allocating the shared bandwidth of the shared frequency band to the original uplink frequency band and the original downlink frequency band after dividing the bandwidth into a plurality of dispatched units on the basis of preset frequency width or time width, the required dispatched units may be quantified. Thus, by means of the present technical solution, the shared frequency spectrum may be effectively and accurately allocated on the basis of specific

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proportion of the uplink service to the downlink service, thereby improving the utilization rate of the shared frequency spectrum. A mode of dividing the shared bandwidth into the dispatched units on the basis of a certain frequency width is as shown in Fig. 5.

[0051] In the above technical solution, preferably, the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

[0052] In this technical solution, the shared frequency band may be constituted by a dedicated band, however, with the increase of the service, if the shared frequency band is merely the dedicated band, the bandwidth demands of users may be far from met. Meanwhile, the demands of users for the uplink resource and the downlink resource are different, and sometimes, the uplink (downlink) resource may be too much while the downlink (uplink) resource may be not sufficient. At this moment, the uplink (downlink) frequency band in the idle state may be allocated as a shared frequency band to the downlink (uplink) frequency band, thereby increasing the downlink (uplink) resource to meet the network demands of users. Thus, by means of the present technical solution, the shared frequency band resource may be increased, and the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted, which is advantageous for improving the utilization rate of the uplink frequency band and the download frequency band and meeting the real-time requirements of users.

[0053] In the above technical solution, preferably, when the shared frequency band is constituted by the original uplink frequency band, an allocation unit may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission; when the shared frequency band is constituted by the original downlink frequency band, the allocation unit may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

[0054] In this technical solution, when the shared frequency band is constituted by the original uplink (downlink) frequency band, the allocation unit may not allocate all the shared frequency band to the downlink (uplink) frequency band, since a part of the original uplink (downlink) frequency band merely serves as the uplink (downlink) frequency band transmitting resource, and may not transmit the downlink (uplink) data. A specific mode of allocating resource by the allocation unit to the uplink and the downlink is as shown in Fig. 6.

[0055] In the above technical solution, preferably, the shared frequency band may be constituted by unlicensed public frequency spectrum resources.

[0056] In this technical solution, with the increase of the network service for users, the shared frequency band constituted by a dedicated band, or constituted by the original uplink frequency band or the original downlink frequency band in the idle state is still quite limited, and the demands of users may not be effectively met. Furthermore, operators, in order to meet the demands of users, often need to buy these licensed frequency spectrum resources, however, it usually lead to a large expense to buy these licensed frequency spectrum resources. Thus, by means of the present technical solution, sources for the shared frequency band may be further increased, thereby meeting the network demands of users, improving user experience and reducing the economic cost of deploying the dedicated "shared frequency band" by operators.

[0057] In the above technical solution, when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, it is preferable to further comprise: performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

[0058] In this technical solution, the unlicensed public frequency spectrum resources may generally include much interference from other systems, such as Wi-Fi and so on. Thus, when being used, the interference detection should be performed with interference detection technology, in order to determine whether to serve as a shared frequency band. Therefore, by means of the present technical solution, it is ensured that the unlicensed shared frequency band has a high quality, such that users may smoothly use the network service.

[0059] When detecting the strength of the interference with the unlicensed public frequency spectrum, some prior interference detection technologies, such as cognitive radio technology may be utilized.

[0060] Fig. 2 shows a schematic structural diagram of a resource allocation device according to an embodiment of the present disclosure.

[0061] As shown in Fig. 2, a resource allocation device 200 according to an embodiment of the present disclosure, comprises: a setting unit 202 for setting a shared frequency band; and an allocation unit 204 for allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

[0062] In this technical solution, firstly, one shared frequency band is set for the uplink frequency band and the downlink frequency band, such that when service demands are changed, the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted so as to meet the service demands. For example, in the original network service, the original uplink

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frequency bandwidth and the original downlink frequency bandwidth are both 10MHz, while the shared frequency bandwidth is 5MHz, and if after a period of time t, demands of users for the uplink frequency band are increased to 12MHz, the uplink frequency bandwidth may be increased by means of utilizing the shared frequency band, i.e., 2MHz is allocated from the shared frequency band which is 5MHz to serve as the uplink resource, so as to meet the service demands. Thus, by means of the present technical solution, the uplink frequency bandwidth and the downlink frequency bandwidth of the FDD system may be adjusted in real time by fully utilizing the shared frequency band, so as to meet different network service demands and improve user experience.

[0063] In the above technical solution, preferably, the setting unit 202 is further for, when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

[0064] In this technical solution, the FDD system is a duplexing system having two channels (specifically, one uplink frequency band and one downlink frequency band). One channel is used to transmit downlink information, and the other channel is used to transmit uplink information. The information transmissions in these two channels are in opposite directions, and a transmitter and a receiver are disposed at two ends of each channel, respectively. Thus, by setting a certain isolation bandwidth between the channels (the uplink frequency band and the downlink frequency band), out-of-band interference (radiation) may be prevented, and mutual interference between the adjacent transmitter and receiver may also be prevented. The specific setting mode of the isolation bandwidth is as shown in Fig. 4.

[0065] Furthermore, the shared frequency band may also be divided into portions for uplink transmission and portions for downlink transmission by time slots. The shared frequency band is divided into a plurality of uplink sub-frames and downlink sub-frames, and protective time slots are disposed between the uplink sub-frames and the downlink sub-frames, such that not only interference may be prevented, but also times for switching from the uplink to the downlink or from the downlink to the uplink are provided. The specific setting mode of the protective time slots is as shown in Fig. 7.

[0066] Meanwhile, prior wireless communication systems (such as LTE systems) may only use continuously distributed and standardized broadband resources, such as 10MHz, 20MHz, and may not use frequency band resources which are non-continuous or have a non-standardized width. Thus, the share frequency band may not be directly used after being allocated to the uplink frequency band and the downlink frequency band, and may be used only by means of dispatching the shared frequency band which is non-continuous or has a non-standardized width with prior CA (Carrier Aggregation) or NCT (New Carrier Type) technology.

[0067] In the above technical solution, it is preferable to further comprise a dividing unit 206 for dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band on the basis of the proportion of network service processed in the original uplink frequency band to network service processed in the original downlink frequency band.

[0068] In this technical solution, when allocating the shared bandwidth of the shared frequency band to the original uplink frequency band and the original downlink frequency band after dividing the bandwidth into a plurality of dispatched units on the basis of preset frequency width or time width, the required dispatched units may be quantified. Thus, by means of the present technical solution, the shared frequency spectrum may be effectively and accurately allocated on the basis of specific proportion of the uplink service to the downlink service, thereby improving the utilization rate of the shared frequency spectrum. A mode of dividing the shared bandwidth into the dispatched units on the basis of a certain frequency width is as shown in Fig. 5.

[0069] In the above technical solution, preferably, the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

[0070] In this technical solution, the shared frequency band may be constituted by a dedicated band, however, with the increase of the service, if the shared frequency band is merely the dedicated band, the bandwidth demands of users may be far from met. Meanwhile, the demands of users for the uplink resource and the downlink resource are different, and sometimes, the uplink (downlink) resource may be too much while the downlink (uplink) resource may be not sufficient. At this moment, the uplink (downlink) frequency band in the idle state may be allocated as a shared frequency band to the downlink (uplink) frequency band, thereby increasing the downlink (uplink) resource to meet the network demands of users. Thus, by means of the present technical solution, the shared frequency band resource may be increased, and the proportion of the resource allocated to the uplink frequency band to the resource allocated to the downlink frequency band may be rationally adjusted, which is advantageous for improving the utilization rate of the uplink frequency band and the download frequency band and meeting the real-time requirements of users.

[0071] In the above technical solution, preferably, when the shared frequency band is constituted by the original uplink frequency band, the allocation unit 204

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may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission; when the shared frequency band is constituted by the original downlink frequency band, the allocation unit 204 may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

[0072] In this technical solution, when the shared frequency band is constituted by the original uplink (downlink) frequency band, the allocation unit 204 may not allocate all the shared frequency band to the downlink (uplink) frequency band, since a part of the original uplink (downlink) frequency band merely serves as the uplink (downlink) frequency band transmitting resource, and may not transmit the downlink (uplink) data. A specific mode of allocating resource by the allocation unit to the uplink and the downlink is as shown in Fig. 6.

[0073] In the above technical solution, preferably, the shared frequency band may be constituted by unlicensed public frequency spectrum resources.

[0074] In this technical solution, with the increase of the network service for users, the shared frequency band constituted by a dedicated band, or constituted by the original uplink frequency band or the original downlink frequency band in the idle state is still quite limited, and the demands of users may not be effectively met. Furthermore, operators, in order to meet the demands of users, often need to buy these licensed frequency spectrum resources, however, it usually lead to a large expense to buy these licensed frequency spectrum resources. Thus, by means of the present technical solution, sources for the shared frequency band may be further increased, thereby meeting the network demands of users, improving user experience and reducing the economic cost of deploying the dedicated "shared frequency band" by operators.

[0075] In the above technical solution, preferably, when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, it is preferable to further comprise: performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

[0076] In this technical solution, the unlicensed public frequency spectrum resources may generally include much interference from other systems, such as Wi-Fi and so on. Thus, when being used, the interference detection should be performed with interference detection technology, in order to determine whether to serve as a shared frequency band. Therefore, by means of the present technical solution, it is ensured that the unlicensed shared frequency band has a high quality, such that users may smoothly use the network service.

[0077] When detecting the strength of the interference with the unlicensed public frequency spectrum, some prior interference detection technologies, such as cognitive radio technology may be utilized.

[0078] Fig. 3A and 3B show schematic diagrams of allocating a non-dedicated "shared frequency band" according to an embodiment of the present disclosure

[0079] As shown in Fig. 3A, if detecting the demands of users in a community for downlink data transmission gradually increasing and the demands for uplink data transmission gradually decreasing currently from a moment t_1, a base station may determine a proper proportion of the downlink resource to the uplink resource according to a certain algorithm. Provided that the uplink resource : the downlink resource = 5:1 and the probably required total downlink resource, for example 30MHz, is estimated according to a certain algorithm, the required uplink resource is probably 6MHz.

[0080] Provided that the original uplink bandwidth and the original downlink bandwidth are both 20MHz, the uplink frequency bandwidth may be reduced at this time, and the saved bandwidth of approximately 14MHz may be used as a "shared frequency band".

[0081] In the case of the foregoing service demands, the shared frequency band of approximately 14MHz may be all allocated to the downlink, and the downlink data may be dispatched in this bandwidth with the CA or NCT technology so as to increase the downlink resource quantity and increase the downlink throughput. Alternatively, 10MHz of the resource may be allocated to the downlink, while the remaining 4MHz is temporarily not utilized. Meanwhile, since the shared frequency band is constituted by the "saved" uplink resource and the adjacent frequency is currently for uplink transmission, a sufficient "protective isolation bandwidth" is required.

[0082] As shown in Fig. 3B, when the behavior of users changes at a moment t_2, the uplink resource is required to increase to 10MHz and the downlink resource is required to reduce to 25MHz according to a certain algorithm. At this time, the resources may be reallocated. 4MHz is allocated to the uplink from the original shared frequency band of 14MHz, and the remaining part except the protective bandwidth may be partially or all allocated to the downlink.

[0083] Fig. 3A and Fig. 3B specifically show the allocation mode of the non-dedicated "shared frequency band", however, if an operator has extra frequency spectrum or unlicensed frequency spectrum to be used as a "shared frequency band", a frequency of a certain width may be allocated independently to serve as the dedicated "shared frequency band". The allocation mode of the dedicated "shared frequency band" is similar to the mode as shown in Fig. 3A and Fig. 3B, i.e., when the downlink data quantity increases at a certain moment, the base station may allocate a certain quantity of "shared frequency band" (considering dispatched units as allocation granularities) to the downlink, so as to supplement the downlink resource. In contrast, when the uplink resource

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is inadequate, a certain quantity of "shared frequency band" (considering dispatched units as allocation granularities) may be allocated to the uplink, so as to supplement the uplink resource. And when the "shared frequency band" is simultaneously allocated to the uplink and the downlink, it is necessary to arrange a "protective isolation bandwidth" of a certain width in the "shared frequency band".

[0084] Fig. 4 shows a schematic diagram of a specific setting mode of a isolation bandwidth according to an embodiment of the present disclosure.

[0085] Because of the out-of-band radiation, when the "shared frequency band" is simultaneously for the uplink and downlink transmission, it is necessary to arrange a protective bandwidth of a certain width between the uplink portion and the downlink portion, so as to avoid the generation of the out-of-band interference. The specific setting mode of the isolation bandwidth in the shared frequency band in the FDD system is as shown in Fig. 4.

[0086] Fig. 5 shows a schematic diagram of dividing a shared bandwidth into dispatched units on the basis of frequency width according to an embodiment of the present disclosure.

[0087] In order to further effectively utilize the shared frequency spectrum, it is necessary to perform resource division on the shared frequency band, and thus the shared bandwidth defines dispatched units of a certain frequency width, thereby facilitating effectively dispatching according to the proportion of the uplink service to the downlink service. The specific division mode of dispatched units is as shown in Fig. 5. In this way, the base station, when allocating resource, may allocate a certain quantity of dispatched units to the uplink or downlink resource according to specific service demands.

[0088] Fig. 6 shows a schematic diagram of a specific mode of allocating resource by an allocation unit to an uplink and a downlink according to an embodiment of the present disclosure.

[0089] As shown in Fig. 6, the shared frequency band is constituted by a part of the downlink spectrum, and when the shared frequency band is utilized by the uplink, the base station may merely use the PDSCH portion except the PDCCH (a frequency band which should serve as the downlink transmitting resource) portion during the uplink dispatching.

[0090] Furthermore, the shared frequency band may also be divided into portions for uplink transmission and portions for downlink transmission by time slots. As shown in Fig. 7, the shared frequency band is divided into portions for uplink transmission and portions for downlink transmission by time slots. Between the uplink sub-frames and the downlink sub-frames in the "shared frequency band", the protective time slots are required to be inserted, i.e., a certain isolation time (black solid portion in the Fig. 7) should be added between the uplink frequency band and the downlink frequency band. In this way, not only the interference may be prevented, but also the times for switching from the uplink to the downlink or from the downlink to the uplink are provided.

[0091] The technical solution of the present disclosure is described in detail in conjunction with the accompanying drawings. By means of the technical solution of the present disclosure, a flexible duplexing solution of a FDD system can be realized, so that the allocation proportion of an uplink resource to a downlink resource is matched with the proportion of an actual uplink load to an actual downlink load, thereby achieving the purpose of rationally using resources.

[0092] The foregoing is merely the preferable embodiments of the present disclosure, and is not intended to limit the present disclosure. For persons skilled in the art, the present disclosure could have various modifications and variations. Any amendments, equivalents, or improvements and so on within the spirit and principle of the present disclosure should be included within the protection scope of the present disclosure.

Claims

1. A resource allocation method, used for a frequency division duplexing system, comprising:

   setting a shared frequency band; and
   allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service

2. The resource allocation method according to claim 1, further comprising:

   when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or
   when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

3. The resource allocation method according to claim 2, further comprising:

   dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band

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on the basis of the proportion of current network service.

4. The resource allocation method according to claim 1, wherein the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

5. The resource allocation method according to claim 4, wherein
when the shared frequency band is constituted by the original uplink frequency band, an allocation unit may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission;
when the shared frequency band is constituted by the original downlink frequency band, the allocation unit may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

6. The resource allocation method according to claim 1, wherein the shared frequency band is constituted by unlicensed public frequency spectrum resources.

7. The resource allocation method according to claim 6, wherein when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, the method further comprises:

performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

8. A resource allocation device, used for a frequency division duplexing system, comprising:

a setting unit for setting a shared frequency band; and
an allocation unit for allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

9. The resource allocation device according to claim 8, wherein the setting unit is further for,
when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting a protective isolation bandwidth between allocated uplink frequency band and allocated downlink frequency band; or
when the shared frequency band is simultaneously allocated to the original uplink frequency band and the original downlink frequency band, setting protective time slots between allocated uplink sub-frames and allocated downlink sub-frames.

10. The resource allocation device according to claim 9, further comprising: a dividing unit for dividing the shared bandwidth of the shared frequency band into a plurality of dispatched units on the basis of preset frequency width or time width, and allocating corresponding quantity of dispatched units to the original uplink frequency band and the original downlink frequency band on the basis of the proportion of network service processed in the original uplink frequency band to network service processed in the original downlink frequency band.

11. The resource allocation device according to claim 8, wherein the shared frequency band is constituted by a dedicated frequency band, or is constituted by the original uplink frequency band or the original downlink frequency band in an idle state.

12. The resource allocation device according to claim 11, wherein when the shared frequency band is constituted by the original uplink frequency band, the allocation unit may merely allocate the remaining resource of the original uplink frequency band except that required for necessary normal uplink transmission; when the shared frequency band is constituted by the original downlink frequency band, the allocation unit may merely allocate the remaining resource of the original downlink frequency band except that required for necessary normal downlink transmission.

13. The resource allocation device according to claim 8, wherein the shared frequency band is constituted by unlicensed public frequency spectrum resources.

14. The resource allocation device according to claim 8, wherein when the shared frequency band is constituted by the unlicensed public frequency spectrum resources, the device is further for performing interference detection on the public frequency spectrum resources, and allowing the public frequency spectrum resources to serve as the shared frequency band when the interference with the public frequency spectrum resources is less than the preset interference threshold, otherwise, not allowing the public frequency spectrum resources to serve as the shared frequency band.

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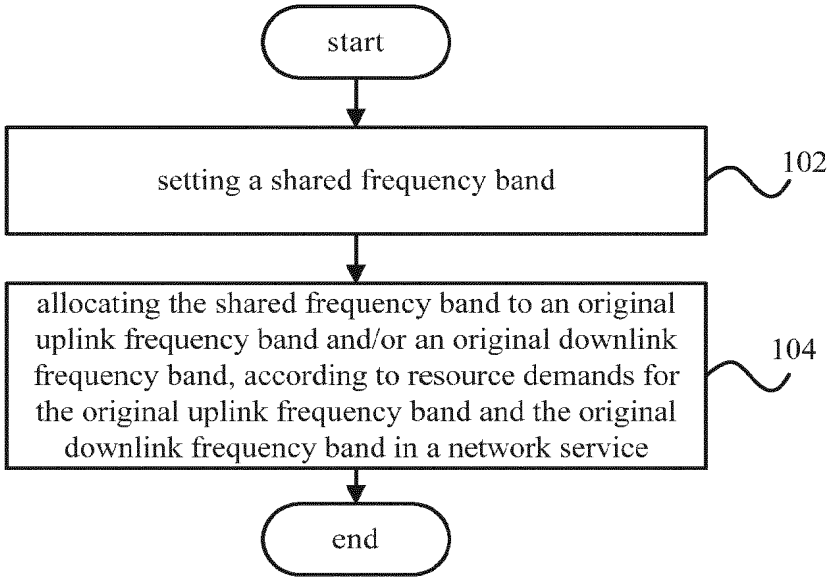


Fig. 1

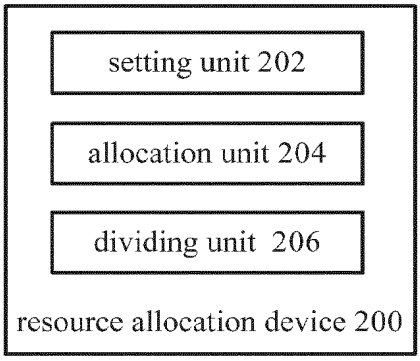


Fig. 2

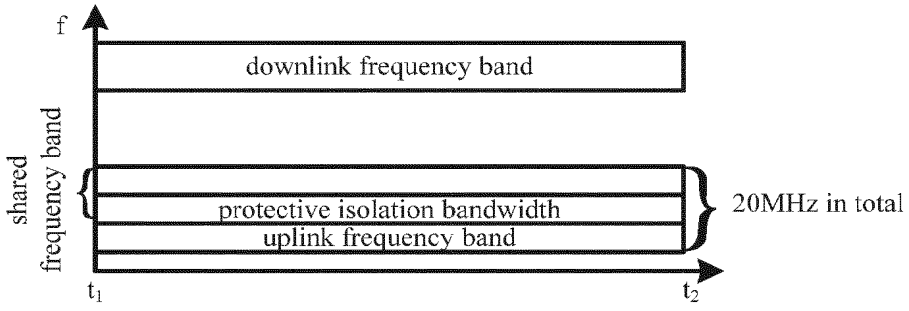


Fig. 3A

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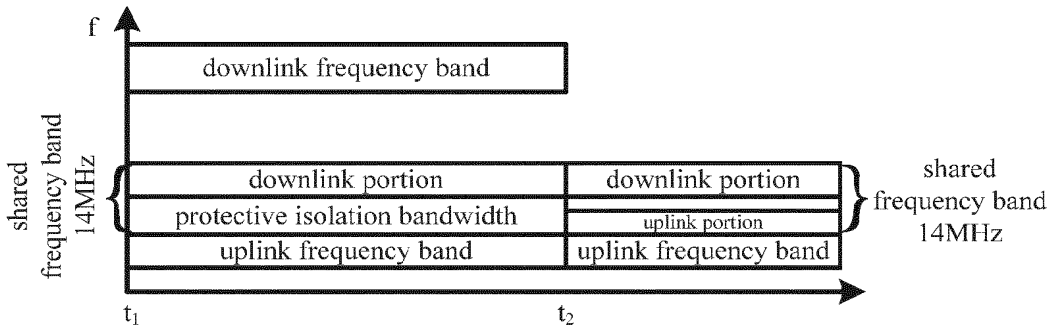


Fig. 3B

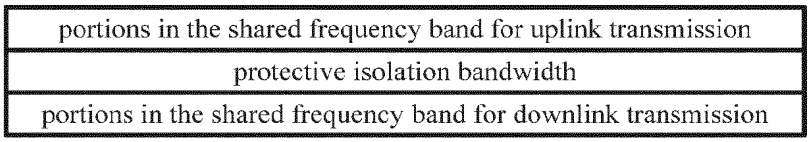


Fig. 4

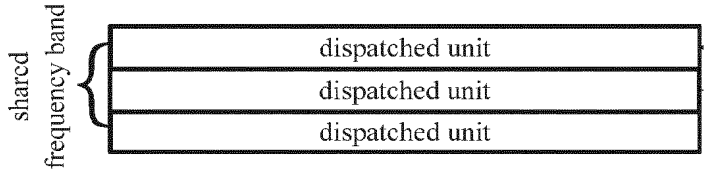


Fig. 5

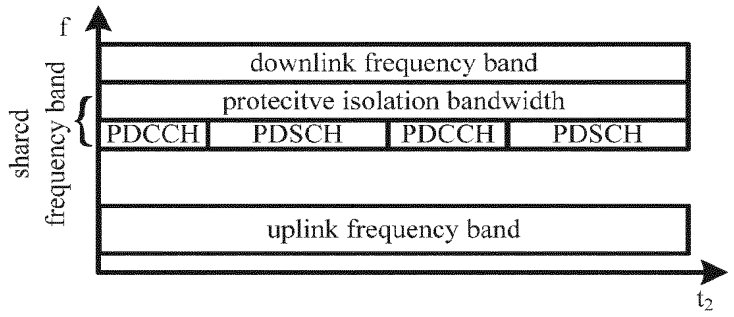


Fig. 6

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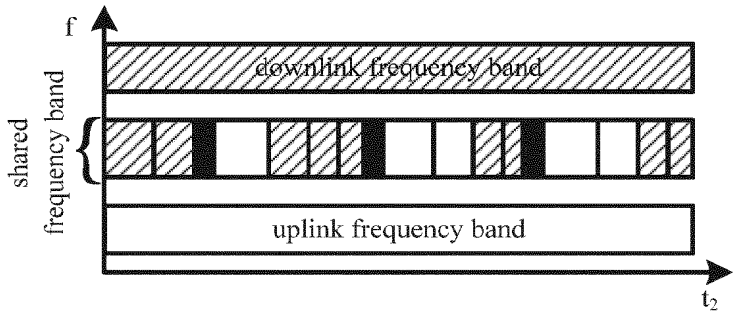


Fig. 7

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/095932

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04 (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

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)

CNABS, CNKI: uplink, downlink, resource, frequency, frequency band, share, frequency division duplex

VEN: uplink, downlink, resource, frequency, band, share, FDD

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103037447 A (CHINA GRIDCOM CORPORATION, LIMITED et al.), 10 April 2013 (10.04.2013), description, paragraphs 5-32	1-14
X	CN 103002451 A (ZTE CORP.), 27 March 2013 (27.03.2013), claims 1-15	1-14
A	CN 101784056 A (POTEVIO INSTITUTE OF TECHNOLOGY CO., LTD. et al.), 21 July 2010 (21.07.2010), the whole document	1-14
A	CN 101291515 A (BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS), 22 October 2008 (22.10.2008), the whole document	1-14
A	CN 102232307 A (HUAWEI TECHNOLOGIES CO., LTD.), 02 November 2011 (02.11.2011), the whole document	1-14

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 February 2015 (27.02.2015)	**18 March 2015 (18.03.2015)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **LI, Xiaopeng** Telephone No.: (86-10) **62412002**

Form PCT/ISA/210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/095932

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 103037447 A	10 April 2013	None	
CN 103002451 A	27 March 2013	WO 2013037231 A1	21 March 2013
CN 101784056 A	21 July 2010	CN 101784056 B	10 October 2012
CN 101291515 A	22 October 2008	CN 101291515 B	08 December 2010
CN 102232307 A	02 November 2011	EP 2713643 A4	17 December 2014
		CN 102232307 B	11 September 2013
		US 2014120975 A1	01 May 2014
		WO 2012171200 A1	20 December 2012
		EP 2713643 A1	02 April 2014

Form PCT/ISA/210 (patent family annex) (July 2009)

Samsung Ex. 1002, Page 268 of 387

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	Anpeng HUANG	
Application No.:	15/500,928	Art Unit 2464
Filed:	January 31, 2017	
Conf. No.:	4629	
For:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK	
Examiner:	Ricky Quoc Ngo	
Customer No.:	144521	
Attorney Docket No.:	I1013.10213US01	

REQUEST TO CORRECT APPLICANT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The above-referenced application is the U.S. national stage of international application no. PCT/CN2014/083578, filed August 1, 2014. The international application designated EMPIRE TECHNOLOGY DEVELOPMENT LLC and ANPENG HUANG, as the applicants. The documents to enter the national stage were filed at the U.S. Patent & Trademark Office (USPTO) on January 31, 2017, with an Application Data Sheet that designated EMPIRE TECHNOLOGY DEVELOPMENT LLC. as the sole applicant.

Assignments from the inventor to EMPIRE TECHNOLOGY DEVELOPMENT LLC were recorded on February 23, 2017. The undersigned attorney hereby requests a change in the applicant under the provisions of 37 CFR 1.46(c)(2) by removing ANPENG HUANG as a joint applicant, such that EMPIRE TECHNOLOGY DEVELOPMENT LLC. is designated as the sole

applicant. The remaining applicant establishes its ownership in the accompanying statement filed under 37 CFR 3.73(c).

This request is not accompanied by a marked-up ADS because the original ADS filed on January 31, 2017, was correct.

If there are any deficiencies in this request, the Office is invited to contact the undersigned attorney.

Dated this 8th day of March, 2018.

Respectfully submitted,

/R. Burns Israelsen, Reg. No. 42685/

R. Burns Israelsen
Registration No. 42685
Attorney for Applicant
Customer No. 97149
Telephone No. (435) 252-1360

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: EMPIRE TECHNOLOGY LLC

Application No./Patent No.: 15/500,928 Filed/Issue Date: August 1, 2014

Titled: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

EMPIRE TECHNOLOGY DEVELOPMENT LLC, a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: ANPENG HUANG To: BEIJING JINDIANCHUANGQI TECHNOLOGY DEVELOPMENT CO., LTD.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 041359, Frame 0412, or for which a copy thereof is attached.

2. From: BEIJING JINDIANCHUANGQI TECHNOLOGY DEVELOPMENT CO., LTD. To: EMPIRE TECHNOLOGY DEVELOPMENT LLC

   The document was recorded in the United States Patent and Trademark Office at
   Reel 041359, Frame 0450, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/R. Burns Israelsen, Reg. No. 42685/	March 8, 2018
Signature	Date
R. Burns Israelsen	42685
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	32002069
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	144521
Filer:	Robert Burns Israelsen/Claire Rigby
Filer Authorized By:	Robert Burns Israelsen
Attorney Docket Number:	I1013.10213US01
Receipt Date:	08-MAR-2018
Filing Date:	31-JAN-2017
Time Stamp:	18:42:14
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Corrected Filing Receipt	I1013-10213US01_Req_Corrected_Filing_Receipt.pdf	221816 4d279132c177662c9e7caa0e35f3579f21b26bd8	no	2

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	I1013-10213US01_Statement_Under373c.pdf	121091 28904f500b9909e7f9f70137fa4a7177088cd010	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	342907		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/500,928
Filing Date	01-31-2017
First Named Inventor	HUANG, Anpeng
Title	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
Art Unit	2464
Examiner Name	NGO, RICKY QUOC
Attorney Docket Number	I1013.10213US01

SIGNATURE of Applicant or Patent Practitioner

Signature	/Ajay K. Gambhir/	Date (Optional)	28 March 2018
Name	Ajay K. Gambhir	Registration Number	44,115
Title (if Applicant is a juristic entity)	Attorney for Applicant		
Applicant Name (if Applicant is a juristic entity)	EMPIRE TECHNOLOGY DEVELOPMENT LLC		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 154241

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Empire Technology Development LLC

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	[signature]	Date (Optional)	March 13, 2019
Name	Dong-Gun Kim		
Title	CFO		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	32188038
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	144521
Filer:	Ajay K. Gambhir/Leigha LaFleur
Filer Authorized By:	Ajay K. Gambhir
Attorney Docket Number:	I1013.10213US01
Receipt Date:	28-MAR-2018
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	15500928_aia0082_28Mar2018.pdf	350161 9e9434d7376c6f5ab1a5d2f1e7b60929f92ed094	no	3

Warnings:

Information:	
Total Files Size (in bytes):	350161

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/500,928	01/31/2017	Anpeng HUANG	I1013.10213US01

CONFIRMATION NO. 4629

154241
IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

POA ACCEPTANCE LETTER

OC000000098478703

Date Mailed: 04/03/2018

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/28/2018.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ldvan/

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/500,928	01/31/2017	Anpeng HUANG	I1013.10213US01

CONFIRMATION NO. 4629

144521
Maschoff Brennan/Allied Inventors
111 East Broadway, Suite 725
Salt Lake City, UT 84111

POWER OF ATTORNEY NOTICE

OC000000098478669

Date Mailed: 04/03/2018

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/28/2018.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ldvan/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

154241 7590 09/26/2018

IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

EXAMINER	
UDDIN, MD SHARIF	

ART UNIT	PAPER NUMBER
2465	

NOTIFICATION DATE	DELIVERY MODE
09/26/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ajay.gambhir@ipspring.com
docket@ipspring.com
paralegalteam@ipspring.com

Office Action Summary	Application No. 15/500,928	Applicant(s) HUANG, Anpeng	
	Examiner MD SHARIF UDDIN	Art Unit 2465	AIA Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 31 January 2017.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-13 and 15-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-13 and 15-20 is/are rejected.

8) ☑ Claim(s) 3 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on See Continuation Sheet is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 03/02/2018.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Continuation of Application Papers 11): 31 January 2017

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Objections

2. Claim 3 objected to because of the following informalities: The claim is dependent on claim 2. To be consistent with claim 2, the text should recite 'fourth frequency' not 'third frequency'.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

4. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. Claim 1 – 9, 11 – 13, 15-17 and 19 – 20 are rejected under 35 U.S.C. 103 as being unpatentable over Liu et al. (US 20150365941 A1 hereinafter Liu) in view of Zhang et al. (US 10,057,901 B2 hereinafter Zhang).

Regarding claim 1, Liu teaches a method for a base station (**Fig.5, Radio Network Node 50**) of a wireless network to allocate communication resources between uplink and downlink channels (**Para 10, lines 1-2, ... an improved resource allocation in a radio communication network**), the method comprising:

determining a quality of spectrum resource that is available for use by the base station for an uplink channel or a downlink channel status **(Fig. 3a, step 320; Para 51, lines 11- 14**, **determine 320 ... allocation priority and/or allocation probability)**

assigning the spectrum resources based on the determined quality status of the first frequency spectrum resource **(Fig. 3a, step 330; Para 51, lines 18 – 20**, *resources are allocated **330** to one or several UEs based on the determined allocation priority and/or allocation probability)*;

but Liu does not teach that the first frequency spectrum resource is assigned to a shared resource pool; scheduling a second frequency spectrum resource that is available for use by the

base station for the uplink channel or the downlink channel based on an initial directional allocation of communication resources for the base station; after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

Zhang teaches assigning the first frequency spectrum resource (**Fig.7 SHARED FREQUENCY BAND**) to a shared resource pool (**Fig 1, step 102; Colum 2, lines 1-3**, *one shared frequency band is set for the uplink frequency band and the downlink frequency band*);

scheduling a second frequency spectrum resource (**Fig. 7, Downlink frequency band, Uplink frequency band**) that is available for use by the base station for the uplink channel or the downlink channel based on an initial directional allocation of communication resources for the base station (**Column 8, lines 16-17 , the original uplink frequency band and the original downlink frequency band**);

after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and

selecting the first frequency spectrum resource from the shared resource pool and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station (**Colum 2, para 1 and Fig. 1, step 104**, *allocating shared frequency band to original uplink frequency band and original downlink frequency band according to resource demands for original uplink frequency band and original downlink frequency band in network service*).

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Zhang's teachings into Liu's teachings to make frequency resource allocation as a first frequency spectrum resource as a shared resource for uplink and downlink and a second frequency spectrum resource for directional uplink or downlink .

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 2 and 19, Liu and Zhang teach the method of claim 1 and the wireless base station of claim 11.

Liu further teaches that assigning the first frequency spectrum resource to the shared resource pool according to the first frequency spectrum resource being: less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

Liu discloses a method of allocating frequency resources based on signal quality (**Fig. 3a, step 320; Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*). Liu discloses that downlink signal quality is determined by CQI and uplink signal quality is determined by RIP (**Para 113, lines 3-4, 8-12**; *DL signal quality can be determined by CQI; UL signal quality can be determined by RIP*). A quality based allocation would allocate high CQI frequency resources to the downlink and the low RIP frequency resources to the uplink. Obviously the remaining resources would be less suitable for downlink than the dedicated downlink resources (fourth frequency) and less suitable for uplink than the dedicated uplink resources (third frequency).

Regarding Claim 3, Liu and Zhang teach the method of claim 2.

Liu further teaches wherein the first frequency spectrum resource is less suitable for the downlink channel than the third frequency spectrum resource (**Fig. 3a, step 320; Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*) in response to a channel quality indicator (CQI) of the first frequency spectrum resource being less than a CQI of the third frequency spectrum resource (**Para 113, lines 3-4,** DL signal quality can be determined by CQI).

Regarding Claim 4, Liu and Zhang teach the method of claim 2.

Liu further teaches wherein the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource (**Fig. 3a, step 320; Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*) in response to a received interference power (RIP) of the first frequency spectrum resource being greater than an RIP of the third frequency spectrum resource (**Para 113, lines 9 -12,** UL signal quality can be determined by RIP).

Regarding claim 5, Liu and Zhang teach the method of claim 1.

Liu teaches determining a quality status of the second frequency spectrum resource **(Fig. 3a, step 320; Para 51, lines 11- 14, determine 320 … allocation priority and/or allocation probability)** and make assignment based on the determined quality status **(Fig. 3a, step 330; Para 51, lines 18 – 20**, *resources are allocated **330** to one or several UEs based on the determined allocation priority and/or allocation probability)* but not explicitly wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool .

Zhang teaches assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool (**Fig. 7, Downlink frequency band, Uplink frequency band**),

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Liu's teaching into Zhang's teachings to determine quality status of the second frequency spectrum and make allocation based on the quality status.

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 6, Liu and Zhang teach the method of claim 5.

Liu teaches assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the uplink channel, and assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative that the second frequency spectrum is usable for the downlink channel (**Fig. 3a, step 320; Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*) but not explicitly that wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises:

Zhang teaches assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool (,**Fig. 7, Downlink frequency band, Uplink frequency band**).

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Liu's teaching into Zhang's teachings to determine quality status of the second frequency spectrum and make allocation based on the quality status.

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 7 and 9, Liu and Zhang teach the method of claim 1 and 5. Liu further teaches teach that wherein determining the quality status ... comprises determining at least one of a channel quality indicator (CQI) and a received interference power (RIP) (**Para 113, lines 2-4 & 8 -12, DL sub-band quality may be determined by the network node from the UE radio measurements e.g. sub-band CQI (channel quality indicator); UL sub-band quality can be determined by the radio network node from the sub-band radio measurements performed by the radio network node (e.g. SNR, SINR, received interference power (RIP)**).

However Liu does not teach the second frequency spectrum resource and the first frequency spectrum resource.

Zhang teaches the second frequency spectrum resource (,**Fig. 7, Downlink frequency band, Uplink frequency band**) and the first frequency spectrum resource (**Fig.7 SHARED FREQUENCY BAND**).

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Zhang's teachings into Liu's teachings to assign the second and the first frequency spectrum for downlink or uplink based on their quality status determined by CQI and RIP measurements.

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 8, Liu and Zhang teach the method of claim 5. Liu further teaches that wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool (**Para 68, lines 7-9**, *The subframe allocation priority can also be expressed in terms of distinct levels, such as "low", "medium", "high"*) based on the quality status of the second frequency spectrum resource (**Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*).

Regarding claim 11, Liu teaches a wireless base station (**Fig.5, Radio Network Node 50**) for a wireless communication network (**Para 10, lines 1-2, … an improved resource allocation in a radio communication network**), the wireless base station comprising:
a quality status module (**Fig.5 Radio Network Node 50**) configured to determine a quality status, (**Fig. 3a, step 320; Para 51, lines 11- 14, determine 320 … allocation priority and/or allocation probability)** of frequency spectrum resources; a processor module (**Fig.5 Processor 52)** coupled to the quality status module(**Fig.5, Radio Network Node 50**) and configured to assign the frequency spectrum resources based on the determined quality status **(Fig. 3a, step 330; Para 51, lines 18 – 20**, *resources are allocated **330** to one or several UEs based on the*

determined allocation priority and/or allocation probability); and a scheduler module (**Fig.5, Radio Network Node 50**) coupled to the processor module (**Fig.5, Processor 52**)

Liu does not teach a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for the uplink channel or the downlink channel; and to assign the first frequency spectrum resource to a shared resource pool; and configured to schedule the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

Zhang working in the same field of technology teaches a first frequency spectrum resource associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel (**Fig.7 SHARED FREQUENCY BAND**), and a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for the uplink channel or the downlink channel (**Fig. 7, Downlink frequency band, Uplink frequency band**); and to assign the first frequency spectrum resource to a shared resource pool (**Fig 1, step 102; Colum 2, lines 1-3**, *one shared frequency band is set for the uplink frequency band and the downlink frequency band*); and configured to schedule the second frequency spectrum resource (**Fig. 7, Downlink frequency band, Uplink frequency band**) for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station (**Column 8, lines 16-17 , the original uplink frequency band and the original downlink frequency band**) and to schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station (**Colum 2, para 1 and Fig. 1, step 104**, *allocating shared frequency band*

to original uplink frequency band and original downlink frequency band according to resource demands for original uplink frequency band and original downlink frequency band in network service)..

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Zhang's teachings into Liu's teachings to make frequency resource allocation as a first frequency spectrum resource as a shared resource for uplink and downlink and a first frequency spectrum resource for directional uplink or downlink .

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 12, Liu and Zhang teach the wireless base station of claim 11. Zhang further teaches that the wireless base station of claim 11, wherein the processor module is further configured to determine the updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for the uplink channel or the downlink channel (**Column 15, lines 31-35,** the processor **802** is configured to execute the plurality of computer-readable program codes **8011** to set a shared frequency band; and *allocate the shared frequency band to an original uplink frequency band and/or an original downlink frequency band, according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service*.)

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Zhang's teachings into Liu's teachings to configured to determine the updated directional allocation of frequency spectrum resources.

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 13, Liu and Zhang teach the wireless base station of claim 11,Liu teaches a memory (**Fig. 5, MEM 53**) coupled to the processor module (**Fig. 5, 52**) and configured to store the shared resource pool (**Para 34, lines the memory and the computer program code may be configured to, with the processor, cause the radio network node to allocate the one or more flexible subframes**) but not explicitly , wherein the processor module is further configured to assign the second frequency spectrum resource to one of an uplink resource pool stored in the memory or a downlink resource pool stored in the memory based on the determined quality status of the second frequency spectrum resource

Zhang teaches wherein the processor module is further configured to assign the second frequency spectrum resource to one of an uplink resource pool stored in the memory or a downlink resource pool stored in the memory (**Fig. 7, Downlink frequency band, Uplink frequency band**) based on the determined quality status of the second frequency spectrum resource. (**Fig. 3a, step 320; Para 56, lines 3 – 5**, *the allocation priority can be based on … a determined signal quality*).

Regarding claim 15, Liu and Zhang teach the wireless base station of claim 13. Zhang further teaches that the wireless base station of claim 13, wherein the updated directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, on current resource requests from the wireless base station, on a number of frequency spectrum resources scheduled from the uplink resource pool for uplink channels, and on a number of frequency spectrum resources scheduled from the downlink resource pool for downlink channels. (**Column 2, lines 25 - 29**, *the uplink frequency bandwidth and the downlink frequency bandwidth of the FDD system may be adjusted in real time …so as to meet different network service demands.*)

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Zhang's teachings into Liu's teachings to make an updated frequency resource allocation based on current resource request for uplink and downlink.

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 16, Liu and Zhang teach the wireless base station of claim 11,

Liu teaches wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station and from the wireless base station (**Para 56, lines 2-6** ***the allocation priority can be based on ... a determined traffic load, a determined traffic demand, a determined proportion of traffic direction, a determined service type***).

Liu and Zhang are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Liu's teachings into Zhang's teachings to make initial directional allocation based on determined traffic load, traffic demand and proportion of traffic direction which is constituted by current resource requests from a wireless device serviced by the wireless base station and from the wireless base station

The motivation would be to rationally adjust the allocated resources to meet the service demand (**Zhang, Column 2, lines 4-7**).

Regarding claim 17, Liu and Zhang teach the wireless base station of claim 11. Liu further teaches that wherein the quality status module (**Fig.5 Radio network node 50**) is configured to determine the quality status of the first frequency spectrum resource by

determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource (**Para 113, lines 3-4 and 10-12, DL signal quality can be determined by CQI, UL signal quality can be determined by RIP**).

Regarding claim 20, Liu further teaches a non-transitory computer-readable medium (**Fig.5, MEM 53**) that includes computer-executable instructions stored thereon, which in response to execution by a processor (**Fig. 5, Processor 52**), cause the processor to perform or control performance of the method of claim 1 **(Para 170, lines 1-3, memory 53 stores computer program code which, when run in a processor 52 causes the eNB 50 to determine a TDD configuration**).

7. Claim 10 and 18 are rejected under 35 U.S.C. 103 as being unpatentable over Liu et al. (US 20150365941 A1 hereinafter Liu) in view of Zhang et al. (US 10,057,901 B2 hereinafter Zhang) and further in view of Non-patent literature ""LTE-Advanced Physical Layer" by Mathew Baker (hereinafter Mathew) .

Regarding claim 10 and 18, Zhang and Liu teach the method of claim 1 and the wireless base station of claim 11. Liu further teaches that wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block to the shared resource pool. (**Para 99, lines 1-4, frequency domain resources include resource blocks (also known as physical resource block (PRB), subband (e.g. group of PRBs), subcarrier, ...**) but not explicitly that a PRB includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers

Mathew Baker working in the same field of wireless communications and chairman of the 3GPP TSG RAN WG1 discloses in his paper "LTE-Advanced Physical Layer" that the basic unit

of resource is the Physical Resource Block (PRB) which includes 12 sub-carrier and multiple resource elements in each sub-carrier **(slide -7**).

Liu, Zhang and Mathew are analogous art because they are in the same field of endeavor of wireless communications. It would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to incorporate Mathew's teachings into the teachings of Liu and Zhang to allocate resources in PRBs

The motivation would be to follow 3GPP transmission resource structure (**Mathew, slide - 7**).

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MD SHARIF UDDIN whose telephone number is (571)272-0952. The examiner can normally be reached on 9:00 am to 5:00 pm EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Marsha Banks-Harold can be reached on (571) 272-7905. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished

applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MD SHARIF UDDIN/
Examiner, Art Unit 2465

/MARSHA D BANKS HAROLD/
Supervisory Patent Examiner, Art Unit 2465

Notice of References Cited	Application/Control No. 15/500,928	Applicant(s)/Patent Under Reexamination HUANG, Anpeng	
	Examiner MD SHARIF UDDIN	Art Unit 2465	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-10057901-B2	08-2018	Zhang; Chenlu	H04W72/04	1/1
*	B	US-20150365941-A1	12-2015	LIU; Jinhua	H04W72/0446	370/280
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	LTE-Advanced Physical Layer, Mathew Baker (Year: 2009)
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	MD SHARIF UDDIN	2465

CPC - Searched*		
Symbol	Date	Examiner
H04W 72/0406; H04W 72/044; H04W 72/0493; H04W 72/06; H04W 72/08; H04W 72/085	09/12/2018	M.U.
H04W72/1231, H04W72/0453, H04W72/082, H04L5/0057, H04W16/14, H04W16/28	09/06/2018	M.U.

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
370	329.000		M.U.

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor search and assignee search have been performed by East and PALM	09/05/2018	M.U.

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/M.U./ Examiner, Art Unit 2465	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	MD SHARIF UDDIN	2465

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/13/2018								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
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	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	-								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

Bibliographic Data

Application No: 15/500,928

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /MD SHARIF UDDIN/ (Examiner's Signature) | (Initials)

Title: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/31/2017	370	2465	APA-CN-879177-02-US-NAT
RULE			

APPLICANTS

EMPIRE TECHNOLOGY DEVELOPMENT LLC, Wilmington, DE, UNITED STATES

Anpeng HUANG, Beijing, CHINA

INVENTORS

Anpeng HUANG Beijing, CHINA

CONTINUING DATA

This application is a 371 of PCT/CN2014/083578 08/01/2014

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

04/26/2017

STATE OR COUNTRY

CHINA

ADDRESS

IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601
UNITED STATES

FILING FEE RECEIVED

$1,480

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1726	((("EMPIRE") near3 ("TECHNOLOGY") near3 ("DEVELOPMENT") near3 ("LLC")) OR (("HUANG") near3 ("Anpeng"))).AS,AANM.	USPAT	OR	ON	2018/09/04 19:40
S2	3670	((("EMPIRE") near3 ("TECHNOLOGY") near3 ("DEVELOPMENT") near3 ("LLC")) OR (("HUANG") near3 ("Anpeng"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:10
S3	2983	S2 and @ad<"20140801"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:13
S4	13	"2007145557"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:14
S5	10	"2010075638"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:20
S6	12	"2013170426"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:28
S8	12	"2016015345"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 10:47
S9	168312	(H04W72/085 or H04W72/1231 or H04W72/0453 or H04W72/082 or H04L5/0057 or H04W16/14 or H04W16/28 or H04W88/08).cpc.	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2018/09/05 15:15

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			EPO; JPO; DERWENT; IBM_TDB			
S10	171315	(H04W72/085 or H04W72/1231 or H04W72/0453 or H04W72/082 or H04L5/0057 OR H04L5/0058 or H04W16/14 or H04W16/28 or H04W88/08).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:19
S22	34	"6529497"	USPAT	OR	ON	2018/09/05 17:54
S23	2	"20170223719"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 19:20
S24	292443	(resource (frequency adj spectrum) prb rb (resource adj block) channel) near3 (allot allocation assign schedul$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:08
S25	30920	S24 same uplink same downlink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:08
S26	21468	S25 and (shar$3 near5 (resource channel$1 pool))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:09
S27	171382	(H04W72/085 or H04W72/1231 or H04W72/0453 or H04W72/082 or H04L5/0057 OR H04L5/0058 or H04W16/14 or H04W16/28 or H04W88/08).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10
S28	200406	(resource (frequency adj spectrum) prb rb (resource adj block) channel) near3 allocation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10
S29	21416	S28 same uplink same downlink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10

S30	14962	S29 and (shar$3 near5 (resource channel$1 pool))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10
S31	4163	S27 and S30	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10
S32	3026	S31 and (CQI (channel adj quality adj indicator) CSI (channel adj status))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:10
S33	10106	S30 and (CQI (channel adj quality adj indicator) CSI (channel adj status))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:12
S34	2264	S33 and (frequency near3 (first second third fourth))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:13
S35	20	S34 and (RIP (received adj interference adj power))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:14
S36	851	S27 and S34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:16
S37	457	S36 and @ad<"20140801"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:18
S38	501	S36 and @ay<"2015"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/09/06 10:23

			DERWENT; IBM_TDB			
S40	467	S36 and @ad<"20140901"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:54
S45	38	"6418317"	USPAT	OR	ON	2018/09/10 10:39
S46	21	(US-20130165134-$ or US-20170223719-$ or US-20160020875-$ or US-20150382222-$ or US-20150358977-$ or US-20150334730-$ or US-20150312783-$ or US-20150110026-$ or US-20090264142-$ or US-20130215838-$ or US-20130170406-$ or US-20120182910-$ or US-20120014330-$ or US-20110305155-$ or US-20110105136-$ or US-20090213802-$).did. or (WO-2010075638-$ or WO-2013170426-$ or WO-2016015345-$).did. or (WO-2007145557-$).did. or (WO-2016015345-$).did.	US-PGPUB; FPRS; EPO; DERWENT	OR	ON	2018/09/10 10:52
S47	17	S46 and CQI	US-PGPUB; FPRS; EPO; DERWENT	OR	ON	2018/09/10 10:53
S48	201027	(resource (frequency adj spectrum) prb rb (resource adj block) channel) near3 allocation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 11:52
S49	21443	S48 same uplink same downlink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 11:52
S50	14964	S49 and (shar$3 near5 (resource channel$1 pool))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 11:52
S51	10106	S50 and (CQI (channel adj quality adj indicator) CSI (channel adj status))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 11:52
S52	2264	S51 and (frequency near3 (first second third fourth))	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2018/09/10 11:52

			EPO; JPO; DERWENT; IBM_TDB			
S54	2	S46 and (RIP (received adj interference adj power)) and uplink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 11:54
S55	4	ep ADJ "3142434"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 12:51
S56	201027	(resource (frequency adj spectrum) prb rb (resource adj block) channel) near3 allocation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S57	21443	S56 same uplink same downlink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S58	14964	S57 and (shar$3 near5 (resource channel$1 pool))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S59	10106	S58 and (CQI (channel adj quality adj indicator) CSI (channel adj status))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S60	2264	S59 and (frequency near3 (first second third fourth))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S61	20	S60 and (RIP (received adj interference adj power)) and uplink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/10 20:10
S62	2	"10,057,901"	US-PGPUB; USPAT	OR	ON	2018/09/11 11:19

S63	0	("10057901").URPN.	USPAT	OR	ON	2018/09/11 15:12
S64	13	("20130083710" | "20130301565" | "20150245333" | "20150358990" | "20170374559" | "7020471" | "8396498" | "8615250" | "8700078" | "8792923" | "8897253" | "9119163" | "9215715").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/09/11 15:13
S66	201159	(resource (frequency adj spectrum) prb rb (resource adj block) channel) near3 allocation	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:42
S67	21473	S66 same uplink same downlink	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:42
S68	14990	S67 and (shar$3 near5 (resource channel$1 pool))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:42
S69	1135	S68 and sub-carrier and (resource adj element)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:42
S70	1135	S69 and (PRB physical resource block)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:47
S71	1134	S69 and (allocat$4 near4 resource)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:50
S72	8	S71 and multiple and (share$1 near5 pool)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/11 16:55
S73	66518	(h04w72/0406 or h04w72/044 or h04w72/0493 or h04w72/06 or h04w72/08 or h04w72/085).cpc.	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2018/09/12 15:58

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			EPO; JPO; DERWENT; IBM_TDB			
S74	9033	S73 and ("CSI"$2 or "CQI"$2 or "MR"$1 or "CSI-RS")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:02
S75	9044	S73 and ("CSI"$2 or "CQI"$2 or "MR"$1 or "CSI-RS" OR "RIP")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:03
S76	4229	S75 and ((sort$2 or sorting or rank$2 or ranking or order$2 or ordering) same (block or "RB" or power$2 or level$2))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:07
S77	3256	S76 and ((allot allocation assign schedul$3) near3(resource (frequency adj spectrum) prb rb (resource adj block) channel))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:23
S78	2721	S77 and (uplink and downlink and shar$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:25
S79	1556	S78 and @ad<"20140730"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:52
S80	1468	S79 and quality	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 16:54
S81	244	S80 and (measurement adj report)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/12 17:09

EAST Search History (Interference)

< This search history is empty>

9/ 13/ 2018 6:51:15 PM
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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15500928
Filing Date	2017-01-31
First Named Inventor	Anpeng HUANG
Art Unit	~~2464~~ 2465
Examiner Name	~~Ricky Quoc Ngo~~ Md Sharif Uddin
Attorney Docket Number	I1013.10213US01

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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/M.U./	1	2013170426	WO	A1	2013-11-21	NOKIA CORPORATION		
/M.U./	2	3142434	EP	A1	2017-03-15	Yulong Computer Telecommunication Scientific		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15500928
Filing Date	2017-01-31
First Named Inventor	Anpeng HUANG
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	I1013.10213US01

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/M.U./	1	CHEN, L., et al., "Dynamic timeslot allocation algorithms suitable for asynmetric traffic in multimedia TOMA/TDD cellular radio," 48th IEEE Vehicular Technology Conference, Vol. 02, pp. 1424-1428 (May 18, 1998)	
/M.U./	2	Extended European Search Report for European Patent Application No. EP14899031.0 mailed on February 16, 2018, Pages 11	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/MD SHARIF UDDIN/	Date Considered	09/12/2018

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /MD S/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15500928
Filing Date	2017-01-31
First Named Inventor	Anpeng HUANG
Art Unit	2464
Examiner Name	Ricky Quoc Ngo
Attorney Docket Number	I1013.10213US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/R. Burns Israelsen, Reg. No. 42685/	Date (YYYY-MM-DD)	2018-03-02
Name/Print	R. Burns Israelsen	Registration Number	42685

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15/500,928
Filing Date	01/31/2017
First Named Inventor	Anpeng HUANG
Art Unit	2465
Examiner Name	Md Sharif Uddin
Attorney Docket Number	I1013.10213US01

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/M.U./	1	2007145557	WO	A1	2007-12-21	TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)		
/M.U./	2	2010075638	WO	A1	2010-07-08	TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)		
/M.U./	3	CN101415275	CN	B	2013-05-08	ZTE CORP	See english abstract	X

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Anpeng HUANG
	Art Unit	
	Examiner Name	
	Attorney Docket Number	I1013.10213US01

/M.U./	4	CN103874221A	CN	A	2014-06-18	CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY	See english abstract	☒

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/M.U./	1	COSTA, E., et al., "Duplex arrangements for future broadband radio interfaces," D2.5 v1.1, in Information Society Technologies, pages 121 (October 30, 2004)	
/M.U./	2	International Search Report and Written Opinion for International Application No. PCT/CN2014/083578 mailed on April 24, 2015, pages 8	

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EXAMINER SIGNATURE

Examiner Signature	/MD SHARIF UDDIN/	Date Considered	09/12/2018

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /MD S/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Anpeng HUANG
Art Unit	
Examiner Name	
Attorney Docket Number	I1013.10213US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/R. Burns Israelsen Reg. No. 42685/	Date (YYYY-MM-DD)	2017-01-31
Name/Print	R. Burns Israelsen	Registration Number	42685

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Samsung Ex. 1002, Page 319 of 387

Privacy Act Statement

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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PTO/SB/06 (09-11)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/500,928	Filing Date 01/31/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	12/18/2018	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TIMOTHY COLE/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:			
Anpeng HUANG		Confirmation No.:	4629
Appl. No.:	15/500,928	Examiner:	Brian T. O CONNOR
Filing Date:	January 31, 2017	Group Art Unit:	2465
For:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN WIRELESS NETWORK		

RESPONSE TO NON-FINAL OFFICE ACTION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

In response to the Non-Final Office Action mailed on September 26, 2018, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are shown in the listing of claims, which begins on page 3 of this paper.

Remarks begin on page 10 of this paper.

Electronic Acknowledgement Receipt

EFS ID:	34612805
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	154241
Filer:	Dennis Moises De Guzman/Katherine Gardner
Filer Authorized By:	Dennis Moises De Guzman
Attorney Docket Number:	APA-CN-879177-02-US-NAT
Receipt Date:	18-DEC-2018
Filing Date:	31-JAN-2017
Time Stamp:	17:46:51
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		CN-879177-02-US-NAT_RNFOA_18DEC2018.pdf	161043 64ad0932c315ece1b3bd192c428cde39f946f387	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	10	14
	Claims	3	9
	Specification	2	2
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	161043	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REMARKS

This paper is being filed in response to the Office Action having a mailing date of September 26, 2018. Various claims are amended as shown. Claim 14 was canceled previously without prejudice. No new matter is added. With this filing, claims 1-13 and 15-20 are pending in the application for examination.

Support for the claim amendments can be found at least in Fig. 4 and its accompanying description in the specification.

Claim Objections

The Office Action, on page 2, objects to claim 3 because of the alleged informalities.

Claim 3, as set forth above, has been amended as suggested by the Office Action. Hence, it is kindly requested that the objection to claim 3 be withdrawn.

Rejection under 35 U.S.C. § 103

The Office Action rejects claims 1-9, 11-13, 15-17, 19, and 20 under 35 U.S.C. § 103 as allegedly being unpatentable over Liu (U.S. Patent Application Publication No. 2015/0365941) in view of Zhang (U.S. Patent No. 10,057,901).

The Office Action rejects claims 10 and 18 under 35 U.S.C. § 103 as allegedly being unpatentable over Liu (U.S. Patent Application Publication No. 2015/0365941) in view of Zhang (U.S. Patent No. 10,057,901) and further in view of Mathew (Non-Patent Literature entitled "LTE-Advanced Physical Layer" by Mathew Baker).

Without conceding that the above rejections are proper and for purposes of facilitating prosecution, the claims are amended as shown. For the reasons set forth below, it is kindly requested that these rejections be reconsidered and withdrawn.

Independent claims 1, 11, and 20 and their dependent claims

Claim 1 is amended herein to recite, *inter alia*, the following:

> *"... determining, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station; in response to determining that the first frequency spectrum resource is the sub-optimal resource, assigning the first frequency spectrum resource to a shared resource pool ..."*

The Office Action, on pages 3 and 4, states that "Liu teaches ... determining a quality of spectrum resource that is available for use by the base station for an uplink channel or a downlink channel status (Fig. 3a, step 320; Para 51, lines 11-4, determine 320 ... allocation priority and/or allocation probability) ... assigning the spectrum resources based on the determined quality status of the first frequency spectrum resource (Fig. 3a, step 330; Para 51, lines 18-20, resources are allocated 330 to one or several UEs based on the determined allocation priority and/or allocation probability) ... but Liu does not teach that the first frequency spectrum resource is assigned to a shared resource pool ... Zhang teaches assigning the first frequency spectrum resource (Fig.7 SHARED FREQUENCY BAND) to a shared resource pool (Fig 1, step 102; Colum 2, lines 1-3, one shared frequency band is set for the uplink frequency band and the downlink frequency band)."

Liu, in the cited portions and elsewhere, describes a subframe to be configured as a "flexible" subframe, which can be dynamically allocated as either a downlink subframe or an uplink subframe. For each "flexible" subframe, an allocation priority and/or allocation probability of using the flexible subframe as an uplink subframe or a downlink subframe is determined, and subsequent resource allocation to user equipments (UEs) is based on the determined allocation priority and/or allocation probability.

Liu further describes that the allocation priority and/or probability for one or more subframes (e.g., flexible subframes) can be determined or assigned by a radio network node based on one or more criteria, which includes UE radio measurements (e.g., channel quality indicator (CQI), received interference power (RIP) etc.).

Hence, Liu, at best, describes allocating the flexible subframe to UEs as the uplink subframe or the downlink subframe based on the one or more criteria such as UE radio measurements including CQI, RIP etc.

Liu nowhere teaches or suggests *"determining, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station; in response to determining that the first frequency spectrum resource is the sub-optimal resource, assigning the first frequency spectrum resource to a shared resource pool*," as recited by amended claim 1.

The other cited reference Zhang, in the cited portions and elsewhere, describes setting a shared frequency band, and allocating the shared frequency band to an original uplink frequency band and/or an original downlink frequency band according to resource demands for the original uplink frequency band and the original downlink frequency band in a network service.

However, Zhang nowhere teaches or suggests how any frequency spectrum resource is assigned to the shared frequency band (the alleged "shared resource pool").

Explained in another way, Zhang nowhere teaches or suggests determining, based on a quality status of a frequency spectrum resource, that the frequency spectrum resource is a sub-optimal resource, and in response to determining that the frequency spectrum resource is the sub-optimal resource, assigning the frequency spectrum resource to a shared resource pool.

Hence, assuming *arguendo* that the references Liu and Zhang can be combined in the manner as alleged by the Office Action, the combination of Liu and Zhang, at best, would teach or suggest setting a shared frequency band and allocating the frequency resources from the shared frequency band to the uplink band and/or the downlink band for servicing of UEs based on one or more criteria such as UE radio measurements including CQI, RIP etc.

The combination of Liu and Zhang would still fail to teach or suggest "*determining, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station; in response to determining that the first*

frequency spectrum resource is the sub-optimal resource, assigning the first frequency spectrum resource to a shared resource pool" (emphasis added), as recited by amended claim 1.

Mathew fails to remedy the deficiencies of Liu and Zhang.

Hence, it is believed that claim 1 is allowable, for at least the remarks provided above. Amended claims 11 and 20 recite analogous features, and hence, for similar reasons, claims 11 and 20 are believed to be allowable.

The claims that depend directly or indirectly on claims 1, 11, and 20 are also allowable by virtue of their respective dependency upon claims 1, 11, and 20 and also by virtue of their additional recitations. Accordingly, it is kindly requested that the rejection of claims 1, 11, and 20, and their dependent claims be withdrawn.

CONCLUSION

It is respectfully submitted that the present claims are in condition for allowance and an early Notice of Allowance is earnestly sought. Attorney Dennis M. de Guzman may be contacted at telephone number (425) 505-0910 at the Examiner's convenience if it would help in the prosecution of this matter.

The Commissioner is hereby authorized to charge to the Deposit Account No. 50-5597 (APA-CN-879177-02-US-NAT) any (large entity size) deficiency of fees under 37 CFR 1.16 and 1.17 that may be required by this paper and to credit any overpayment to that Account. If any extension of time is required in connection with the filing of this paper and has not been separately requested, such extension is hereby requested.

Respectfully submitted,

Date: December 18, 2018

By /Dennis M. de Guzman/
Dennis M. de Guzman
Reg. No. 41,702

Customer No. 154241
IP Spring-AI
180 N. LaSalle St, Ste. 3700
Chicago, IL 60601
(425) 505-0910

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Currently Amended) A method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, the method comprising:

determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink channel or a downlink channel;

determining, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station;

in response to determining that the first frequency spectrum resource is the sub-optimal resource, assigning the first frequency spectrum resource to a shared resource pool ~~based on the determined quality status of the first frequency spectrum resource~~;

scheduling, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel ~~based on an initial directional allocation of communication resources for the base station~~;

after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and

selecting the first frequency spectrum resource from the shared resource pool, and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

2. (Currently Amended) The method of claim 1, wherein determining that the first frequency spectrum resource is the sub-optimal resource comprises determining that ~~assigning the first frequency spectrum resource to the shared resource pool based on the determined quality status of the first frequency spectrum resource comprises assigning the~~

~~first frequency spectrum resource to the shared resource pool according to~~ the first frequency spectrum resource [[being]]is:

less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and

less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

3. (Currently Amended) The method of claim 2, wherein determining that the first frequency spectrum resource is less suitable for the downlink channel than the [[third]]fourth frequency spectrum resource comprises determining that ~~in response to~~ a channel quality indicator (CQI) of the first frequency spectrum resource [[being]]is less than a CQI of the [[third]]fourth frequency spectrum resource.

4. (Currently Amended) The method of claim 2, wherein determining that the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource comprises determining that ~~in response to~~ a received interference power (RIP) of the first frequency spectrum resource [[being]]is greater than an RIP of the third frequency spectrum resource.

5. (Currently Amended) The method of claim 1, further comprising:

determining a quality status of the second frequency spectrum resource; and

based on the determined quality status of the second frequency spectrum resource, assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool~~,~~

~~wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises determining a quality status of the second frequency spectrum resource~~.

6. (Currently Amended) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises:

assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative

[[that]]of the second frequency spectrum [[is]]being usable for the uplink channel, [[and]]or

assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative [[that]]of the second frequency spectrum [[is]]being usable for the downlink channel.

7. (Previously Presented) The method of claim 5, wherein determining the quality status of the second frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the second frequency spectrum resource.

8. (Currently Amended) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking, based on the quality status of the second frequency spectrum resource, the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool ~~based on the quality status of the second frequency spectrum resource~~.

9. (Previously Presented) The method of claim 1, wherein determining the quality status of the first frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

10. (Original) The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

11. (Currently Amended) A wireless base station for a wireless communication network, the wireless base station comprising:

a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource, wherein each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an

uplink channel or a downlink channel~~, and to determine a quality status of a second frequency spectrum resource associated with the air interface that is available for use by the wireless base station for the uplink channel or the downlink channel~~;

a processor ~~module~~ coupled to the quality status module and configured to:

determine, based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station; and

in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool ~~based on the determined quality status of the first frequency spectrum resource~~; and

a scheduler module coupled to the processor ~~module~~ and configured to:

schedule the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station; and

[[to]]schedule the first frequency spectrum resource based on an updated directional allocation of frequency spectrum resources for the wireless base station.

12. (Currently Amended) The wireless base station of claim 11, wherein the processor ~~module~~ is further configured to determine the updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for the uplink channel or the downlink channel.

13. (Currently Amended) The wireless base station of claim 11, further comprising:

a memory coupled to the processor ~~module~~ and configured to store an uplink resource pool, a downlink resource pool, and the shared resource pool,

wherein the processor ~~module~~ is further configured to assign, based on the determined quality status of the second frequency spectrum resource, the second frequency spectrum resource to one of [[an]]the uplink resource pool ~~stored in the memory~~ or [[a]]the downlink resource pool ~~stored in the memory based on the determined quality status of the second frequency spectrum resource~~.

14. (Canceled)

15. (Currently Amended) The wireless base station of claim [[13]]12, wherein the updated directional allocation of frequency spectrum resources is based on one or more of: current resource requests from a wireless device serviced by the wireless base station, [[on]]current resource requests from the wireless base station, [[on]]a number of frequency spectrum resources scheduled from [[the]]an uplink resource pool for uplink channels, and [[on]]a number of frequency spectrum resources scheduled from [[the]]a downlink resource pool for downlink channels.

16. (Currently Amended) The wireless base station of claim 11, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, and current resource requests from the wireless base station.

17. (Previously Presented) The wireless base station of claim 11, wherein the quality status module is configured to determine the quality status of the first frequency spectrum resource by determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

18. (Currently Amended) The wireless base station of claim 11, wherein ~~the processor module is configured to assign~~ the first frequency spectrum resource ~~to the shared resource pool by assignment of a physical resource block that~~ includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers ~~to the shared resource pool~~.

19. (Currently Amended) The wireless base station of claim 11, wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the processor ~~module~~ is configured to:

~~assign the first frequency spectrum resource to the shared resource pool in response to~~ determine that the first frequency spectrum resource [[being]]is less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the wireless base station;[[,]] and

determine that the first frequency spectrum resource is ~~being~~ less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the wireless base station.

20. (Currently Amended) A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of operations that comprise: ~~the method of claim 1~~

determine a quality status of a first frequency spectrum resource that is available for use by a base station for an uplink channel or a downlink channel;

determine, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station,

wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the computer-executable instructions, in response to execution by the processor, cause the processor to perform or control performance of at least one operation that comprises:

determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station; and

determine that a received interference power (RIP) of the first frequency spectrum resources is greater than a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station;

in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool;

schedule, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel;

after the second frequency spectrum resource is scheduled for use by the base station, determine an updated directional allocation of communication resources for the base station; and

select the first frequency spectrum resource from the shared resource pool, and schedule the first frequency spectrum resource for either the uplink channel or the

downlink channel based on the determined updated directional allocation of communication resources for the base station.

AMENDMENTS TO THE SPECIFICATION

Please amend the following paragraph (as previously submitted on January 31, 2017) on page 1 of the application, under the CROSS-REFERENCE TO RELATED APPLICATION heading, as follows.

The present application is a U.S. National Stage filing under 35 U.S.C. § 371 of International Application ~~Serial~~ No. PCT/CN2014/083578, filed on August 01, 2014.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

154241 7590 02/20/2019

IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

EXAMINER	
O CONNOR, BRIAN T	

ART UNIT	PAPER NUMBER
2465	

NOTIFICATION DATE	DELIVERY MODE
02/20/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ajay.gambhir@ipspring.com
docket@ipspring.com
paralegalteam@ipspring.com

Office Action Summary	Application No. 15/500,928	Applicant(s) HUANG, Anpeng	
	Examiner Brian T O'Connor	Art Unit 2465	AIA Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 12/18/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-13 and 15-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☑ Claim(s) 20 is/are allowed.

7) ☑ Claim(s) 1,5,9-11,16 and 18 is/are rejected.

8) ☑ Claim(s) 2-4,6-8,12-13,15,17 and 19 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. This office action is in response to Applicant's amendment filed on 12/18/2018.

3. Claims 1-13 and 15-20 are currently pending.

Claim Rejections - 35 USC § 103

4. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

5. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1, 5, 9, 10, 11, 16 and 18 are rejected under 35 U.S.C. 103 as being unpatentable over Xu et al. (US 8,937,895 B2; hereafter Xu) in view of Komine et al. (US 8,565,147 B2; hereafter Komine).

With respect to claim 1, Xu discloses a method for a base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) of a wireless network to allocate communication resources between uplink and downlink channels (**col. 3, lines 20-38; col. 8, lines 48-55**), the method comprising:

determining a quality status (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**) of a first frequency spectrum resource that is available for use by the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) for an uplink channel or a downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**);

determining, based on the quality status (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**), that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**), relative to other frequency spectrum resources that are available for use by the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**);

in response to determining that the first frequency spectrum resource is the sub-optimal resource (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**), assigning (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the first frequency spectrum resource to a shared resource pool (**downlink carrier set of FIG. 8B; downlink carrier set of FIG. 8C**);

scheduling (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**), based on an initial directional allocation of communication resources

(**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) for the base station, a second frequency spectrum resource that is available for use by the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) for the uplink channel or the downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**);

after scheduling (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the second frequency spectrum resource for the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**), determining an updated directional allocation of communication resources for the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**); and

selecting the first frequency spectrum resource (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) from the shared resource pool (**downlink carrier set of FIG. 8B; downlink carrier set of FIG. 8C**) and scheduling the first frequency spectrum resource (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) for either the uplink channel or the downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**) based on the determined updated directional allocation of communication resources for the base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**).

Xu does not specifically disclose allocate communication resources between uplink and downlink channels; and

that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel.

Komine discloses allocate communication resources (**col. 3, lines 55-65, see the Resource blocks and number of sub-carriers**) between uplink and downlink channels (**downstream link and upstream link of FIG. 1; col. 4, lines 1-10**); and

that the first frequency spectrum resource (**col. 3, lines 55-65, see the Resource blocks and number of sub-carriers**) is a sub-optimal resource, for the uplink channel and the downlink channel (**downstream link and upstream link of FIG. 1; col. 4, lines 1-10**).

Komine teaches the benefit of reaching the best channel quality by allocating over uplink and downlink resources (**column 1, lines 35-52**). Thus, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to use the allocation as taught by Komine with the method and base station of Xu to produce an expected result.

With respect to claim 5, Xu further discloses comprising:

determining a quality status of the second frequency spectrum resource; and

based on the determined quality status (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**) of the second frequency spectrum resource, assigning (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool (**col. 3, lines 20-38; col. 8, lines 48-55**).

With respect to claim 9, Xu further discloses wherein determining the quality status of the first frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI) (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C; col. 16, lines 11-18**) and a received interference power (RIP) of the first frequency spectrum resource.

With respect to claim 10, Xu further discloses wherein assigning the first frequency spectrum resource to the shared resource pool (**downlink carrier set of FIG. 8B; downlink carrier set of FIG. 8C**) comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool (**downlink carrier set of FIG. 8B; downlink carrier set of FIG. 8C**).

With respect to claim 11, Xu discloses a wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) for a wireless communication network, the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) comprising:

a quality status module (**1100, 1140, 1120, 1190, 1230 1200 of FIG. 12**) configured to determine a respective quality status (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**) of a first frequency spectrum resource and a second frequency spectrum resource (**col. 15, lines 10-17; col. 16, lines 11-25**), wherein each of the first frequency spectrum resource and the second frequency spectrum resource (**col. 15, lines**

10-17; col. 16, lines 11-25) are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**);

a processor (**1100, 1140, 1120, 1190, 1230 1200 of FIG. 12**) coupled to the quality status module (**1100, 1140, 1120, 1190, 1230 1200 of FIG. 12**) and configured to;

determine, based on the quality status (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**) of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel (**col. 3, lines 20-38; col. 8, lines 48-55**), relative to other frequency spectrum resources that are available for use by the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**); and

in response to the determination that the first frequency spectrum resource is the sub-optimal resource (**'carrier 2 has a better signal quality' of FIG. 8B; 'carrier 3 has a better signal quality' of FIG. 8C**), assign (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the first frequency spectrum resource to a shared resource pool (**downlink carrier set of FIG. 8B; downlink carrier set of FIG. 8C**); and

a scheduler module (**1100, 1140, 1120, 1190, 1230 1200 of FIG. 12**) coupled to the processor (**1100, 1140, 1120, 1190, 1230 1200 of FIG. 12**) and configured to;

schedule (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) of frequency spectrum resources for

the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**), and

schedule (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) the first frequency spectrum resource based on an updated directional allocation (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) of frequency spectrum resources (**col. 15, lines 10-17; col. 16, lines 11-25**) for the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**).

Xu does not specifically disclose that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel.

Komine discloses that the first frequency spectrum resource (**col. 3, lines 55-65, see the Resource blocks and number of sub-carriers**) is a sub-optimal resource, for the uplink channel and the downlink channel (**downstream link and upstream link of FIG. 1; col. 4, lines 1-10**).

Komine teaches the benefit of reaching the best channel quality by allocating over uplink and downlink resources (**column 1, lines 35-52**). Thus, it would have been obvious to one of ordinary skill in the art before the effective filing date of the claimed invention to use the allocation as taught by Komine with the method and base station of Xu to produce an expected result.

With respect to claim 16, Xu further discloses wherein the initial directional allocation of frequency spectrum resources (**'Configure and active carrier 2' of FIG. 8B; 'Reconfigure the se; remove carrier 1' of FIG. 8C**) is based on current resource requests from a wireless device (**UE of FIG. 8A; 13, UE of FIG. 13**) serviced by the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**) and current resource requests (**col. 15, lines 10-17; col. 16, lines 11-25**) from the wireless base station (**Base Station in FIG. 8A; 11, Base station of FIG. 11; 11, Base station of FIG. 12**).

With respect to claim 18, Xu further discloses wherein the first frequency spectrum resource (**col. 15, lines 10-17; col. 16, lines 11-25**) includes multiple subcarriers (**col. 3, lines 20-38; col. 8, lines 48-55**) and multiple resource elements (**col. 15, lines 10-17; col. 16, lines 11-25**) associated with each of the multiple subcarriers (**col. 3, lines 20-38; col. 8, lines 48-55**).

Allowable Subject Matter

7. Claims 2-4, 6-8, 12, 13, 15, 17, and 19 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

8. Claim 20 is allowed.

Response to Arguments

9. Applicant's arguments with respect to claims 1 and 11 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

10. Applicant's amendment necessitated the new ground of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brian T O'Connor whose telephone number is (571)270-1081. The examiner can normally be reached on Mon-Fri Flex 10am-6:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Marsha Banks-Harold can be reached on 571-272-7905. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BRIAN T O CONNOR/
Primary Examiner, Art Unit 2465
February 13, 2019

Notice of References Cited	Application/Control No. 15/500,928	Applicant(s)/Patent Under Reexamination HUANG, Anpeng	
	Examiner Brian T O'Connor	Art Unit 2465	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20150085808-A1	03-2015	XU; Haibo	H04L5/001	370/329
*	B	US-20150009924-A1	01-2015	Takano; Hiroaki	H04L5/0035	370/329
*	C	US-20140219210-A1	08-2014	Lunttila; Timo E.	H04L5/0007	370/329
*	D	US-20130308583-A1	11-2013	OGAWA; Yoshihiko	H04L5/0007	370/329
*	E	US-10172119-B2	01-2019	Lunttila; Timo E.	H04L5/0007	1/1
*	F	US-8937895-B2	01-2015	Xu; Haibo	H04L5/001	370/311
*	G	US-7782821-B2	08-2010	Matsuo; Hidenori	H04L5/0007	370/334
*	H	US-9571244-B2	02-2017	Takano; Hiroaki	H04L5/0035	1/1
*	I	US-8565147-B2	10-2013	Komine; Toshihiko	H04B7/2621	370/320
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	Brian T O'Connor	2465

CPC - Searched*		
Symbol	Date	Examiner
H04W 72/0406; H04W 72/044; H04W 72/0493; H04W 72/06; H04W 72/08; H04W 72/085	09/12/2018	M.U.
H04W72/1231, H04W72/0453, H04W72/082, H04L5/0057, H04W16/14, H04W16/28	09/06/2018	M.U.
H04L 5/0039; H04L 5/0041; H04L 5/0058; H04L 5/006; H04L 5/0076	02/13/2019	Brian O'Connor

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
370	329.000		M.U.

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor search and assignee search have been performed by East and PALM	09/05/2018	M.U.
Updated Search	02/13/2019	Brian O'Connor

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	Brian T O'Connor	2465

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/13/2018	02/13/2019							
	1	✓	✓							
	2	✓	O							
	3	✓	O							
	4	✓	O							
	5	✓	✓							
	6	✓	O							
	7	✓	O							
	8	✓	O							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	O							
	13	✓	O							
	14	-	-							
	15	✓	O							
	16	✓	✓							
	17	✓	O							
	18	✓	✓							
	19	✓	O							
	20	✓	=							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	24561	(h04l5/0039 or h04l5/0041 or h04l5/0058 or h04l5/006 or h04l5/0076).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/02/13 13:17
S2	2112	S1 and ((releas$3 or deallocat$3 or unallocat$3 or remov$3) same (block$2 or pool$2 or group$3 or set$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/02/13 13:17
S3	310	S1 and ((releas$3 or deallocat$3 or unallocat$3 or remov$3) same (block$2 or pool$2 or group$3 or set$3) same (quality$2 or "CQI" or "BER"$2 or "SNR"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/02/13 13:18
S4	24	("20100113078" | "20110268007" | "20120008522" | "20120014272" | "20120020230" | "20120051250" | "20120076038" | "20120140694" | "20120172076" | "20120208547" | "20120218962" | "20120218968" | "20120257515" | "20120282966" | "20130003788" | "20130021925" | "20130021926" | "20130039349" | "20130053078" | "20130077514" | "20130083681" | "20130114656" | "20130163461" | "20130301450").PN. OR ("9571244").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2019/02/13 14:22

2/13/2019 4:52:52 PM
C:\Users\boconnor\Documents\EAST\Workspaces\cy2019\15_500928_update_feb2019.wsp

Samsung Ex. 1002, Page 353 of 387

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:			
Anpeng HUANG		Confirmation No.:	4629
Appl. No.:	15/500,928	Examiner:	Brian T. O CONNOR
Filing Date:	January 31, 2017	Group Art Unit:	2465
For:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN WIRELESS NETWORK		

RESPONSE AFTER FINAL REJECTION UNDER 37 CFR 1.116

Mailstop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

This paper is being filed along with a Certification and Request for Consideration under the After Final Consideration Pilot Program 2.0, in response to the Final Office Action mailed on February 20, 2019. Please amend the above-identified application as follows:

Amendments to the Claims are shown in the listing of claims, which begins on page 2 of this paper.

Remarks begin on page 8 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (Currently Amended) A method for a base station of a wireless network to allocate communication resources between uplink and downlink channels, the method comprising:

determining a quality status of a first frequency spectrum resource that is available for use by the base station for an uplink channel or a downlink channel;

determining, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station;

in response to determining that the first frequency spectrum resource is the sub-optimal resource, assigning the first frequency spectrum resource to a shared resource pool;

scheduling, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel;

after scheduling the second frequency spectrum resource for the base station, determining an updated directional allocation of communication resources for the base station; and

selecting the first frequency spectrum resource from the shared resource pool, and scheduling the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station,

wherein determining that the first frequency spectrum resource is the sub-optimal resource comprises determining that the first frequency spectrum resource is:

less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the base station, and

less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the base station.

2. (Canceled)

3. (Currently Amended) The method of ~~claim 2~~ claim 1, wherein determining that the first frequency spectrum resource is less suitable for the downlink channel than the fourth frequency spectrum resource comprises determining that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a CQI of the fourth frequency spectrum resource.

4. (Currently Amended) The method of ~~claim 2~~ claim 1, wherein determining that the first frequency spectrum resource is less suitable for the uplink channel than the third frequency spectrum resource comprises determining that a received interference power (RIP) of the first frequency spectrum resource is greater than an RIP of the third frequency spectrum resource.

5. (Previously Presented) The method of claim 1, further comprising:

determining a quality status of the second frequency spectrum resource; and

based on the determined quality status of the second frequency spectrum resource, assigning the second frequency spectrum resource to one of an uplink resource pool or a downlink resource pool.

6. (Previously Presented) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises:

assigning the second frequency spectrum resource to the uplink resource pool in response to the quality status of the second frequency spectrum resource being indicative of the second frequency spectrum being usable for the uplink channel, or

assigning the second frequency spectrum resource to the downlink resource pool in response to the quality status of the second frequency spectrum resource being indicative of the second frequency spectrum being usable for the downlink channel.

7. (Previously Presented) The method of claim 5, wherein determining the quality status of the second frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the second frequency spectrum resource.

8. (Previously Presented) The method of claim 5, wherein assigning the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool comprises ranking, based on the quality status of the second frequency spectrum resource, the second frequency spectrum resource with respect to other frequency spectrum resources assigned to the uplink resource pool or the downlink resource pool.

9. (Previously Presented) The method of claim 1, wherein determining the quality status of the first frequency spectrum resource comprises determining at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

10. (Original) The method of claim 1, wherein assigning the first frequency spectrum resource to the shared resource pool comprises assigning a physical resource block that includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers to the shared resource pool.

11. (Currently Amended) A wireless base station for a wireless communication network, the wireless base station comprising:

a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource, wherein each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel;

a processor coupled to the quality status module and configured to:

determine, based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station; and

in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool; and

a scheduler module coupled to the processor and configured to:

schedule the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station;

determine an updated directional allocation of frequency spectrum resources for the wireless base station after the second frequency spectrum resource is scheduled for the uplink channel or the downlink channel; and

schedule the first frequency spectrum resource based on [[an]]the updated directional allocation of frequency spectrum resources for the wireless base station.

12. (Canceled)

13. (Previously Presented) The wireless base station of claim 11, further comprising:

a memory coupled to the processor and configured to store an uplink resource pool, a downlink resource pool, and the shared resource pool,

wherein the processor is further configured to assign, based on the determined quality status of the second frequency spectrum resource, the second frequency spectrum resource to one of the uplink resource pool or the downlink resource pool.

14. (Canceled)

15. (Currently Amended) The wireless base station of ~~claim 12~~ claim 11, wherein the updated directional allocation of frequency spectrum resources is based on one or more of: current resource requests from a wireless device serviced by the wireless base station, current resource requests from the wireless base station, a number of frequency spectrum resources scheduled from an uplink resource pool for uplink channels, and a number of frequency spectrum resources scheduled from a downlink resource pool for downlink channels.

16. (Previously Presented) The wireless base station of claim 11, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, and current resource requests from the wireless base station.

17. (Previously Presented) The wireless base station of claim 11, wherein the quality status module is configured to determine the quality status of the first frequency spectrum resource by determination of at least one of a channel quality indicator (CQI) and a received interference power (RIP) of the first frequency spectrum resource.

18. (Previously Presented) The wireless base station of claim 11, wherein the first frequency spectrum resource includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers.

19. (Previously Presented) The wireless base station of claim 11, wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the processor is configured to:

determine that the first frequency spectrum resource is less suitable for the uplink channel than a third frequency spectrum resource that is available for use by the wireless base station; and

determine that the first frequency spectrum resource is less suitable for the downlink channel than a fourth frequency spectrum resource that is available for use by the wireless base station.

20. (Previously Presented) A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of operations that comprise:

determine a quality status of a first frequency spectrum resource that is available for use by a base station for an uplink channel or a downlink channel;

determine, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station,

wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the computer-executable instructions, in response to execution by the processor, cause the processor to perform or control performance of at least one operation that comprises:

determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station; and

determine that a received interference power (RIP) of the first frequency spectrum resources is greater than a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station;

in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool;

schedule, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel;

after the second frequency spectrum resource is scheduled for use by the base station, determine an updated directional allocation of communication resources for the base station; and

select the first frequency spectrum resource from the shared resource pool, and schedule the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

REMARKS

This paper is being filed in response to the final Office Action having a mailing date of February 20, 2019. Claims 1, 3, 4, 11, and 15 are amended as shown. Claims 2 and 12 are canceled herein without prejudice. Claim 14 was previously canceled without prejudice. With this filing, claims 1, 3-11, 13, and 15-20 remain pending in the application.

Allowable subject matter

The final Office Action allowed independent claim 20, and indicated that dependent claims 2-4, 6-8, 12, 13, 15, 17, and 19 would be allowable if rewritten in independent form. The Examiner is thanked for this indication of allowable subject matter.

Independent claim 1 is amended herein to include the recitations of allowable dependent claim 2, which is now canceled without prejudice. With this amendment, it is believed that claim 1 and its dependent claims are in condition for allowance. Notice to that effect is kindly requested.

Independent claim 11 is amended herein to include the recitations of allowable dependent claim 12, which is now canceled without prejudice. With this amendment, it is believed that claim 11 and its dependent claims are in condition for allowance. Notice to that effect is also kindly requested.

Rejection under 35 U.S.C. § 103

The final Office Action rejected claims 1, 5, 9-11, 16, and 18 under 35 U.S.C. § 103 as allegedly being unpatentable over Xu et al. (U.S. Patent No. 8,937,895) in view of Komine et al. (U.S. Patent No. 8,565,147).

In view of the amendments made above to independent claims 1 and 11, it is respectfully submitted that these rejections are rendered moot. Therefore, it is kindly requested that these rejections be withdrawn.

CONCLUSION

It is respectfully submitted that the present claims are in condition for allowance and an early Notice of Allowance is earnestly sought. Attorney Dennis M. de Guzman may be contacted at telephone number (425) 505-0910 at the Examiner's convenience if it would help in the prosecution of this matter.

The Commissioner is hereby authorized to charge to the Deposit Account No. 50-5597 (APA-CN-879177-02-US-NAT) any (large entity size) deficiency of fees under 37 CFR 1.16 and 1.17 that may be required by this paper and to credit any overpayment to that Account. If any extension of time is required in connection with the filing of this paper and has not been separately requested, such extension is hereby requested.

Respectfully submitted,

Date: April 19, 2019

By /Dennis M. de Guzman/
Dennis M. de Guzman
Reg. No. 41,702

Customer No. 154241
IP Spring-AI
180 N. LaSalle St, Ste. 3700
Chicago, IL 60601
(425) 505-0910

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
APA-CN-879177-02-US-NAT	15/500,928	January 31, 2017

First Named Inventor:	Title:
Anpeng Huang	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:
    - Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
    - The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
        - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
        - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
            - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
            - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
/Dennis M. de Guzman/	April 19, 2019
Name (Print/Typed) Dennis M. de Guzman	Practitioner Registration No. 41,702

***Note**: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

☑ * Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	35771565
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	154241
Filer:	Dennis Moises De Guzman/Katherine Gardner
Filer Authorized By:	Dennis Moises De Guzman
Attorney Docket Number:	APA-CN-879177-02-US-NAT
Receipt Date:	19-APR-2019
Filing Date:	31-JAN-2017
Time Stamp:	07:57:24
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		CN-879177-02-US-NAT_RFOA_19APR2019.pdf	116562 8a9cbb59573eda9df8e37a3b6a98223e86495121	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	9

Warnings:					
Information:					
2	After Final Consideration Program Request	CN-879177-02-US-NAT_sb0434_19APR2019.pdf	228096 91aef5f2433c754db62aa2167e3ba28038958bbd	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	344658		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/500,928	Filing Date 01/31/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/19/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/VIOLA D ROGERS/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

154241 7590 05/08/2019

IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

EXAMINER
O CONNOR, BRIAN T

ART UNIT	PAPER NUMBER
2465	

DATE MAILED: 05/08/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

TITLE OF INVENTION: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	08/08/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

154241 7590 05/08/2019
IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

TITLE OF INVENTION: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	08/08/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
O CONNOR, BRIAN T	2465	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Samsung Ex. 1002, Page 369 of 387

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

154241 7590 05/08/2019

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180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

EXAMINER	
O CONNOR, BRIAN T	
ART UNIT	PAPER NUMBER
2465	

DATE MAILED: 05/08/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/500,928	Applicant(s) HUANG, Anpeng	
	Examiner Brian T O'Connor	Art Unit 2465	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to Applicant's AFCP request filed on 4/19/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☑ Other PTOL-2323.

/BRIAN T O CONNOR/
Primary Examiner, Art Unit 2465

Continuation of 3. The allowed claim(s) is/are: 1, 3-11, 13, and 15-20 (renumbered as 1-17 respectively)

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	Brian T O'Connor	2465

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/13/2018	02/13/2019	05/02/2019						
1	1	✓	✓	=						
	2	✓	O	-						
2	3	✓	O	=						
3	4	✓	O	=						
4	5	✓	✓	=						
5	6	✓	O	=						
6	7	✓	O	=						
7	8	✓	O	=						
8	9	✓	✓	=						
9	10	✓	✓	=						
10	11	✓	✓	=						
	12	✓	O	-						
11	13	✓	O	=						
12	14	-	-	=						
	15	✓	O	-						
13	16	✓	✓	=						
14	17	✓	O	=						
15	18	✓	✓	=						
16	19	✓	O	=						
17	20	✓	=	=						

AFCP 2.0 Decision

Application No.	Applicant(s)	
15/500,928	HUANG, Anpeng	
Examiner	**Art Unit**	**AIA (FITF) Status**
Brian T O'Connor	2465	Yes

This is in response to the After Final Consideration Pilot request filed 19 April 2019.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ A proper AFCP 2.0 request was submitted in response to the most recent final rejection.

   ☐ Other: _____

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☐ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☑ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action . See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other: _____

   Examiner Note: Please attach an interview summary when necessary as described above.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	Art Unit
	Brian T O'Connor	2465

CPC - Searched*		
Symbol	Date	Examiner
H04W 72/0406; H04W 72/044; H04W 72/0493; H04W 72/06; H04W 72/08; H04W 72/085	09/12/2018	M.U.
H04W72/1231, H04W72/0453, H04W72/082, H04L5/0057, H04W16/14, H04W16/28	09/06/2018	M.U.
H04L 5/0039; H04L 5/0041; H04L 5/0058; H04L 5/006; H04L 5/0076	02/13/2019	Brian O'Connor

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
370	329.000		M.U.

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor search and assignee search have been performed by East and PALM	09/05/2018	M.U.
Updated Search	02/13/2019	Brian O'Connor

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H04W	72/085	05/02/2019	Brian O'Connor

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	**Art Unit**
	Brian T O'Connor	2465

CPC								
Symbol							**Type**	**Version**
H04W	/	72	/	085			F	2013-01-01
H04L	/	5	/	0057			I	2013-01-01
H04W	/	16	/	14			I	2013-01-01
H04W	/	72	/	0453			I	2013-01-01
H04W	/	72	/	082			I	2013-01-01
H04W	/	72	/	1231			I	2013-01-01
H04W	/	16	/	10			I	2013-01-01
H04W	/	88	/	08			A	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/BRIAN T O CONNOR/ Primary Examiner, Art Unit 2465	02 May 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

U.S. Patent and Trademark Office

Part of Paper No.: 20190502

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	**Art Unit**
	Brian T O'Connor	2465

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04W72/08	/	72	/	08
H04L5/00	/	5	/	00
H04W16/14	/	16	/	14
H04W72/04	/	72	/	04
H04W72/12	/	72	/	12
H04W16/10	/	16	/	10
H04W88/08	/	88	/	08

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
370	329

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/BRIAN T O CONNOR/ Primary Examiner, Art Unit 2465	02 May 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

U.S. Patent and Trademark Office

Part of Paper No.: 20190502

Samsung Ex. 1002, Page 378 of 387

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/500,928	HUANG, Anpeng
	Examiner	**Art Unit**
	Brian T O'Connor	2465

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	9	10	16	19										
	2	10	11	17	20										
2	3		12												
3	4	11	13												
4	5		14												
5	6	12	15												
6	7	13	16												
7	8	14	17												
8	9	15	18												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	17	
/BRIAN T O CONNOR/ Primary Examiner, Art Unit 2465	02 May 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

U.S. Patent and Trademark Office

Part of Paper No.: 20190502

Samsung Ex. 1002, Page 379 of 387

Application No. 15/500,928
Attorney Ref. APA-CN-879177-02-US-NAT

OK TO ENTER: /B.T.O/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:			
Anpeng HUANG		Confirmation No.:	4629
Appl. No.:	15/500,928	Examiner:	Brian T. O CONNOR
Filing Date:	January 31, 2017	Group Art Unit:	2465
For:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN WIRELESS NETWORK		

RESPONSE AFTER FINAL REJECTION UNDER 37 CFR 1.116

Mailstop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

This paper is being filed along with a Certification and Request for Consideration under the After Final Consideration Pilot Program 2.0, in response to the Final Office Action mailed on February 20, 2019. Please amend the above-identified application as follows:

Amendments to the Claims are shown in the listing of claims, which begins on page 2 of this paper.

Remarks begin on page 8 of this paper.

OK TO ENTER: /B.T.O/

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	22134	h04w72/085.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/02 12:49
L2	116	1 and ((quality or qos or level$3 or measure$2 or measurement$2) with (cqi$2 or csi$2) with (snr or itc or "S"$2"I" or interfering or interference$3)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/02 12:51
L3	16	1 and ((quality or qos or level$3 or measure$2 or measurement$2) with (cqi$2 or csi$2) with (snr or itc or "S"$2"I" or interfering or interference$3) with (assignment or assign$3 or schedul$3 or selecting)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2019/05/02 12:53

5/2/2019 12:55:36 PM
C:\Users\boconnor\Documents\EAST\Workspaces\cy2019\15_500928_interfer.wsp

Samsung Ex. 1002, Page 381 of 387

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

154241 7590 05/08/2019

IP Spring - AI
180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	01/31/2017	Anpeng HUANG	APA-CN-879177-02-US-NAT	4629

TITLE OF INVENTION: ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	08/08/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
O CONNOR, BRIAN T	2465	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Empire Technology Development LLC

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Wilmington, Delaware

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ☒ Corporation or other private group entity ❑ Government

4a. Fees submitted: ☒ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

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☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 505597

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Dennis M. de Guzman/ Date June 12, 2019

Typed or printed name Dennis M. de Guzman Registration No. 41,702

Electronic Patent Application Fee Transmittal

Application Number:	15500928
Filing Date:	31-Jan-2017
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Filer:	Dennis Moises De Guzman/Katherine Gardner
Attorney Docket Number:	APA-CN-879177-02-US-NAT

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1000**

Electronic Acknowledgement Receipt

EFS ID:	36272578
Application Number:	15500928
International Application Number:	
Confirmation Number:	4629
Title of Invention:	ADAPTIVE COMMUNICATION RESOURCE ALLOCATION IN A WIRELESS NETWORK
First Named Inventor/Applicant Name:	Anpeng HUANG
Customer Number:	154241
Filer:	Dennis Moises De Guzman/Katherine Gardner
Filer Authorized By:	Dennis Moises De Guzman
Attorney Docket Number:	APA-CN-879177-02-US-NAT
Receipt Date:	12-JUN-2019
Filing Date:	31-JAN-2017
Time Stamp:	17:07:33
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1000
RAM confirmation Number	061319INTEFSW17081000
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	CN-879177-02-US-NAT_IssueFeeTrans_12JUN2019.pdf	89585 b76dc68173ec1e36ede28dbde1741ff6c36e8149	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30521 f73f56344fa9e35766501dcaf33079ec31db23ef	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	120106		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/500,928	07/30/2019	10368361	APA-CN-879177-02-US-NAT	4629

154241 7590 07/10/2019

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180 N. LaSalle St.
Suite 3700
Chicago, IL 60601

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 178 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Anpeng HUANG, Beijing, CHINA;
EMPIRE TECHNOLOGY DEVELOPMENT LLC, Wilmington, DE;
Anpeng HUANG, Beijing, CHINA

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