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(54) Title: SCANNING OF ACCESS NODES

(57) Abstract: There is provided a method, comprising: establishing, by a wireless terminal device, an association to an access node; performing at least one basic scanning in order to detect one or more candidate access nodes; determining, on the basis of the at least one basic scanning, first radio link assessments with respect to the detected one or more candidate access nodes; detecting, based at least partly on the first radio link assessments, whether or not a predefined check scanning criterion is met with a candidate access node; upon detecting that the predefined check scanning criterion is met, performing a check scanning in order to update the first radio link assessment with respect to the candidate access node; and performing, on the basis of the updated first radio link assessment, a decision of whether or not to handover from the currently associated access node to the candidate access node.

Scanning of Access Nodes

Field

The invention relates generally to wireless communication networks. More particularly, the invention relates to a user terminal performing scanning in order to detect access nodes providing better quality of service.

Background

Wireless devices, such as user terminal or stations, may need to associate to a certain access node in order to communicate with the network. Scanning and selection of an appropriate access node may be needed in order to meet the quality of service requirements. However, scanning may cause power consumption.

Brief description of the invention

According to an aspect of the invention, there is provided a method as specified in claim 1.

According to an aspect of the invention, there are provided apparatuses as specified in claims 16 and 31.

According to an aspect of the invention, there is provided a computer program product as specified in claim 32.

According to an aspect of the invention, there is provided a computer-readable distribution medium carrying the above-mentioned computer program product.

According to an aspect of the invention, there is provided an apparatus comprising a processing system configured to cause the apparatus to perform any of the embodiments as described in the appended claims.

According to an aspect of the invention, there is provided an apparatus comprising means for performing any of the embodiments as described in the appended claims.

Embodiments of the invention are defined in the dependent claims.

List of drawings

In the following, the invention will be described in greater detail with reference to the embodiments and the accompanying drawings, in which

Figure 1 presents a network according to an embodiment;

Figure 2 shows a method according to an embodiment;

Figure 3 shows radio link assessments with respect to currently associated access nodes and with respect to other detected access nodes, according to an embodiment;

Figures 4 and 5 illustrate examples related to periodicity of initial scans, according to some embodiments;

Figure 6 depicts a use of a check scanning criterion according to an embodiment;

Figure 7 illustrates examples related to decision of whether or not to perform a handover, according to an embodiment; and

Figure 8 shows an apparatus according to an embodiment.

Description of embodiments

The following embodiments are exemplary. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

The number of IEEE 802.11-enabled mobile devices is increasing. The IEEE 802.11 is a set of standards for implementing wireless local area network (WLAN), also known as the Wi-Fi. Such an IEEE 802.11-enabled station (STA), such as a user terminal 100 in Figure 1, may associate with one or more access nodes (APs) 102, 104,106 and 108. The STA 100 may comprise a mobile phone, a palm computer, a wrist computer, a laptop, a personal computer, or any device capable to access the wireless radio access network, such as the WLAN. The access nodes 102 to 108 may be WLAN (IEEE 802.11) access points (e.g. Wi-Fi base stations), for example.

As said earlier, the STA 100 needs to associate to at least one of the APs 102 to 108 for communicating with a network. For this, the STA 100 may perform active or passive scanning, such as, for example, transmission of probe request(s) and reception of probe response(s), or listening to beacons from the APs 102 to 108, respectively. In case the scanning of channels from the APs 102 to 108 is done very frequently, the STA 100 may most of the time be connected to the best available AP. In that case the throughput and delays are often better which increase the quality-of-service (QoS). However, frequent scanning may create frequent handovers (out of which some may be unnecessary because the current serving AP may provide good-enough service) and increase the power consumption, which is not desired. Therefore, improvements are needed for optimiz-

ing the scanning process and achieving a good tradeoff between the QoS and power consumption.

As shown in Figure 2, there is proposed a scanning mechanism that reduces the STA's 100 power consumption while the STA 100 maintains understanding of the available links to surrounding APs and is associated to one AP with at least an acceptable performance. In step 200, the STA 100 establishes an association to an access node, such as, e.g., to the AP 102. Prior to associating with the AP 102, the STA 100 may have detected the AP 100 on the basis of scanning, such as listening to a beacon from the AP 100 or receiving a probe response from the AP 102. The STA 100 may have further performed a Generic Advertisement Service (GAS) procedure with the AP 102. The method of Figure 2 may be viewed in parallel with Figure 3 which shows APs 102 to 108 detected by the STA 100. In the beginning (prior to a basic scan), the STA 100 has detected only the AP 102 and is connected/associated to the AP 102.

In step 202, while being associated to the AP 102, the STA 100 may perform a basic scanning in order to detect one or more candidate access nodes. The basic scanning may result in detecting APs 104 to 108, for example, as shown in Figure 3. The basic scanning may comprise active and/or passive scanning. The parameters related to the APs 104 to 108 that are detected in the basic scan may comprise received signal power and available data rate, for example. Further, channel load, channel access delays, and capabilities of the APs may be acquired in the basic scan. The STA 100 may obtain these parameters from the beacon or probe response, for example. Further, the STA 100 may acquire parameters related to network identification, such as service set ID, medium access control (MAC) address, and parameters related to network operation mode parameters, such as supported data rates, extended supported rates, high throughput (HT) capability, HT operation, etc.

In an embodiment, however, the basic scan is used to acquire only the reception power, (for instance RCPI) and the MAC address of the AP. The STA 100 may use the reception power to ensure that the AP 104-108 is available and to assess the goodness of the radio link to the AP 104-108. The reception power may be obtained in data, control or management frame that is transmitted by the AP 104-108. The MAC address may be used to request the operating parameters of the AP 104-108 from the server in Internet, or the MAC address may be used to fetch the information of the AP 104-108 that is stored to the memory of the STA 100. In an embodiment, the STA 100 may detect whether or not the STA 100 is able to operate through an AP detected in the basic scan. In order to detect that the STA 100 is able to (and allowed to) create the link to the detected AP, the STA

100 may be required to perform a network discovery through the GAS protocol. Thereafter, upon detecting that the operation through the detected AP is possible, the STA 100 may consider that AP as one of the candidate APs. For example, the STA 100 may have downloaded a set of AP and the network parameters. Consequently, if the STA 100 detects transmissions from the basic service set identifier (BSSID) that matches to the BSSID of downloaded parameters, or if the scanned parameters of the AP indicate that the STA 100 is capable to operate through that AP, the STA 100 may consider that AP as one of the candidate APs. However, in case the detected AP is not available for the STA 100, then the STA 100 may decide not to consider the AP as a candidate AP and/or remove that AP from a list of candidate access nodes.

In an embodiment, the STA 100 may reduce the number of the candidate APs 104 to 108 after the basic scan on the basis of predetermined selection preferences. Any AP 102 to 108 has many parameters which values are not changing. The values of these static parameters may beneficially be obtained only once. Based on these values the STA 100 may decide is it able to create a link to the corresponding AP. For example, if the STA 100 discovers many candidate APs and the end user of the STA 100 and/or the network operator has defined a specific preferences, the STA 100 may reduce the number of candidate APs 104 to 108. These predetermined selection preferences may characterize the achievable performance of the AP, for example. Non-limiting example predetermined preferences may be related to limitations in the use the AP (such as allowed duration of the use), limitations in the capabilities of the AP, required cost of the AP use. However, it may be noted that the predetermined preferences may be seen as suggestions or recommendations, but may not directly prevent the use of the corresponding AP.

In an embodiment, the STA 100 may detect whether or not a predefined basic scanning criterion 300 is met with respect to the currently associated access node 102. In an embodiment, the basic scanning criterion comprises at least one threshold for at least one of the following: received signal strength, data transmission rate, channel access delay, modulation and coding. Thus, In an embodiment it may denote that a radio link performance is below a required level.. For simplicity, let us consider the received signal level (RxPower) in the following as the parameter which is under observation when detecting whether or not the basic scanning criterion is met. As shown in Figure 3, let as assume that the basic scanning criterion 300 is met with respect to the currently associated AP 102. In other words, for example, the RxPower of the AP 102 is below the required level 302, which may be called also a basic scanning threshold level 302.

In an embodiment, the level 302 may have been mathematically modeled or empirically derived. Further, the value of the level 302 may be set according to the application data transmission / reception needs, battery status, user preference and area / topology knowledge, for example. Thus, the basic scanning criterion 300 may be adjusted in real-time and it may be STA-specific. In an embodiment, the STA 100 may further consider at least one of the following when deciding whether or not to perform the basic scan and when setting the basic scanning threshold level 302:

- The transmission time that is saved. In other words, the benefit that is obtained by switching to the candidate AP and being capable to use higher physical layer (PHY) transmission rate. The higher PHY transmission rate may also lower the power consumption of the data transmission and reception
- Possible mitigation of the BSS and/or channel congestion
- The signaling overhead, scanning delay, power consumption, the improvement of the link reliability

For example, the STA 100 compares the shorter transmission time (due to the available higher PHY transmission rate) against the overhead of performing the basic scanning and transitioning to the available candidate AP. In one example, the STA 100 may decide to perform the basic scanning if $T_{TX}^{AvailableRate} < (T_{TX-CurrentRate} + T_{Add})$, where, for real time applications, T_{TX} is the total PHY operating time (RX ON + TX ON time) to transmit and receive the given traffic amount in configurable duration of application data transmission, and, for data transmission, the T_{TX} is the total operating time that is estimated to transmit the given data amount. The superscript "AvailableRate" corresponds to the assumed transmission rate that is likely obtained with the available candidate link. For instance, the STA 100 may not consider that it is not likely to obtain the best transmission rate because the network is congested, or the STA 100 may not be capable to operate at the maximum PHY rate. However, in an embodiment, the assumed transmission rate may be the highest rate. The superscript "CurrentRate" represents the current PHY transmission rate with the currently associated AP 102. The additional time T_{Add} is a surplus that may be used to adjust the scanning initiation time.

Let us further look at a few non-limiting examples of setting the basic scanning threshold 302. In one example where the STA 100 is using Voice Over IP (VoIP) call in a non-congested channel, the scanning threshold 302 may be set to 18 Mbit/s PHY transmission rate. The VoIP packets are typically small and generated between 20 ms. In another example, the STA 100 is receiving a periodical "push" updates from applications, like Facebook, email, Twitter, etc. Let us further

assume that a cloud server combines these update messages, so that all the applications transmit 1 kilobyte packet once every 30 s. Again this may be considered as a small amount of data and the scanning threshold 302 may be set to, for example, 6 Mbit/s transmission rate. In case the "push" update packet would be 1 megabyte packet once every 30s, then the basic scanning threshold 302 may be set to a higher value, such as to 48 Mbit/s.

It may be worth noting that in case the basic scanning threshold 302 value is set to a high value, the STA 100 may need to be able to use a high MCS. Typically this means that the STA 100 is required to be close to the AP. If the STA 100 moves, the scanning of other APs is started soon when the STA 100 moves away from the close proximity of the AP. Such basic scanning threshold 302 value may provide good performance when the STA 100 is transmitting or receiving a lot of traffic. On the other hand, in case the basic scanning threshold 302 is selected to be low, the STA 100 starts to perform scanning later, possibly at the border of the coverage area of the currently serving AP 102. This reduces the number of scanning operations and the terminal's 100 power consumption. Such basic scanning threshold 302 value may provide good operation when the terminal is not transmitting or receiving a lot of data.

As said, let us in Figure 3 assume that the basic scanning criterion 300 is met with respect to the currently associated AP 102. Thereafter, upon detecting that the basic scanning criterion 300 is met, the STA 100 may trigger the basic scanning. However, the STA 100 may not perform the basic scanning if the radio link performance (such as the RxPower) of the currently associated AP 102 is above the basic scanning threshold 302 (i.e. the basic scanning criterion 300 is not met with respect to the currently associated AP 102).

In an embodiment, as shown in Figure 4, the basic scan may be performed periodically, wherein the frequency of performing the basic scans is based on at least one of the following: mobility of the STA 100, speed of the STA 100, number of candidate access nodes detected in the previous basic scanning. In Figure 4, the time interval between the first and second of the basic scans is marked with an arrow 400, whereas the interval between the second and third of the basic scans is marked with an arrow 402. As shown the time interval 402 is longer than the time interval 400. This may be due to the STA 100 staying still or moving slower, or due to the fact that many candidate APs were detected in the scan after the time interval 400, for example.

In an embodiment, the scanning STA 100 may perform X consecutive basic scans and if the basic scans fail, then the STA 100 may use a longer interval between the basic scans. A failed scan may denote that there was no candidate

APs detected in the scan, for example. This may reduce the power consumption of the STA 100.

In an embodiment, after having performed at least one basic scan, the STA 100 may detect that the predefined basic scanning criterion 300 is not met with respect to at least one candidate access node 104-108. For example, in Figure 3 this is shown by the RxPower of the candidate APs 104 and 106 exceeding the required basic scanning threshold level 302. The STA 100 may assess the available RXPower / data rate / MCS / delays from any transmitted frame from any of the candidate APs 104 to 108, and from the currently associated AP 102. As at least one link (e.g. the one to the AP 104/106) shows good performance, the STA 100 may proceed to determining whether or not the check scan criterion is met by that AP 104/106. That is, the STA 100 may stop assessing links to other APs, or stop performing active and passive scanning, when the link to the associated AP 102 or the link to at least one candidate AP 106 is better than the basic scanning threshold 302. This may reduce the power consumption of the STA 100.

In an embodiment, the STA 100 may assess the performance of multiple links to a plurality of APs 102 to 108, and start or continue scanning or increase the frequency of performing the basic scanning if the maximum value, or average, or minimum value of all the links meets the basic scanning criterion 300. This may be to ensure that better candidate AP is detected early.

Such capability to start or stop performing the basic scan, or changing the frequency of the basic scans may be advantageous as then the STA 100 may not consume battery power for making the basic scans too frequently. In case the currently associated link provides adequate (good-enough) performance or at least one candidate AP is found which provides adequate performance, then there is no need to scan again, at least not immediately. The frequency or periodicity of the basic scans may be selected so that there is a good tradeoff between the received QoS and the power consumption of the STA 100.

In an embodiment, the STA 100 stores a preconfigured minimum value of the basic scanning threshold 302. The minimum value may be used when the STA 100 desires to minimize the power consumption and to maintain connectivity or knowledge of the available candidate APs 104 to 108. This may be desirable when the STA 100 is not transmitting any traffic, or if it transmits only little traffic. In case of high demand of traffic transmission, the basic scanning threshold 302 may be set higher so that the STA 100 more frequently tries to detect candidate APs 104 to 108 which may offer better QoS than the currently serving AP 102.

In step 204 of Figure 2, the STA 100 may determine, on the basis of the basic scanning/scan, first radio link assessments with respect to the detected one

or more candidate APs 104 to 108. Let us take a look at this with respect to Figure 3. The first radio link assessment may comprise estimating the available RxPower, data rate, QoS, MCS, load situation (congestion), access delay of the transmitted frames, AP admission control related parameters, etc. of each of the candidate APs 104 to 108. For example, in Figure 3, the AP 106 shows the highest available RxPower or data rate.

Thereafter, in step 206 of Figure 2, the STA 100 may detect, on the basis of the first radio link assessments, whether or not a predefined check scanning criterion is met with at least one candidate access node 104 to 108, and, upon detecting that the predefined check scanning criterion is met, the STA 100 may perform, in step 208, a check scanning in order to update the first radio link assessment with respect to the at least one candidate access node 104 to 108.

It should be noted that the previously mentioned “basic scanning” may be performed periodically, but the periodicity may be relatively low in order to reduce power consumption. Owing to the basic (first) scans, the STA 100 may have some knowledge about nearby APs 104 to 108 and some estimate on the radio link quality towards them. However, as the periodicity of the basic scans may be low and the set of obtained information may be minimized, the first radio link assessment information may not be up-to-date. Therefore, a check (second) scan may be needed to update the current “estimate” of link before a handover decision may be reliably made. It may be considered that the basic scan is performed at point T1 in time domain and the check scan is performed at point T2 in time domain, wherein T2 is later than T1. Thus, the scanning is performed in two phases defined by the basic scan and the check scan.

However, the check scan is not automatically done for each detected candidate AP 104-108 done. Whether or not to perform the second, check scan may depend on the predefined check scanning criterion. When the check scanning criterion is met with respect to at least one of the candidate APs 104 to 108, the STA 100 may perform the last check of the QoS and channel performance related parameters to collect the most up-to-date parameters for a possible handover.

Let us now look at some examples of the check scanning criterion. In an embodiment, the check scanning criterion requires that the radio link quality with respect to at least one of the candidate APs 104 to 108 exceeds a predefined check scanning threshold, which may be set STA-specifically so that the required data transmission capability of the corresponding STA is met, which may depend on the use of network applications, etc.

In another embodiment, as shown in Figure 6, the predefined check scanning criterion 600 requires a predefined difference between radio link quality

with respect to the currently associated access node 102 and the radio link quality with respect to the one or more candidate access nodes, such as with respect to APs 104 to 106. Thus, the STA 100 may determine a second radio link assessment with respect to the currently associated access node 102. The second radio link assessment may comprise detecting similar parameters from the currently associated AP 102 as what are detected from the candidate APs 104 to 108 for the first radio link assessments. In other words, it may comprise detecting what the current RxPower, MCS, data rate, load, delays, etc. are with respect to the AP 102. Further, a GAS protocol may be employed also in the check scan.

In an embodiment, as shown in Figure 5, the STA 100 may determine the second radio link assessment more frequently than the first radio link assessments. This may be due to the fact that it may not consume as much power to check, for example, the signal level from the currently serving AP 102 than from the non-associated AP 106. Also, it may be important to know what the radio link performance from the currently associated AP 102 is at a given point in time. The periodicities of the first and second radio link assessments in Figure 5 are merely non-limiting examples.

Looking back to Figure 6, it is shown that the STA 100 may then compare the second radio link assessment with the first radio link assessment of the candidate APs 104, 106 in order to detect whether or not the predefined check scanning criterion 600 is met with at least one candidate access node 104 to 108. However, here it may be assumed that the AP 108 is not considered as one of the candidate nodes due to its radio link performance being below the basic scanning threshold 302, or due the AP 108 being not-available for the STA 100. Thus, only APs 104 and 106 are considered in Figure 6.

As shown in Figure 6, the STA 100 may discover that the performance of the AP 106 exceeds the check scanning threshold 602, i.e. the performance of the AP 106 is at least predetermined amount better than the performance of the current AP 102. Thus, the AP 106 meets the check scanning criterion 600. However, the radio link performance to the AP 104 does not meet the check scanning criterion 600. As at least one AP (e.g. AP 106) meets the criterion 600, the STA 100 may decide to perform the check scanning. The check scanning threshold 602 may be set based on empirical or mathematical modeling and the same aspects as considered when deriving the basic scanning threshold 302 may be analyzed here when determining the check scanning threshold 602.

In an embodiment, the STA 100 may extract values of a predefined parameter from the first and second radio link assessments, wherein the extracted parameter value represents the quality of the corresponding radio link. Examples

of the predefined parameter may be data rate, access delay, and/or RxPower, which is used for the comparison in Figure 6.

In an embodiment, the check scanning is performed only with respect to the at least one candidate access node 106 which fulfills the predefined check scanning criterion 600. Thus, the check scanning need not be made with respect to each of the candidate APs 104 to 108.

In an embodiment, active scanning takes place during the check scanning. As a result, the STA 100 may transmit a Probe Request with information which specify IDs of the elements which the AP 106 should include to the Probe Response. Consequently, the Probe Request frame may be transmitted to the candidate APs which fulfill the check scanning criterion 600, such as to the AP 106. In an embodiment, the Probe Request frame may request the AP 106 to respond with at least one of the following elements of information: BSS Load, BSS Average Access Delay, BSS Available Admission Capacity, BSS AC Access Delay, Extended BSS Load, Association management related parameters, Association delays, link setup delays and Request of the same parameters for all reported BSSs.

In an embodiment a bitmap is used to request that the specified information elements to be present in the response. The bitmap may comprise bits, each set to 1 to indicate the requirement of the element. In an embodiment, the bitmap may further include any optionally transmitted information elements. Table 1 shows an example bitmap. In the Table 1, bit number #9 is parameter that controls the devices that are allowed to associate to the AP. Bit number #10 represents the estimated duration of the link setup. The STA 100 may include the bitmap to the Probe Request or to a Fast Discovery Request frame to indicate that the STA 100 requests to receive the QoS and channel specific parameters, as indicated in the bitmap, from the AP 106.

Bit number:	Indicates the presence of the field:
0	BSS Load
1	AP Channel Report
2	BSS Average Access Delay
3	BSS Available Admission Capacity
4	BSS AC Access Delay
5	Overlapping BSS Scan Parameters
6	Channel Usage
7	Extended BSS Load
8	Operating mode

9	Association management related parameters
10	Association delays / link set-up delays
11	Request of the same parameters for all reported BSSs

Table 1. An example mapping of the bitmap bits and the presence of the specified field.

It should be noted that each of these parameters may, in an embodiment, be obtained also in the first, basic scan. However, the values of the parameter may change over the time and the check (i.e. check scan) just before the decision of whether or not to change the serving AP enables the STA 100 to compare the most recent radio qualities.

However, in an embodiment, the STA 100 may perform passive scanning, such as listening to beacons which carry the required information, during the second, check scan. If the STA 100 is using the passive scanning, the beacon frame may include a QoS related parameters in a periodically transmitted Beacon field. Further, the bitmap similar to that of Table 1 may be included in the Beacon to indicate which elements are included in the Beacon. The STA 100 may receive, from at least one candidate AP 104 to 108, a message indicating periodicity of beacon frames which include information elements required in the check scan. The Information related to the periodicity of the specific Beacon comprising the QoS related information may be, for example, one octet in length, and indicate the number of beacon intervals or a target beacon transmission times (TBTTs) to the next TBTT in which a Beacon with QoS related information is transmitted from the AP 106. As an example, a value of zero (0) may indicate that the Beacon transmitted at the next TBTT contains the information. Such periodicity information in Beacon helps the terminal to receive only the Beacons with the QoS related information. To reduce the size of the Beacon frames, the periodicity information may be present at the Beacons that contain the QoS information or it may be present in the delivery traffic indication map (DTIM). Use of such interval when the QoS related parameters are present may help the passive scanning to select the correct frames for the link maintenance and avoids a Beacon bloat.

As a result, the check scanning collects QoS and congestion related parameters from the AP 106. The collected parameters may be combined with PHY link performance parameters obtained in the basic scan. The acquisition of all these parameters may ensure that STA 100 does not roam to a congested or to a poor performing AP. The performance of many APs may be compared in order to

ensure that an appropriate AP, capable of providing the needed performance improvement, is selected.

In this way, either by active or passive scanning of the check scan, the STA 100 acquires updated first radio link assessments to the APs 106 which fulfill the check scanning criterion 600. Now, looking back to Figure 2, in step 210, the STA 100 may then perform, on the basis of the updated first radio link assessment(s) obtained in step 208, a decision of whether or not to handover from the currently associated access node 102 to one (such as to the AP 106) of the at least one candidate access node. This is shown with more details in Figure 7, which is a continuation of Figure 6. In Figure 6 it was decided that a check scan is to be made, at least with respect to the AP 106 which exceeded the check scanning threshold 602 and thus met the check scanning criterion 600. The STA 100 may then detect, on the basis of the updated first radio link assessments with respect to the AP 106, whether or not a predefined handover criterion 700 is met.

As shown in Figure 7, there are two options which may take place after the second, check scan. On the left-hand figure it is shown that the predefined handover criterion 700 is met. That is the situation has not changed significantly from the first, basic scan. The AP 106 still provides better QoS than the currently serving AP 102. Thus, upon detecting that the predefined handover criterion 700 is met, the STA 100 may decide to handover from the currently associated access node 102 to the candidate access node 106. However, as shown on the right-hand figure, in another embodiment it may be detected that the handover criterion 700 is not met. For example, the RxPower from the AP 106 may have dropped from the one detected in the basic scan. This may be due to the fact that the STA 100 has moved further away from the AP 106. Thus, upon detecting that the predefined handover criterion 700 is not met, the STA 100 may decide to stay associated to the currently associated access node 102.

Further, in an embodiment, the STA 100 may decide to perform the basic scanning again in order to possibly detect another candidate AP which may fulfill the check scanning criterion 600 and the handover criterion 700. On the other hand, it may be that the currently serving AP 102 is now able to provide more resources for the STA 100 (due to less load) or that the STA 100 has moved closer to the AP 102. In such case it may be that the basic scanning criterion 300 is not met anymore. In such case, the STA 100 need not perform the basic scan.

The predefined handover criterion 700 may be similar to the check scanning criterion 600. In other words, the predefined handover criterion 700 may, in an embodiment, require a predefined difference between radio link quality with respect to the currently associated access node 102 and the radio link quality with

respect to the candidate access node 106. There may be a handover threshold 702 defined (similarly as the check scanning threshold 602) which defines this difference, as shown in Figure 7. It should be noted that the thresholds 602 and 702 may or may not be the same. For example, it may be that there is some hysteresis to favor the currently associated AP 102. In such case, the threshold 702 may be set to a high value, for example. However, in an embodiment, the check scanning criterion 600 is the same as the handover criterion 700.

In an embodiment, the STA 100 detects that the predefined check scanning criterion 600 is met with a plurality of candidate access nodes. Then the STA may perform the check scanning with respect to the plurality of candidate access nodes to in order to update the corresponding first radio link assessments. Thereafter, the STA 100 may, upon detecting that the predefined handover criterion 700 is met with at least one of the plurality of candidate access nodes, decide to handover from the currently associated access node 102 to one of the at least one candidate access node which fulfills the predefined handover criterion 700.

In another embodiment, the STA 100 may detect that the predefined check scanning criterion 600 is met with a plurality of candidate access nodes. Then the STA 100 may select one of the plurality of candidate access nodes on the basis of a predefined selection criterion. The predefined selection criterion may include selecting the candidate AP which provides the best link quality, e.g. highest signal strength, highest data rate, smallest access delay, etc. to mention only a few non-limiting selection criteria. Then the STA 100 may perform the check scanning with respect to the selected candidate access node to in order to update the corresponding first radio link assessment and, upon detecting, that the predefined handover criterion 700 is met with the selected candidate access node, decide to perform the handover. This embodiment may provide efficiency as the check scan is not performed for all of the APs exceeding the check scanning threshold 602.

In an embodiment, if none of the available candidates 104 to 108 shows performance exceeding the check scanning threshold 602, the STA 100 may perform the basic scan again or repeat the check scanning threshold consideration after a predefined timeout.

In an embodiment, if the AP 106, which met the check scanning criterion 600, does not fulfill the handover criterion 700, the STA 100 may adjust the check scanning criterion 600 on the basis of the handover criterion 700. For example, the terminal 100 may consider changing the check scanning criterion 600 if the handover was not performed due to a parameter that is not compared in the handover criterion 700 but not in the check scanning criterion 600. The changing may in this case comprise including the consideration of the missing parameter to

the check scanning criterion. In an embodiment, the changes in the added parameter may be monitored with respect to the associated AP 102. If it is detected that the added parameter changes, the STA 100 may performs the check scanning. For example, if the access delay of the candidate AP 106 was poor so that the handover was not performed due to that reason, the STA 100 may add the access delay to the check scanning criterion 600 and if the access delay of the currently associated AP 102 increase (i.e. becomes poor), the STA 100 may redo the check scanning.

In an embodiment, the scanning of the candidate APs 104 to 108 may be reduced to the link maintenance related parameters in the basic scans, which may be performed periodically. Thus, the terminal may optimize its power consumption and avoid receiving these parameters all the time. The check scanning may be more thorough and result in acquisition of the required QoS parameters. However, the second/check scanning may not be performed as frequently as the basic scanning. This reduces the signalling overhead and the power consumption for the link maintenance.

An embodiment, as shown in Figure 8, provides an apparatus 800 comprising a control circuitry (CTRL) 802, such as at least one processor, and at least one memory 804 including a computer program code (PROG), wherein the at least one memory 804 and the computer program code (PROG), are configured, with the at least one processor 802, to cause the apparatus 800 to carry out any one of the embodiment. The memory 804 may be implemented using any suitable data storage technology, such as semiconductor based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory.

In an embodiment, the apparatus 800 may comprise a wireless terminal device capable to co-operate in a wireless network, such as in a WLAN. The terminal device may be, e.g. Wi-Fi station, a user equipment (UE), user terminal (UT), a computer (PC), a laptop, a tabloid computer, a cellular phone, a mobile phone, a communicator, a smart phone, a palm computer, or any other communication apparatus. Alternatively, the apparatus 800 is comprised in such a terminal device. Further, the apparatus 800 may be or comprise a module (to be attached to the UE) providing connectivity, such as a plug-in unit, an “USB dongle”, or any other kind of unit. In an embodiment, the apparatus 800 is or is comprised in the STA 100.

The control circuitry 802 may comprise an basic scan control circuitry 810 for controlling the performing of the first, basic scans, according to any of the embodiments. A check scan control circuitry 812 is for controlling the performing of

the second, check scans, according to any of the embodiments. A handover control circuitry 814 may be for controlling the performing of the handover to a candidate access point.

The apparatus 800 may further comprise communication interface 806 (TRX) comprising hardware and/or software for realizing communication connectivity according to one or more communication protocols. The TRX 806 may provide the apparatus 800 with communication capabilities to communicate with the access point, for example.

The apparatus 800 may also comprise a user interface 808 comprising, for example, at least one keypad, a microphone, a touch display, a display, a speaker, etc. The user interface 808 may be used to control the apparatus 800 by the user.

As used in this application, the term 'circuitry' refers to all of the following: (a) hardware-only circuit implementations, such as implementations in only analog and/or digital circuitry, and (b) combinations of circuits and software (and/or firmware), such as (as applicable): (i) a combination of processor(s) or (ii) portions of processor(s)/software including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus to perform various functions, and (c) circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term in this application. As a further example, as used in this application, the term 'circuitry' would also cover an implementation of merely a processor (or multiple processors) or a portion of a processor and its (or their) accompanying software and/or firmware. The term 'circuitry' would also cover, for example and if applicable to the particular element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, or another network device.

The techniques and methods described herein may be implemented by various means. For example, these techniques may be implemented in hardware (one or more devices), firmware (one or more devices), software (one or more modules), or combinations thereof. For a hardware implementation, the apparatus(es) of embodiments may be implemented within one or more application-specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof. For firmware or software, the implementation can be car-

ried out through modules of at least one chip set (e.g. procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in a memory unit and executed by processors. The memory unit may be implemented within the processor or externally to the processor. In the latter case, it can be communicatively coupled to the processor via various means, as is known in the art. Additionally, the components of the systems described herein may be rearranged and/or complemented by additional components in order to facilitate the achievements of the various aspects, etc., described with regard thereto, and they are not limited to the precise configurations set forth in the given figures, as will be appreciated by one skilled in the art.

Embodiments as described may also be carried out in the form of a computer process defined by a computer program. The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, which may be any entity or device capable of carrying the program. For example, the computer program may be stored on a computer program distribution medium readable by a computer or a processor. The computer program medium may be, for example but not limited to, a record medium, computer memory, read-only memory, electrical carrier signal, telecommunications signal, and software distribution package, for example. Coding of software for carrying out the embodiments as shown and described is well within the scope of a person of ordinary skill in the art.

In an embodiment, there is provided at least one processor and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to: establish an association to an access node; perform at least one basic scanning in order to detect one or more candidate access nodes; determine, on the basis of the at least one basic scanning, first radio link assessments with respect to the detected one or more candidate access nodes; detect, based at least partly on the first radio link assessments, whether or not a predefined check scanning criterion is met with a candidate access node; upon detecting that the predefined check scanning criterion is met, perform a check scanning in order to update the first radio link assessment with respect to the candidate access node; and perform, on the basis of the updated first radio link assessment, a decision of whether or not to handover from the currently associated access node to the candidate access node.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: detect, at least partly on the basis of the basic scanning, whether or not the

apparatus is able to operate through an access node detected in the basic scan; upon detecting that the operation through the detected access node is possible, set that access node as a candidate access node; and upon detecting that the operation through the detected access node is not possible, decide not to set that access node as a candidate access node.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: reduce the number of the candidate access nodes after the basic scanning on the basis of predetermined preferences.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: detect whether or not a predefined basic scanning criterion is met with respect to the currently associated access node; and upon detecting that the predefined basic scanning criterion is met, perform the basic scanning.

In an embodiment, the predefined basic scanning criterion comprises at least one threshold for at least one of the following: received signal strength, data transmission rate, channel access delay, modulation and coding.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: perform the basic scanning periodically, wherein the frequency of performing the basic scanning is based on at least one of the following: mobility of the user terminal, speed of the user terminal, number of candidate access nodes detected in the previous basic scanning.

In an embodiment, the predefined check scanning criterion represents a required difference between radio link quality with respect to the currently associated access node and the radio link quality with respect to the candidate access node, and the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: determine a second radio link assessment with respect to the currently associated access node; and compare the second radio link assessment with the first radio link assessment of the candidate access node in order to detect whether or not the predefined check scanning criterion is met with the candidate access node.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: extract values of a predefined parameter from the first and second radio link assessments, wherein the extracted parameter value represents the quality of the corresponding radio link; and compare the extracted parameter values.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: determine the second radio link assessment more frequently than the first radio link assessment.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: perform active scanning during the check scanning.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: perform passive scanning during the check scanning; receive, from at least one candidate access node, a message indicating periodicity of beacon frames which include information elements required in the check scan; and listen to the beacon channel according to the indicated periodicity.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: detect, on the basis of the updated first radio link assessment, whether or not a predefined handover criterion is met; upon detecting that the predefined handover criterion is met, decide to handover from the currently associated access node to the candidate access node; and upon detecting that the predefined handover criterion is not met, decide to stay associated to the currently associated access node.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: detect that the predefined check scanning criterion is met with a plurality of candidate access nodes; perform the check scanning with respect to the plurality of candidate access nodes to in order to update the corresponding first radio link assessments; and upon detecting, on the basis of the updated first radio link assessments, that a predefined handover criterion is met with at least one of the plurality of candidate access nodes, decide to handover from the currently associated access node to one of the at least one candidate access node which fulfills the predefined handover criterion.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: perform the check scanning only with respect to the at least one candidate access node which fulfills the predefined check scanning criterion.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to: detect that the predefined check scanning criterion is met with a plurality of

candidate access nodes; select one of the plurality of candidate access nodes on the basis of a predefined selection criterion; perform the check scanning with respect to the selected candidate access node to in order to update the corresponding first radio link assessment; and upon detecting, on the basis of the updated first radio link assessment, that a predefined handover criterion is met with the selected candidate access node, decide to handover from the currently associated access node to the selected candidate access node.

Even though the invention has been described above with reference to an example according to the accompanying drawings, it is clear that the invention is not restricted thereto but can be modified in several ways within the scope of the appended claims. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, the embodiment. It will be obvious to a person skilled in the art that, as technology advances, the inventive concept can be implemented in various ways. Further, it is clear to a person skilled in the art that the described embodiments may, but are not required to, be combined with other embodiments in various ways.

Claims

1. A method, comprising:

establishing, by a wireless terminal device, an association to an access node;

performing at least one basic scanning in order to detect one or more candidate access nodes;

determining, on the basis of the at least one basic scanning, first radio link assessments with respect to the detected one or more candidate access nodes;

detecting, based at least partly on the first radio link assessments, whether or not a predefined check scanning criterion is met with a candidate access node;

upon detecting that the predefined check scanning criterion is met, performing a check scanning in order to update the first radio link assessment with respect to the candidate access node; and

performing, on the basis of the updated first radio link assessment, a decision of whether or not to handover from the currently associated access node to the candidate access node.

2. The method of claim 1, further comprising:

detecting, at least partly on the basis of the basic scanning, whether or not the wireless terminal device is able to operate through an access node detected in the basic scan;

upon detecting that the operation through the detected access node is possible, setting that access node as a candidate access node; and

upon detecting that the operation through the detected access node is not possible, deciding not to set that access node as a candidate access node.

3. The method of any of claims 1 to 2, further comprising:

reducing the number of the candidate access nodes after the basic scanning on the basis of predetermined preferences.

4. The method of any of claims 1 to 3, further comprising:

detecting whether or not a predefined basic scanning criterion is met with respect to the currently associated access node; and

upon detecting that the predefined basic scanning criterion is met, performing the basic scanning.

5. The method of claim 4, wherein the predefined basic scanning criterion comprises at least one threshold for at least one of the following: received signal strength, data transmission rate, channel access delay, modulation and coding.

6. The method of any of claims 1 to 5, further comprising:

performing the basic scanning periodically, wherein the frequency of performing the basic scanning is based on at least one of the following: mobility of the user terminal, speed of the user terminal, number of candidate access nodes detected in the previous basic scanning.

7. The method of any of claims 1 to 6, wherein the predefined check scanning criterion represents a required difference between radio link quality with respect to the currently associated access node and the radio link quality with respect to the candidate access node, and the method further comprises:

determining a second radio link assessment with respect to the currently associated access node; and

comparing the second radio link assessment with the first radio link assessment of the candidate access node in order to detect whether or not the predefined check scanning criterion is met with the candidate access node.

8. The method of claim 7, further comprising:

extracting values of a predefined parameter from the first and second radio link assessments, wherein the extracted parameter value represents the quality of the corresponding radio link; and

comparing the extracted parameter values.

9. The method of any of claims 7 to 8, further comprising:

determining the second radio link assessment more frequently than the first radio link assessment.

10. The method of any of claims 1 to 9, further comprising:

performing active scanning during the check scanning.

11. The method of any of claims 1 to 9, further comprising:

performing passive scanning during the check scanning;

receiving, from at least one candidate access node, a message indicating periodicity of beacon frames which include information elements required in the check scan; and

listening to the beacon channel according to the indicated periodicity.

12. The method of any of claims 1 to 11, further comprising:

detecting, on the basis of the updated first radio link assessment, whether or not a predefined handover criterion is met;

upon detecting that the predefined handover criterion is met, deciding to handover from the currently associated access node to the candidate access node; and

upon detecting that the predefined handover criterion is not met, deciding to stay associated to the currently associated access node.

13. The method of any of claims 1 to 12, further comprising:

detecting that the predefined check scanning criterion is met with a plurality of candidate access nodes;

performing the check scanning with respect to the plurality of candidate access nodes to in order to update the corresponding first radio link assessments; and

upon detecting, on the basis of the updated first radio link assessments, that a predefined handover criterion is met with at least one of the plurality of candidate access nodes, deciding to handover from the currently associated access node to one of the at least one candidate access node which fulfills the predefined handover criterion.

14. The method of claim 13, further comprising:

performing the check scanning only with respect to the at least one candidate access node which fulfills the predefined check scanning criterion.

15. The method of any of claims 1 to 12, further comprising:

detecting that the predefined check scanning criterion is met with a plurality of candidate access nodes;

selecting one of the plurality of candidate access nodes on the basis of a predefined selection criterion;

performing the check scanning with respect to the selected candidate access node to in order to update the corresponding first radio link assessment; and

upon detecting, on the basis of the updated first radio link assessment, that a predefined handover criterion is met with the selected candidate access node, deciding to handover from the currently associated access node to the selected candidate access node.

16. An apparatus, comprising:

at least one processor and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to:

establish an association to an access node;

perform at least one basic scanning in order to detect one or more candidate access nodes;

determine, on the basis of the at least one basic scanning, first radio link assessments with respect to the detected one or more candidate access nodes;

detect, based at least partly on the first radio link assessments, whether or not a predefined check scanning criterion is met with a candidate access node;

upon detecting that the predefined check scanning criterion is met, perform a check scanning in order to update the first radio link assessment with respect to the candidate access node; and

perform, on the basis of the updated first radio link assessment, a decision of whether or not to handover from the currently associated access node to the candidate access node.

17. The apparatus of claim 16, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

detect, at least partly on the basis of the basic scanning, whether or not the apparatus is able to operate through an access node detected in the basic scan;

upon detecting that the operation through the detected access node is possible, set that access node as a candidate access node; and

upon detecting that the operation through the detected access node is not possible, decide not to set that access node as a candidate access node.

18. The apparatus of any of claims 16 to 17, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

reduce the number of the candidate access nodes after the basic scanning on the basis of predetermined preferences.

19. The apparatus of any of claims 16 to 18, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

detect whether or not a predefined basic scanning criterion is met with respect to the currently associated access node; and

upon detecting that the predefined basic scanning criterion is met, perform the basic scanning.

20. The apparatus of claim 19, wherein the predefined basic scanning criterion comprises at least one threshold for at least one of the following: received signal strength, data transmission rate, channel access delay, modulation and coding.

21. The apparatus of any of claims 16 to 20, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

perform the basic scanning periodically, wherein the frequency of performing the basic scanning is based on at least one of the following: mobility of the user terminal, speed of the user terminal, number of candidate access nodes detected in the previous basic scanning.

22. The apparatus of any of claims 16 to 21, wherein the predefined check scanning criterion represents a required difference between radio link quality with respect to the currently associated access node and the radio link quality with respect to the candidate access node, and the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

determine a second radio link assessment with respect to the currently associated access node; and

compare the second radio link assessment with the first radio link assessment of the candidate access node in order to detect whether or not the predefined check scanning criterion is met with the candidate access node.

23. The apparatus of claim 22, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

extract values of a predefined parameter from the first and second radio link assessments, wherein the extracted parameter value represents the quality of the corresponding radio link; and

compare the extracted parameter values.

24. The apparatus of any of claims 22 to 23, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

determine the second radio link assessment more frequently than the first radio link assessment.

25. The apparatus of any of claims 16 to 24, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

perform active scanning during the check scanning.

26. The apparatus of any of claims 16 to 24, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

perform passive scanning during the check scanning;

receive, from at least one candidate access node, a message indicating periodicity of beacon frames which include information elements required in the check scan; and

listen to the beacon channel according to the indicated periodicity.

27. The apparatus of any of claims 16 to 26, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

detect, on the basis of the updated first radio link assessment, whether or not a predefined handover criterion is met;

upon detecting that the predefined handover criterion is met, decide to handover from the currently associated access node to the candidate access node; and

upon detecting that the predefined handover criterion is not met, decide to stay associated to the currently associated access node.

28. The apparatus of any of claims 16 to 27, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

detect that the predefined check scanning criterion is met with a plurality of candidate access nodes;

perform the check scanning with respect to the plurality of candidate access nodes to in order to update the corresponding first radio link assessments; and

upon detecting, on the basis of the updated first radio link assessments, that a predefined handover criterion is met with at least one of the plurality of candidate access nodes, decide to handover from the currently associated access node to one of the at least one candidate access node which fulfills the predefined handover criterion.

29. The apparatus of claim 28, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

perform the check scanning only with respect to the at least one candidate access node which fulfills the predefined check scanning criterion.

30. The apparatus of any of claims 16 to 27, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus further to:

detect that the predefined check scanning criterion is met with a plurality of candidate access 3003rnodes;

select one of the plurality of candidate access nodes on the basis of a predefined selection criterion;

perform the check scanning with respect to the selected candidate access node to in order to update the corresponding first radio link assessment; and

upon detecting, on the basis of the updated first radio link assessment, that a predefined handover criterion is met with the selected candidate access node, decide to handover from the currently associated access node to the selected candidate access node.

31. An apparatus, comprising processing means configured to cause the apparatus to perform the method according to any of claims 1 to 15.

32. A computer program product embodied on a distribution medium readable by a computer and comprising program instructions which, when loaded into an apparatus, execute the method according to any of claims 1 to 15.

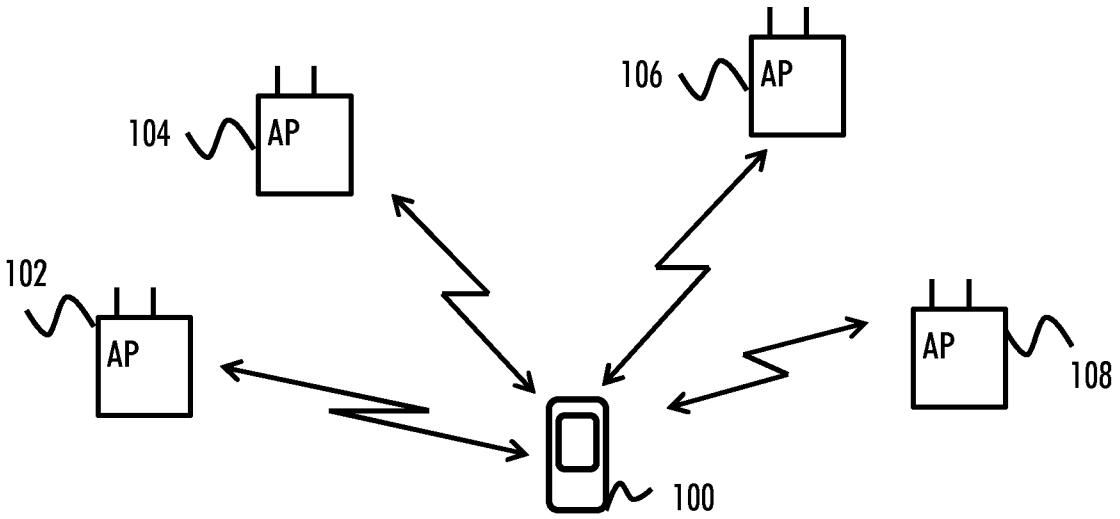

106
AP
104
AP
102
AP
AP
108
100

FIG. 1

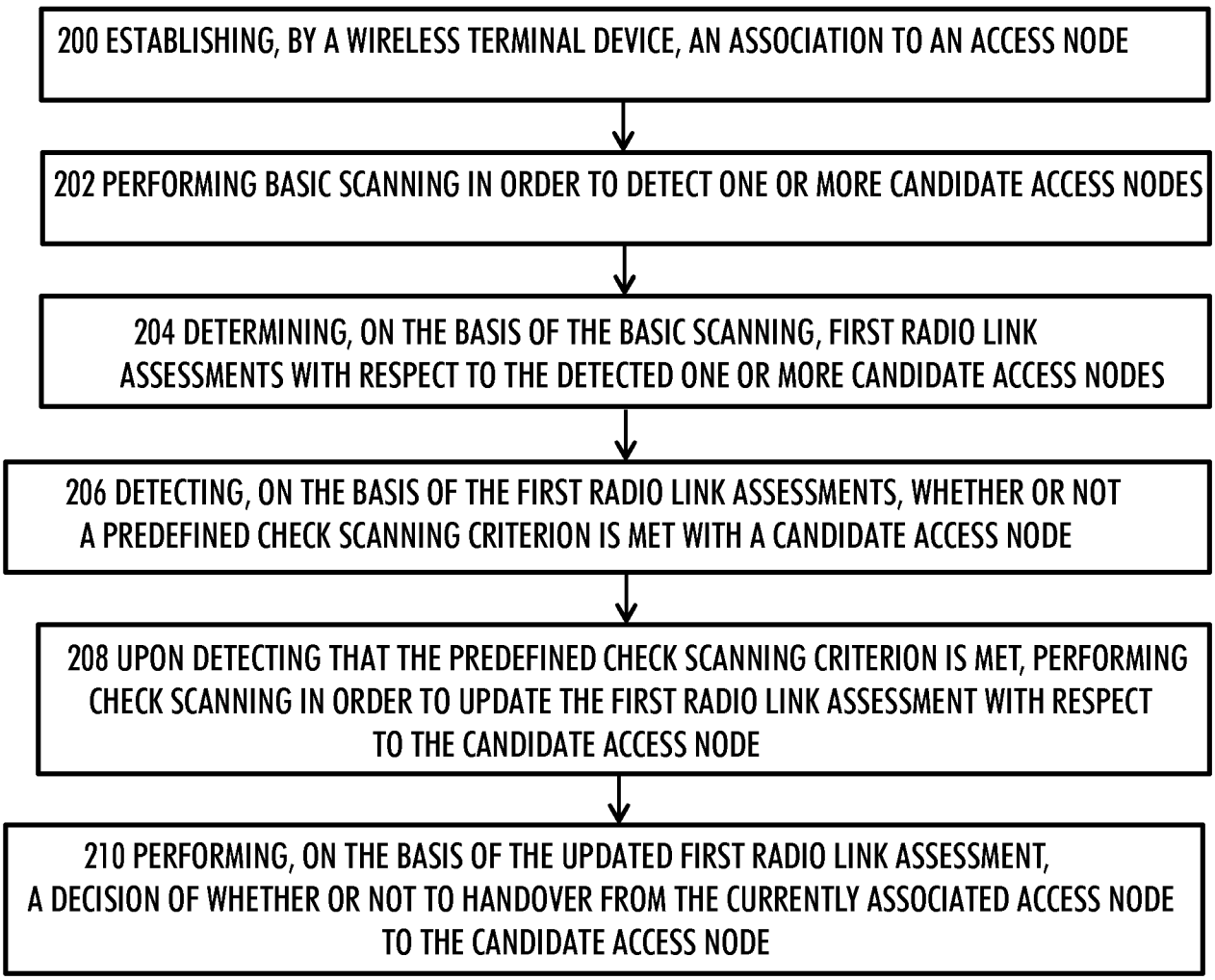

200 ESTABLISHING, BY A WIRELESS TERMINAL DEVICE, AN ASSOCIATION TO AN ACCESS NODE
202 PERFORMING BASIC SCANNING IN ORDER TO DETECT ONE OR MORE CANDIDATE ACCESS NODES
204 DETERMINING, ON THE BASIS OF THE BASIC SCANNING, FIRST RADIO LINK ASSESSMENTS WITH RESPECT TO THE DETECTED ONE OR MORE CANDIDATE ACCESS NODES
206 DETECTING, ON THE BASIS OF THE FIRST RADIO LINK ASSESSMENTS, WHETHER OR NOT A PREDEFINED CHECK SCANNING CRITERION IS MET WITH A CANDIDATE ACCESS NODE
208 UPON DETECTING THAT THE PREDEFINED CHECK SCANNING CRITERION IS MET, PERFORMING CHECK SCANNING IN ORDER TO UPDATE THE FIRST RADIO LINK ASSESSMENT WITH RESPECT TO THE CANDIDATE ACCESS NODE
210 PERFORMING, ON THE BASIS OF THE UPDATED FIRST RADIO LINK ASSESSMENT, A DECISION OF WHETHER OR NOT TO HANDOVER FROM THE CURRENTLY ASSOCIATED ACCESS NODE TO THE CANDIDATE ACCESS NODE

FIG. 2

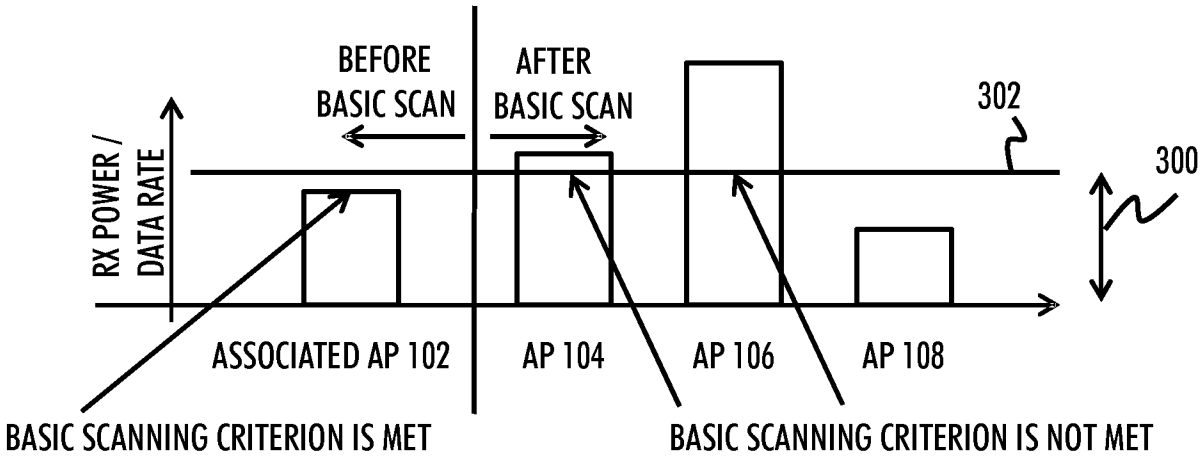


FIG. 3

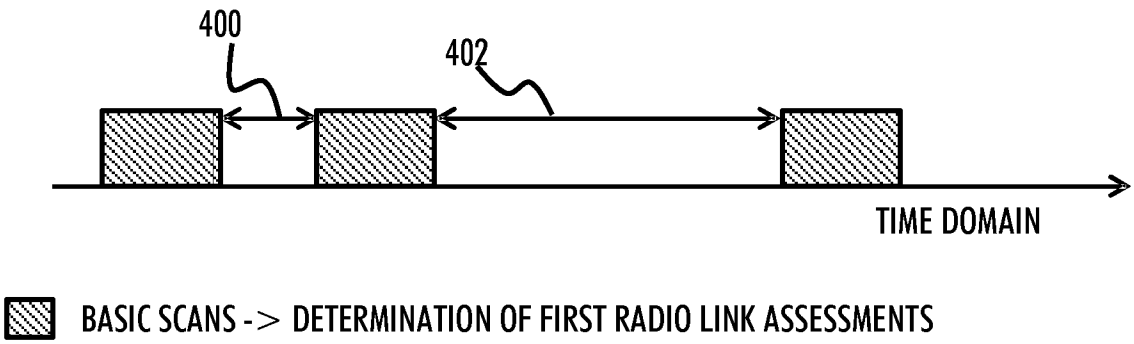


FIG. 4

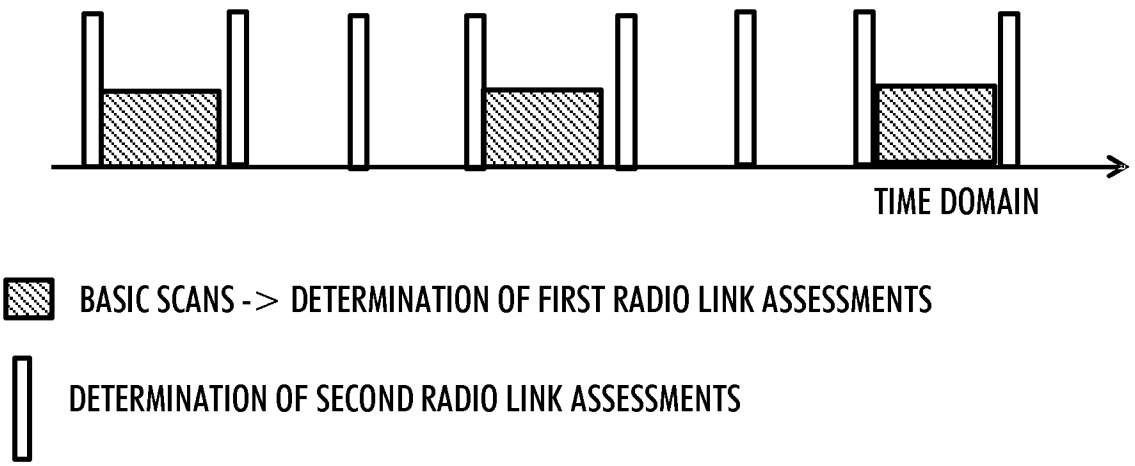


FIG. 5

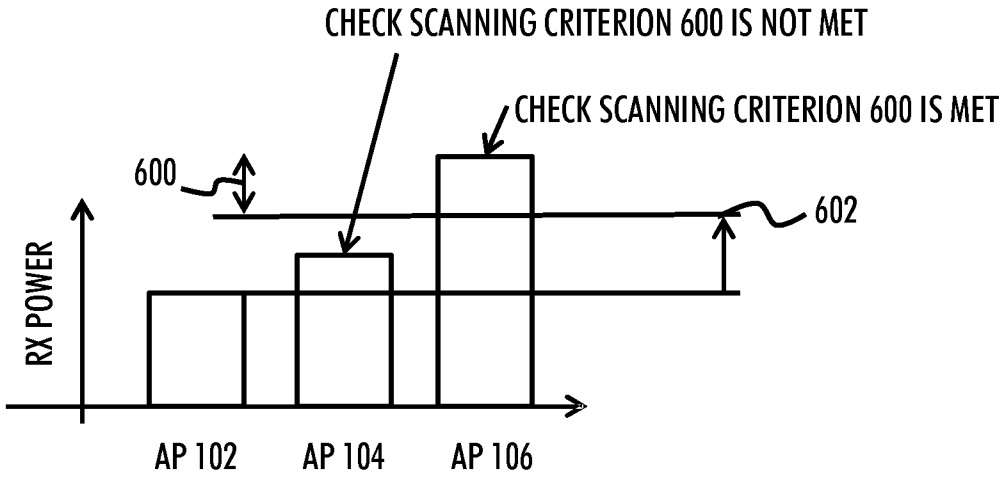

CHECK SCANNING CRITERION 600 IS NOT MET
CHECK SCANNING CRITERION 600 IS MET
600
602
RX POWER
AP 102
AP 104
AP 106

FIG. 6

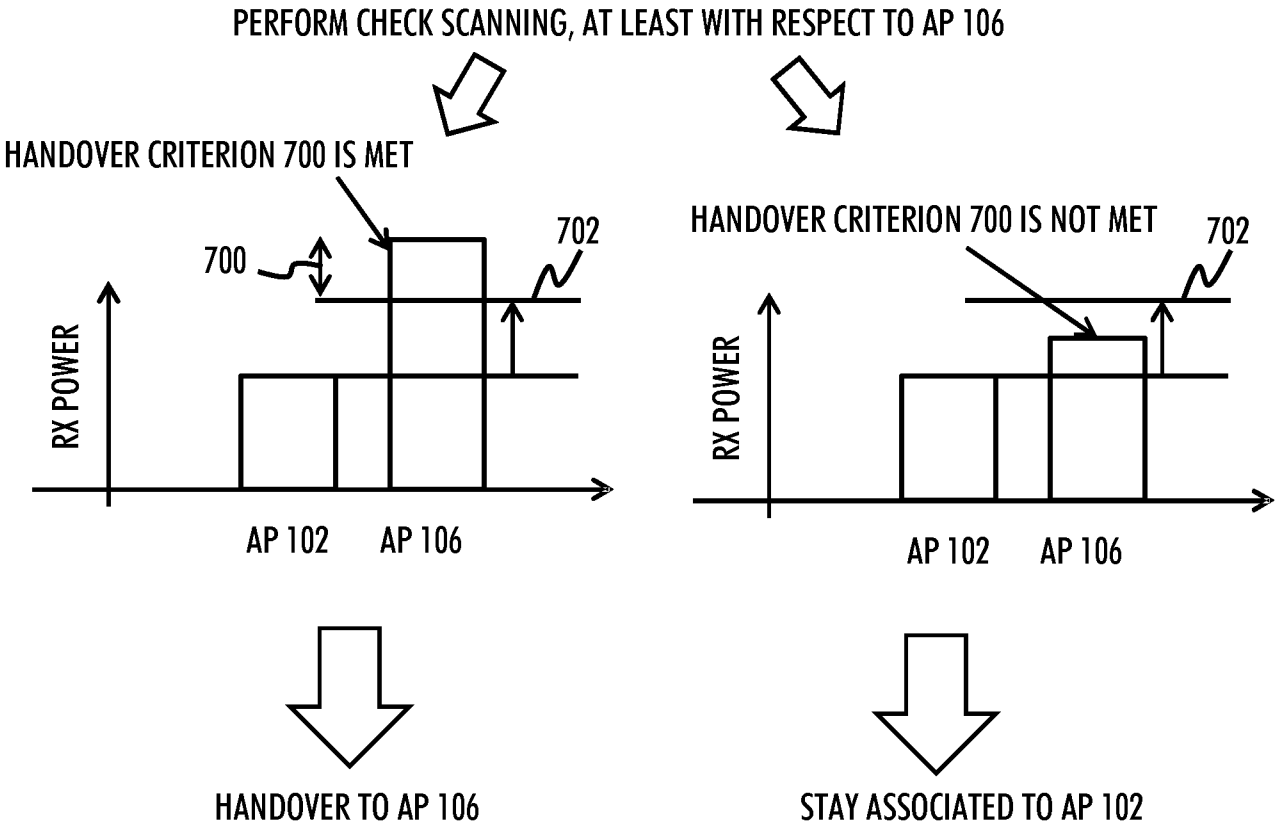

PERFORM CHECK SCANNING, AT LEAST WITH RESPECT TO AP 106
HANDOVER CRITERION 700 IS MET
700
702
RX POWER
AP 102
AP 106
HANDOVER TO AP 106
HANDOVER CRITERION 700 IS NOT MET
702
RX POWER
AP 102
AP 106
STAY ASSOCIATED TO AP 102

FIG. 7

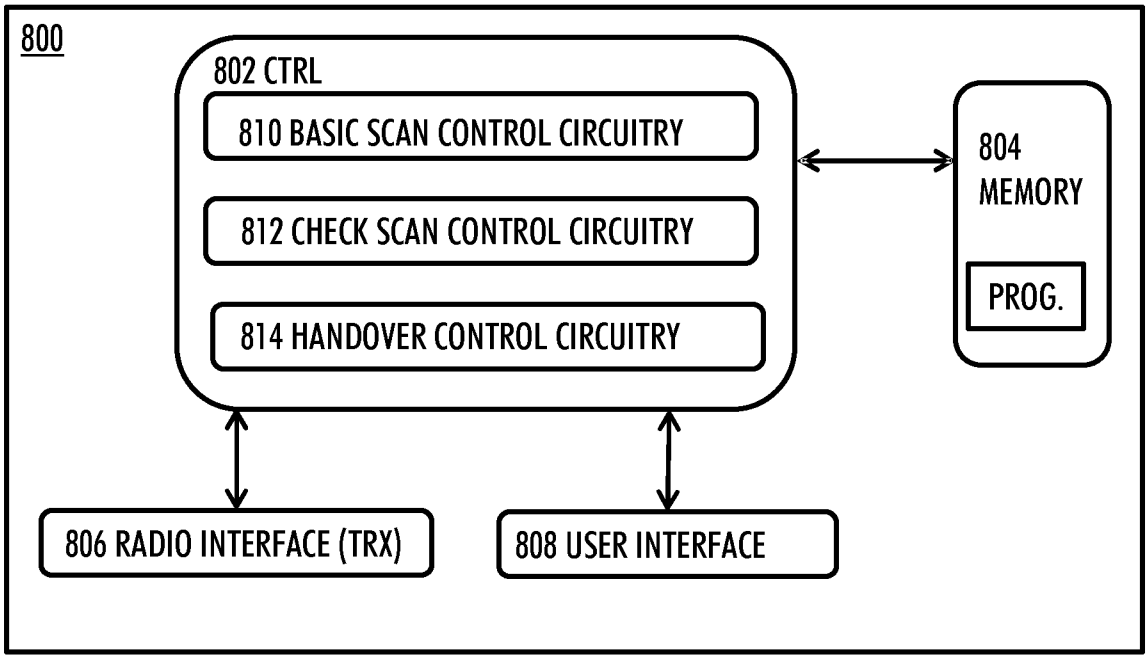

800
802 CTRL
810 BASIC SCAN CONTROL CIRCUITRY
812 CHECK SCAN CONTROL CIRCUITRY
814 HANDOVER CONTROL CIRCUITRY
804
MEMORY
PROG.
806 RADIO INTERFACE (TRX)
808 USER INTERFACE

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2013/050613

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/24
ADD. H04W84/12

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/093799 A1 (KYUNGPOOK NAT UNIV IND ACAD [KR]; PARK JONG TAE [KR]) 30 July 2009 (2009-07-30) page 4, paragraph 34 - page 6, paragraph 39 page 11, paragraph 84 - page 14, paragraph 98; figure 4	1-32

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"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

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Date of the actual completion of the international search	Date of mailing of the international search report
6 February 2014	13/02/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	López García, J

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2013/050613

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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