(11) Application No. AU 2006252481 C1

(19) AUSTRALIAN PATENT OFFICE

(54) Title

Use of supplemental assignments to decrement resources

(51)[6] International Patent Classification(s)

H04W 28/16 (2009.01)
20090101AFI2009010
5BMEP
H04W 72/04 (2009.01)
20090101ALN200901
05BMEP
H04W 28/16
PCT/US2006/021207

(21) Application No: 2006252481

(22) Application Date: 2006.05.31

(87) WIPO No: WO06/130741

(30) Priority Data

(31) Number	(32) Date	(33) Country
11/370,639	2006.03.07	US
11/142,121	2005.05.31	US

(43) Publication Date : 2006.12.07

(71) Applicant(s)

Qualcomm Incorporated

(72) Inventor(s)

Gorokhov, Alexei; Teague, Edward Harrison; Khandekar, Aamod; Agrawal, Avneesh

(74) Agent/Attorney

Madderns Patent & Trade Mark Attorneys, Level 4 19 Gouger Street, Adelaide, SA, 5000

(56) Related Art

US 6483820
WO 02/45456
WO 98/48581

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 December 2006 (07.12.2006)

PCT

(10) International Publication Number
WO 2006/130741 A1

(51) International Patent Classification:
H04Q 7/38 (2006.01)

(21) International Application Number:
PCT/US2006/021207

(22) International Filing Date: 31 May 2006 (31.05.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/142,121 31 May 2005 (31.05.2005) US
11/370,639 7 March 2006 (07.03.2006) US

(71) Applicant *(for all designated States except US)*: **QUALCOMM INCORPORATED** [US/US]; 5775 Morehouse Drive, San Diego, California 92121 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **AGRAWAL, Avneesh** [IN/US]; 7891 Doug Hill, San Diego, California 92127 (US). **KHANDEKAR, Aamod** [IN/US]; 8465 Regents Road, #339, San Diego, California 92122 (US). **GOROKHOV, Alexei** [FR/US]; 12543 El Camino Real, San Diego, California 92130 (US). **TEAGUE, Edward, Harrison** [US/US]; 4614 Bryson Terrace, San Diego, California 92130 (US).

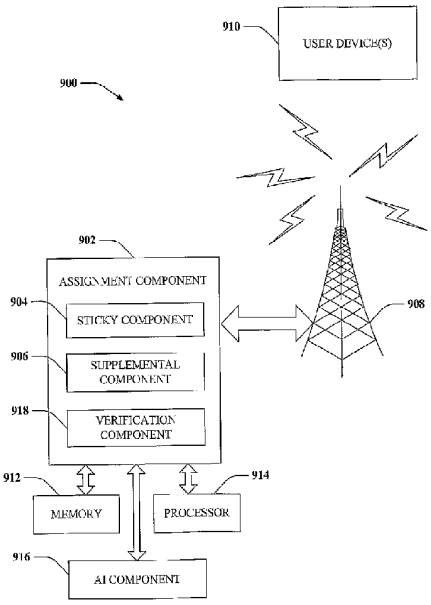
(74) Agents: **WADSWORTH, Philip, R.** et al.; 5775 Morehouse Drive, San Diego, California 92121 (US).

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: USE OF SUPPLEMENTAL ASSIGNMENTS TO DECREMENT RESOURCES



(57) Abstract: Systems and methodologies are described that facilitate dynamically supplementing or decrementing resource assignments to mobile devices in a wireless network environment without requiring transmission of replacement assignments. Supplemental assignments can be generated based on information related to mobile device need and resource availability. Moreover, resource assignments can be persisted for a mobile device.

WO 2006/130741 A1

European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

USE OF SUPPLEMENTAL ASSIGNMENTS TO DECREMENT RESOURCES

Claim of Priority under 35 U.S.C. §120

[0001] The present Application for Patent claims priority to U.S. Patent Application No. 11/142,121 entitled "USE OF SUPPLEMENTAL ASSIGNMENTS" filed May 31, 2005, pending, which is hereby expressly incorporated by reference herein.

BACKGROUND

I. Field

[0002] The following description relates generally to wireless communications and more particularly to dynamically managing network resources by providing supplemental resource assignments that facilitate decrementing resources.

II. Background

[0003] Wireless networking systems have become a prevalent means by which a majority of people worldwide has come to communicate. Wireless communication devices have become smaller and more powerful in order to meet consumer needs and to improve portability and convenience. The increase in processing power in mobile devices such as cellular telephones has lead to an increase in demands on wireless network transmission systems. Such systems typically are not as easily updated as the cellular devices that communicate there over. As mobile device capabilities expand, it can be difficult to maintain an older wireless network system in a manner that facilitates fully exploiting new and improved wireless device capabilities.

[0004] For example, it can be expensive (*e.g.*, bit-wise, ...) to precisely describe channel assignments in a wireless networking environment. Such can be especially true when users (*e.g.*, mobile devices) are not required to be aware of system resource assignments to other users of the wireless system. In such cases, assignments of system resources, such as broadcast channels an the like can require updating on virtually every broadcast cycle in order to provide each user with adequate bandwidth and/or networking power, which can tax the wireless network system and expedite realization of network limitations. Additionally, by requiring such continuous updates and/or

2006252481 11 Jun 2010

complete reassignment messages to be transmitted to users so frequently, such conventional methods of system resource allocation can require expensive and high- powered communication components (eg, transceivers, processors, ...) just to meet system demand.

Multiple-access communication systems typically employ methods of assigning system resources to the individual users of the system. When such assignments change rapidly over time, system overhead required just to manage the assignments can become a significant portion of the overall system capacity. When assignments are sent using messages that constrain the assignment of resource blocks to a subset of the total possible permutations of blocks, assignment expense can be reduced somewhat, but by definition, assignments are constrained. Further, in a system where assignments are "sticky" (eg, an assignment persists over time rather than having a deterministic expiration time), it can be difficult to formulate a constrained assignment message that addresses an instantaneous available resources.

In view of at least the above, there exists a need in the art for a system and/or methodology of improving assignment notification and/or updates and reducing assignment message overhead in wireless network systems.

SUMMARY

According to a first aspect of the present invention, there is provided a method of dynamically allocating system resources, including:

transmitting a persistent non-supplemental assignment to at least one mobile device connected to a wireless network to assign an initial set of resources to the at least one mobile device;

determining whether the at least one mobile device requires resource de-allocation;

generating a supplemental assignment that de-assigns the resources and is indicated as a supplemental assignment message; and

transmitting the supplemental assignment to the at least one mobile device.

According to a second aspect of the present invention, there is provided a system that facilitates supplementing resource assignments for mobile devices, including:

an assignment component that generates non-supplemental resource assignments for a plurality of respective mobile devices, wherein the non-supplemental resource assignments are persisted until a subsequent non-supplemental resource assignment is received by the mobile device to which the assignment corresponds;

a supplemental component that receives information related to increased or decreased resource requirements of at least one of the plurality of mobile devices and generates a supplemental assignment to allocate additional resources or de-allocate existing resources to satisfy the resource requirements of the at least one mobile device; and

a transceiver that transmits supplemental assignment messages to the plurality of mobile devices.

2006252481 11 Jun 2010

According to a third aspect of the present invention, there is provided an apparatus including:

means for generating a persistent initial resource assignment that assigns resources to at least one mobile device;

means for determining whether the at least one mobile device requires resource de-allocation;

means for generating a supplemental assignment that de-assigns the resources and is indicated as a supplemental assignment message; and

a transmitter that transmits the supplemental assignment to the at least one mobile device.

According to a fourth aspect of the present invention, there is provided a mobile device, including:

a processor configured to identify whether an assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment, and if it is a supplemental assignment to determine whether the supplemental assignment is intended to de-assign resources assigned by a prior persistent non-supplemental assignment; and

a memory coupled to the processor.

According to a fifth aspect of the present invention, there is provided a method of processing assignments, including:

determining whether a received assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment;

if the assignment message is a supplemental assignment, then determining whether the supplemental assignment is intended to de-assign resources; and

if the supplemental assignment is a de-assignment, de-assigning resources based upon resources identified in the supplemental assignment.

According to a sixth aspect of the present invention, there is provided an apparatus including:

means for determining whether a received assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment;

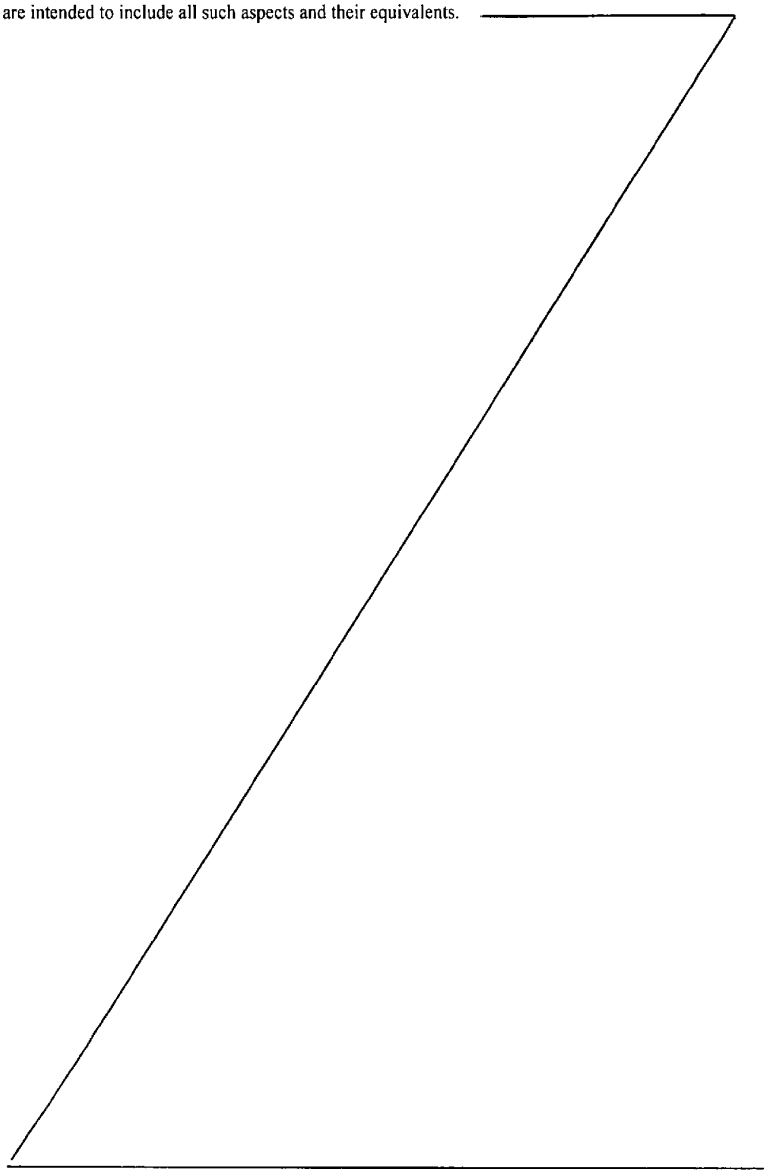
means for, if the assignment message is a supplemental assignment, then determining whether the supplemental assignment is intended to de-assign resources; and

means for, if the supplemental assignment is a de-assignment, de-assigning resources based upon resources identified in the assignment message.

To the accomplishment of the foregoing and related ends, the one or more embodiments comprises the features hereinafter fully described and particularly pointed out in the claims. The

2006252481 11 Jun 2010

following description and the annexed drawings set forth in detail certain illustrative aspects of the one or more embodiments. These aspects are indicative, however, of but a few of the various ways in which the principles of various embodiments may be employed and the described embodiments are intended to include all such aspects and their equivalents.



BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 illustrates a group of N system resource blocks in order to facilitate understanding of a manner in which various embodiments presented herein can operate.

[0016] FIG. 2 is an illustration of a channel table that can be employed in a wireless networking system to facilitate assigning system resources that comprises a plurality of users (*e.g.*, devices) and their respective resource assignments.

[0017] FIG. 3 illustrates a group of resource blocks that can be allocated to a plurality of users.

[0018] FIG. 4 is an illustration of a series of non-persistent (*e.g.*, non-sticky) assignments made over time.

[0019] FIG. 5 is an illustration of a series of persistent, or "sticky" assignments made over time, such as can be employed with regard to various embodiments described herein.

[0020] FIG. 6 is an illustration of a system that facilitates employing supplemental assignments to allocate system resources in a manner that reduces system overhead and/or transmission requirements by reducing signal size.

[0021] FIG. 7 illustrates a system that facilitates providing supplemental resource assignments to users of a communication network in order to reduce assignment signal overhead cost.

[0022] FIG. 8 is an illustration of a system that facilitates generating supplemental assignments to assign system resources to users of a communication network while mitigating resource allocation costs.

[0023] FIG. 9 illustrates a system that facilitates assigning system resources to a user at minimal overhead cost.

[0024] FIG. 10 illustrates a methodology for generating and providing supplemental system resource assignments to users of a wireless network.

[0025] FIG. 11 illustrates a methodology for generating and transmitting supplemental assignments to a user in a wireless network environment is illustrated.

[0026] FIG. 12 is an illustration of a methodology for providing supplemental resource assignments to devices communication over a wireless network.

[0027] FIG. 13 is an illustration of a wireless network environment that can be employed in conjunction with the various systems and methods described herein.

[0028] FIG. 14 is an illustration of a methodology for processing supplemental resource assignments to determine whether to de-assign resources at a wireless communication apparatus.

[0029] FIG. 15 is an illustration of an apparatus for processing supplemental resource assignments to determine whether to de-assign resources at a wireless communication apparatus.

DETAILED DESCRIPTION

[0030] Various embodiments are now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of one or more embodiments. It may be evident, however, that such embodiment(s) may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to facilitate describing one or more embodiments.

[0031] As used in this application, the terms "component," "system," and the like are intended to refer to a computer-related entity, either hardware, a combination of hardware and software, software, or software in execution. For example, a component may be, but is not limited to being, a process running on a processor, a processor, an object, an executable, a thread of execution, a program, and/or a computer. One or more components may reside within a process and/or thread of execution and a component may be localized on one computer and/or distributed between two or more computers. Also, these components can execute from various computer readable media having various data structures stored thereon. The components may communicate by way of local and/or remote processes such as in accordance with a signal having one or more data packets (*e.g.*, data from one component interacting with another component in a local system, distributed system, and/or across a network such as the Internet with other systems by way of the signal).

[0032] Furthermore, various embodiments are described herein in connection with a subscriber station. A subscriber station can also be called a system, a subscriber unit, mobile station, mobile, remote station, access point, base station, remote terminal, access terminal, user terminal, user agent, or user equipment. A subscriber station may be a cellular telephone, a cordless telephone, a Session Initiation Protocol (SIP) phone, a

wireless local loop (WLL) station, a personal digital assistant (PDA), a handheld device having wireless connection capability, or other processing device connected to a wireless modem.

[0033] Moreover, various aspects or features described herein may be implemented as a method, apparatus, or article of manufacture using standard programming and/or engineering techniques. The term "article of manufacture" as used herein is intended to encompass a computer program accessible from any computer-readable device, carrier, or media. For example, computer readable media can include but are not limited to magnetic storage devices (*e.g.*, hard disk, floppy disk, magnetic strips...), optical disks (*e.g.*, compact disk (CD), digital versatile disk (DVD)...), smart cards, and flash memory devices (*e.g.*, card, stick, key drive...).

[0034] Referring now to the drawings, **Fig. 1** illustrates a group of N system resource blocks 100 in order to facilitate understanding of a manner in which various embodiments presented herein can operate. Such resource blocks 100 can be, for instance, time slots, frequencies, code slots, a combination of the preceding, *etc.* A general description of a subset of such blocks can be, for example, a block index list, such as a list of blocks assigned to a particular user. For example, an index list such as {2, 3, 10, 11, 12, 13} could be employed to represent that the user is assigned such blocks. Alternatively, a Boolean array can be employed to describe the same assignment, such as an array of *N* bits {01100000011110}. Conventional systems employing such assignment mechanisms will realize significant expense in doing so, albeit with different properties. For instance, a block index list can be substantially more expensive with regard to a number of bits required to convey such assignments as a subset of blocks to be assigned grows in size. The Boolean array, on the other hand, exhibits a somewhat fixed expense regardless of the number of 1s and 0s, but the expense is relatively large, especially as *N* grows.

[0035] Additionally, in cases where assignments are restricted to contiguous sets of blocks, or resources, such assignments can be signaled by indicating a first block in the assignment and a total number of blocks in the assignment. For example, a block index assignment such as {11, 12, 13, 14, 15} can be signaled as {11, 5}, where "11" represents a first block to be assigned to a given user and "5" represents the total number of contiguous blocks to be assigned, of which 11 is the first block. Still furthermore, if an ordering of users is known, then an assignment signal can be

transmitted without user information. For instance, only the number of blocks being assigned need be signaled so long as all users are aware of the assignments for all other users. For instance, if assignments for users 1-3 are represented by {user 1: 1-5}, {user 2: 6-7}, and {user 3: 8-12}, and if all users are aware of their respective user numbers, such an assignment can be written as {5, 2, 5}. However, this arrangement requires that all users on the system are aware of the assignments to all other users since, for example, user 2 cannot know that its assignment begins with block 6 unless it knows that user 1 has been assigned blocks 1-5. Thus, it can be seen that systems employing such conventional methods of assigning system resources can be expensive to implement and can incur a substantial burden on system transmission resources in which they are implemented. As will be seen the systems and methods described herein facilitate surmounting such conventional burdens.

[0036] **Fig. 2** is an illustration of a channel table 200 that can be employed in a wireless networking system to facilitate assigning system resources (*e.g.*, transmission channels, time slots, code slots, frequencies, ...), which comprises a plurality of users (*e.g.*, devices) and their respective resource assignments. Such a table 200 can be known to all users, which can employ the channel table indices to interpret assignment messages. For example, according the table 200, an assignment such as {user 1: index 2} can be written, which can reduce assignment signal expense when compared to block index and/or Boolean array techniques. The following table sets forth a summary of conventional assignment mechanism characteristics with their relative benefits and consequences.

Method	*Restrictive*	*Expense*	*All users must view all assignments*
Block index list	No	High	No
Contiguous block	Yes	Medium	No
Boolean array	No	High	No
Known user order	Yes	Low	Yes
Channel table	Yes	Medium	No

[0037] Thus, it can be seen that typical assignment allocation schemes do not provide a mechanism that is both cheap and non-restrictive and which does not require all users on a system to view all user assignments.

[0038] **Fig. 3** illustrates a group of resource blocks 300 that can be allocated to a plurality of users. Such resources can include, for example, system channels, time slots,

frequencies, code slots, and the like. According to an embodiment, sticky assignments (*e.g.*, assignments that are valid until a further assignment signal is received) can be employed to assign system resources in, for example, wireless communication networks (*e.g.*, OFDM, OFDMA, CDMA, TDMA, GSM, ...). Such assignments can also be restrictive, such that signal expense is reduced at a cost of limiting ability to arbitrarily assign sets of resource blocks. In order to overcome such restrictions while minimizing allocation signal expense, supplemental assignments can be employed to manage system resources and meet user resource needs. For example, the resource blocks 300 can comprise a first block set 302 that contains blocks 1-4 that are assigned to user 1. User 2 can be assigned a second block set 304 that comprises blocks 5 and 6. Finally, blocks 7-9 can comprise a block set 306 that consists of unused blocks. It can be determined that the requirements of user 1 have increased to a point that user 1 requires additional resource blocks. According to this aspect, a supplemental assignment can be generated that can augment user 1's current assignment rather than completely replacing it. For example, a designating bit can be incorporated into the supplemental assignment to tag the assignment as a supplemental assignment so that a recipient device can recognize it as such. If the designator bit is set to "supplemental," then a channel or resource described by the message can be added to the previously held assignment of the user. If the designator bit is nor set to "supplemental," then the message can be construed to replace the previous assignment. It will be appreciated by one skilled in the art that other methods of message designation with regard to supplemental/non-supplemental assignments can be employed, and that embodiments described herein are not limited to employing a designator bit, but rather can utilize any suitable designation mechanism, whether implicit or explicit.

[0039] For example, user 1's initial sticky assignment can be represented as {1, 2, 3, 4: 0}, where "0" indicates a non-supplemental assignment and channels 1-4 are assigned. Additionally, to mitigate signal transmission expense in cases where assigned channels are contiguous, such a non-supplemental assignment can be represented as [1,4: 0] where the first integer "1" represents a first assigned channel, and the second integer "4" represents a length of assigned channels. If supplemental channels are to be assigned to user 1 for instance due to increased user needs and the like, then a supplemental assignment can be generated and transmitted to user 1. For example, {7, 8, 9: 1} can represent that channels 7, 8, and 9 are additionally to be assigned to user 1.

In this example, the designator bit is set to "1" to indicate that the assignment is supplemental and should not merely replace the previous user 1 assignment of channels 1-4, but rather augment such assignment. Additionally, because the additional channels 7-9 are contiguous, the supplemental assignment can be expressed as [7, 3: 1], where 7 is the first supplemental channel assignment, and the length of contiguous supplemental channels to be assigned is 3. According to this latter aspect, assignment signal overhead can be further reduced when compared to conventional systems (*e.g.*, having to transmit a bulky second signal such as {1, 2, 3, 4, 7, 8, 9: 0}).

[0040] In other aspects, a supplemental assignment may function as decremental assignment, one that reduces assigned resources, this may be done by transmitting an assignment with the supplemental flag set but that identifies an existing resource or resources already assigned to the user. That way, the user will receive the supplemental assignment, and reduce its resources. This approach allows for the use of a same format message for supplemental assignments that increase and decrease resource allocation. This saves on the overhead of new assignments, while at the same time not requiring implicit de-assignment processing by a user.

[0041] For example, a user receives an initial sticky assignment that can be represented as {1, 2, 3, 4: 0}, where "0" indicates a non-supplemental assignment and channels 1-4 are assigned. Then user 1 receives a supplemental assignment, for example, {3: 1} can represent that channel 3 and 4 are being maintained as assigned to user 1, and the other channels 1 and 2, and are being removed from user 1. In this example, the designator bit is set to "1" to indicate that the assignment is supplemental and should not merely replace the previous user 1 assignment of channels 1-4. Alternatively, the supplemental assignment {3: 1} can represent that channels 1-3 are being maintained for user 1, while channel 4 is being removed.

[0042] According to a related aspect, supplemental assignment transmission permissions can be predicated upon validation of a previous assignment to a user (*e.g.*, reception of some validating data, such as a verification message indicating successful packet or sequence decode over a reverse link, an acknowledgement of successful receipt or decode over a forward link, ...). In such a manner, a network can validate a user's assignment prior to supplementing such assignment.

[0043] **Fig. 4** is an illustration of a series of non-persistent (*e.g.*, non-sticky) assignments made over time. Frequencies are illustrated as the type of system resource

being assigned, although assignable system resources are not limited to being such. According to the Figure, a first user, U1, is assigned frequency A at time 1. At time 2, frequency A can be reassigned to user 2, in part because the initial assignment is not a sticky assignment. Frequency C is illustrated as being assigned to user 3 during both time 1 and time 2. However, because the assignment of frequency C to user 3 is not a sticky assignment, user 3's retention of frequency C can require separate assignments at each of time 1 and time 2, resulting in undesirable increases in assignment signal overhead, which in turn can detrimentally affect system resources. Thus, a system employing non-sticky assignments would require *n* different assignment messages per time frame to assign n available frequencies to *N* users.

[0044] **Fig. 5** is an illustration of a series of persistent, or "sticky" assignments 500 made over time, such as can be employed with regard to various embodiments described herein. For example, a first set of assignments can be transmitted to users 1-N during a first time frame, and such assignments can persist until one or more subsequent assignments are transmitted to one or more individual users. Thus, the first set of N assignments can suffice to provide system resource assignments to all users until a change in such assignments is desired and/or necessary (*e.g.*, due to user needs, bandwidth availability, ...). A subsequent user such as U6 can be assigned frequency D should such frequency become available, as illustrated at t3. In this manner, fewer assignment messages need be transmitted over a network than when employing non-sticky assignments.

[0045] Additionally, available system resources can be assigned to any user 1-N should the user require additional resources. For instance, it can be determined that U5 requires additional frequency availability at some time during communication over a network, in addition to frequency E. A subsequent assignment message can be transmitted to U5 to indicate that frequencies E and F are assigned U5. Moreover, in connection with the various embodiments detailed herein, such additional assignment message can be a supplemental assignment to mitigate consumption of network resources when reassigning frequencies to U5.

[0046] Further, a supplemental assignment may function as decremental assignment. For example, with respect to U5, sometime after being assigned frequencies E and F, it may be decided to remove a resource. As such, a supplemental assignment identifying frequency F. U5 would interpret such a message as a de-

assignment of frequency E, and would cease utilizing or expecting communication on frequency E.

[0047] **Fig. 6** is an illustration of a system 600 that facilitates employing supplemental assignments to allocate system resources in a manner that reduces system overhead and/or transmission requirements by reducing signal size. System 600 can comprise an assignment component 602 that controls system resource (*e.g.*, channel, frequency, time slot, code slot, ...) allocation. Assignment component 602 comprises a sticky component 604 that generates sticky assignments that can be persisted in time until subsequent assignment information is received by a user (*e.g.*, device). Assignment component 602 additionally comprises a supplemental component 606 that generates supplemental assignments to apportion system resources according to user needs as they change. Additionally, supplemental component 606 may be utilized to de-assign resources already assigned to one more user devices 610. For example, a supplemental assignment may identify one resource from which the other resources that are de-assigned are inferred, based upon a pre-determined algorithm, or explicitly identify the remaining or de-assigned resources.

[0048] According to an example, user device 610 can be initially assigned a subset of available resources, such as {1, 3, 4, 6: 0}. User device 610 can then require additional resources and it can be determined that a resource block or channel, 2, is available. According to an embodiment, a supplemental assignment [2, 1: 1] can be generated and transmitted to the user to add resources beginning with block 2 and having a length of 1 (*e.g.*, channel 2). In this manner, system 600 need not retransmit a bulky complete assignment message (*e.g.*, {1, 2, 3, 4, 6: 0}).

[0049] According to another example, a user can be assigned resources 1-4 by assignment component 602 through an assignment such as [1, 4: 0] (*e.g.*, using a block index array, contiguous assignment, ...) or the like. Upon an increase in user resource requirements, additional resources can be assigned to the user through a supplemental assignment message. A conventional approach might resubmit a completely new assignment message such as [1, 5: 0] to add resource block 5 to the list of assigned resources for the user. Alternatively, a supplemental assignment can be generated by the supplemental component, such as [5, 1: 1]. However, resource block 5 must be available for the conventional system to be able to employ the reduced message format of the contiguous assignment for resources 1-5, as denoted herein by hard brackets (*e.g.*,

"[]"). In the event that resource block 5 is subject to a sticky assignment to another user (*e.g.*, unavailable) system 600 can permit supplemental assignment of resources at reduced overhead cost even when resources are not contiguous. Thus, where non-contiguous resources are available, a conventional system would require an expensive new assignment message such as {1, 2, 3, 4, 6: 0} be generated and transmitted to the user to assign resources 1, 2, 3, 4, and 6. In contrast, supplemental component 606 can generate a supplemental assignment message such as [6, 1: 1], which indicates that the user's assigned resources are to be augmented by a resource allocation beginning with resource 6 and having a vector length of 1. The supplemental resource assignment can then be transmitted by one or more base stations 608 to the user device 610.

[0050] According to yet another example, a user who is in an initial stage of a communication event can require a number of system resource blocks. For instance blocks 3, 4, 7, and 8 can be determined to be available by assignment component 602. In such a case, two simple messages can be simultaneously generated and/or transmitted to assign the channels to the user. For example, the messages can be represented as [3, 2: 0] and [7, 2: 1]. Thus, sticky component 604 can generate an initial assignment message and supplemental component 606 can generate a supplemental assignment that can be simultaneously transmitted to the user to assign non-contiguous channels 3, 4, 7, and 8 to the user at reduced cost to system 600. It will be appreciated that the systems and/or methods detailed herein according to various embodiments can be employed in conjunction with systems that employ non-sticky assignments as well sticky assignments.

[0051] **Fig. 7** illustrates a system 700 that facilitates providing supplemental resource assignments to users of a communication network in order to reduce assignment signal overhead cost. System 700 comprises an assignment component 702 that can generate resource assignments for users. Assignment component 702 comprises a sticky component 704 that can selectively generate sticky (*e.g.*, persistent) assignments for users, wherein such assignments are maintained until a subsequent non-supplemental assignment signal resets the user's resource assignments. Assignment component 702 can generate non-sticky assignments if desired, while the use of sticky assignments can facilitate reducing system overhead by mitigating the number of assignment messages required to allocate resources to users of the network. Once assignments have been assigned to users of the network by assignment component 702

and/or sticky component 704, a supplemental component 706 can generate supplemental assignments as need to allocate additional resources to one or more users. Additionally, supplemental component 706 may be utilized to de-assign resources already assigned to one more user devices 710. For example, a supplemental assignment may identify one resource from which the other resources that are de-assigned are inferred, based upon a pre-determined algorithm, or explicitly identify the remaining or de-assigned resources.

[0052] System 700 can additionally comprise memory 712 that is operatively coupled to assignment component 702 and that stores information related to user devices 710, system resources, assignments thereof, and any other suitable information related to providing dynamic allocation of system resources (*e.g.*, channels, frequencies, time slots, code slots, ...) to one or more users. A processor 714 can be operatively connected to assignment component 702 (and/or memory 712) to facilitate analysis of information related to generating resource assignments and the like. It is to be appreciated that processor 714 can be a processor dedicated to analyzing and/or generating information received by assignment component 702, a processor that controls one or more components of system 700, and/or a processor that both analyzes and generates information received by assignment component 702 and controls one or more components of system 700.

[0053] Memory 712 can additionally store protocols associated with generating supplemental and/or non-supplemental assignments, *etc.*, such that system 700 can employ stored protocols and/or algorithms to achieve supplemental assignment of system resources as described herein. It will be appreciated that the data store (*e.g.*, memories) components described herein can be either volatile memory or nonvolatile memory, or can include both volatile and nonvolatile memory. By way of illustration, and not limitation, nonvolatile memory can include read only memory (ROM), programmable ROM (PROM), electrically programmable ROM (EPROM), electrically erasable ROM (EEPROM), or flash memory. Volatile memory can include random access memory (RAM), which acts as external cache memory. By way of illustration and not limitation, RAM is available in many forms such as synchronous RAM (SRAM), dynamic RAM (DRAM), synchronous DRAM (SDRAM), double data rate SDRAM (DDR SDRAM), enhanced SDRAM (ESDRAM), Synchlink DRAM (SLDRAM), and direct Rambus RAM (DRRAM). The memory 712 of the subject

systems and methods is intended to comprise, without being limited to, these and any other suitable types of memory

[0054] **Fig. 8** is an illustration of a system 800 that facilitates generating supplemental assignments to assign system resources to users of a communication network while mitigating resource allocation costs. System 800 comprises an assignment component 802 that generates resource assignment signals for transmission through one or more base stations 808 to one or more network user devices 810. Such assignments can by non-sticky (*e.g.*, generated during each time frame). The assignment component comprises a sticky component 804 that generates non-supplemental sticky, or persistent, assignments for devices 810, where such resource assignments are persisted for the user's device 810 until a subsequent non-supplemental assignment message is transmitted to the particular user. By transmitting persistent assignments, sticky component 804 can facilitate reducing a number of assignment messages that need to be sent to users of a network. In order to further reduce transmission costs and assignment message size, assignment component 802 can comprise a supplemental component 806 that generates supplemental assignment messages as described with regard to the preceding figures. Additionally, supplemental component 606 may be utilized to de-assign resources already assigned to one more user devices 610. For example, a supplemental assignment may identify one resource from which the other resources that are de-assigned are inferred, based upon a pre-determined algorithm, or explicitly identify the remaining or de-assigned resources.

[0055] Such supplemental assignment messages can comprise a designator bit that informs a receiving device 810 that the message is indeed supplemental and should augment, or de-assign depending on the identified resources, existing resource assignments for the device 810 rather than just replacing such existing assignments. For instance, a designator bit can be appended to an assignment message by assignment component 802, such that a message in which the designator bit value is "0" can indicate that the assignment message is a standard sticky assignment such that assignments comprised thereby should replace existing assignments. Additionally, if the designator bit has a value of "1," such can indicated that the assignment message is a supplemental assignment message and assignments therein should be added to existing resource assignments. As will be appreciated by one skilled in the art, the designator bit can be designed to provide an active low indication of supplemental/non-supplemental

status, whereby a designator bit of "1" (*e.g.*, high) can indicate non-supplemental status while a zero value can indicate supplemental status, as desired with regard to system design goals and the like.

[0056] System 800 can additionally comprises a memory 812 and a processor 814 as detailed above with regard to Fig. 7. Moreover, an AI component 816 can be operatively associated with assignment component 802 and can make inferences regarding resource allocation in view of overhead cost considerations, *etc.* As used herein, the term to "infer" or "inference" refers generally to the process of reasoning about or inferring states of the system, environment, and/or user from a set of observations as captured *via* events and/or data. Inference can be employed to identify a specific context or action, or can generate a probability distribution over states, for example. The inference can be probabilistic–that is, the computation of a probability distribution over states of interest based on a consideration of data and events. Inference can also refer to techniques employed for composing higher-level events from a set of events and/or data. Such inference results in the construction of new events or actions from a set of observed events and/or stored event data, whether or not the events are correlated in close temporal proximity, and whether the events and data come from one or several event and data sources.

[0057] **Fig. 9** illustrates a system 900 that facilitates assigning system resources to a user at minimal overhead cost. System 900 comprises an assignment component 902 that can assign resources, such as frequencies, channels, transmission time slots, *etc.*, to one or more user devices 910 by way of one or more base stations 908 in a communications network. Assignment component 904 can comprise a sticky component that provides non-supplemental assignments and a supplemental component 906 that can generate supplemental assignments as described herein with regard to preceding figures. Assignment component 902 is additionally operatively coupled to each of a memory 912, a processor 914, and an AI component 916, each of which can in turn be operatively coupled to the other. Additionally, supplemental component 906 may be utilized to de-assign resources already assigned to one more user devices 910. For example, a supplemental assignment may identify one resource from which the other resources that are de-assigned are inferred, based upon a pre-determined algorithm, or explicitly identify the remaining or de-assigned resources.

[0058] The assignment component 902 can additionally comprise a verification component 918 that receives validation data from one or more user devices 910 via one or more base stations 908. According to this scenario, user devices 910 can comprise transceiving functionality in order to transmit validation information back to assignment component 902. Such validation data can be, for instance, a verification message indicating successful packet or sequence decode over a reverse link, an acknowledgement (ACK) of successful assignment receipt and/or decode over a forward link, and the like. Such a verification message can be generated by a verification component (not shown) associated with the user device(s), *etc.*, which can recognize a successful resource assignment, receipt of a message conveying assignment information and the like. In this manner, system 900 can validate an assignment to a user prior to supplementing the assignment with a signal generated by supplemental component 906.

[0059] Referring to **Figs. 10-12**, methodologies relating to generating supplemental system resource assignments are illustrated. For example, methodologies can relate to supplemental assignments in an OFDM environment, an OFDMA environment, a CDMA environment, or any other suitable wireless environment. While, for purposes of simplicity of explanation, the methodologies are shown and described as a series of acts, it is to be understood and appreciated that the methodologies are not limited by the order of acts, as some acts may, in accordance with one or more embodiments, occur in different orders and/or concurrently with other acts from that shown and described herein. For example, those skilled in the art will understand and appreciate that a methodology could alternatively be represented as a series of interrelated states or events, such as in a state diagram. Moreover, not all illustrated acts may be required to implement a methodology in accordance with one or more embodiments.

[0060] Referring now solely to **Fig. 10**, a methodology 1000 for generating and providing supplemental system resource assignments to users of a wireless network. The methodology 1000 can permit the use of efficient channel assignment techniques while avoiding primary limitations of such techniques. Through utilization of supplemental resource assignments, a network can closely match a user's resource assignment to the user's needs and enable the network to optimize usage of system resources, even when subsets of assignable resources are restricted by assignment

message format. Additionally, by using supplemental assignment messages to increase or decrease assigned resources, the method 1000 can reduce a number of assignment, and de-assignment, messages required to be communicated to achieve a desired resource allocation.

[0061] In order to facilitate utilization of supplemental resource assignments, at 1002, initial resource assignments can be generated and transmitted to one or more users' devices throughout the network. For example, assignments can be non-supplemental assignments of resources such as network frequencies, channels, time slots, *etc.* Additionally such assignments can be sticky assignments in order to facilitate minimizing a number of total assignments that need to be transmitted over the network over time. Once assignments have been transmitted to users of the network, the network can be monitored to determine whether any users require additional resources, or that resources should be reduced, at 1004. Upon a determination that a user requires resource assignment in addition to the user's existing assignments, or that a user's resources need to be reduced, a supplemental assignment can be generated for the user and transmitted to the user's communications device at 1006. Once the supplemental assignment has been transmitted, the method can revert to 1004 for continued monitoring and/or determination of whether additional resources are required by any users, or existing resources should be de-assigned, which can then trigger generation and transmission of further supplemental resource assignments at 1006.

[0062] For example, the user can initially be assigned resource blocks 1-5 at 1002. If the user requires additional resources, the determination at 1004 can detect such requirement, and at 1006 such resource assignments are generated in a manner that facilitates reducing system overhead with regard to assignment message size, *etc.* For example, generation of a supplemental assignment can comprise first determining which resources (and/or resource blocks) are available. Upon such assessment, a supplemental assignment can be generated and can be flagged as such to permit the network and/or receiving device to identify the assignment as supplemental. For instance, if it is determined that resource blocks 11 and 12 are available for assignment to the user, then a supplemental message assigning only blocks 11 and 12 can be generated at 1106. The message can be suitable tagged as "supplemental" to ensure that blocks 11 and 12 are added to assigned blocks 1-5 rather than replace such blocks. In the case of a decremental assignment, a determination 1004 can detect a need to reduce resources and

then at 1006 such resource de-assignments may be transmitted as a supplemental assignment.

[0063] Tagging an assignment message can be facilitated by appending a designator bit to all assignment messages, whether supplemental or non-supplemental, such that the value of the designator bit informs the recipient device and/or the network that the subject assignment should either replace an existing assignment or should augment it. For example, a designator bit has a value of "0" can indicate that the assignment is non-supplemental, while a value of "1" can indicate that the assignment is supplemental. It will be appreciated that the values of the designator bit can be inverted, so long as such values are consistently applied to denote each of the two possible statuses of an assignment message (*e.g.*, supplemental and non-supplemental). Moreover, designation of an assignment as such is not limited to employment of a designator bit, but rather can be effected using any suitable indicator(s) (*e.g.*, a bit sequence, a message prefix, a flag in a message header, ...).

[0064] Turning now to **Fig. 11**, a methodology 1100 for generating and transmitting supplemental assignments to a user in a wireless network environment is illustrated. At 1102, initial resource allocations can be transmitted to users of the network. For instance, non-supplemental assignment messages can be generated and transmitted to individual user devices, which need not be aware of assignments to other devices. At 1104, mobile devices can provide a validation signal to the network to verify successful decoding and acceptance of the assigned resource message. At 1106, a determination can be made regarding whether one or more mobile devices require additional system resources, or if resources should be de-assigned from the user. If the determination is that no additional resources are required, or should be de-assigned, then the method can terminate.

[0065] If, at 1106, it is determined that additional resources are required, or should be de-assigned, by the device, then at 1108 such resources can be provided with a supplemental assignment. For example a mobile device such as a cellular phone can receive an initial resource allocation at 1102 that permits voice transmission. The determination at 1106 can indicate that a user of the mobile device is attempting to download a web page, transmit a digital photograph or video clip, *etc.*, which can require additional transmission bandwidth. Thus, at 1108, a supplemental resource

assignment can be generated to meet bandwidth needs of the device, and can be transmitted to the device to meet device needs.

[0066] According to a related example, if the device initially verified receipt and/or acceptance of resource blocks 100-104 and requires an additional four resource blocks, then a supplemental assignment message such as [X, 4: 1] can be transmitted to the device, where X is an integer representing a first resource block in a first contiguous set of available resource blocks. Because all previous resource assignments have been validated at 1104, a complete list of available resources can be known for supplemental assignment generation and transmission at 1108. After supplemental assignment transmission at 1108, the method can revert to 1104 for another iteration of assignment verification, which can include verification of supplemental assignments, prior to network monitoring to determine whether subsequent supplemental assignments are necessary for one or more users at 1106. It will be appreciated that supplemental resource assignment messages need not comprise contiguous resource assignments, but that such assignments can be expressed in a manner (*e.g.*, a block index array, ...) that facilitates generation of a convenient and cost-effective assignment message. For example, such messages can be expressed with two indices and a designator bit.

[0067] Referring now to **Fig. 12**, a methodology 1200 for providing supplemental resource assignments to devices communication over a wireless network. At 1202, initial resource allocations can be made and assignments can be transmitted to one or more devices using the network. For instance, a first user can be assigned resource blocks by way of a non-supplemental sticky assignment such as {1, 2, 3, 6, 7, 10: 0}, while a second user can be assigned resource blocks according to a second non-supplemental assignment message such as {4, 5, 8: 0}, where ":0" represents a designator bit identifying the assignment message as non-supplemental. Users need not be aware (*e.g.*, need not view) other users' assignment messages. At 1204, assignment messages can be validated by recipient mobile devices. For instance, a simple acknowledgement message can be transmitted to the network verifying receipt, successful decoding, and /or acceptance of the assignment message. In this manner, the network can be apprised of precisely which resources remain available for supplemental assignment, *etc.* At 1206, a determination can be made regarding which, if any, devices require additional system resources or should have resources removed. If no additional resources are required or need to be removed, the method can terminate. If additional

resources are required, or need to be removed, by one or more devices, then the message can proceed to 1208. For example, the first user described above can require an additional three resource blocks for an operation over the network. A most efficient supplemental message format can be inferred at 1208 to provide supplemental assignments to the first user at a lowest overhead cost (*e.g.*, based on cost-benefit analysis, optimization techniques, ...).

[0068] For example, if all initial resource block assignments have been validated as of 1204, then the next three available resource blocks can be known to be blocks 7, 9, and 11. A supplemental assignment message comprising assignments of these blocks can be represented as {7, 9, 11: 1} and can be transmitted to the first user at 1210. However, a more efficient message (*e.g.*, shorter message) can be [9, 4: 1], which transmits supplemental resource assignments of four contiguous resource blocks beginning with block 9. Since block 10 is already assigned to the first user's device, there is no conflict, and new blocks 9, 11, and 12 will additionally be assigned to the first user to meet the user's resource needs. Inferences can be made at 1208 (*e.g.*, using artificial intelligence techniques, machine-learning techniques, ...) that can facilitate a determination that the more efficient (*e.g.*, cheaper) message is desirable, and such can be selected for generation and transmission at 1210. In the case of a decremental assignment, a determination 12064 can detect a need to reduce resources and then at 1208 such resource de-assignments may be transmitted as a supplemental assignment.

[0069] According to a similar example, it can be determined at 1204 that a second user failed to verify receipt/acceptance of its initial assignment message. So long as such resource blocks are still available (*e.g.*, have not been assigned to a third or subsequent user device), they can be assigned to the first user in a supplemental assignment message such as {4, 5, 8: 1}. Only the first user need be aware of the supplemental assignment, as supplemental assignments can be transparent to all users but the recipient in order to still further reduce network overhead, processing time, *etc.* Additionally, at 1208, it can be inferred that the supplemental assignment message can be reduced to a contiguous assignment such as [4, 5: 1], where "4" represents a first resource block, "5" represents a contiguous series of blocks that begins with "4", and ":1" designates the message as supplemental. Such is permissible because it is known that blocks 6 and 7 are already assigned to the first user, such that the more efficient contiguous supplemental assignment does not conflict with the first user's existing

assignments. In this manner, inferences made at 1208 can facilitate generation and transmission of a supplemental assignment message at 1210 that is most cost-efficient with respect to overhead requirements and/or assignment transmission message size.

[0070] **Fig. 13** shows an exemplary wireless communication system 1300. The wireless communication system 1300 depicts one base station and one terminal for sake of brevity. However, it is to be appreciated that the system can include more than one base station and/or more than one terminal, wherein additional base stations and/or terminals can be substantially similar or different for the exemplary base station and terminal described below. In addition, it is to be appreciated that the base station and/or the terminal can employ the systems (**Figs. 6-9**) and/or methods (**Figs. 9-12**) described herein to facilitate wireless communication there between.

[0071] Referring now to **Fig. 13**, on a downlink, at access point 1305, a transmit (TX) data processor 1310 receives, formats, codes, interleaves, and modulates (or symbol maps) traffic data and provides modulation symbols ("data symbols"). An OFDM modulator 1315 receives and processes the data symbols and pilot symbols and provides a stream of OFDM symbols. An OFDM modulator 1320 multiplexes data and pilot symbols on the proper subbands, provides a signal value of zero for each unused subband, and obtains a set of N transmit symbols for the N subbands for each OFDM symbol period. Each transmit symbol may be a data symbol, a pilot symbol, or a signal value of zero. The pilot symbols may be sent continuously in each OFDM symbol period. Alternatively, the pilot symbols may be time division multiplexed (TDM), frequency division multiplexed (FDM), or code division multiplexed (CDM). OFDM modulator 1320 can transform each set of N transmit symbols to the time domain using an N-point IFFT to obtain a "transformed" symbol that contains N time-domain chips. OFDM modulator 1320 typically repeats a portion of each transformed symbol to obtain a corresponding OFDM symbol. The repeated portion is known as a cyclic prefix and is used to combat delay spread in the wireless channel.

[0072] A transmitter unit (TMTR) 1320 receives and converts the stream of OFDM symbols into one or more analog signals and further conditions (*e.g.*, amplifies, filters, and frequency upconverts) the analog signals to generate a downlink signal suitable for transmission over the wireless channel. The downlink signal is then transmitted through an antenna 1325 to the terminals. At terminal 1330, an antenna 1335 receives the downlink signal and provides a received signal to a receiver unit

(RCVR) 1340. Receiver unit 1340 conditions (*e.g.*, filters, amplifies, and frequency downconverts) the received signal and digitizes the conditioned signal to obtain samples. An OFDM demodulator 1345 removes the cyclic prefix appended to each OFDM symbol, transforms each received transformed symbol to the frequency domain using an N-point FFT, obtains N received symbols for the N subbands for each OFDM symbol period, and provides received pilot symbols to a processor 1350 for channel estimation. OFDM demodulator 1345 further receives a frequency response estimate for the downlink from processor 1350, performs data demodulation on the received data symbols to obtain data symbol estimates (which are estimates of the transmitted data symbols), and provides the data symbol estimates to an RX data processor 1355, which demodulates (i.e., symbol demaps), deinterleaves, and decodes the data symbol estimates to recover the transmitted traffic data. The processing by OFDM demodulator 1345 and RX data processor 1355 is complementary to the processing by OFDM modulator 1315 and TX data processor 1310, respectively, at access point 1300.

[0073] On the uplink, a TX data processor 1360 processes traffic data and provides data symbols. An OFDM modulator 1365 receives and multiplexes the data symbols with pilot symbols, performs OFDM modulation, and provides a stream of OFDM symbols. The pilot symbols may be transmitted on subbands that have been assigned to terminal 1330 for pilot transmission, where the number of pilot subbands for the uplink may be the same or different from the number of pilot subbands for the downlink. A transmitter unit 1370 then receives and processes the stream of OFDM symbols to generate an uplink signal, which is transmitted by the antenna 1335 to the access point 1310.

[0074] At access point 1310, the uplink signal from terminal 1330 is received by the antenna 1325 and processed by a receiver unit 1375 to obtain samples. An OFDM demodulator 1380 then processes the samples and provides received pilot symbols and data symbol estimates for the uplink. An RX data processor 1385 processes the data symbol estimates to recover the traffic data transmitted by terminal 1335. A processor 1390 performs channel estimation for each active terminal transmitting on the uplink. Multiple terminals may transmit pilot concurrently on the uplink on their respective assigned sets of pilot subbands, where the pilot subband sets may be interlaced.

[0075] Processors 1390 and 1350 direct (*e.g.*, control, coordinate, manage, etc.) operation at access point 1310 and terminal 1335, respectively. For example, processor

1350 may be configured to perform the functions described with respect to FIGS. 14 and 15. Respective processors 1390 and 1350 can be associated with memory units (not shown) that store program codes and data. Processors 1390 and 1350 can also perform computations to derive frequency and impulse response estimates for the uplink and downlink, respectively.

[0076] FIG. 14 is an illustration of a methodology 1400 for processing supplemental resource assignments to determine whether to de-assign resources at a wireless communication apparatus. The methodology 1400 can permit the use of efficient channel assignment techniques while avoiding primary limitations of such techniques. Through utilization of supplemental resource assignments, a network can closely match a user's resource assignment to the user's needs and enable the network to optimize usage of system resources, even when subsets of assignable resources are restricted by assignment message format. Additionally, by using supplemental assignment messages to increase or decrease assigned resources, the method 1000 can reduce a number of assignment, and de-assignment, messages required to be communicated to achieve a desired resource allocation.

[0077] In order to facilitate utilization of supplemental resource assignments a user determines that an assignment message has been received, block 1402. Then, a determination is made as to whether the assignment message is standard assignment message or supplemental assignment message, block 1404. In certain aspects, this determination may be made by determining whether the supplemental flag or bit is set in the assignment message.

[0078] If the assignment is not supplemental no further processing with respect to resource de-assignment need occur. If the assignment is a supplemental assignment, then a determination is made as to whether the supplemental assignment is used to de-assign resources, block 1406. This may be done by determining whether any of the resources identified by the supplemental assignment are already assigned to the user. If this is the case, the supplemental assignment may be assumed to be a de-assignment of some resources.

[0079] If the supplemental assignment is not a de-assignment of resources no further processing with respect to resource de-assignment need occur. If the assignment is a supplemental assignment, then the appropriate resources are de-assigned, block 1408. This may be determined by the explicit resources in the supplemental

assignment, from those resources that overlap the current assignment,. Alternatively, the determination may be made by all resources that have a logical order, e.g. channel ID or channel tree node ID, that is greater, or lesser, than the logical order of the resource that is identified in the supplemental assignment. Further, a de-assignment may be specified by providing first and second resources and all resources of a logical order between them are to remain, or be removed, after the de-assignment.

[0080] FIG. 15 is an illustration of an apparatus 1500 for processing supplemental resource assignments to determine whether to de-assign resources at a wireless communication apparatus. Means 1502 for determining whether an assignment message received is standard assignment message or supplemental assignment message, is in communication with means 1504 for determining whether the supplemental assignment is used to de-assign resources. This may be done by determining whether any of the resources identified by the supplemental assignment are already assigned to the user. If this is the case, the supplemental assignment may be assumed to be a de-assignment of some resources.

[0081] Means 1504 is in communication with means 1506 for de-assigning the appropriate resources. This may be determined by the explicit resources in the supplemental assignment, from those resources that overlap the current assignment,. Alternatively, the determination may be made by all resources that have a logical order, e.g. channel ID or channel tree node ID, that is greater, or lesser, than the logical order of the resource that is identified in the supplemental assignment. Further, a de-assignment may be specified by providing first and second resources and all resources of a logical order between them are to remain, or be removed, after the de-assignment.

[0082] For a multiple-access OFDM system (*e.g.*, an orthogonal frequency division multiple-access (OFDMA) system), multiple terminals may transmit concurrently on the uplink. For such a system, the pilot subbands may be shared among different terminals. The channel estimation techniques may be used in cases where the pilot subbands for each terminal span the entire operating band (possibly except for the band edges). Such a pilot subband structure would be desirable to obtain frequency diversity for each terminal. The techniques described herein may be implemented by various means. For example, these techniques may be implemented in hardware, software, or a combination thereof. For a hardware implementation, the processing units used for channel estimation may be implemented within one or more application

2006252481 03 May 2010

specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof. With software, implementation can be through modules (eg, procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in memory unit and executed by the processors 1390 and 1350.

A detailed description of one or more preferred embodiments of the invention is provided above along with accompanying figures that illustrate by way of example the principles of the invention. While the invention is described in connection with such embodiments, it should be understood that the invention is not limited to any embodiment. On the contrary, the scope of the invention is limited only by the appended claims and the invention encompasses numerous alternatives, modifications, and equivalents. For the purpose of example, numerous specific details are set forth in the description above in order to provide a thorough understanding of the present invention. The present invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the present invention is not unnecessarily obscured.

Throughout this specification and the claims that follow unless the context requires otherwise, the words 'comprise' and 'include' and variations such as 'comprising' and 'including' will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge of the technical field.

2006252481 11 Jun 2010

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of dynamically allocating system resources, including:

transmitting a persistent non-supplemental assignment to at least one mobile device connected to a wireless network to assign an initial set of resources to the at least one mobile device;

determining whether the at least one mobile device requires resource de-allocation;

generating a supplemental assignment that de-assigns the resources and is indicated as a supplemental assignment message; and

transmitting the supplemental assignment to the at least one mobile device.

2. The method of claim 1, generating includes identifying at least one resource that is indicative of multiple resources to remain as part of the assignment after de-assignment.

3. The method of claim 1 or 2, generating includes explicitly identifying at least one resource to remain as part of the assignment after de-assignment

4. The method according to any one of claims 1 to 3, generating includes explicitly identifying at least one resource to remove as part of the de-assignment.

5. The method according to any one of claims 1 to 4, generating includes setting a flag in the supplemental assignment message to identify the message as a supplemental assignment.

6. The method of claim 5, wherein the flag consists of one bit.

7. A system that facilitates supplementing resource assignments for mobile devices, including:

an assignment component that generates non-supplemental resource assignments for a plurality of respective mobile devices, wherein the non-supplemental resource assignments are persisted until a subsequent non-supplemental resource assignment is received by the mobile device to which the assignment corresponds;

a supplemental component that receives information related to increased or decreased resource requirements of at least one of the plurality of mobile devices and generates a supplemental assignment to allocate additional resources or de-allocate existing resources to satisfy the resource requirements of the at least one mobile device; and

a transceiver that transmits supplemental assignment messages to the plurality of mobile devices.

8. The system of claim 7, the supplemental component identifies one resource that is indicative of multiple resources to remain as part of the assignment after de-assignment.

2006252481 11 Jun 2010

9. The system according to any one of claims 7 or 8, the supplemental component explicitly identifies multiple resources to remain as part of the assignment after de-assignment

10. The system according to any one of claims 7 to 9, the supplemental component explicitly identifies multiple resources to remove as part of the de-assignment.

11. The system according to any one of claims 7 to 10, the supplemental component sets a flag in the supplemental assignment message to identify the message as a supplemental assignment.

12. The system of claim 11, wherein the flag consists of one bit.

13. An apparatus including:

means for generating a persistent initial resource assignment that assigns resources to at least one mobile device;

means for determining whether the at least one mobile device requires resource de-allocation;

means for generating a supplemental assignment that de-assigns the resources and is indicated as a supplemental assignment message; and

a transmitter that transmits the supplemental assignment to the at least one mobile device.

14. The apparatus of claim 13, the means for generating includes means for identifying at least one resource that is indicative of multiple resources to remain as part of the assignment after de-assignment.

15. A mobile device, including:

a processor configured to identify whether an assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment, and if it is a supplemental assignment to determine whether the supplemental assignment is intended to de-assign resources assigned by a prior persistent non-supplemental assignment; and

a memory coupled to the processor.

16. The mobile device of claim 15, the processor is configured to determine resources being de-assigned by the supplemental assignment.

17. The mobile device of claim 15 or 16, the processor is configured to determine multiple resources being de-assigned from one resource indicated in the supplemental assignment.

2006252481 11 Jun 2010

18. The mobile device according to any one of claims 15 to 17, the processor is configured to determine multiple resources being de-assigned from multiple resources indicated in the supplemental assignment.

19. The mobile device according to any one of claims 15 to 18, wherein the processor determines whether the assignment is a supplemental assignment based on a flag in the assignment message.

20. The mobile device of claim 19, wherein the flag consists of one bit.

21. A method of processing assignments, including:

determining whether a received assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment;

if the assignment message is a supplemental assignment, then determining whether the supplemental assignment is intended to de-assign resources; and

if the supplemental assignment is a de-assignment, de-assigning resources based upon resources identified in the supplemental assignment.

22. The method of claim 21, de-assigning includes de-assigning multiple resources based upon one identified resource that is indicative of multiple resources to remain as part of the assignment after de-assignment.

23. The method of claim 21 or 22, de-assigning includes de-assigning multiple resources based upon multiple identified resources that are indicative of multiple resources to remain as part of the assignment after de-assignment.

24. The method according to any one of claims 21 to 23, de-assigning includes de-assigning multiple resources that are the same as multiple identified resources that are indicative of multiple resources to remain as part of the assignment after de-assignment.

25. The method according to any one of claims 21 to 24, determining includes at least one of determining according to a flag in the assignment message to identify the message as a supplemental assignment, or determining based on an overlap of resources assigned in a previously obtained non-supplemental persistent assignment and the supplemental assignment.

26. The method of claim 25, wherein the flag consists of one bit.

2006252481 11 Jun 2010

27. An apparatus including:

means for determining whether a received assignment message is at least one of a persistent non-supplemental assignment that assigns resources to at least one mobile device, or a supplemental assignment;

means for, if the assignment message is a supplemental assignment, then determining whether the supplemental assignment is intended to de-assign resources; and

means for, if the supplemental assignment is a de-assignment, de-assigning resources based upon resources identified in the assignment message.

28. The apparatus of claim 27, means for de-assigning includes means for de-assigning multiple resources based upon one identified resource that is indicative of multiple resources to remain as part of the assignment after de-assignment.

29. The apparatus of claim 27 or 28, means for de-assigning includes means for de-assigning multiple resources based upon multiple identified resources that are indicative of multiple resources to remain as part of the assignment after de-assignment.

30. The apparatus according to any one of claims 27 to 29, means for de-assigning includes means for de-assigning multiple resources that are the same as multiple identified resources that are indicative of multiple resources to remain as part of the assignment after de-assignment.

31. The apparatus according to any one of claims 27 to 30, means for determining includes means for determining based on at least one of a flag in the assignment message to identify the message as a supplemental assignment, or an intersection of resources indicated in a previously obtained non-supplemental persistent assignment and the supplemental assignment.

32. The apparatus of claim 31, wherein the flag consists of one bit.

33. A method as claimed in claim 1, substantially as herein described with reference to the accompanying drawings.

34. A system as claimed in claim 7, substantially as herein described with reference to the accompanying drawings.

35. An apparatus as claimed in claim 13, substantially as herein described with reference to the accompanying drawings.

2006252481 11 Jun 2010

36. A mobile device as claimed in claim 15, substantially as herein described with reference to the accompanying drawings.

37. A method as claimed in claim 21, substantially as herein described with reference to the accompanying drawings.

38. An apparatus as claimed in claim 27, substantially as herein described with reference to the accompanying drawings.

39. A method substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

40. A system substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

41. An apparatus substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

42. A mobile device substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings.

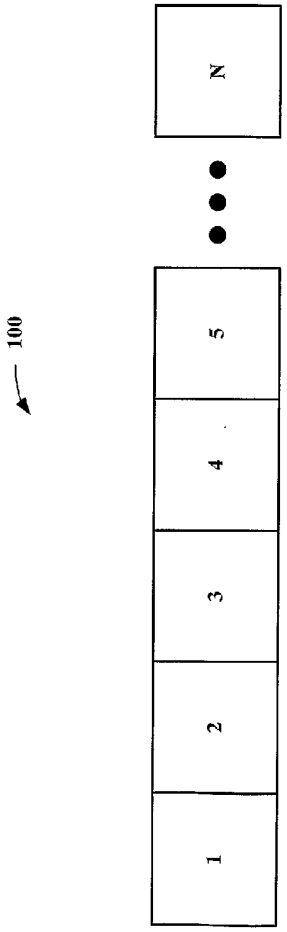


FIG. 1

200

1	1-5
2	2, 3, 7-20
3	6-8, 17
...	
M	16

FIG. 2

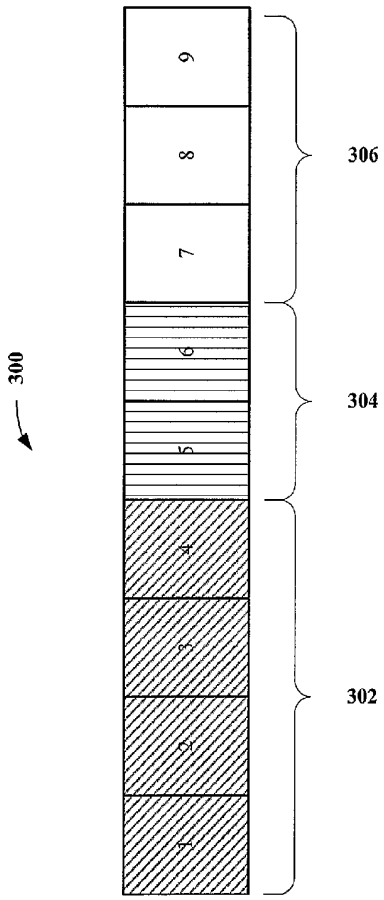


FIG. 3

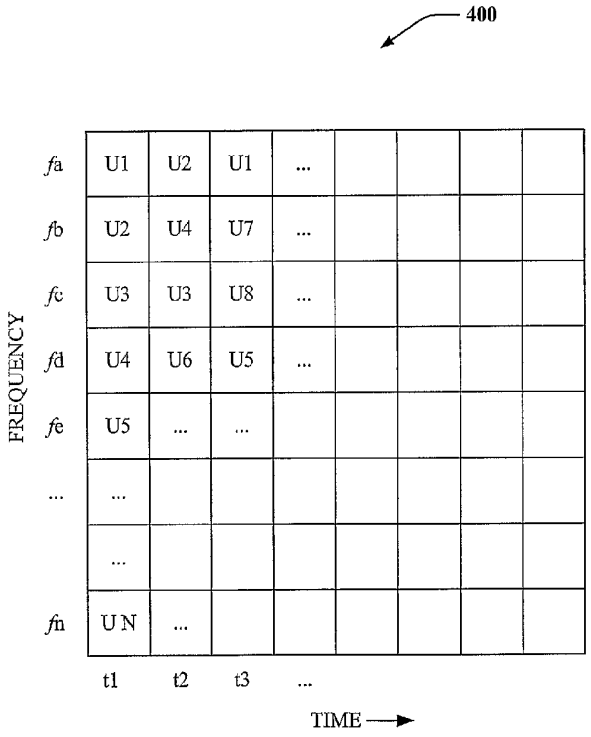

400
FREQUENCY
fa
fb
fc
fd
fe
...
...
fn
U1 U2 U1 ...
U2 U4 U7 ...
U3 U3 U8 ...
U4 U6 U5 ...
U5 ... ...
...
...
U N ...
t1 t2 t3 ...
TIME

FIG. 4

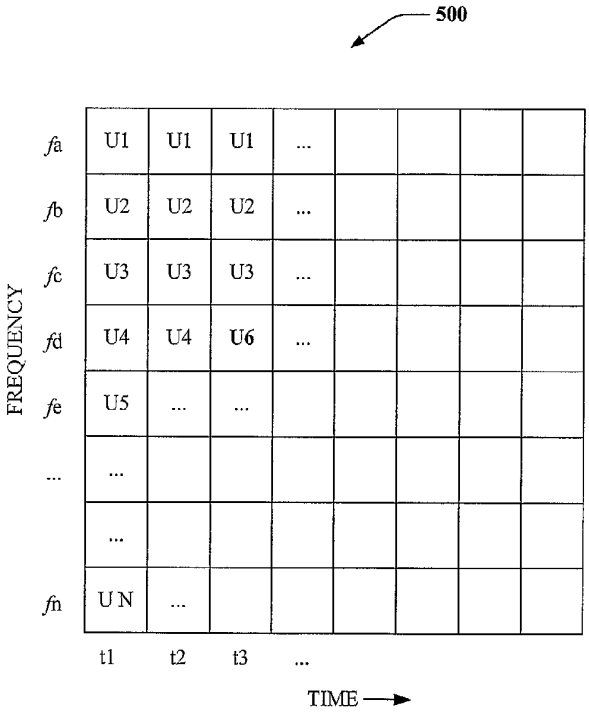

500
FREQUENCY
fa
fb
fc
fd
fe
...
...
fn
U1 U1 U1 ...
U2 U2 U2 ...
U3 U3 U3 ...
U4 U4 U6 ...
U5 ... ...
...
...
U N ...
t1 t2 t3 ...
TIME

FIG. 5

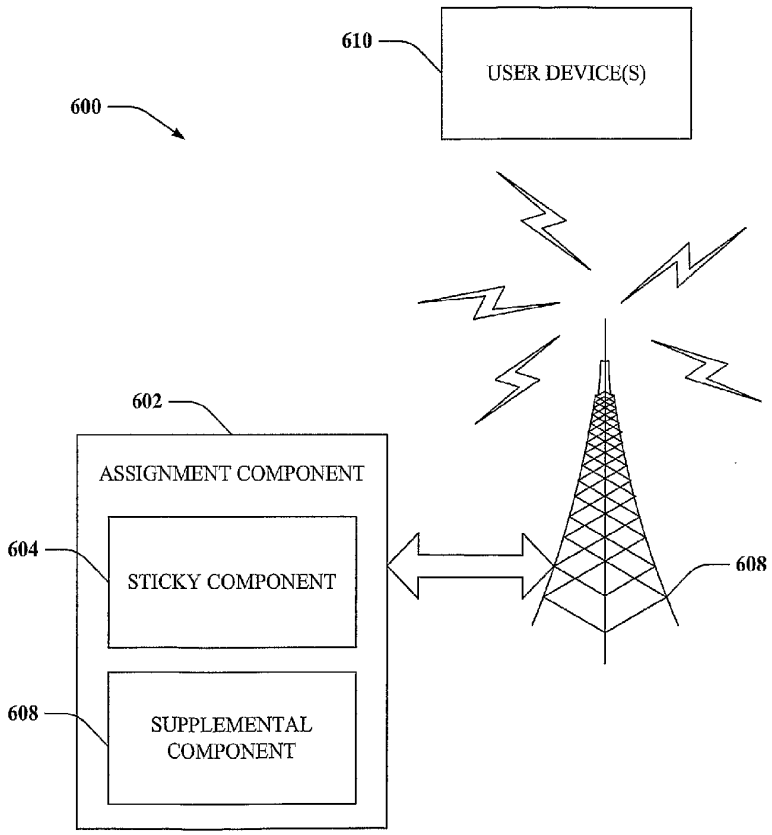

610
USER DEVICE(S)
600
602
ASSIGNMENT COMPONENT
604
STICKY COMPONENT
608
608
SUPPLEMENTAL COMPONENT

FIG. 6

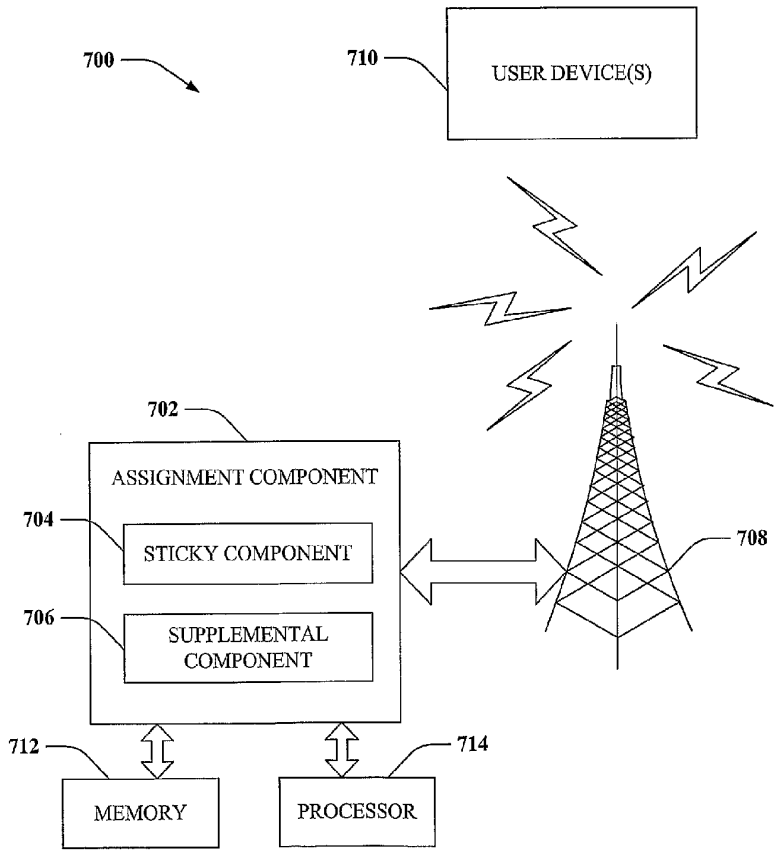

700
710
USER DEVICE(S)
702
ASSIGNMENT COMPONENT
704
STICKY COMPONENT
706
SUPPLEMENTAL COMPONENT
708
712
MEMORY
714
PROCESSOR

FIG. 7

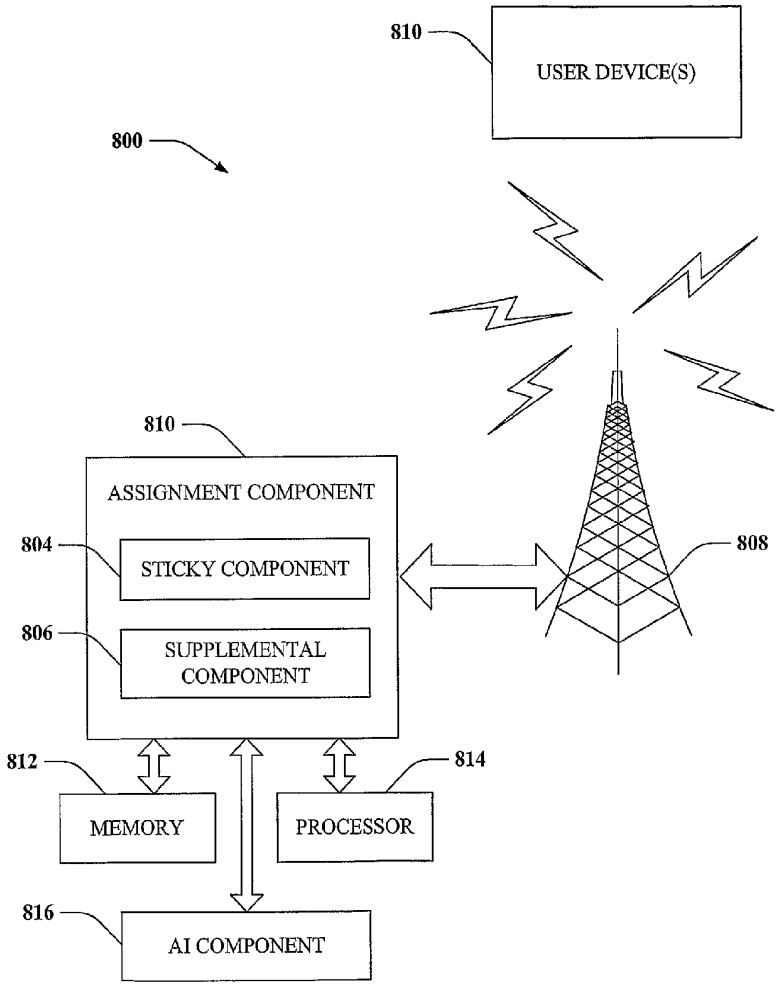

810
USER DEVICE(S)
800
810
ASSIGNMENT COMPONENT
804
STICKY COMPONENT
806
SUPPLEMENTAL COMPONENT
808
812
814
MEMORY
PROCESSOR
816
AI COMPONENT

FIG. 8

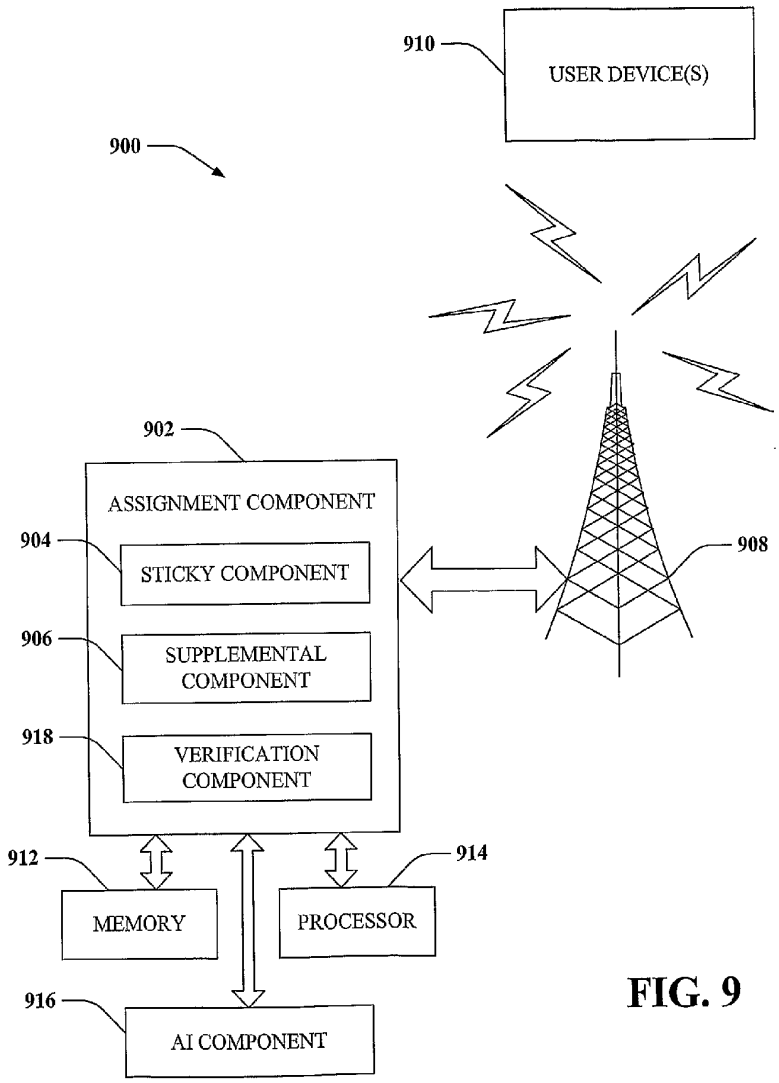

910
USER DEVICE(S)
900
902
ASSIGNMENT COMPONENT
904
STICKY COMPONENT
906
SUPPLEMENTAL COMPONENT
918
VERIFICATION COMPONENT
908
912
MEMORY
914
PROCESSOR
916
AI COMPONENT

FIG. 9

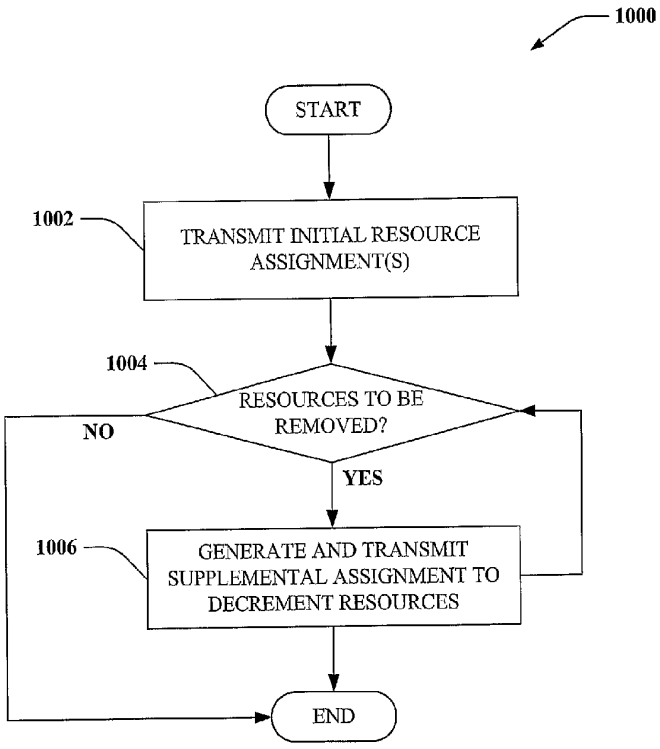

1000
START
1002
TRANSMIT INITIAL RESOURCE ASSIGNMENT(S)
1004
RESOURCES TO BE REMOVED?
NO
YES
1006
GENERATE AND TRANSMIT SUPPLEMENTAL ASSIGNMENT TO DECREMENT RESOURCES
END

FIG. 10

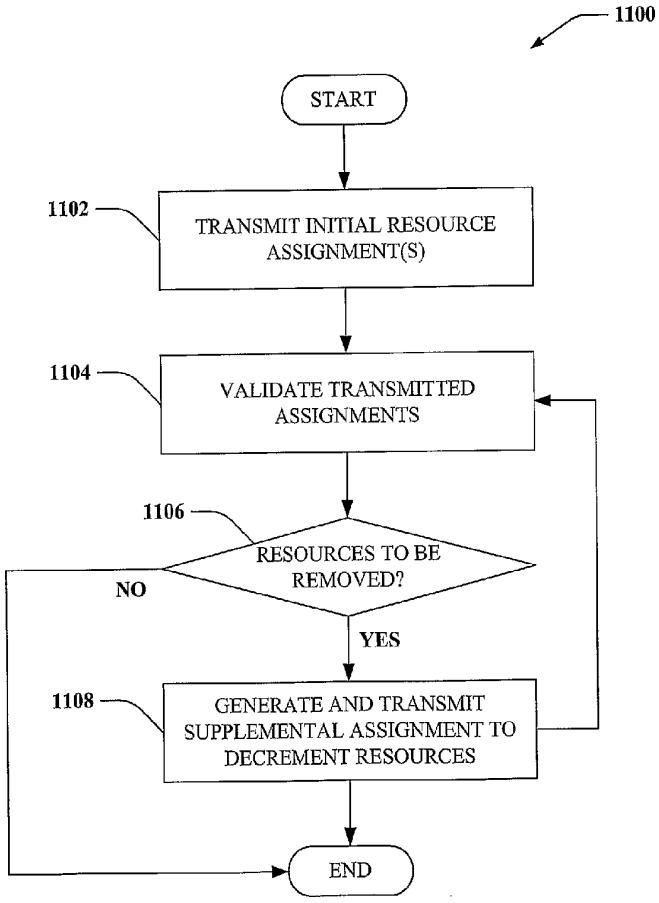

1100
START
1102
TRANSMIT INITIAL RESOURCE ASSIGNMENT(S)
1104
VALIDATE TRANSMITTED ASSIGNMENTS
1106
RESOURCES TO BE REMOVED?
NO
YES
1108
GENERATE AND TRANSMIT SUPPLEMENTAL ASSIGNMENT TO DECREMENT RESOURCES
END

FIG. 11

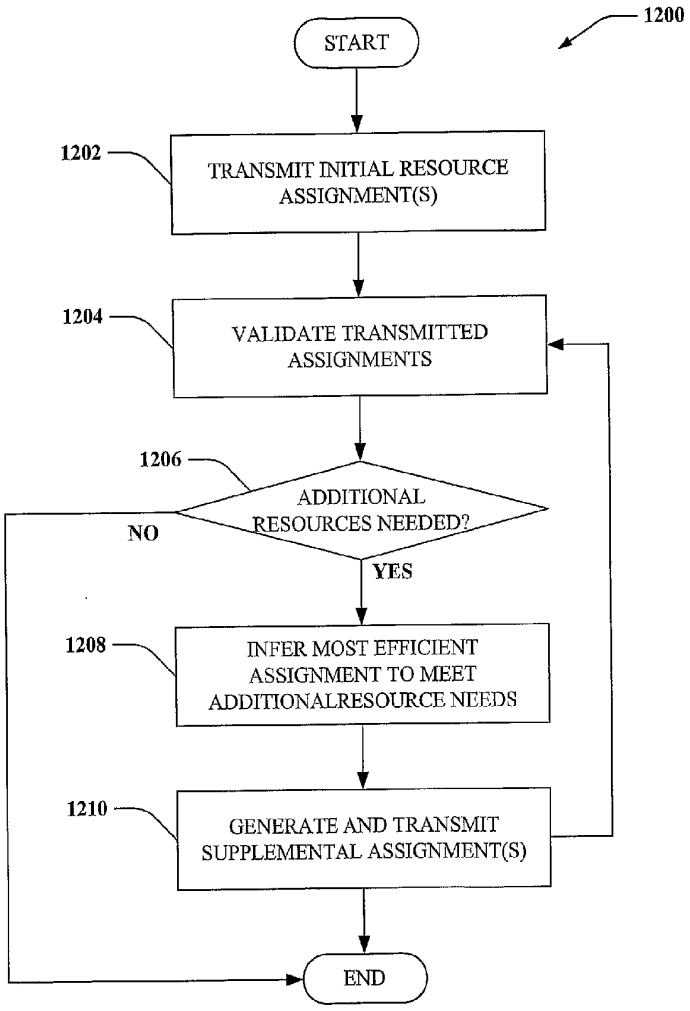

1200
START
1202
TRANSMIT INITIAL RESOURCE ASSIGNMENT(S)
1204
VALIDATE TRANSMITTED ASSIGNMENTS
1206
ADDITIONAL RESOURCES NEEDED?
NO
YES
1208
INFER MOST EFFICIENT ASSIGNMENT TO MEET ADDITIONALRESOURCE NEEDS
1210
GENERATE AND TRANSMIT SUPPLEMENTAL ASSIGNMENT(S)
END

FIG. 12

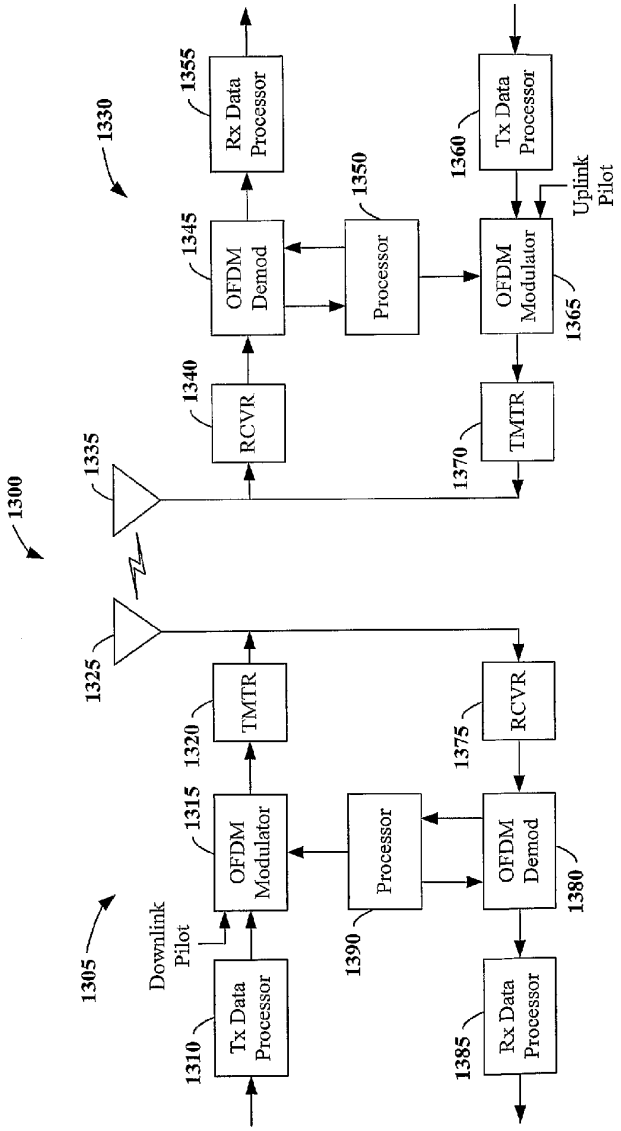

1300
1305
1310
Tx Data Processor
1315
OFDM Modulator
1320
TMTR
1325
1330
1335
1340
RCVR
1345
OFDM Demod
1350
Processor
1355
Rx Data Processor
1360
Tx Data Processor
1365
OFDM Modulator
1370
TMTR
1375
RCVR
1380
OFDM Demod
1385
Rx Data Processor
1390
Processor
Downlink Pilot
Uplink Pilot

FIG. 13

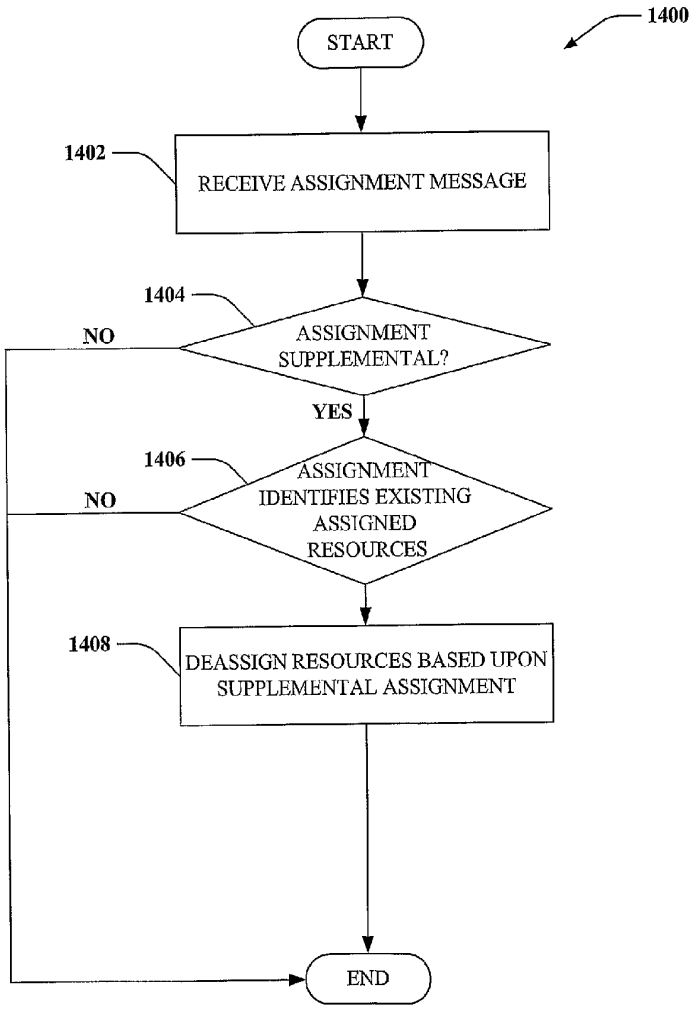

1400
START
1402
RECEIVE ASSIGNMENT MESSAGE
1404
ASSIGNMENT SUPPLEMENTAL?
NO
YES
1406
ASSIGNMENT IDENTIFIES EXISTING ASSIGNED RESOURCES
NO
1408
DEASSIGN RESOURCES BASED UPON SUPPLEMENTAL ASSIGNMENT
END

FIG. 14

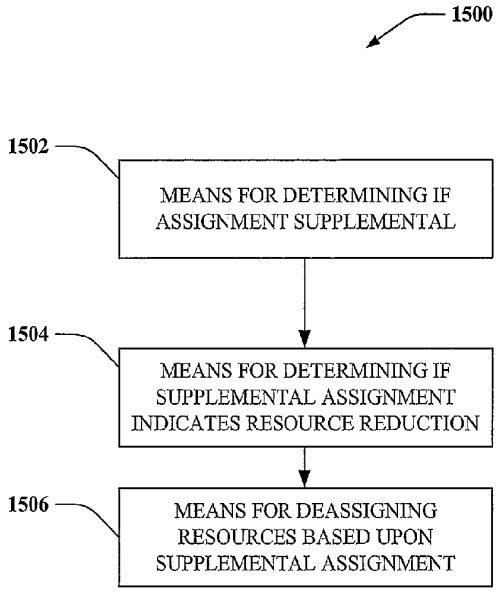

1500
1502
MEANS FOR DETERMINING IF ASSIGNMENT SUPPLEMENTAL
1504
MEANS FOR DETERMINING IF SUPPLEMENTAL ASSIGNMENT INDICATES RESOURCE REDUCTION
1506
MEANS FOR DEASSIGNING RESOURCES BASED UPON SUPPLEMENTAL ASSIGNMENT

FIG. 15