



(51) International Patent Classification:

H04W 72/04 (2009.01) H04W 28/16 (2009.01)
H04W 24/10 (2009.01) H04W 72/08 (2009.01)

(21) International Application Number:

PCT/SE2015/050088

(22) International Filing Date:

28 January 2015 (28.01.2015)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

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

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

Published:

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

(54) Title: A METHOD AND A NETWORK NODE FOR IMPROVING RADIO RESOURCE UTILIZATION IN A WIRELESS COMMUNICATION NETWORK

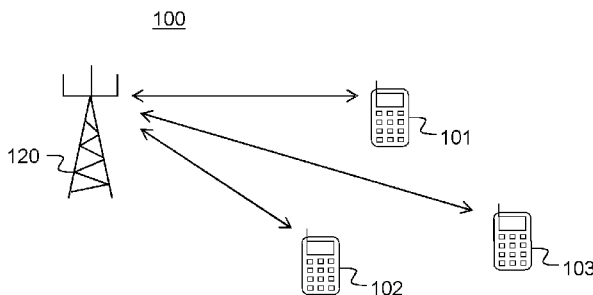
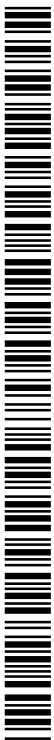


Fig. 1

(57) Abstract: Disclosed is a method performed by a network node (120) in a wireless communication network (100), for improving radio resource utilization of wireless radio resources provided by the network node. The method comprises obtaining, for each of a plurality of mobile stations (101, 102, 103) wirelessly connected to the network node (120), a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The method further comprises determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station, grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and allocating transmission time to each of the one or more subgroups based on the determined

time need.



A METHOD AND A NETWORK NODE FOR IMPROVING RADIO RESOURCE UTILIZATION IN A WIRELESS COMMUNICATION NETWORK

Technical field

[0001] The present disclosure relates generally to a method, a network node and a computer program for improving radio resource utilization in a wireless communication network. More specifically, it relates to improving radio resource utilization of radio resources provided by a base station.

Background

[0002] Wireless communication is constantly increasing in the world today. Efficient usage of communication resources is a hot topic in any type of wireless communication network, such as different 3GPP defined access technology networks, e.g. Universal Mobile Telecommunication System, UMTS, UMTS Terrestrial Radio Access Network, UTRAN, evolved UTRAN, E-UTRAN, GSM Edge Radio Access Network, GERAN and other wireless networks such as Wireless Local Area Networks, WLAN, Bluetooth and networks based on IEEE 802.15.

[0003] One wireless communication field which is positioned to be one of the fastest growing wireless communication technology segments in the next decade is Machine-to-Machine, M2M, communication.

[0004] In the M2M communication field as well as in other wireless communication fields there is an interest to achieve more efficient utilization of wireless communication resources handled by a base station to mobile stations located within a radio communication coverage area of the base station.

Summary

[0005] It is an object of some embodiments of the invention to address at least some of the issues outlined above. It is another object to achieve better utilization of radio resources provided by a base station of a wireless communication network. It is possible to achieve these objects and others by using a method and an apparatus as defined in the attached independent claims.

[0006] According to one aspect, a method is provided performed by a network node in a wireless communication network, for improving radio resource utilization. The method comprises obtaining, for each of a plurality of mobile stations wirelessly connected to the network node, a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The method further comprises determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station, grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and allocating transmission time to each of the one or more subgroups based on the determined time need.

[0007] By grouping the plurality of mobile stations of one base station into one or more subgroups based on their determined time need and allocating transmission time to each subgroup based on the determined time need, the transmission resources of the base station are better utilized. Further, especially for M2M communication where there may be a large number of mobile stations such as sensor devices connected to one base station, such a grouping characteristic will result in a less complicated way of allocating transmission time compared to allocating transmission time individually, based on individual time need. Thereby a good utilization of transmission resources is achieved at the same time as computational resources needed for such allocation are kept on a reasonable level. By using the three input variables channel quality, channel bandwidth and amount of data to communicate as basis for determining communication time need, a good estimate of necessary communication time is achieved.

[0008] According to another aspect, a network node is provided operable in a wireless communication network, for improving radio resource utilization. The

network node comprises a processor and a memory, said memory containing instructions executable by said processor, whereby the network node is operative for obtaining, for each of a plurality of mobile stations wirelessly connected to the network node, a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The memory further contains instructions executable by said processor, whereby the network node is operative for determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station, grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and allocating transmission time to each of the one or more subgroups based on the determined time need.

[0009] According to other aspects, computer programs and carriers are also provided, the details of which will be described in the claims and the detailed description.

[00010] Further possible features and benefits of this solution will become apparent from the detailed description below.

Brief description of drawings

[00011] The solution will now be described in more detail by means of exemplary embodiments and with reference to the accompanying drawings, in which:

[00012] Fig. 1 is a communication scenario illustrating a part of a wireless communication network in which embodiments of the present invention may be used.

[00013] Figs. 2-4 are flow charts illustrating methods performed by a network node, according to possible embodiments.

[00014] Fig. 5 is a diagram showing grouping of mobile stations based on their individual communication time need.

[00015] Figs. 6-7 are block diagrams illustrating a network node in more detail, according to further possible embodiments.

Detailed description

[00016] Briefly described, a solution is provided to be able to better utilize radio resources of a base station to which a plurality of mobile stations are connected. This is achieved by the base station grouping the mobile stations into different groups based on a determined communication need for each individual mobile station, and allocating time resources for the mobile stations of each group based on the determined communication need. The communication need for individual mobile stations is determined based on the channel bandwidth for the individual mobile station, the channel quality of the individual mobile station and the amount of data to communicate between the individual mobile station and the base station.

[00017] Fig. 1 describes a wireless communication network 100 in which embodiments of the present invention may be used. The wireless communication network 100 comprises a base station 120 and a plurality of mobile stations 101, 102, 103 that each has a radio connection with the base station 120. The wireless communication network may be any type of wireless access network, such as the UTRAN, E-UTRAN, GERAN, WLAN, Bluetooth or networks based on IEEE 802.15. Similarly, the base station 120 may be any type of network node providing wireless access to mobile stations, such as a Base Transceiver Station, BTS (GERAN), a node B (UTRAN), an e-node B (E-UTRAN) or an access point, AP (WLAN). The mobile station may be any kind of mobile communication device enabled for wireless communication in a wireless communication network, such as a mobile phone, a laptop, a User Equipment as defined in 3GPP, a station, STA as defined in the IEEE.

[00018] Fig. 2 shows a method performed by a network node 120 in a wireless communication network 100, for improving radio resource utilization. Dashed lines of some boxes in Fig. 2 indicate that the corresponding action is not mandatory.

The method comprises obtaining 202, for each of a plurality of mobile stations 101, 102, 103 wirelessly connected to the network node 120, a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The method further comprises determining 208 a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station, grouping 210 the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and allocating 214 transmission time to each of the one or more subgroups based on the determined time need.

[00019] The wireless communication network 100 may be an IEEE based network such as a Wi-Fi network or a 3GPP based network such as a GERAN, UTRAN or e-UTRAN, or any other access technology based network. The wireless communication network may be adapted for machine to machine communication. The wireless communication network may be a wireless local area network, WLAN, using the IEEE 802.11 standard or an amendment such as 802.11ah. The network node may be e.g. a base station of a 3GPP based network or an access point, AP of a WLAN, but also a two-hop relay situated between an AP or base station and a plurality of mobile stations for relaying signals between mobile stations situated on e.g. a wide distance from the network node or in a hidden area where there is no radio coverage from the network node. The two-hop relay may have two parts, one part working as a relay between the network node and other mobile stations, and one regular mobile station part. The channel quality may be for example Signal to Noise Ratio, SNR, signal to interference ratio, SIR, signal to noise and interference ration, SINR, or modulation and coding scheme, MCS. The channel bandwidth may be the current bandwidth used by the mobile station. The measure of the amount of data to communicate between the mobile station and the network node may be e.g. a size of a file to transmit. A communication time

need is a time needed for communicating the amount of data over the channel between the individual mobile station and the network node. The communication may be in either uplink, i.e. from mobile station to network node or in downlink, i.e. from network node to mobile station. By such grouping and time allocation, the radio resources of the network node are utilized in an efficient manner.

[00020] According to an embodiment, in the determining 208 of communication time need for each mobile station, at least one of the channel quality, the channel bandwidth and the amount of data to communicate may be weighted differently than the other two. This feature makes it possible to prioritize one or two of channel quality, channel bandwidth and amount of data over the other(s). For example, if the channel quality is considered to be more important when it comes to allocating transmission time, it may be weighted higher than the channel bandwidth and the amount of data to communicate.

[00021] According to another embodiment, the method may further comprise determining 212 an average communication time need for the mobile stations grouped into one subgroup based on the determined 208 individual time need for each mobile station in that subgroup, and wherein the allocation 214 may be performed based on the determined average communication time need. Such an average time need results in a more accurate allocation of transmission time. For example, if two groups have similar average communication time need they may receive similar time allocations. On the other hand, if two groups have large differences in their average communication time need they will receive time allocation proportional to their average communication time need.

[00022] According to another embodiment that is described in fig. 3, the method further comprises obtaining 302, for at least one of the plurality of mobile stations, an updated value for any of the channel quality, the channel bandwidth and the amount of data to communicate, the updated value being different from the already obtained channel quality, channel bandwidth or amount of data to communicate. Also, the method may further comprise re-determining 304, for the at least one of the plurality of mobile stations, the time need based on the updated value and the of the channel quality, the channel bandwidth and the amount of

data to communicate for the at least one of the plurality of mobile stations for which no updated value has been obtained. Further, the method may comprise regrouping 306 the plurality of mobile stations into subgroups based on the re-determined time need; and reallocating 308 transmission time to each subgroup based on the re-determined time need. By regrouping and reallocating transmission time when the obtained values changes, the utilization of the radio resources are kept on a high, efficient level even when the conditions changes.

[00023] According to another embodiment, the regrouping 306 and the reallocating 308 are only performed when a certain amount of values of the channel quality, the channel bandwidth and/or the amount of data to communicate have been updated. Thereby, processing power is saved. For example, the certain amount of values may be a certain percentage of all values of the channel quality, the channel bandwidth and/or the amount of data to communicate for all mobile stations connected to a network node. Further, to save even more processing power, the values of channel quality, channel bandwidth and amount of data to communicate may have to change by at least a certain percentage or absolute value to be detected as a change that may lead to regrouping and reallocating.

[00024] In the following, embodiments of the invention will be described in the context of a WLAN wherein the base station 120 is a WLAN access point and the mobile stations 101, 102, 103 are machines or other non-human devices that are equipped with wireless communication capabilities, such as wireless sensor devices.

[00025] There is an emerging IEEE standard 802.11ah that addresses the need for a machine-to-machine, M2M, wireless standard that covers an existing gap between traditional wireless communication networks such as a network built on the 3GPP LTE standard, and the growing demand for wireless sensor networks. 802.11ah deals with the specification of an unlicensed sub-1GHz worldwide WLAN for future M2M communications supporting a wide set of scenarios based on a large number of devices, a long range and energy constraints. The IEEE 802.11ah offers a simple, robust and efficient solution in the Industrial Scientific and Medical, ISM, band.

[00026] An IEEE 802.11ah access point, AP, is required to support up to 8191 mobile stations, called STAs in the 802.11ah, through a hierarchical identifier structure along with power saving mechanisms for the STAs. The 802.11ah standard defines two different types of STAs, each with different procedures and time period to access the common channel. The different types are:

- Traffic indication map, TIM, stations, which is a type of STA that needs to listen to AP beacons to receive data. Their data transmissions may be performed within a restricted access window, RAW, period. An AP may configure STA with a high downlink traffic load as TIM STA.
- Non-TIM station, which is type of STA that may not listen to beacons to communicate with the AP. During the association process, non-TIM STAs may directly negotiate with the AP to obtain a transmission time allocated in a periodic restricted access window, PRAW. The following transmissions may be either periodically defined or renegotiated, depending on the requirements set by the station.

[00027] The AP may group STAs into smaller groups or sub-groups within each groups using TIM, non-TIM, RAW, PRAW, page, page slicing etc., which are defined in 802.11ah standard. The 802.11ah standard defines Association identifier structure, AID, to support the up to 8191 STAs served by the AP in one Basic Service Set, BSS. TIM, page, page slicing, RAW are the mechanisms defined in the standard to further divide the up to 8191 STAs in different groups and sub-groups. For e.g. 8191 STAs, the STAs may be divided into 8 TIM groups of around 1000 STAs each. Further, each of the TIM groups can be divided into 4 pages of 250 STAs each. Moreover, each of the pages may be divided into 32 page slices of 8 STAs each. Further, RAW groups may be defined to divide these 8 STAs within a page slice in smaller sub-groups.

[00028] There are prior art documents such as US patent application 2013/0155930 and US patent application 2013/0229959 that discusses how to form such groups. In US2013/0155930 it is proposed to organize the STAs base on similar power save requirements and/or based on nearby geographical location. In US2013/0229959 it is discussed to assign STAs to one of multiple

groups based on wake-up intervals, in which STAs assigned to a group all have the same wake-up interval and each group has a different wake-up intervals. It would be beneficial to form such groups of STAs connected to an AP such that contention is minimized and/or such that radio resources of the AP are better utilized. However, there is no prior art addressing this question.

[00029] In the following is presented an exemplary method to group mobile stations similar to the method presented in figures 2 and 3, in the context of an IEEE 802.11h system. An access point receives from a plurality of STAs, or in any other way learns, STA specific Signal to Noise Ratio, SNR, bandwidth and amount of traffic. The AP uses this information to form groups of STAs as will be explained further, using a time-need, tn , metric, which may be computed as follows in function (1):

$$\frac{1}{tn} \propto w_1 \times BW + w_2 \times f_{snr}(SNR) + \frac{1}{traffic} \times w_3 \quad (1)$$

[00030] Time-need, tn , is a metric proportional to the communication time need that each STA needs for its current wireless communication. Tn is based on the channel rate of the channel connecting the STA with the AP, and traffic need. The channel rate is a function of the available bandwidth for the STA and the channel quality, e.g. the SNR or SINR of the link (or channel) between the STA and the AP. The STA's bandwidth, BW , and SNR are known at the access point. The function $f_{SNR}(SNR)$ may be defined as $f_{SNR}(SNR) = \log(1 + SNR)$.

[00031] The term Traffic (or traffic need) represents the amount of data to be sent between the STA and the AP, which is either learned at the AP or signaled by the STA to the AP, e.g. based on the application need at the STA. Signaling of the traffic need of the STA to the AP or the learning algorithm at the AP to determine the traffic need of the STA is not explained further herein.

[00032] In the function (1), the variables W_1 , W_2 , W_3 symbolizes weights for bandwidth, SNR and Traffic, respectively. By varying W_1 , W_2 and W_3 , BW , SNR and Traffic may be prioritized differently. For example, if $W_1=1$, $W_2=0,5$ and

$W_3=0,5$, the value of BW is weighted double than the value of SNR and Traffic. When using the function (1), the following behavior is achieved: If the STA has high BW and high SNR, it will need less time for data transmission. Moreover, if the STA has less traffic needs, it will need less time for data transmission. In other words, if the STA has “k” times bandwidth, the time for data transmission is reduced by “k” times. Moreover, if the STA has “k” times traffic, then the time for data transmission is increased by “k” times.

[00033] Fig. 4 describes another embodiment performed by a network node such as an AP for handling radio resources in a wireless communication network, especially in a M2M network based on 802.11h. The method comprises obtaining 402 the values of BW, SNR, Traffic, and possibly also W_1 , W_2 and W_3 . The AP then calculates 404 the tn metric for each STA in its coverage area, for example in its Basic Service Set, BSS. Thereafter, the AP groups 406 the STAs into different groups using the calculated metric tn of each STA. Then the AP allocates 408 communication time to each group of STAs using their respective calculated metric tn . The AP then tracks the BW, SNR and Traffic of specific STAs and if any of them have changed 410, recalculates 404 the value of the metric tn and possibly re-assigns the STA to a different group of STAs, depending on the recalculated value.

[00034] For example, the method can be used in a 802.11ah WLAN network where a group of STAs can be a Traffic Indication Map, TIM, group or a subgroup of STAs (i.e. RAW group) within the TIM group. The 802.11ah AP receives signals from the individual STAs about the amount of traffic, the BW and the SNR of the STAs, or in any other way learns about any of the amount of traffic, the BW and the SNR. With this information, the AP computes the metric tn as in step 404.

[00035] The APs may further calculate the average metric \bar{tn} and its standard deviation σ^2 for each group. Different types of groups can be imagined such that e.g. the average metric of all groups \bar{tn} is similar, the average metric of all groups \bar{tn} is similar and its standard deviation σ^2 is small or the average metric of the groups \bar{tn} having large mutual differences.

[00036] The allocation of time to each group may be performed so that each group of STAs are allocated transmission time in proportion to its average metric \bar{tn} . For example, if all groups have similar average metric \bar{tn} , then the groups receive similar time allocations, if all groups have similar average metric \bar{tn} and their standard deviations σ^2 are small, then the groups receive similar time allocations, and if all groups have large differences in their average metric \bar{tn} , then the groups receive time allocation proportionally to the average metric \bar{tn} .

[00037] According to an embodiment, the AP can use modulation and coding scheme, MCS, for grouping of the STAs, instead of using SNR. Thereby, similar to step 404, the AP may use MCS in combinations with BW and traffic conditions of the served STAs to calculate the time-need metric t_n .

[00038] In the 802.11ah system, a TIM beacon is sent by the AP every TIM beacon interval, which is the same time for all TIM beacons. For example, the AP can construct TIM groups with similar average metric \bar{tn} , thus the time allocation of the TIM groups will be similar and will be proportional to the beacon intervals. As another example, the AP can construct groups within TIM groups, i.e. RAW groups, with large differences of average metric \bar{tn} , thus the time allocation of each RAW groups will be different, but still in proportion to their average metric \bar{tn} .

[00039] According to the standard 802.11ah, an AP serves 8191 STAs, which are divided into 8 TIM groups of 1000 STAs each. In an example, it is proposed to form sub-groups from each TIM group of 1000 STAs. In this example the following is performed using the method of fig. 4: The time-metric \bar{tn} is calculated for the 1000 STAs. The AP groups the 1000 STAs into two smaller groups, based on similar values of metric \bar{tn} . As exemplified in the figure 5, the first group of 500 STAs has \bar{tn} at approximately 0.25 and the second group of 500 STAs has \bar{tn} at approximately 0.5. As a result, the AP allocates the STAs of the second group double the time to access the communication channel towards the AP compared to the STAs of the first group.

[00040] Fig. 6 shows a network node 120 operable in a wireless communication network, for improving radio resource utilization. The dashed lines in the figure are

used to illustrate that those boxes are only optional. The network node 120 comprises a processor 603 and a memory 604. The memory contains instructions executable by said processor, whereby the network node 120 is operative for obtaining, for each of a plurality of mobile stations 101, 102, 103 wirelessly connected to the network node 120, a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The memory further contains instructions executable by said processor, whereby the network node 120 is operative for determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station, grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and allocating transmission time to each of the one or more subgroups based on the determined time need.

[00041] According to an embodiment, the memory 604 further contains instructions executable by said processor, whereby the network node 120 is operative for, in the determining, weighting at least one of the channel quality, the channel bandwidth and the amount of data to communicate differently than the other two.

[00042] According to another embodiment, said memory 604 further contains instructions executable by said processor, whereby the network node 120 is operative for determining an average communication time need for the mobile stations grouped into one subgroup based on the determined individual time need for each mobile station in that subgroup, and wherein the allocation is performed based on the determined average communication time need.

[00043] According to another embodiment, said memory 604 further contains instructions executable by said processor, whereby the network node 120 is operative for obtaining, for at least one of the plurality of mobile stations, an

updated value for any of the channel quality, the channel bandwidth and the amount of data to communicate, the updated value being different from the already obtained channel quality, channel bandwidth or amount of data to communicate. Further, said memory 604 may further contain instructions executable by said processor, whereby the network node 120 is operative for re-determining, for the at least one of the plurality of mobile stations, the time need based on the updated value and the of the channel quality, the channel bandwidth and the amount of data to communicate for which no updated value has been obtained, regrouping the plurality of mobile stations into subgroups based on the re-determined time need, and reallocating transmission time to each subgroup based on the re-determined time need.

[00044] According to another embodiment, said memory 604 further contains instructions executable by said processor, whereby the network node 120 is operative for only performing the regrouping and the reallocating when a certain amount of values of the channel quality, the channel bandwidth and/or the amount of data to communicate have been updated.

[00045] The network node 120 may further comprise a communication unit 602, which may be considered to comprise conventional means for wirelessly communicating from and/or to the mobile stations 101, 102, 103, such as the ones described in connection with fig. 2. The conventional communication means may include at least one transceiver. The communication unit may further comprise one or more communication ports for communicating with other nodes higher up in the network, such as a Mobility Management Entity, MME, in case of an LTE network. The network node may further comprise one or more storage units 606 and further functionality 607 useful for the network node to serve its purpose as network node. The instructions executable by said processor may be arranged as a computer program 605 stored in said memory 604. The processor 603 and the memory 604 may be arranged in an arrangement 601. The arrangement 601 may be a micro processor and adequate software and storage therefore, a Programmable Logic Device, PLD, or other electronic component(s)/processing circuit(s) configured to perform the actions, or methods mentioned above.

[00046] The computer program 605 may comprise computer readable code means, which when run in the network node 120 causes the network node to perform the steps described in any of the described embodiments. The computer program may be carried by a computer program product connectable to the processor. The computer program product may be the memory 604. The memory 604 may be realized as for example a RAM (Random-access memory), ROM (Read-Only Memory) or an EEPROM (Electrical Erasable Programmable ROM). Further, the computer program may be carried by a separate computer-readable medium, such as a CD, DVD or flash memory, from which the program could be downloaded into the memory 604. Alternatively, the computer program may be stored on a server or any other entity connected to the communication network to which the network node has access via its communication unit 602. The computer program may then be downloaded from the server into the memory 604.

[00047] Fig. 7 describes another embodiment of a network node 120 in a wireless communication network, for improving radio resource utilization. The network node comprises an obtaining module 702 for obtaining, for each of a plurality of mobile stations 101, 102, 103 wirelessly connected to the network node 120, a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node. The network node 120 further comprises a determining module 704 for determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station. The network node further comprises a grouping module 706 for grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and an allocating module 708 for allocating transmission time to each of the one or more subgroups based on the determined time need.

[00048] Although the description above contains a plurality of specificities, these should not be construed as limiting the scope of the concept described herein but as merely providing illustrations of some exemplifying embodiments of the described concept. Reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." All structural and functional equivalents to the elements of the above-described embodiments that are known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed hereby. Moreover, it is not necessary for an apparatus or method to address each and every problem sought to be solved by the presently described concept, for it to be encompassed hereby.

CLAIMS

1. A method performed by a network node (120) in a wireless communication network (100), for improving radio resource utilization, the method comprising:

obtaining (202), for each of a plurality of mobile stations (101, 102, 103) wirelessly connected to the network node (120), a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node;

determining (208) a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station;

grouping (210) the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and

allocating (214) transmission time to each of the one or more subgroups based on the determined time need.

2. Method according to claim 1, wherein in the determining (208) of communication time need for each mobile station, at least one of the channel quality, the channel bandwidth and the amount of data to communicate are weighted differently than the other two.

3. Method according to claim 1 or 2, further comprising:

determining (212) an average communication time need for the mobile stations grouped into one subgroup based on the determined (208) individual time need for each mobile station in that subgroup, and wherein the allocation (214) is performed based on the determined average communication time need.

4. Method according to any of the preceding claims, further comprising

obtaining (302), for at least one of the plurality of mobile stations, an updated value for any of the channel quality, the channel bandwidth and the amount of data to communicate, the updated value being different from the already obtained channel quality, channel bandwidth or amount of data to communicate;

re-determining (304), for the at least one of the plurality of mobile stations, the time need based on the updated value and the of the channel quality, the channel bandwidth and the amount of data to communicate for which no updated value has been obtained;

regrouping (306) the plurality of mobile stations into subgroups based on the re-determined time need; and

reallocating (308) transmission time to each subgroup based on the re-determined time need.

5. Method according to claim 4, wherein the regrouping and the reallocating is only performed when a certain amount of values of the channel quality, the channel bandwidth and/or the amount of data to communicate have been updated.

6. Network node (120) operable in a wireless communication network (100), for improving radio resource utilization, the network node comprising a processor (603) and a memory (604), said memory containing instructions executable by said processor, whereby the network node (120) is operative for:

obtaining, for each of a plurality of mobile stations (101, 102, 103) wirelessly connected to the network node (120), a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node;

determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth

and the obtained measure of amount of data to communicate for each respective mobile station;

grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and

allocating transmission time to each of the one or more subgroups based on the determined time need.

7. Network node according to claim 6, wherein said memory (604) further contains instructions executable by said processor, whereby the network node (120) is operative for, in the determining, weighting at least one of the channel quality, the channel bandwidth and the amount of data to communicate differently than the other two.

8. Network node according to claim 6 or 7, wherein said memory (604) further contains instructions executable by said processor, whereby the network node (120) is operative for determining an average communication time need for the mobile stations grouped into one subgroup based on the determined individual time need for each mobile station in that subgroup, and wherein the allocation is performed based on the determined average communication time need.

9. Network node according to any of claims 6-8, wherein said memory (604) further contains instructions executable by said processor, whereby the network node (120) is operative for:

obtaining, for at least one of the plurality of mobile stations, an updated value for any of the channel quality, the channel bandwidth and the amount of data to communicate, the updated value being different from the already obtained channel quality, channel bandwidth or amount of data to communicate;

re-determining, for the at least one of the plurality of mobile stations, the time need based on the updated value and the of the channel quality, the channel bandwidth and the amount of data to communicate for which no updated value has been obtained;

regrouping the plurality of mobile stations into subgroups based on the re-determined time need; and

reallocating transmission time to each subgroup based on the re-determined time need.

10. Network node according to claim 9, wherein the network node (120) is operative for only performing the regrouping and the reallocating when a certain amount of values of the channel quality, the channel bandwidth and/or the amount of data to communicate have been updated.

11. Computer program (605) comprising computer readable code means, which when run in a network node (120) operable in a wireless communication network (100), causes the network node (120) to perform the following steps:

obtaining, for each of a plurality of mobile stations (101, 102, 103) wirelessly connected to the network node (120), a channel quality describing a quality of a radio channel connecting the one of the plurality of mobile stations to the network node, a channel bandwidth of the radio channel connecting the one of the plurality of mobile stations to the network node, and a measure of an amount of data to communicate between the one of the plurality of mobile stations and the network node;

determining a communication time need for each of the plurality of mobile stations based on the obtained channel quality, the obtained channel bandwidth and the obtained measure of amount of data to communicate for each respective mobile station;

grouping the plurality of mobile stations into one or more subgroups based on their respective determined communication time need, and

allocating transmission time to each of the one or more subgroups based on the determined time need.

12. A carrier containing the computer program (605) according to claim 11, wherein the carrier is one of an electronic signal, optical signal, radio signal or computer readable storage medium.

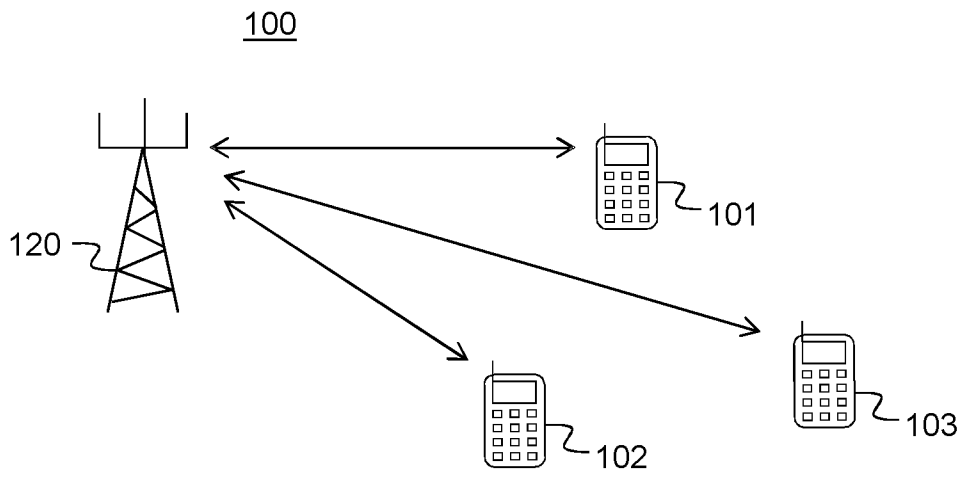
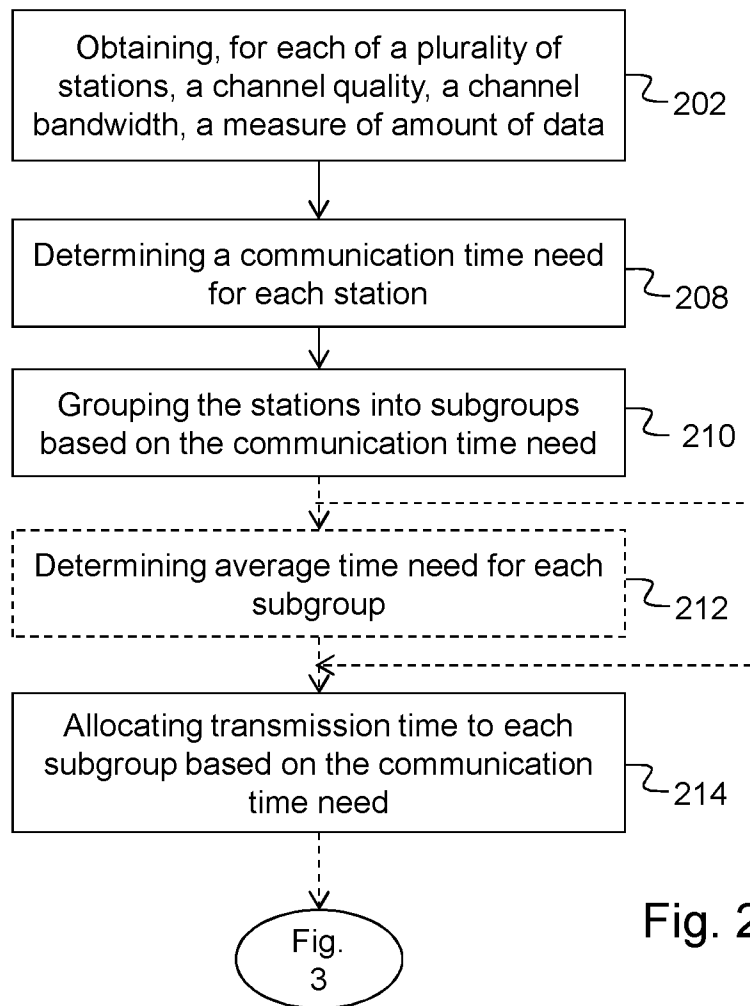


Fig. 1



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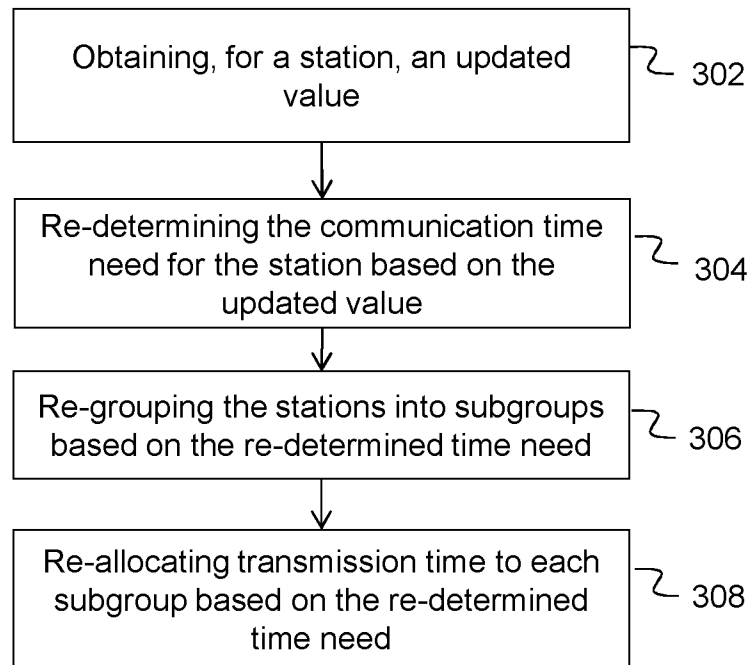


Fig. 3

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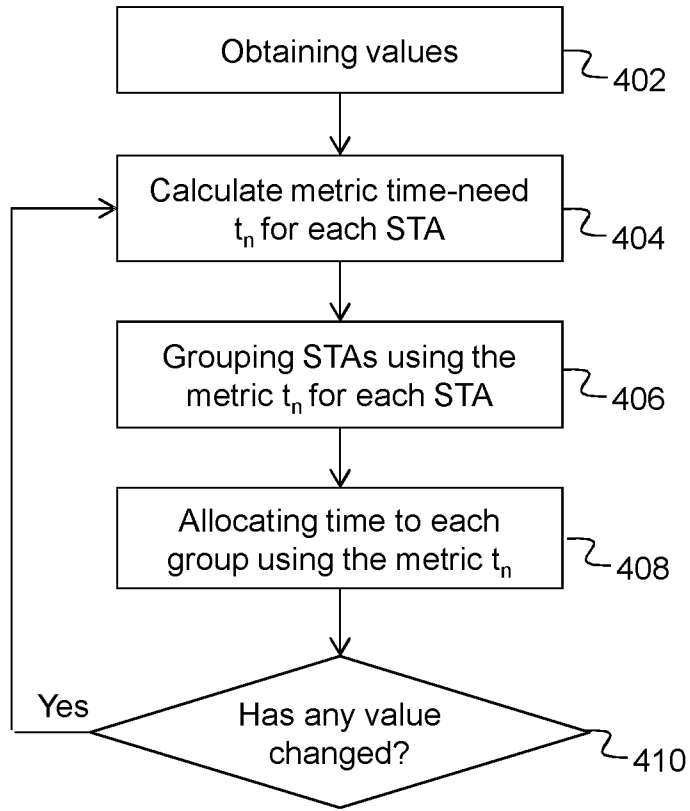


Fig. 4

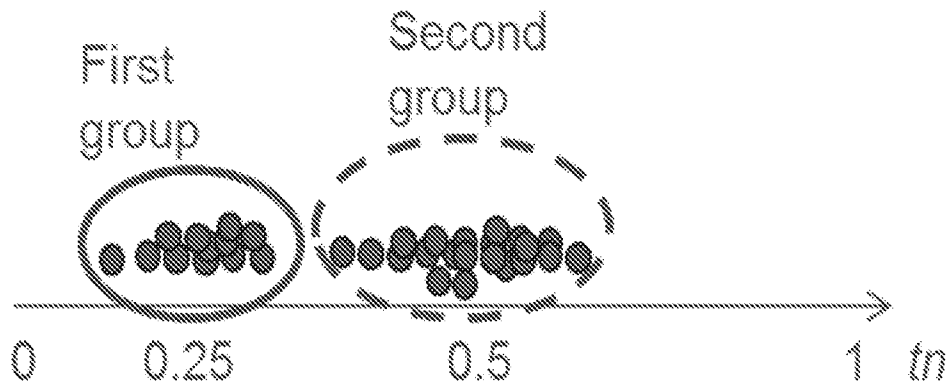


Fig. 5

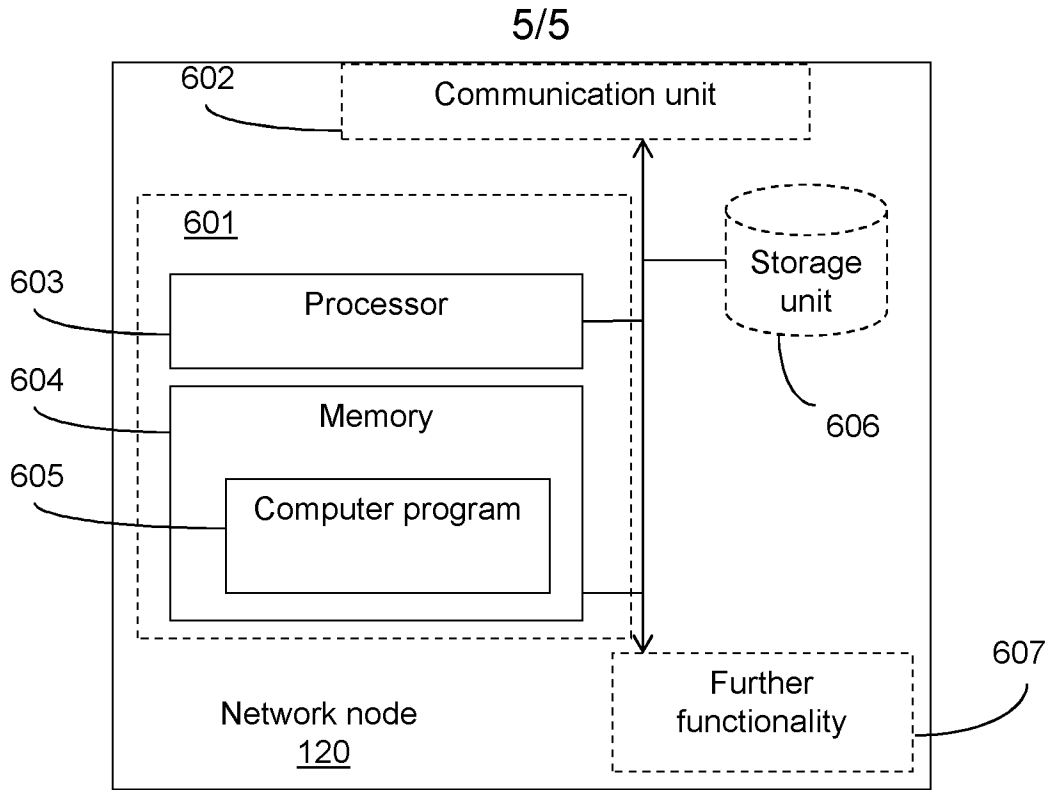


Fig. 6

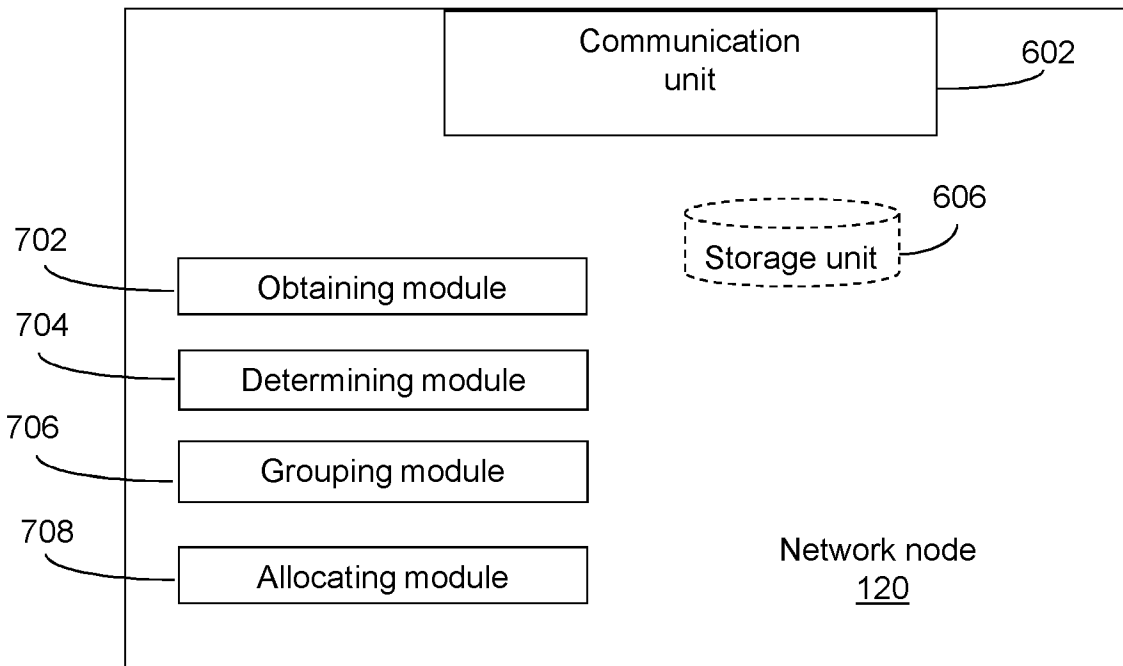


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050088

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: H04W		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2013148671 A1 (INTEL CORP ET AL), 3 October 2013 (2013-10-03); page 1, line 1 - page 28, line 17 --	1-12
Y	US 20120030358 A1 (MACKENZIE JAMES A), 2 February 2012 (2012-02-02); paragraphs [0006]-[0009], [0023]-[0025] --	1-12
A	WO 2014170851 A2 (ERICSSON TELEFON AB L M), 23 October 2014 (2014-10-23); page 7, line 11 - page 11, line 11 --	1-12
A	WO 2012121751 A1 (INTEL CORP ET AL), 13 September 2012 (2012-09-13); paragraphs [0087]-[0095] --	1-12
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
03-11-2015		04-11-2015
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86		Authorized officer Behroz Moradi Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050088

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 2011149252 A2 (LG ELECTRONICS INC ET AL), 1 December 2011 (2011-12-01); paragraphs [0005]-[0008], [0112]-[0115]</p> <p style="text-align: center;">-- -----</p>	1-12

Continuation of: second sheet

International Patent Classification (IPC)

H04W 72/04 (2009.01)

H04W 24/10 (2009.01)

H04W 28/16 (2009.01)

H04W 72/08 (2009.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2015/050088

WO	2013148671	A1	03/10/2013	CN	104205675	A	10/12/2014
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				KR	20140140057	A	08/12/2014
				US	9131480	B2	08/09/2015
				US	20130258953	A1	03/10/2013
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