ADAPTIVE ASSIGNMENT OF UNIQUE WORDS IN A COMMUNICATION SYSTEM

ATtribution Adaptive de mots uniques dans un système de communication

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to wireless communication systems, and more specifically to assigning unique words in an SDMA (spatial division multiple access) communication system using a base station.

BACKGROUND OF THE INVENTION

[0002] The deployment and use of wireless communication systems is dramatically increasing, with associated pressures to increase system capacity, bandwidth, and quality. One way to increase system capacity is by employing a multiple access process, which allows a scarce system resource to be shared between multiple users. An example of resource sharing in which resources are reserved based upon anticipated activity is described in US 2004/0203832. For example, some communication systems operate according to a TDMA (time division multiple access) process. In a TDMA communication system, a predetermined time frame is sub-divided into slots, and each user is assigned a slot for receiving and transmitting data or voice signals. In this way, multiple users are able to share the same time frame. In another example, some communication systems operate according to an SDMA (spatial division multiple access). In an SDMA system, a directable antenna array is configured to allow a particular frequency to be used by multiple users operating in the same general geographic area.

[0003] In use, each mobile user has a device that is assigned a unique word prior to initiating data or voice communication with a base station. Thereafter, from time to time, the unique word is transmitted from the remote, user, which assists the base station in determining the spatial signature of the remote device. In turn, this allows the base station to configure its directable antenna to better differentiate communication signals originating from different mobile devices, even though the devices are communicating on the same frequency. In this way, an SDMA communication system allows multiple users to share the same frequency. For a discussion of SDMA channel allocation, see for example, I channel allocation in SCMA cellular systems® IEEE 54th Vehicular Technology Conference, Vol. 1 of 4, October 7 to 11, 2001, pages 399 to 403; P. Ccardier et al..

[0004] In another example, some communication systems may use more than one multiple access process to further increase system capacity. For example, the PHS (personal handyphone system) communication system, which is widely deployed in Japan, combines the benefits of both TDMA and SDMA. That is, PHS divides a time frame into slots, and then assigns unique words with respect to each slot. In this way, each time frame allows for multiple users in the slots, and each slot allows for multiple access by using the same frequency. In PHS, the base station is generally referred to as the cell station, while the remote mobile device is referred to as the personal station.

[0005] The PHS system is a recognized international standard promulgated by ARIB (Association of Radio Industries and Businesses). More particularly, document RCR-STD-28 details the requirements and options available in a PHS communication system. For example, PHS, as with other SDMA communication systems, may be implemented with a limited number of available unique words. Although the unique words may be selected for low cross correlation effects, because there are a limited number available, unique words are reused throughout the PHS communication system. However, to enable the directable antenna to operate properly, it is important that the unique words for personal stations be different, and more importantly, to be different enough to support signal differentiation by the cell station. Accordingly, when a personal station makes a request to access the PHS cell station, the PHS cell station should consider which unique words are in use in an area around the requesting personal station.

[0006] With the increased usage of mobile and wireless devices, existing base stations may become overloaded with traffic, deny access to some mobile units, or drop calls as mobile units move cell to cell. Since each cell station in a PHS system typically has a defined set of available unique words, the overall cell and system capacity is static, and is set by system managers according to expected communication traffic.

[0007] Therefore, there exists a need for a process and system for assigning unique words to achieve an improved system capacity, lower interference, and better adaptability to changing communication demands.

SUMMARY

[0008] The present invention relates to methods for adaptively assigning unique words in an SDMA communication system according to the features of respective independent claims 1, 11 and 13.

[0009] A method for assigning unique words in an SDMA (spatial division multiple access) communication system is disclosed. A network management system logically arranges cell stations into clusters of stations, and monitors for a heavy traffic condition. Responsive to determining that a heavy traffic condition exists, the network management system may 1) redistribute unique words within a single cluster; 2) move one or more cell stations from a busy cluster to a less busy cluster; or 3) create a new cluster, and move cells from one or more busy cluster into the new cluster. In this way, the communication system continually adapts so that more unique words are made available at cell stations having heavier communication demands.

[0010] These and other features of the present invention will become apparent from a reading of the following
description, and may be realized by means of the instrumentalties and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The drawings constitute a part of this specification and include exemplary embodiments of the invention, which may be embodied in various forms. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

FIG. 1 is a flowchart of a method for adaptively assigning unique words in accordance with one embodiment of the present invention.

FIG. 2 is a diagram of a system for adaptively assigning unique words in accordance with one embodiment of the present invention.

FIG. 3 is a flowchart of a method for adaptively assigning unique words in accordance with one embodiment of the present invention.

FIG. 4 is a diagram of a system for adaptively assigning unique words in accordance with one embodiment of the present invention.

FIG. 5 is a diagram of a system for adaptively assigning unique words in accordance with one embodiment of the present invention.

FIG. 6 is a flowchart of a method for adaptively assigning unique words in accordance with the present invention.

FIG. 7 is a diagram of a system for adaptively assigning unique words in accordance with the present invention.

FIG. 8 is a diagram of a system for adaptively assigning unique words in accordance with the present invention.

FIG. 9 is a flowchart of a method for adaptively assigning unique words in accordance with the present invention.

FIG. 10 is a flowchart of a method for adaptively assigning unique words in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0012] Detailed descriptions of examples of the invention are provided herein. It is to be understood, however, that the present invention may be exemplified in various forms. Therefore, the specific details disclosed herein are not to be interpreted as limiting, but rather as a representative basis for teaching one skilled in the art how to employ the present invention in virtually any detailed system, structure, or manner.

[0013] Referring now to Figure 1, process 10 for adaptively assigning unique words for a communication system is illustrated. Process 10 is illustrated as a method operating within a PHS communication system as shown. However, it will be appreciated that other communication systems employing an SDMA (spatial division multiple access) system may be used.

[0014] The PHS Communication process typically has a set of base stations for communicating with a number of remote mobile devices. Each base station has a local area in which it communicates, which is often referred to as a "cell". Cells may be arranged in a pattern so that adjacent cells somewhat overlap. In this way, as a mobile device moves from one cell to another, one base station may hand off the communication to the other base station in an orderly and controlled manner. This handoff process is often referred to as a soft handoff or handover.

[0015] Since the PHS communication system operates according to an SDMA process, the cell station assigns each personal station a unique word responsive to an establish request. These unique words are used for determining the spatial signature of personal stations during communication processes. This spatial signature assists the cell stations in directing their antenna array, as well as in differentiating the communication signal arriving from each personal station. At termination of the communication with the cell station, the unique word is released; and is available to be assigned for another communication session.

[0016] It will be appreciated that the number of unique words available for each cell station may vary according to the particular communication system in use. Typically, a communication system has a limited number of unique words available for use, so unique words are shared and reused across the communication system. Each cell is responsible for providing transmission and reception communication within a specific but limited geographic area. Accordingly, as a mobile wireless user moves between cells, the responsibility for communicating with that personal station is transferred from one cell to another. In most cases, the base stations for cells are connected to a central office, either by wired or wireless connection. For example, the base stations may communicate with the central office through an Internet or TCP/IP connection, or may communicate through satellite, microwave, or other wireless standard. The central office, therefore, may act to provide supervisory control for the individual cell stations.

[0017] In process 10, the central office is used to logically arrange cell stations into clusters of cell stations. Each cluster may contain, for example, a predefined number of cell stations, or the number of cell stations per cluster may be adjusted according to current or expected
communication needs. In a specific example, each cluster is initially assigned to have seven cell stations. Each cluster also has a defined pool of unique words that may be distributed among that clusters cell stations. For example, a cluster may be assigned 21 unique words, and if the cluster has seven cell stations, then each cell station may be distributed three unique words. In other cases, the unique words may be unequally distributed among the cell stations according to actual or anticipated communication loading. The assignment of cell stations may be made from a central office, or may be made cooperatively between cell stations in a cluster. In one example, a network manager system operates on a central station to manage the definition and assignment of unique words within a cluster. It will be appreciated that the number of clusters, the number of cell stations per cluster, the number of unique words in each cluster, and the distribution of unique words within each cluster may be adjusted according to application and communication requirements.

With the clusters defined and the unique words assigned, the communication system operates according to its PHS communication standard. Process 10 monitors communication traffic within communication system as shown in block 14. The monitoring process may be done at the central office using a network management system, or may be done within the cluster itself. For example, individual cell stations may report when they have usually high or unusually low communication traffic. In this way, other cell stations within the cluster are made aware of the resource requirements for other cells. In another example, a network management system operating on a server within a cluster or at a central office, monitors overall communication flow within the cluster, and therefore can determine immediate resource needs, and may be able to predict upcoming loading events. The network management system may also monitor the overall communication loading of the communication system: For example, the network management system may monitor traffic within individual cells, overall traffic within individual clusters, and communication traffic within the entire communication system. In this way, the network management system maintains a system-level view of current communication traffic.

As a result of monitoring the communication traffic, the network management system may determine that traffic has become unusually heavy in one cell as shown in block 16. In such a case, the network management system may redistribute the unique words between the cells in one cluster as shown in block 17. For example, a cell station operating with relatively low traffic may relinquish one of its unique words, and that relinquished unique word may be reassigned to the cell station having heavy loading. In this way, the burdened cell station may distribute its communication traffic over more unique words, and therefore may more readily handle current communication demand. The distribution of unique words within a cluster adapts to the immediate traffic loading.

It will also be appreciated that some unique words may be reassigned to reduce correlation effects between unique words in adjacent cells. For example, if one cell is assigned a new unique word, but that unique word has a relatively high correlation with a unique word in an adjacent cell, then the adjacent cell may request that the network management system replace that unique word with another unique word having lower correlation effects. In this way, both cell stations may operate a more robust communication process.

In response to monitoring the system traffic, the network management system may find that one cluster has an unusually high level of traffic as shown in block 19. The level of traffic within the cluster may be such that a simple redistribution of unique words within the cluster is not sufficient to allow robust communication. In such a case, the network management system may move one or more cells out of the busy cluster as shown in block 20. The cluster maintains its existing pool of unique words, so now the same number of unique words may be distributed among fewer cells. Accordingly, each cell may have a higher number of unique words as compared to the originally sized cluster. Take for example a cluster having seven cells and 21 unique words. If this cluster becomes unusually busy, then one of its cell's stations may be moved to an adjacent cluster. Now 21 unique words are available for distribution over six cell stations. These unique words provide a higher density of unique words for the smaller cluster, allowing a greater density of traffic communication. In moving cells out of the busy cluster, the moved cell would be moved to a less busy cluster, increasing the number of cells in that cluster. Accordingly, the moved cell station would be reassigned unique words from less busy cell stations within that cluster. Take for example where a cluster originally has seven cell stations, and a new cell station is assigned to that cluster, bringing the total to eight cell stations. If the cluster originally has 21 assigned unique words, then the 21 assigned unique words now must be distributed among eight cell stations. Typically, cell stations will be moved in a way that allows contiguous arrangements of cells. However, it will be understood that clustering is a logical process, and therefore is not constrained by physical position.

The network management system may also determine through monitoring that traffic is heavy in adjacent clusters as shown in the block 22. In this way, the mere shifting of cells from one cluster to another would not substantially alleviate the overloading problem. In such a case, the network management system creates a new cluster and moves cells from each of the heavily loaded clusters into the new cluster as shown in block 23. Take for example two adjacent clusters, each cluster having seven cells and 21 unique words each. Both clusters are heavily loaded. Accordingly, the network management system creates a third cluster and moves, for example, two cells from each busy cluster into the new cluster. As a result, the original two clusters now have
five cells each, and the newly created cluster has four cells. The network management system assigns a pool of unique words to the newly created cluster, and the unique words are distributed among the four cells. Assume that the new cluster was assigned 21 unique words. Now 63 unique words are available in the geography that previously had 42 unique words. Although more unique words are available, and likely will allow for greater communication densities, the network management system may also need to redistribute numbers to reduce correlation effects between unique words in adjacent cells.

[0023] Advantageously, process 10 enables an SDMA communication system to readily and efficiently adapt to current communication loading. Responsive to detected loading, a network management system is able to efficiently redistribute unique words within a cluster, redistribute cells between or among clusters, or dynamically create or remove clusters as required. In this way, more unique words are available in high traffic cells, as shown in block 25.

[0024] Referring now to Figure 2, system 50 for adaptively assigning unique words is illustrated. System 50 has original cluster 52 having seven individual cells, such as cell 56, 57, and 58. Although cluster 52 is illustrated with seven cells, it will be appreciated that other numbers of cells may be used. Network management system 55 communicates with cluster 52, and provides monitoring and control functions. Network management system 55 may be a central function operating at a central office facility, or may be a distributed function operating at least in part within cluster 52. As illustrated, each cell is assigned to cluster one, and is numbered 1, 2, 3, 4, 5, 6, or 7. Each cell station has three unique words, thereby having a total available pool of 21 unique words for cluster 52.

[0025] Network management system 55 operates a process, such as process 75 shown with reference to Figure 3. The network management system monitors traffic in cluster 52 of cells as shown in block 77. Network management system 55 may determine that traffic becomes heavy in one cell as shown in the block 79. Network management system 55 may also identify another cell within the cluster that has relatively lighter traffic as shown in block 81. Network management system 55 may then select a unique word to remove from the cell with lighter traffic as shown in block 83. The selected unique word is then redistributed and assigned to the cell having heavy traffic as shown in block 85. In one example, the unique word to be moved was selected according to its expected correlation effects in the cell it was being moved to. Referring again to Figure 2, network management system 55 has determined that cell station 57 had unusually high traffic, and that cell station 56 and 58 had relatively light traffic, as shown in cluster arrangement 52. Accordingly, unique word "c" was relinquished from cell station 56 and reassigned to cell station 57. In a similar manner, unique word "j" was relinquished from cell station 58 and reassigned to cell station 57. Cell station 57 now operates with five total unique words, and therefore can accommodate its heavier communication world, as shown in cluster arrangement 62. It will be appreciated that the assignment of unique words within cluster 62 may be continually adapted to detected traffic flows.

[0026] Referring now to Figure 4, system 100 for adaptively assigning unique words is illustrated. System 100 has cluster one 104 having seven cell stations, such as cell stations 111, 113, 115, 117, and 119. Each cell station within cluster 104 is identified as "CL 1 ", and is consecutively numbered. System 100 also has cluster two 106, which also has seven cells stations such as cell station 121, 123 and 125. Each cell in cluster two 106 is identified as "CL 2 ", and is also consecutively numbered. Both cluster one 104 and cluster two 106 each have 21 unique words in their respective pool. The clusters 104 and 106 communicate with network management system 102. Network management system 102 may be centrally operated at a central office, or may have some of its processing requirements distributed with in one or more cells. Network management system 102 operates an adaptive assignment process, such as process 150 shown in Figure 6. Network management system 102 monitors traffic in both first cluster 104 and second cluster 106 as shown in block 153.

[0027] Network management system 102 may determine that traffic becomes heavy in cluster one 104 as shown in block 155. Network management system 102 selects one or more cell station(s) to remove from cluster one 104 as shown in block 157. In this way, cluster one 104 has fewer cells, but has the original number of unique words. The pool of unique words is then redistributed among the remaining cell stations in cluster one as shown in block 159. The moved cell is now assigned to cluster two, as shown in block 161. The unique words in cluster two are also redistributed to accommodate the additional cell as shown in block 163. Referring to Figure 5, the communication system 100 of Figure 4 has been updated according to monitored traffic conditions. More particularly, network management system 102 determined that traffic had become heavy in cluster one 104, and that traffic was relatively light in cluster two 106. Accordingly, cell stations 115 and 117, which were originally assigned to cluster one, have now been assigned to cluster two. Cluster one 131 now has five total cells, while cluster two 132 now has nine total cells. Originally, cells 115 and 117 had unique words m, n, o, p, q, and r. These six unique words now have been reassigned within smaller cluster 131. For example, m, n, and o have been assigned to cell 111, and p, q, and r have been assigned to cell station 113. In this way, the cell stations within new cluster 131 may more readily accommodate heavier traffic conditions. New cluster 132 has had to redistribute unique words to accommodate the two additional cells. For example, unique word c, originally in cell station 121, has now been moved to cell station 117. In a similar manner, unique word f was originally assigned to sell station 123, and has now been reassigned to cell station 115. It will
be appreciated that the unique words may be redistributed within each new cluster, or that the size of clusters may be continually adapted according to changing traffic conditions.

[0028] Referring now to Figure 7, system 175 for adaptively assigning unique words is illustrated. System 175 has first cluster 176 having seven cell stations such as cell stations 111, 113, 115, 117, 119, and 129. System 175 also has second cluster 177 also having seven cell stations such as cell stations 121, 123, 125, and 127. System 175 is monitored by network management system 102. Network management system 102 may be centrally operated on a central office processor, or may have its processes distributed between clusters or cells. Network management system 102 operates a process such as process 225 illustrated in Figure 9. Process 225 has a network management system monitoring traffic in both a first cluster and a second cluster as shown in block 227. The network management system determines that traffic has become heavy in both cluster one and two as shown in block 229. In this way, a simple redistribution of unique words within an individual cluster, or even assignment of one cell to another cluster will not accommodate the increased traffic. Accordingly, the process 225 selects certain cells to remove from cluster one as shown in block 231.

[0029] Since cluster one now has fewer cells but the same number of unique words, additional unique words are available for the remaining cells. In this way, cluster one may now accommodate a higher density of traffic flow. In a similar manner, the network management system selects cells to remove from cluster two. Cluster two now has fewer cells but the same number of unique words, so the unique words have been distributed over a fewer number of cells, allowing for higher communication densities as shown in block 238. Network management system 227 creates a third cluster and assigns the selected cells to the new cluster as shown in block 241. The network management system also assigns the new cluster three a pool of available words, and those unique words are distributed among the cell stations as shown in block 243. The words may be distributed evenly among the cell stations as shown in block 245, according to monitored traffic as shown in block 246, or according to an order intended to reduce correlation effects with adjacent cells as shown in block 247. The network management system then continues to monitor traffic as shown in block 249. In this way, the network management system is able to continually adapt the communication system to current traffic conditions.

[0030] Referring now to Figure 7 and Figure 8, system 175 has been adapted from its original configuration (Figure 7) to a new configuration (Figure 8) that is able to better accommodate heavy traffic demand. More particularly, network management system 102 monitored traffic in the original clusters 176 and 177, and found each to have a high traffic condition. Accordingly, the network management system 102 created a third cluster 180. The third cluster 180 has been assigned four cells. For example, cluster 180 has cells 115 and 117, which were previously assigned to cluster one. In a similar manner, cluster 180 now has cell stations 121 and 123 which were previously assigned to cluster two. As a result, cluster one 178 now has five cell stations, cluster two 179 now has five cell stations, and cluster three 180 has four cell stations. The unique words originally assigned to cell stations 115 and 117 have now been redistributed with in the five cell stations remaining in cluster one 178. In a similar manner, the unique words assigned to cell stations 121 and 123 were reassigned to the remaining five cells in cluster two 179. The network management system assigned a new pool of unique words to cluster three 180, and those words have been distributed among the four cells of cluster three 180. It will be understood that some redistribution of unique words in clusters one and two may be required to reduce correlation effects.

[0031] It will also be appreciated that since the overall density of unique words has been increased, the likelihood of interfering correlation effects has also been increased. As a result, in some cases it may be beneficial to reduce the number of unique words operating in a particular geographic area after traffic conditions have reduced. For example, in the system shown in Figure 8, when traffic returns to a more normal state, then it may be desirable to eliminate cluster three 180 and reassign the cells according to the original assignments shown with reference to Figure 7.

[0032] Referring now to Figure 10, process 250 is illustrated for adaptively assigning unique words. In process 250 a network management system monitors traffic in a first and second cluster as shown in block 252. The network management system determines that traffic has become light in both clusters one and two as shown in block 254. Accordingly, the network management system may dissolve or remove cluster two, and thereby unassign the unique words within the cells of cluster two as shown in block 256. The cells originally within cluster two are now assigned to cluster one as shown in block 258. The unique words within cluster one are then redistributed among the higher number of cells as shown in block 261. In this way, the assignment of a fewer number of unique words in a particular geographic area may reduce the risk of undesirable correlation effects with adjacent cells. The network management system then continues to monitor traffic as shown in block 263. In this way, process 250 is able to continually adapt to current traffic conditions.

[0033] While particular preferred and alternative embodiments of the present intention have been disclosed, it will be apparent to one of ordinary skill in the art that many various modifications and extensions of the above described technology may be implemented using the teaching of this invention described herein. All such modifications and extensions are intended to be included within the scope of the invention as discussed in the appended claims.
Claims

1. A method for adaptively assigning unique words in a spatial division multiple access, SDMA, communication system, comprising:

   logically arranging (12) a plurality of cell stations into a first cluster, the first cluster having a first pool of available unique words; assigning one or more unique words from the first pool to each cell station in the first cluster; characterized by monitoring (14) communication traffic in the communication system; determining (16, 19, 22) a heavy traffic condition exists; and redistributing (17, 20, 23) unique words in the plurality of cell stations according to the heavy traffic condition.

2. The method according to claim 1, wherein the determining step comprises determining (79) that the heavy traffic condition exists at a first cell station in the first cluster, and the redistributing step comprises reassigning (85) a unique word from a second cell station in the first cluster to the first cell station, so that the first cell station has one more unique word, and the second cell station has one fewer unique world.

3. The method according to claim 1, wherein under a normal traffic condition the first pool of available unique words is distributed evenly among the cell stations in the first cluster, so that each cell station has the same number of unique words.

4. The method according to claim 1, further comprising the steps of:

   logically arranging a second plurality of cell stations into a second cluster, the second cluster having a second pool of available unique words; assigning one or more unique words from the second pool to each cell station in the second cluster; determining (155) that a heavy traffic condition exists in the first cluster; moving (161) one or more cells from the first cluster to the second cluster; redistributing the unique words in the first pool among the cells remaining in the first cluster so that the one or more cell stations with the heavy traffic have more unique words; and distributing (243) unique words from a third pool among the cells in the second cluster so that each of the moved cells has at least one unique word from the third pool.

5. The method according to claim 4, further including the step of selecting the cells to be moved so that the cells to be moved are adjacent to cells in the second cluster.

6. The method according to claim 1, further comprising the steps of:

   logically arranging a second plurality of cell stations into a second cluster, the second cluster having a second pool of available unique words; assigning one or more unique words from the second pool to each cell station in the second cluster; determining (229) that a heavy traffic condition exists in the first cluster and in the second cluster; moving (241) one or more cells from the first cluster to a third cluster; moving (241) one or more cells from the second cluster to the third cluster; redistributing (233) the unique words in the first pool among the cells remaining in the first cluster so that the one or more cell stations with the heavy traffic have more unique words; redistributing (238) the unique words in the second pool among the cells remaining in the second cluster so that the one or more cell stations with the heavy traffic have more unique words; and distributing (243) unique words from a third pool among the cells in the third cluster so that each of the moved cells has at least one unique word from the third pool.

7. The method according to claim 6, wherein the third cluster has only the cells moved from the first and second clusters.

8. The method according to claims 4 and 6, further including the step of selecting the cells to be moved so that each moved cell is adjacent to another moved cell.

9. The method according to claim 6, wherein at least one cell from the first cluster is adjacent to at least one cell in the third cluster; and wherein the redistributing step further includes redistributing the unique words in the first cluster so that the adjacent cells have unique words with lower correlation.

10. The method according to claim 1, wherein the plurality of cell stations in the first cluster is initially selected to be about seven cell stations.

11. A method for adaptively assigning unique words at a cell station of a spatial division multiple access,
SDMA, communication system, comprising:

assigning available unique words to personal, stations operating in the cell station cell area; characterized by

subsequent to determining that a high traffic condition exists, then receiving notification that an additional unique word may be assigned; and assigning the additional unique word to another personal station operating in the cell station area; and

subsequent to reporting that a high traffic condition does not exist, then receiving a command to relinquish use of a unique word; and stopping use or assignment of the relinquished unique word.

12. The method according to claim 11, further comprising:

the cell station operating within a first cluster; and

the cell station receiving a notification to operate in a second cluster.

13. A method for adaptively assigning unique words in a spatial division multiple access, SDMA, communication system, comprising:

arranging cell stations into a plurality of clusters, each cluster having a pool of unique words; characterized by

monitoring the communication system for the existence of heavy traffic in each cluster; if heavy traffic exists in a first cluster, then reducing the number of cells in the first cluster; redistributing unique words among the fewer cells of the first cluster so that more unique words are assignable in cells of the first cluster having heavy traffic.

14. The method according to claim 13, wherein the number of cells are reduced in the first cluster by moving the cells into a second cluster.

15. The method according to claim 13, further including the step of adding a new cluster to the plurality of clusters, so that, on average, the clusters have fewer cells.

Patentansprüche

1. Verfahren zum adaptiven Zuweisen von eindeutigen Wörtern in einem Raumaufteilungsmehrfachzugriff-Kommunikationssystem, SDMA-Kommunikationssystem, aufweisend:

logisches Anordnen (12) einer Mehrzahl von Zellenstationen in eine erste Gruppe, wobei die erste Gruppe einen ersten Vorrat von verfügbaren eindeutigen Worten hat;

Zuweisen eines oder mehrerer eindeutiger Wörter aus dem ersten Vorrat zu jeder Zellenstation in der ersten Gruppe;

charakterisiert durch

Überwachen (14) von Kommunikationsverkehr in dem Kommunikationssystem;

Ermitteln (16, 19, 22), dass eine Starker-Verkehr-Bedingung existiert; und

Wiederverteilen (17, 20, 23) eindeutiger Wörter in der Mehrzahl von Zellenstationen gemäß der Starker-Verkehr-Bedingung.

2. Verfahren gemäß Anspruch 1, wobei der Ermittlungsschritt aufweist Ermitteln (79), dass die Starker-Verkehr-Bedingung bei einer ersten Zellenstation in der ersten Gruppe existiert und der Wiederverteilschritt aufweist Wiederzuweisen (85) eines eindeutigen Wortes von einer zweiten Zellenstation in der ersten Gruppe zu der ersten Zellenstation, so dass die erste Zellenstation ein eindeutiges Wort mehr hat und die zweite Zellenstation ein eindeutiges Wort weniger hat.


4. Verfahren gemäß Anspruch 1, ferner aufweisend die Schritte:

logisches Anordnen einer zweiten Mehrzahl von Zellenstationen in eine zweite Gruppe, wobei die zweite Gruppe einen zweiten Vorrat von verfügbaren eindeutigen Wörtern hat;

Zuweisen einer oder mehrerer eindeutiger Wörter von dem zweiten Vorrat zu jeder Zellenstation in der zweiten Gruppe;

Ermitteln (155), dass eine Starker-Verkehr-Bedingung in der ersten Gruppe existiert;

Bewegen (161) einer oder mehrerer Zellen von der ersten Gruppe zu der zweiten Gruppe;

Wiederverteilen der eindeutigen Wörter in dem ersten Vorrat unter den in der ersten Gruppe verbleibenden Zellen, so dass die ein oder mehreren Zellenstationen mit dem starken Verkehr mehr eindeutige Wörter haben; und

Wiederverteilen (163) der eindeutigen Wörter in dem zweiten Vorrat unter den Zellen in der zweiten Gruppe, so dass jede der bewegten Zellen mindestens ein eindeutiges Wort aus dem zweiten Vorrat hat.
5. Verfahren gemäß Anspruch 4, ferner aufweisend den Schritt des Auswählers der zu bewegenden Zellen, so dass die zu bewegenden Zellen an Zellen in der zweiten Gruppe angrenzen.

6. Verfahren gemäß Anspruch 1, ferner aufweisend die Schritte:

- logisches Anordnen einer zweiten Mehrzahl von Zellenstationen in eine zweite Gruppe, wobei die zweite Gruppe einen zweiten Vorrat von verfügbaren eindeutigen Wörtern hat;
- Zuweisen einer oder mehrerer eindeutiger Wörter aus dem zweiten Vorrat zu jeder Zellenstation in der zweiten Gruppe;
- Ermitteln (229), dass eine Starke-Verkehr-Bedingung in der ersten Gruppe und in der zweiten Gruppe existiert;
- Bewegen (241) einer oder mehrerer Zellen von der ersten Gruppe zu einer dritten Gruppe;
- Bewegen (241) einer oder mehrerer Zellen von der zweiten Gruppe zu der dritten Gruppe;
- Wiederverteilen (233) der eindeutigen Wörter in dem ersten Vorrat unter den in der ersten Gruppe verbleibenden Zellen, so dass die ein oder mehreren Zellenstationen mit dem starken Verkehr mehr eindeutige Wörter haben;
- Wiederverteilen (238) der eindeutigen Wörter in dem zweiten Vorrat unter den in der zweiten Gruppe verbleibenden Zellen, so dass die ein oder mehreren Zellenstationen mit dem starken Verkehr mehr eindeutige Wörter haben; und
- Verteilen (243) eindeutiger Wörter aus einem dritten Vorrat unter den Zellen in der dritten Gruppe, so dass jede der bewegten Zellen mindestens ein eindeutiges Wort von dem dritten Vorrat hat.

7. Verfahren gemäß Anspruch 6, wobei die dritte Gruppe nur die Zellen aufweist, die von der ersten Gruppe und der zweiten Gruppe bewegt worden sind.

8. Verfahren gemäß den Ansprüchen 4 und 6, ferner aufweisend den Schritt des Auswählers der zu bewegenden Zellen, so dass jede bewegte Zelle an eine andere bewegte Zelle angrenzt.

9. Verfahren gemäß Anspruch 6, wobei mindestens eine Zelle von der ersten Gruppe an mindestens eine Zelle in der dritten Gruppe angrenzt; und

- wobei der Wiederverteilungsschritt ferner aufweist Wiederverteilen der eindeutigen Wörter in der ersten Gruppe, so dass die angrenzenden Zellen eindeutige Wörter mit niedrigerer Korrelation haben.

10. Verfahren gemäß Anspruch 1, wobei die Mehrzahl von Zellenstationen in der ersten Gruppe anfänglich ausgewählt wird, so dass sie etwa sieben Zellenstationen ist.

11. Verfahren zum adaptiven Zuweisen von eindeutigen Wörtern in einem Raumaufteilungsmehrfachzugriff-Kommunikationssystem, SDMA-Kommunikationssystem, aufweisend:

- Zuweisen von eindeutigen Wörtern zu persönlichen Stationen, die in dem Zellenstationsbereich agieren; charakterisiert durch anschließend an das Ermitteln, dass eine Starker-Verkehr-Bedingung existiert, dann Empfangen der Benachrichtigung, dass ein zusätzliches eindeutiges Wort zugewiesen werden kann; und
- Zuweisen des zusätzlichen eindeutigen Worts zu einer anderen persönlichen Station, die in dem Zellenstationsbereich agiert; und anschließend an das Berichten, dass eine Starker-Verkehr-Bedingung nicht existiert, dann Empfangen eines Befehls zum Abtreten der Benutzung des eindeutigen Worts; und
- Beenden der Benutzung oder der Zuweisung des abgetretenen eindeutigen Worts.

12. Verfahren gemäß Anspruch 11, ferner aufweisend:

- Agieren der Zellenstation innerhalb einer ersten Gruppe; und
- Empfangen, durch die Zellenstation, einer Benachrichtigung, in der zweiten Gruppe zu agieren.

13. Verfahren zum adaptiven Zuweisen von eindeutigen Wörtern in einem Raumaufteilungsmehrfachzugriff-Kommunikationssystem, SDMA-Kommunikationssystem, aufweisend:


14. Verfahren gemäß Anspruch 13, wobei die Anzahl der Zellen in der ersten Gruppe reduziert werden durch Bewegen der Zellen in die zweite Gruppe.
Verfahren gemäß Anspruch 13, ferner aufweisend den Schritt des Hinzufügens einer neuen Gruppe zu der Mehrzahl von Gruppen, so dass, im Durchschnitt, die Gruppen weniger Zellen haben.

Revendications

1. Procédé destiné à attribuer de manière adaptative des mots uniques dans un système de communication à accès multiple par répartition spatiale, SDMA, comprenant les étapes consistant à :

agencer (12) de manière logique une pluralité de stations cellulaires dans un premier groupe, le premier groupe présentant une première réserve de mots uniques disponibles ;

attribuer un ou plusieurs mots uniques de la première réserve à chaque station cellulaire du premier groupe ;

caractérisé par les étapes consistant à :

surveiller (14) un trafic de communication dans le système de communication ;

déterminer (16, 19, 22) s’il existe un état de fort trafic ; et

redistribuer (17, 20, 23) des mots uniques dans la pluralité de stations cellulaires selon l’état de fort trafic.

2. Procédé selon la revendication 1, dans lequel l’étape de détermination comprend une étape consistant à déterminer (79) que l’état de fort trafic existe au niveau d’une première station cellulaire dans le premier groupe, et l’étape de redistribution comprend une étape consistant à réattribuer (85) un mot unique à partir d’une deuxième station cellulaire dans le premier groupe vers la première station cellulaire, de telle sorte que la première station cellulaire présente un mot unique de plus, et que la deuxième station cellulaire présente un mot unique de moins.

3. Procédé selon la revendication 1, dans lequel, dans un état de trafic normal, la première réserve de mots uniques disponibles est distribuée de manière uniforme parmi les stations cellulaires du premier groupe, de telle sorte que chaque station cellulaire présente le même nombre de mots uniques.

4. Procédé selon la revendication 1, comprenant en outre les étapes consistant à :

agencer de manière logique une deuxième pluralité de stations cellulaires dans un deuxième groupe, le deuxième groupe présentant une deuxième réserve de mots uniques disponibles ;

attribuer un ou plusieurs mots uniques de la deuxième réserve à chaque station cellulaire du deuxième groupe ;

déterminer (155) qu’un état de fort trafic existe dans le premier groupe ;

déplacer (161) une ou plusieurs cellules du premier groupe vers le deuxième groupe ;

redistribuer les mots uniques de la première réserve parmi les cellules qui restent dans le premier groupe de telle sorte que la ou les stations cellulaires qui présentent un fort trafic, disposent de plus de mots uniques ; et

redistribuer (163) les mots uniques de la deuxième réserve parmi les cellules du deuxième groupe de telle sorte que chacune des cellules déplacées présente au moins un mot unique qui provient de la deuxième réserve.

5. Procédé selon la revendication 4, comprenant en outre l’étape consistant à sélectionner les cellules à déplacer de telle sorte que les cellules à déplacer soient adjacentes à des cellules du deuxième groupe.

6. Procédé selon la revendication 1, comprenant en outre les étapes consistant à :

agencer de manière logique une deuxième pluralité de stations cellulaires dans un deuxième groupe, le deuxième groupe présentant une deuxième réserve de mots uniques disponibles ;

attribuer un ou plusieurs mots uniques de la deuxième réserve à chaque station cellulaire du deuxième groupe ;

déterminer (229) qu’un état de fort trafic existe dans le premier groupe et dans le deuxième groupe ;

déplacer (241) une ou plusieurs cellules du premier groupe vers un troisième groupe ;

déplacer (241) une ou plusieurs cellules du deuxième groupe vers le troisième groupe ;

redistribuer (233) les mots uniques de la première réserve parmi les cellules qui restent dans le premier groupe de telle sorte que la ou les stations cellulaires qui présentent un fort trafic, disposent de plus de mots uniques ;

redistribuer (238) les mots uniques de la deuxième réserve parmi les cellules qui restent dans le deuxième groupe de telle sorte que la ou les stations cellulaires qui présentent un fort trafic, disposent de plus de mots uniques ; et

redistribuer (243) des mots uniques qui proviennent d’une troisième réserve parmi les cellules du troisième groupe de telle sorte que chacune des cellules déplacées présente au moins un mot unique qui provient de la troisième réserve.

7. Procédé selon la revendication 6, dans lequel le troi-
sième groupe présente seulement les cellules déplacées en provenance des premier et deuxième groupes.

8. Procédé selon les revendications 4 et 6, comprenant en outre l’étape consistant à sélectionner les cellules à déplacer de telle sorte que chaque cellule déplacée soit adjacente à une autre cellule déplacée.

9. Procédé selon la revendication 6, dans lequel une cellule au moins du premier groupe est adjacente à une cellule au moins du troisième groupe ; et dans lequel l’étape de redistribution comprend en outre une étape consistant à redistribuer les mots uniques dans le premier groupe de telle sorte que les cellules adjacentes présentent des mots uniques avec une corrélation plus faible.

10. Procédé selon la revendication 1, dans lequel la pluralité de stations cellulaires du premier groupe sont sélectionnées au début de façon à être sept stations cellulaires environ.

11. Procédé destiné à attribuer de manière adaptative des mots uniques au niveau d’une station cellulaire d’un système de communication à accès multiple par répartition spatiale, SDMA, comprenant les étapes consistant à :

attribuer des mots uniques disponibles à des stations personnelles qui fonctionnent dans la zone cellulaire de la station cellulaire ;

**caractérisé par** les étapes consistant à :

après une étape consistant à déterminer qu’un état de fort trafic existe, alors :

recevoir une notification selon laquelle il est possible d’attribuer un mot unique supplémentaire ; et attribuer le mot unique supplémentaire à une autre station personnelle qui fonctionne dans la zone cellulaire de la station cellulaire ; et après une étape consistant à signaler qu’un état de fort trafic n’existe pas, alors :

recevoir une commande visant à abandonner l’utilisation d’un mot unique ; et cesser d’utiliser ou d’attribuer le mot unique abandonné.

12. Procédé selon la revendication 11, comprenant en outre :

la station cellulaire fonctionne à l’intérieur d’un premier groupe ; et la station cellulaire reçoit une notification de fonctionner dans un deuxième groupe.

13. Procédé destiné à attribuer de manière adaptative des mots uniques dans un système de communication à accès multiple par répartition spatiale, SDMA, comprenant les étapes consistant à :

agencer les stations cellulaires dans une pluralité de groupes, chaque groupe présentant une réserve de mots uniques ;

**caractérisé par** les étapes consistant à :

surveiller le système de communication de manière à détecter l’existence d’un fort trafic dans chaque groupe ; si un fort trafic existe dans un premier groupe, réduire alors le nombre de cellules dans le premier groupe ; redistribuer des mots uniques parmi moins de cellules du premier groupe de telle sorte que plus de mots uniques puissent être attribués à des cellules du premier groupe qui présentent un fort trafic.

14. Procédé selon la revendication 13, dans lequel le nombre de cellules est réduit dans le premier groupe en déplaçant les cellules dans un deuxième groupe.

15. Procédé selon la revendication 13, comprenant en outre l’étape consistant à ajouter un nouveau groupe à la pluralité de groupes, de telle sorte que, en moyenne, les groupes présentent moins de cellules.
SET UP CLUSTER SYSTEM AND ASSIGN UNIQUE WORDS

MONITOR SYSTEM TRAFFIC

HEAVY IN ONE CELL

REDISTRIBUTE UNIQUE WORD BETWEEN CELL STATIONS IN ONE CLUSTER

HEAVY IN ONE CLUSTER

MOVE CELL(S) TO A LESS BUSY CLUSTER AND REDISTRIBUTE UNIQUE WORDS

HEAVY IN CLUSTERS

MOVE CELLS TO A NEW CLUSTER AND REDISTRIBUTE CELLS

MORE UNIQUE WORDS AVAILABLE IN HIGH TRAFFIC LOCATIONS

FIG. 1
FIG. 2
NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC IN CLUSTER OF CELLS

TRAFFIC BECOMES HEAVY IN ONE CELL

IDENTIFY ANOTHER CELL IN THE CLUSTER WITH LIGHT TRAFFIC

SELECT A UNIQUE WORD TO REMOVE FROM THE CELL WITH LIGHT TRAFFIC

REDISTRIBUTE UNIQUE WORD FROM CELL WITH LIGHT TRAFFIC TO CELL WITH HEAVY TRAFFIC

FIG. 3
FIG. 4
FIG. 5
NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC IN A FIRST CLUSTER AND A SECOND CLUSTER

TRAFFIC BECOMES HEAVY IN CLUSTER 1

SELECT A CELL STATION TO REMOVE FROM CLUSTER 1

REDISTRIBUTE THE UWs OF THE SELECTED CELL TO THE OTHER CELL STATIONS IN CLUSTER 1

ASSIGN THE SELECTED CELL STATION TO CLUSTER 2

REDISTRIBUTE UWs IN CLUSTER 2 TO ACCOMMODATE THE NEWLY ASSIGNED ADDITIONAL CELL STATION

FIG. 6
FIG. 7
FIG. 8
NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC IN A FIRST CLUSTER AND A SECOND CLUSTER

TRAFFIC BECOMES HEAVY IN BOTH CLUSTER 1 AND CLUSTER 2

SELECT CELL STATIONS TO REMOVE FROM CLUSTER 1

SELECT CELL STATIONS TO REMOVE FROM CLUSTER 2

REDISTRIBUTE THE UWs OF THE SELECTED CELL STATIONS TO THE OTHER CELL STATIONS IN CLUSTER 1

REDISTRIBUTE THE UWs OF THE SELECTED CELL STATIONS TO THE OTHER CELL STATIONS IN CLUSTER 2

ASSIGN THE SELECTED CELL STATIONS TO CLUSTER 3

DISTRIBUTE UWs IN CLUSTER 3

NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC

EVENLY

BY TRAFFIC

BY CORRELATION

FIG. 9
FIG. 10

NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC IN A FIRST CLUSTER AND A SECOND CLUSTER

TRAFFIC BECOMES LIGHT IN BOTH CLUSTER 1 AND CLUSTER 2

UNASSIGN THE UWS FOR CLUSTER 2

ASSIGN THE CELL STATIONS FROM CLUSTER 2 TO BE IN CLUSTER 1

REDISTRIBUTE UWS IN CLUSTER 1

NETWORK MANAGEMENT SYSTEM (NMS) MONITORS TRAFFIC
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

• US 20040203832 A [0002]

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