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(54) Title: MOBILITY SET CONFIGURATION FOR RAN-WLAN RADIO AGGREGATION

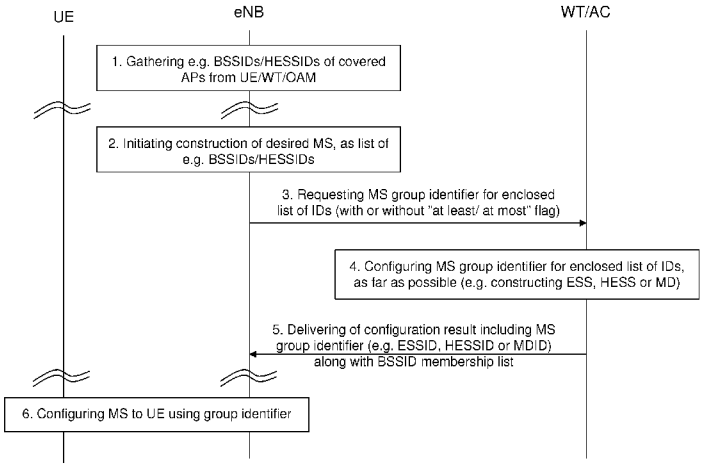


Figure 4

(57) Abstract: There are provided measures for enabling/realizing efficient and dynamic mobility set configuration for RAN-WLAN aggregation. Such measures exemplarily comprise that, for construction of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, is requested at a control node of the wireless local area network, the control node configures the mobility set group identifier to access points which are capable of being members of the mobility set, and the access node configures the mobility set to the terminal node on the basis of at least the mobility set group identifier, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

DESCRIPTION

Title

Mobility set configuration for RAN-WLAN radio aggregation

Field

The present invention relates to mobility set configuration for RAN-WLAN radio aggregation. More specifically, the present invention relates to measures (including methods, apparatuses and computer program products) for enabling/realizing efficient and dynamic mobility set configuration for RAN-WLAN aggregation, i.e. radio level integration/aggregation between a cellular radio access network and a wireless area network.

Background

In cellular communication systems, there is a trend of enabling/realizing interworking between a cellular radio access network (RAN), such as a LTE, LTE-A or UMTS radio access network (e.g. E-UTRAN), and a wireless area network (WLAN) so as to enhance capacity and/or coverage. Such interworking includes radio level integration/aggregation hereinafter denoted as RAN-WLAN aggregation. The RAN-WLAN aggregation basically provides for dual connectivity for terminals being simultaneously served by both the RAN and the WLAN via respective radio interfaces, wherein the serving RAN node (e.g. eNB or RNC) and the serving WLAN node (e.g. WT or AC) are interconnected, while being either collocated, i.e. implemented in an integrated manner, or non-collocated, i.e. implemented in a separate manner with a near-ideal backhaul link there-between. Conceptually, such RAN-WLAN aggregation would be alike LTE dual connectivity with bearer split functionality, being extended to WLAN, wherein data bearers are split and data can be offloaded from the RAN to the WLAN.

In order to support RAN-WLAN aggregation, especially mobility of any terminal node (UE) served by a RAN node (eNB) between WLAN access points (APs), the concept of mobility sets (MS) is defined. Namely, such mobility set is configured to be a group of APs determined by the eNB. The eNB signals to the UE such mobility set where the UE is

allowed to switch APs without informing the eNB. It is also assumed that all the APs within the mobility set are controlled by the same WLAN node (WT). For APs outside the mobility set for APs within different WTs, the decision to change AP is made by the eNB based on e.g. UE measurements.

That is, a MS will be configured to the UE by the eNB, as a list of individual AP identifiers such as BSSIDs and/or a group identifier such as HESSID or MDID. However, problems arise in that configuring an MS as a fully enumerated BSSID list may be prohibitively costly and thus inefficient (as there may be hundreds or thousands of APs in the coverage of one eNB, and each BSSID is 6 bytes long), while configuring an MS using a single group identifier is more efficient but requires careful configuration at the WLAN side and thus hampers flexibility. Among others, using a list of individual AP identifiers inadvertently raises the processing load at the eNB and the amount of required MS configuration signaling towards the UE, while using a single group identifier inadvertently hampers flexibility in terms of the capability for dynamic and/or automatic configurations and takes control away from the eNB.

Even if obtaining AP-related identifiers from one or more of the WT (e.g. based on provision of a MS), the UE (e.g. based on UE measurements) and an OAM node, this cannot facilitate efficient and dynamic MS configuration for RAN-WLAN aggregation at the eNB.

Accordingly, there is a demand for enabling/realizing efficient and dynamic mobility set configuration for RAN-WLAN aggregation.

Summary

Various exemplifying embodiments of the present invention aim at addressing at least part of the above issues and/or problems and drawbacks.

Various aspects of exemplifying embodiments of the present invention are set out in the appended claims.

According to an example aspect of the present invention, there is provided a method comprising: initiating, at an access node of a cellular radio access network, construction of a mobility set for usage by terminal nodes in the coverage of the access node, issuing, at the access node, a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network, acquiring, at the access node, a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, and configuring, by the access node, the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set group identifier.

According to an example aspect of the present invention, there is provided a method comprising: detecting, at a control node of a wireless local area network, a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node, configuring, by the control node, the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and issuing, at the control node, a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

According to an example aspect of the present invention, there is provided 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 to perform at least the following: initiating, at an access node of a cellular radio access network, construction of a mobility set for usage by terminal nodes in the coverage of the access node, issuing, at the access node, a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network, acquiring, at the access node, a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of

the mobility set, and configuring, by the access node, the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set group identifier.

According to an example aspect of the present invention, there is provided 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 to perform at least the following: detecting, at a control node of a wireless local area network, a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node, configuring, by the control node, the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and issuing, at the control node, a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

According to an example aspect of the present invention, there is provided a computer program product comprising (computer-executable) computer program code which, when the program code is executed (or run) on a computer or the program is run on a computer (e.g. a computer of an apparatus according to any one of the aforementioned apparatus-related example aspects of the present invention), is configured to cause the computer to carry out the method according to any one of the aforementioned method-related example aspects of the present invention.

The computer program product may comprise or may be embodied as a (tangible/non-transitory) computer-readable (storage) medium or the like, on which the computer-executable computer program code is stored, and/or the program is directly loadable into an internal memory of the computer or a processor thereof.

Further developments and/or modifications of the aforementioned exemplary aspects of the present invention are set out in the following.

By way of exemplifying embodiments of the present invention, efficient and dynamic mobility set configuration for RAN-WLAN aggregation can be enabled/realized. Thereby, it is facilitated that a RAN node can control the content of a mobility set for a terminal node in its coverage while using a single identifier.

Brief description of the drawings

In the following, the present invention will be described in greater detail by way of non-limiting examples with reference to the accompanying drawings, in which

Figure 1 shows a schematic diagram illustrating a system configuration, for which exemplifying embodiments of the present invention are applicable,

Figure 2 shows a flowchart illustrating an example of a method, operable at an access node of a cellular radio access network, according to exemplifying embodiments of the present invention,

Figure 3 shows a flowchart illustrating an example of a method, operable at a control node of a wireless local area network, according to exemplifying embodiments of the present invention,

Figure 4 shows a flow diagram illustrating an example of a procedure according to exemplifying embodiments of the present invention,

Figure 5 shows a flow diagram illustrating another example of a procedure according to exemplifying embodiments of the present invention,

Figure 6 shows a schematic diagram illustrating an example of a structure of apparatuses according to exemplifying embodiments of the present invention, and

Figure 7 shows a schematic diagram illustrating another example of a functional structure of apparatuses according to exemplifying embodiments of the present invention.

Detailed description

The present invention is described herein with reference to particular non-limiting examples and to what are presently considered to be conceivable embodiments of the present invention. A person skilled in the art will appreciate that the present invention is by no means limited to these examples and embodiments, and may be more broadly applied.

It is to be noted that the following description of the present invention and its embodiments mainly refers to specifications being used as non-limiting examples for certain exemplifying network configurations and system deployments. Namely, the present invention and its embodiments are mainly described in relation to 3GPP specifications being used as non-limiting examples. While LTE and LTE-based systems are adopted as examples of present cellular communication systems, the present disclosure is generally applicable to any modern or future cellular communication system, including e.g. 3GPP and non-3GPP 4G, 5G systems and onwards, such as systems of LTE Release 13, 14 and onwards. As such, the description of exemplifying embodiments given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples and embodiments, and does naturally not limit the invention in any way. Rather, any other system configuration or deployment may equally be utilized as long as complying with what is described herein and/or exemplifying embodiments described herein are applicable to it.

Hereinafter, various exemplifying embodiments and implementations of the present invention and its aspects are described using several variants and/or alternatives. It is generally to be noted that, according to certain needs and constraints, all of the described variants and/or alternatives may be provided alone or in any conceivable combination (also including combinations of individual features of the various variants and/or alternatives). In this description, the words “comprising” and “including” should be understood as not limiting the described exemplifying embodiments and implementations to consist of only those features that have been mentioned, and such exemplifying embodiments and implementations may also contain features, structures, units, modules etc. that have not been specifically mentioned.

In the drawings, it is to be noted that lines/arrows interconnecting individual blocks or entities are generally meant to illustrate an operational coupling there-between, which may

be a physical and/or logical coupling, which on the one hand is implementation-independent (e.g. wired or wireless) and on the other hand may also comprise an arbitrary number of intermediary functional blocks or entities not shown.

According to exemplifying embodiments of the present invention, in general terms, there are provided measures and mechanisms for enabling/realizing mobility set configuration for RAN-WLAN aggregation, i.e. radio level integration/aggregation between a cellular radio access network and a wireless area network.

Generally, a mobility set (MS) represents a LWA feature which as such does not specify how the MS functionality is implemented. A WT/AC, as described below, may implement the MS functionality by configuring an L2 network for a group of APs, by configuring a mobility domain (MD) for a group of APs, or by other means.

Figure 1 shows a schematic diagram illustrating a system configuration, for which exemplifying embodiments of the present invention are applicable.

As shown in Figure 1, a dual-connectivity scenario for a terminal node using RAN-WLAN interworking is illustrated, as outlined above. In this exemplary dual-connectivity scenario, a RAN node (also referred to as access node) of a cellular radio access network (RAN) is inter-connected with a WLAN node (also referred to as control node) of a wireless local area network (WLAN) via a RAN-WLAN interface (e.g. a Xw reference point), and both the RAN and the WLAN serve the terminal node via a respective radio interface. The RAN node and the WLAN node may be non-collocated, as illustrated, or collocated, as indicated by a dashed block.

For example, the RAN may be an E-UTRAN of a LTE or LTE-A or LTE-Advanced Pro system, and the RAN node may be an eNB thereof, or the RAN may be an UTRAN of an UMTS system, and the RAN node may be a RNC thereof. Generally speaking, the RAN may be any modern or future cellular communication system, including e.g. 3GPP and non-3GPP 4G, 5G systems and onwards, such as systems of LTE Release 13, 14 and onwards, and the RAN node may be any network node thereof, such as a base station, communication controller or the like of any modern or future cellular communication system, including e.g. 3GPP and non-3GPP 4G, 5G systems and onwards, such as

systems of LTE Release 13, 14 and onwards. For example, the WLAN may be an IEEE 802.11-conformant network, and the WLAN node may be an AC and/or, in the terminology of LWA, a WT. Generally speaking, the WLAN may be any modern or future wireless local network, including e.g. IEEE and non-IEEE systems of any version or standardization, and the WLAN node may be any control node thereof, such as a communication controller or the like of any modern or future wireless local network, including e.g. IEEE and non-IEEE systems of any version or standardization.

Generally, all of the nodes and entities mentioned herein can be implemented in any conceivable manner. For example, the RAN access node and/or the WLAN control node can be implemented as a hardware entity, as software entity, in virtualized manner, as cloud deployment, and so forth. Also, the terminal node can be implemented as a standalone entity in integration or connection with any electronic device, including any kind of communication devices, computer devices, and so forth.

Figure 2 shows a flowchart illustrating an example of a method, operable at an access node of a cellular radio access network, according to exemplifying embodiments of the present invention. The method of Figure 2 can be executed by a RAN node, such as an eNB or a RNC, like that illustrated in Figure 1.

As shown in Figure 2, a method according to exemplifying embodiments of the present invention, which is operable at an access node of a cellular radio access network, comprises an operation (S210) of initiating construction of a mobility set for usage by terminal nodes in the coverage of the access node, an operation (S220) of issuing a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set for the terminal node, by a control node of the wireless local area network, an operation (S230) of acquiring a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, and an operation (S240) of configuring the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set group identifier (which is included in the configuration result).

Figure 3 shows a flowchart illustrating an example of a method, operable at a control node of a wireless local area network, according to exemplifying embodiments of the present invention. The method of Figure 3 can be executed by a WLAN node, such as a WT or an AC, like that illustrated in Figure 1.

As shown in Figure 3, a method according to exemplifying embodiments of the present invention, which is operable at a control node of a wireless local area network, comprises an operation (S310) of detecting a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node, an operation (S320) of configuring the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and an operation (S330) of issuing a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

In the above-described methods of any one of the RAN node and the WLAN node, the request may include one or more identifiers of access points and/or one or more group identifiers of a group of access points for specifying access points to be included in the mobility set. Such identifiers of the access points which are in the coverage of the access node and/or under control of the control node can previously be gathered at the RAN node, e.g. obtained from information provided by one or more of the one or any other WLAN node, one or more terminal nodes in the coverage of the access node and an OAM node.

The above-mentioned identifiers may be any identifiers suitable for providing the associated effects of identification, respectively. For example, the following identifiers may be used in this regard. An identifier of an access point may comprise at least a service set identifier (SSID) or a basic service set identifier (BSSID). A group identifier of a group of access points may comprise at least an extended service set identifier (ESSID) or a homogeneous extended service set identifier (HESSID). A mobility set group identifier may comprise at least an extended service set identifier (ESSID) or a homogeneous extended service set identifier (HESSID) or a mobility domain identifier (MDID).

Hereinafter, exemplarily use cases of the above-described operabilities of a RAN node and a WLAN node are described for illustrative purposes, yet without limiting (generality of) the present invention. In this regard, the above-mentioned exemplary identifiers are adopted for illustrative purposes, yet without limiting (generality of) the present invention.

In the thus illustrated procedures of any one of Figures 4 and 5, eNB represents an example of a RAN node of certain embodiments, WT/AC represents an example of a WLAN node of certain embodiments, and UE represents an example of a terminal node of certain embodiments (which is served by the eNB, and can be connected to one or more WLAN access points under control of the WT/AC). The UE is to represent one or more terminal nodes in the coverage of the eNB. Generally, it is to be noted that WLAN networks often use access controllers (AC) representing a WLAN entity, which may implement the mobility set (MS) functionality as the LWA feature, wherein the LWA feature defines a logical element called WLAN termination (WT) representing a LWA entity, which can thus in effect be considered to correspond to an AC, at least for the purpose of certain embodiments disclosed herein. Any APs representing access points of certain embodiments, which are under control of the WT/AC, are not shown for the sake of simplicity, while it is to be noted that at least some of these APs may be in the coverage of the eNB (i.e. are located within the coverage/service area of the eNB).

Figure 4 shows a flow diagram illustrating an example of a procedure according to exemplifying embodiments of the present invention.

As shown in Figure 4, a procedure according to exemplifying embodiments of the present invention, which is operable in a system configuration like that of Figure 1, may comprise the following operations.

In step 1, the eNB gathers identifiers of APs which may be in the coverage of the eNB and/or under control of the WT/AC (also referred to as AP-related identifiers), which can include one or more AP identifiers (each AP identifier identifying an individual AP) and/or one or more AP group identifiers of one or more AP groups (each AP group identifier identifying an individual group including one or more APs), as exemplified by BSSIDs and HESSIDs. Such identifiers may be obtained from information provided by one or more

WTs/ACs (possibly including the illustrated WT/AC), one or more UEs in the coverage of the eNB, and an OAM node. For example, the eNB may obtain a list of BSSIDs and/or HESSIDs which could be part of one MS, which list may be obtained as part of UE reports, as part of a list delivered via the Xw, or as part of OAM settings.

While Figure 4 illustrates a dedicated step of gathering identifier information, it is to be noted that such dedicated gathering step may not be required. For example, the eNB may already have sufficient information on AP-related identifiers, and may use the same for the subsequent procedure. Thus, the thus shown dedicated gathering step is only for illustrative purposes. So, the subsequent procedure can be carried out at any arbitrary time, and does not need to be performed immediately after gathering of AP-related identifiers in step 1.

In step 2 (or prior to step 2), the eNB may observe LWA behavior of one or more UEs over time, and so the eNB may want to initialize or reconfigure Xw operability between the eNB and the WT/AC. Namely, the eNB may identify that some APs under control of the WT/AC are not or no longer in the same mobility cluster as others, and hence separate MSs could be defined, which encompasses both initiation of a new MS and reconfiguration of an existing MS (by way of separation of a subset of APs into a split/new MS). It is to be noted that the criteria for the eNB to define what APs should be grouped into a MS is out of the present disclosure. For example, a criterion for MS definition could be for instance to include all APs in one MS which show direct UE transitions among at least two of them, while this criterion is to be understood as a illustrative but non-limiting example only.

In step 2, the eNB decides to initiate construction of a MS for its served UE/s, which may be initiation of a new MS and reconfiguration of an existing MS (by way of separation of a subset of APs into a split/new MS). To this end, the eNB decides to request configuration of a MS group identifier for any one of the above-identified groups of APs which are in a mobility cluster and could/should thus be configured as members of a MS.

In step 3, the eNB prepares a corresponding request for supporting MS construction, i.e. a request for configuration of a MS group identifier for APs in its coverage, which are to be configured as members of the MS, by the WT/AC, and transmits this request to the WT/AC. Such request may include (a list of) the previously collected identifiers for

specifying APs to be included in the MS and, thus, to be configure with the MS group identifier. Optionally, as explained in further detail below, the request may also include an indication of an applicable scope of the MS with respect to APs to be included in the mobility set (hereinafter referred to as “at least/at most” flag), indicating whether the MS is to include at least or at most the specified. Such indication can for example be realized with 1 bit, where e.g. 0 indicates the setting “at least” and 1 indicated the setting “at most”.

For example, the request transmission of step 3 can be part of Xw initialization or reconfiguration request signaling. The initialization or reconfiguration request can be realized as or in the context of a SON feature.

In step 4, upon receipt/detection of this request for supporting MS construction, i.e. the request for configuration of a MS group identifier for APs (which may but need not be in the coverage of the eNB), which are to be configured as members of the MS, by the WT/AC, the WT/AC configures a MS group identifier to APs which are capable of being members of the MS on the basis of the request. That is, the WT/AC may determine for any one of the specified APs whether a configuration of a common group identifier according to the request is possible. For those APs for which configuration of a common group identifier according to the request is possible, the WT/AC configures (or creates) the MS group identifier. Capability of being configured with a common group identifier may correspond to or dependent from MS membership capability, as explained below. That is, those APs which are able to be configured in a single MS, can be those APs which can be assigned a common group identifier (which may also be referred to as MS group identifier).

To this end, the WT/AC may resolve any AP group identifier in the request into one or more AP identifiers included in the AP group, and configure the MS group identifier for the APs on the basis of their respective AP identifiers. Also, the WT/AC may construct an extended service set (ESS) or a homogeneous extended service set (HESS) or a mobility domain (MD), including the APs to be configured as the members of the MS. Specifically, the WT/AC may assign a common or even unique MS group identifier to the MS member APs accordingly (e.g. a ESSID, a HESSID, a MDID, or the like). When the WT/AC receives a request for supporting MS construction containing (an identifier for) AP1 from one eNB, say eNB1, and another request for supporting MS construction containing (an

identifier for) AP1 from another eNB, say eNB2, such that both requests are pending at the same time, the WT/AC will assign AP1 only to one MS group identifier of one of the two eNBs, and the decision may be made in an arbitrary manner on the basis of any conceivable consideration allowing a prioritization of one of the requests or one of the eNBs (e.g. time of arrival).

In step 5, for informing the eNB of the outcome of the configuration, the WT/AC issues a delivery of a configuration result, i.e. a result of the configuration of the MS group identifier of the APs based on the request in step 4. That is, the WT/AC prepares the configuration result and transmits the configuration result to the eNB. The configuration result includes the MS group identifier and one or more AP identifiers of the APs which are to be configured as the members of the MS. The MS group identifier (which identifies a specific MS and, thereby, also the thus included APs) may be exemplified as ESSID, HESSID or MDID, depending on how configuration is performed in step 4, i.e. whether the APs are configured as ESS, HESS or MD.

For example, the configuration result transmission of step 5 can be part of Xw initialization or reconfiguration response signaling. The initialization or reconfiguration response can be realized as or in the context of a SON feature.

In step 6, it is shown how the eNB takes into use the configuration result from the WT/AC. For instance, during the setup of LWA for a UE, the eNB configures the MS to the UE on the basis of the configuration result. To this end, (at least) the MS group identifier included in the configuration result may be utilized, i.e. (at least) the MS group identifier for the MS may be signaled to the UE subject to LWA setup. Thus, only a small amount of required MS configuration signaling towards the UE subject to LWA setup may be ensured. Also, the eNB would still be free to use additional IDs in the MS configuration signaling towards the UE, such as BSSIDs included in the configuration result, e.g. in case the WT/AC was not able to allocate a MS group identifier but still is able to support the MS functionality for all those APs identified in the request.

Such MS configuration to one or more UEs in the coverage of the eNB can be carried out at any arbitrary time or subsequent process. That is, while the operations from steps 1 to 5

are used as a basis, the operation of step 6 does not need to be performed immediately after receipt/acquisition of the configuration result from the WT/AC in step 5.
For example, the configuration signaling of step 6 can be part of LWA setup signaling.

Figure 5 shows a flow diagram illustrating another example of a procedure according to exemplifying embodiments of the present invention.

Basically, the procedure of Figure 5 is similar to that of Figure 4. So, for the sake of brevity, a detailed description thereof is omitted, while referring to the above description of Figure 4, which applies in equal measure for Figure 5 as well. In the following, only the differences between the procedures of Figures 5 and 4 is described.

As evident from Figure 5, in step 2, when deciding to initiate construction of a MS for its served UE/s, the eNB decides to request configuration of MS functionality, in addition to configuration of a MS group identifier, for any one of the above-identified groups of APs which are in a mobility cluster and could/should thus be configured as members of a MS.

In step 3, the eNB prepares a corresponding request for supporting MS construction, i.e. a request for configuration of a MS group identifier for APs in its coverage and a request for configuration of the APs in its coverage, which are to be configured as members of the MS, by the WT/AC, and transmits this request to the WT/AC. As described above, such request may include (a list of) the previously collected identifiers for specifying APs to be included in the MS and to be configure with the MS group identifier. Optionally, as explained in further detail below, the request may also include an indication of an applicable scope of the MS with respect to APs to be included in the mobility set (hereinafter referred to as “at least/at most” flag), indicating whether the MS is to include at least or at most the specified. Such indication can for example be realized with 1 bit, where e.g. 0 indicates the setting “at least” and 1 indicated the setting “at most”.

In step 4, upon receipt/detection of this request for supporting MS construction, i.e. the request for configuration of a MS group identifier for the APs (which may but need not be in the coverage of the eNB) and the request for configuration of the APs (which may but need not be in the coverage of the eNB), which are to be configured as members of the MS, by the WT/AC, the WT/AC configures a MS group identifier and MS functionality to

APs which are capable of being members of the MS on the basis of the request. That is, the WT/AC may determine for any one of the specified APs whether a configuration of a common group identifier and/or configuration as a MS member according to the request is possible. For those APs for which configuration of a common group identifier and/or configuration as a MS member is possible, the WT/AC performs a corresponding configuration. In this regard, the term "MS functionality" refers to the capability and/or setting required for being operable as a member of the MS. Capability of MS membership may be characterized by allowing e.g. transitions between APs that do not require eNB authentication signaling, while this criterion is to be understood as a illustrative but non-limiting example only.

In view of the differences in the operations in steps 2 to 4 of Figure 4 and 5, it is to be noted that configuration of MS functionality of APs to be included in a MS can be regarded as a pre-requisite for configuration of a MS group identifier for these APs (and the configuration/construction of a MS). On the one hand, such pre-requisite might be presumed to be already fulfilled or established, and is thus not required to be performed in the procedure according to exemplifying embodiments of the present invention. If so, the procedure of Figure 4 applies. On the other hand, such pre-requisite might be presumed to be not already fulfilled or established, and is thus required to be performed in the procedure according to exemplifying embodiments of the present invention. If so, the procedure of Figure 5 applies.

As regards the MS group identifier, the MS group identifier in the meaning of the present invention can be regarded as sort of "shortcut" group identifier for a mobility set, which is provided by the WT/AC to the eNB, and which identifies APs under the control of the WT/AC, which are in the same mobility cluster and thus enable configuration of a common MS. In any one of the above-described procedures, it is to be noted that an ESSID or HESSID is a unique ID in general, while a MDID is unique ID only within the APs of one HESSID. The MDID is typically used in conjunction with an HESSID, while there may be one or more MDIDs in one HESSID. Anyway, both identifiers ESSID/HESSID and MDID as well an identifier tuple HESSID-MDID can be understood as group identifiers for a list of BSSIDs.

As evident from any one of the above-described procedures, it can be ensured that the eNB can configure the desired MS with a single identifier or single identifier tuple (e.g. HESSID-MDID) to the UE (wherein such single identifier can abbreviate a long list of BSSIDs). In the meaning of the present disclosure, the term "single identifier" equally encompasses both a single identifier as such (e.g. HESSID) and a single identifier tuple (e.g. HESSID-MDID). Based on the above-outlined principles, the eNB can keep control of (the construction of) the desired MS, while at the same time the amount of UE configuration signaling can be reduced.

As evident from any one of the above-described procedures, the MS group identifier that the WT/AC is requested to configure can be used as an abbreviation for those MSs to be configured for various UEs by the eNB. Namely, the eNB can define a MS per UE, and the UE-MS definition is in the control of the eNB. The WT/AC enables efficient MS configuration by providing, upon request from the eNB, shortcuts or group identifiers. For UE-MS definition, the eNB can use either only the WT/AC-delivered shortcuts or group identifiers, i.e. the abbreviation alone, or the WT/AC-delivered shortcuts or group identifiers plus individual identifiers such as BSSIDs (which can be included in the MS configuration by the WT/AC, but which are not included in or encompassed by the provided shortcuts or group identifiers), i.e. the abbreviation in conjunction with additional identification information.

In the following, an explanation is given for the "at least/at most" flag, i.e. the indication of an applicable scope of the MS with respect to APs to be included in the mobility set, which can be included in the request for supporting MS construction from the eNB to the WT/AC in any one of the above-described procedures. Thus, the eNB can elect the desired MS scope.

In brief, it can be said that the "at least/at most" flag indicates that the specified APs (or, the provided list of AP-related identifiers) can be part of a larger MS or MD (identifier) or should be the only constituents for the MS or MD (identifier) according to the request. Based on such indication, the WT/AC is enabled to operate accordingly, especially in terms of resolving any group identifier in the request into one or more identifiers of the access points included in the group and configuring the access points on the basis of their respective identifiers. Namely, the WT/AC may configure the mobility set group identifier

(and/or the MS) with at least the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of access points which are not identified in the request if it is indicated that the mobility set is to include at least the specified access points, or may configure the mobility set group identifier (and/or the MS) with at most the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of only access points identified in the request, if it is indicated that the mobility set is to include at most the specified access points.

When the eNB initiates MS construction, e.g. in step 2 of Figure 4 or 5, with (a list of) AP-related identifiers including one or more AP group identifiers, the eNB may not know which AP identifiers are contained within or, stated in other words, encompassed by this one or more AP group identifiers. Using the above example of identifiers, this means that the eNB may not know with BSSIDs are contained within or, stated in other words, encompassed by one or more HESSIDs known or previously collected as AP-related identifiers, e.g. in step 1 of Figure 4 or 5. Such lack of knowledge can be resolved by the WT/AC.

For example, the eNB may gather measurement reports from UEs, thereby obtaining a list of BSSIDs associated with an HESSID within its coverage. However, the eNB will not know whether there are also BSSIDs contained in the HESSID, which are not within its coverage. For solving this issue, different approaches may be preferred. For example, an operator of the RAN system may be unconcerned by the eNB requesting the WT/AC to define a MS that contains also APs that are not in the coverage of the eNB, and for this operator the mentioned flag can be used with setting “at least”. If so, the WT/AC would be free to add eNB-requested APs to an already existing AP group identifier such as a HESSID (if possible), which might be in use also by other eNBs. Another operator may be concerned by the eNB requesting the WT/AC to define a MS that contains also APs that are not in the coverage of the eNB, or may be concerned to have a minimal amount of APs in the MS concerned, and may wish to have full control over the contents of an HESSID, and for this operator the mentioned flag can be used with setting “at most”. If so, the WT/AC shall not be free to add eNB-requested APs to an already existing AP group identifier such as a HESSID (if possible), which might be in use also by other eNBs, but should rather assign a new AP group identifier such as a HESSID (if possible).

To illustrate these considerations, two examples are given below.

Example 1: The eNB was signaled, e.g. by the WT/AC (or OAM), that it can use {BSSID1, BSSID2, HESSID1} as AP-related identifiers. The eNB is not aware that HESSID1 describes the HESS with {BSSID3, BSSID4}, where BSSID3 is within the coverage of the eNB, but BSSID4 is outside the coverage of the eNB. The eNB wishes to define a MS with one identifier, i.e. a common MS group identifier, which comprises at least the IDs it knows. In such case, the eNB signals to the WT/AC that it wishes at least {BSSID1, BSSID2, HESSID1} to be part of the MS, i.e. by providing the AP-related identifiers and using the mentioned flag with setting “at least”. The WT/AC realizes that it can accomplish this by configuring and reconfiguring a new HESSID2 containing {BSSID1, BSSID2, BSSID3, BSSID4}. Alternatively, the WT/AC can add BSSID1 and BSSID2 to HESSID1, thereby avoiding affecting neighboring cells’ MSs. Then, the WT/AC delivers this configuration to the eNB, and the eNB can configure to the UEs the MS as HESSID2 (or HESSID1) only.

Example 2: In the same underlying situation as in example 1, the eNB wishes to define a MS with one identifier, i.e. a common MS group identifier, which comprises at most the IDs it knows. In such case, the eNB signals to the WT/AC that it wishes at most {BSSID1, BSSID2, BSSID3} to be part of the MS, i.e. by providing the AP-related identifiers and using the mentioned flag with setting “at most”. The WT/AC configures an HESSID comprising those three BSSIDs. If for instance BSSID4 was part of HESSID1 before, the WT/AC will either reconfigure HESSID1 to only contain BSSID1, BSSID2 and BSSID3, or rather remove BSSID1, BSSID2 and BSSID3 from HESSID1 and configure an HESSID2 containing {BSSID1, BSSID2 and BSSID3}. Then, the WT/AC delivers this configuration to the eNB, and the eNB can configure to the UEs the MS as HESSID2 (or HESSID1) only. Such approach can avoid impacts on neighboring cells’ MSs.

For any one of the above-described procedures, the following is noted.

The procedures can be differentiated in a (UE-unspecific) Xw initialization/reconfiguration part (where Xw is to illustrate operability between the RAN access node and the WLAN control node) and a (UE specific) RAN-WLAN radio aggregation setup part. As

background, during Xw initialization/reconfiguration, the WT/AC informs the eNB about APs under its control, while it is out of scope for the present disclosure whether the eNB will already know then whether or how the APs provided by the WT/AC can be placed into MSs. Such Xw initialization/reconfiguration applies to the eNB as such and, thus, to all UEs in its coverage. That is, the Xw initialization/reconfiguration process is not UE-specific. Further, during RAN-WLAN radio aggregation setup, the eNB provides a constructed MS to UE/S in its coverage. This may be part of during LWA setup for that UE/s, which happens after the aforementioned Xw initialization/reconfiguration. Such RAN-WLAN radio aggregation (i.e. LWA) setup applies to the thus signaled/configured UE/s as such and, thus, is UE-specific. In Figures 4 and 5, steps 2 to 5 (potentially also including step 1) can belong to or be part of Xw initialization/reconfiguration, while step 6 can belong to or be part of RAN-WLAN radio aggregation (i.e. LWA) setup. That is, firstly a general initialization/reconfiguration is established (including e.g. MS group identifier configuration), which is subsequently used for UE-specific setup (including e.g. MS configuration signaling). Accordingly, the operations in steps 2 to 5 (potentially also including step 1) constitute or are based on UE-independent functionality/signaling, and the operations in step 6 constitute or are based on UE-dependent functionality/signaling which uses what has been agreed/configured before in the UE-independent functionality/signaling.

The procedures both result in signaling savings. On the one hand, as the Xw initialization/reconfiguration process is performed for all of the eNB-served UEs in a UE-independent manner in steps 3 and 5 of Figure 4 or 5, a single signaling exchange is sufficient. On the other hand, as the RAN-WLAN radio aggregation (i.e. LWA) setup is performed with or, at least, on the basis of a single/common group identifier in step 6 of Figure 4 or 5, a single/common group identifier is sufficient.

By virtue of exemplifying embodiments of the present invention, as evident from the above, efficient and dynamic mobility set configuration for RAN-WLAN aggregation can be enabled/realized. Thereby, it is facilitated that a RAN node can control the content of a mobility set for a terminal node in its coverage while using a single identifier. That is to say, although the RAN node may not definitely know which ones of initially collected identifiers can or shall be included in the mobility set in the beginning, the RAN node can keep control of (the construction of) the desired mobility set, while the amount of

configuration signaling towards the terminal node can be reduced. Even if the RAN node had such knowledge (at least, implicitly), the RAN access node may wish to attain optimization in the procedure of mobility set construction/configuration. To this end, the RAN access node may wish to be able to use a simplified identifier for the desired mobility set instead of a full listing of identifiers for all WLAN access points. However, neither the RAN access node nor the WLAN control node can know in advance what are the most suitable mobility set or sets to be used by the RAN access node, and hence cannot optimize the identifiers for related APs on their own. Accordingly, the functions of exemplifying embodiments of the present invention are effective to optimize mobility set construction/configuration by enabling usage of a single/common identifier.

Such technique is advantageous in deployments where MDs or MSs can be set up by a WLAN node, but the WLAN node does not have a notion in what way. Then, this technique allows the RAN node to take control over the mobility set while minimizing signaling towards the terminal node. Further, in situations where MDs or MSs have been already set up by a WLAN node, this technique allows the RAN node to regain or retain control over the mobility set, again while minimizing signaling towards the terminal node. Accordingly, the required processing load at the RAN node and the amount of required signaling towards the terminal node can be kept low, while flexibility in terms of the capability for dynamic and/or automatic configurations can be ensured by way of control by the RAN node and cooperation with the WLAN node (which ensures a good and up-to-date picture of the localization and setting of WLAN access points).

The above-described methods, procedures and functions may be implemented by respective functional elements, entities, modules, units, processors, or the like, as described below.

While in the foregoing exemplifying embodiments of the present invention are described mainly with reference to methods, procedures and functions, corresponding exemplifying embodiments of the present invention also cover respective apparatuses, entities, modules, units, network nodes and/or systems, including both software and/or hardware thereof.

Respective exemplifying embodiments of the present invention are described below referring to Figures 6 and 7, while for the sake of brevity reference is made to the detailed description of respective corresponding configurations/setups, schemes, methods and functionality, principles and operations according to Figures 1 to 5.

In Figures 6 and 7, the blocks are basically configured to perform respective methods, procedures and/or functions as described above. The entirety of blocks are basically configured to perform the methods, procedures and/or functions as described above, respectively. With respect to Figures 6 and 7, it is to be noted that the individual blocks are meant to illustrate respective functional blocks implementing a respective function, process or procedure, respectively. Such functional blocks are implementation-independent, i.e. may be implemented by means of any kind of hardware or software or combination thereof, respectively.

Further, in Figures 6 and 7, only those functional blocks are illustrated, which relate to any one of the above-described methods, procedures and/or functions. A skilled person will acknowledge the presence of any other conventional functional blocks required for an operation of respective structural arrangements, such as e.g. a power supply, a central processing unit, respective memories or the like. Among others, one or more memories are provided for storing programs or program instructions for controlling or enabling the individual functional entities or any combination thereof to operate as described herein in relation to exemplifying embodiments.

Figure 6 shows a schematic diagram illustrating an example of a structure of apparatuses according to exemplifying embodiments of the present invention.

As indicated in Figure 6, according to exemplifying embodiments of the present invention, an apparatus 500 may comprise at least one processor 510 and at least one memory 520 (and possibly also at least one interface 530), which may be operationally connected or coupled, for example by a bus 540 or the like, respectively.

The processor 510 and/or the interface 530 of the apparatus 500 may also include a modem or the like to facilitate communication over a (hardwire or wireless) link, respectively. The interface 530 of the apparatus 500 may include a suitable transmitter,

receiver or transceiver connected or coupled to one or more antennas, antenna units, such as antenna arrays or communication facilities or means for (hardwire or wireless) communications with the linked, coupled or connected device(s), respectively. The interface 530 of the apparatus 500 is generally configured to communicate with at least one other apparatus, device, node or entity (in particular, the interface thereof).

The memory 520 of the apparatus 500 may represent a (non-transitory/tangible) storage medium and store respective software, programs, program products, macros or applets, etc. or parts of them, which may be assumed to comprise program instructions or computer program code that, when executed by the respective processor, enables the respective electronic device or apparatus to operate in accordance with the exemplifying embodiments of the present invention. Further, the memory 520 of the apparatus 500 may (comprise a database to) store any data, information, or the like, which is used in the operation of the apparatus.

In general terms, respective apparatuses (and/or parts thereof) may represent means for performing respective operations and/or exhibiting respective functionalities, and/or the respective devices (and/or parts thereof) may have functions for performing respective operations and/or exhibiting respective functionalities.

In view of the above, the thus illustrated apparatus 500 is suitable for use in practicing one or more of the exemplifying embodiments of the present invention, as described herein.

When in the subsequent description it is stated that the processor (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that a (i.e. at least one) processor or corresponding circuitry, potentially in cooperation with a computer program code stored in the memory of the respective apparatus or otherwise available (it should be appreciated that the memory may also be an external memory or provided/realized by a cloud service or the like), is configured to cause the apparatus to perform at least the thus mentioned function.

According to exemplifying embodiments of the present invention, the thus illustrated apparatus 500 may represent or realize/embody a (part of a) access node of a cellular radio access network, also referred to as RAN node herein. Specifically, the thus

illustrated apparatus 500 may be configured to perform a procedure and/or exhibit a functionality and/or implement a mechanism, as described for the RAN node or eNB, in any one of Figures 1, 2, 4 and 5.

Accordingly, the apparatus 500 may be caused or the apparatus 500 or its at least one processor 510 (possibly together with computer program code stored in its at least one memory 520), in its most basic form, is configured initiate construction of a mobility set for usage by terminal nodes in the coverage of the access node, to issue a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network, to acquire a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, and to configure the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility et group identifier (included in the configuration result).

According to exemplifying embodiments of the present invention, the thus illustrated apparatus 500 may represent or realize/embody a (part of a) a control node of a wireless local area network, also referred to as WLAN node herein. Specifically, the thus illustrated apparatus 500 may be configured to perform a procedure and/or exhibit a functionality and/or implement a mechanism, as described for the WLAN node or WT/AC, in any one of Figures 1, 3, 4 and 5.

Accordingly, the apparatus 500 may be caused or the apparatus 500 or its at least one processor 510 (possibly together with computer program code stored in its at least one memory 520), in its most basic form, is configured to detect a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node, to configure the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and to issue a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

As mentioned above, any apparatus according to exemplifying embodiments of the present invention may be structured by comprising respective units or means for performing corresponding operations, procedures and/or functions. For example, such units or means may be implemented/realized on the basis of an apparatus structure, as exemplified in Figure 6, i.e. by one or more processors 510, one or more memories 520, one or more interfaces 530, or any combination thereof.

Figure 7 shows a schematic diagram illustrating another example of a functional structure of apparatuses according to exemplifying embodiments of the present invention.

It is to be noted that the individual apparatuses shown in Figure 7 are inherently independent from each other but could be operable to interwork, i.e. exemplifying embodiments of the present invention cover any one of these apparatuses alone or any combination of such apparatuses (including one or more of any one of these apparatuses).

As shown in Figure 7, an apparatus 600 according to exemplifying embodiments of the present invention may represent a (part of a) access node of a cellular radio access network, also referred to as RAN node herein, such as an eNB of E-UTRAN or the like. Such apparatus may comprise (at least) a unit or means for initiating construction of a mobility set for usage by terminal nodes in the coverage of the access node (denoted as mobility set construction initiating unit/means 610), a unit or means for issuing a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network (denoted as configuration request issuing unit/means 620), a unit or means for acquiring a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set (denoted as configuration result acquiring unit/means 630), and a unit or means for configuring the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set identifier (denoted as mobility set configuring unit/means 640).

As evident from the above, the apparatus 600 may optionally also comprise a unit or means for gathering identifiers of the access points which are in the coverage of the access node and/or under control of the control node, including the one or more identifiers of access points and/or the one or more group identifiers of a group of access points (denoted as access point identifier gathering unit/means 650). Also, the configuration request issuing unit/means 620 may be configured to issue a request for configuration of the access points to be included in the mobility set as the members of the mobility set, by the control node (i.e. to request MS functionality configuration).

As shown in Figure 7, an apparatus 700 according to exemplifying embodiments of the present invention may represent a (part of a) control node of a wireless local area network, also referred to as WLAN node herein, such as a WT and/or AC or the like. Such apparatus may comprise (at least) a unit or means for detecting a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node (denoted as configuration request detecting unit/means 710), a unit or means for configuring the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request (denoted as configuring unit/means 720), and a unit or means for issuing a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node (denoted as configuration result issuing unit/means 730).

As evident from the above, the apparatus 700 may optionally also comprise a unit or means for providing information on identifiers of the access points which are under control of the control node, to the access node (denoted as access point identifier providing unit/means 740). Also, the configuration request detecting unit/means 710 may be configured to detect a request for configuration of the access points to be included in the mobility set as the members of the mobility set, by the control node, and the configuring unit/means 720 may be configured to configure mobility set functionality to the access points on the basis of the request (i.e. to perform MS functionality configuration).

For further details regarding the operability/functionality of the individual apparatuses (or units/means thereof) according to exemplifying embodiments of the present invention, reference is made to the above description in connection with any one of Figures 1 to 4, respectively.

According to exemplifying embodiments of the present invention, any one of the (at least one) processor, the (at least one) memory and the (at least one) interface, as well as any one of the illustrated units/means, may be implemented as individual modules, chips, chipsets, circuitries or the like, or one or more of them can be implemented as a common module, chip, chipset, circuitry or the like, respectively.

According to exemplifying embodiments of the present invention, a system may comprise any conceivable combination of the thus depicted apparatuses and other network elements or functional entities, which are configured to cooperate as described above.

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

Generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention. Such software may be software code independent and can be specified using any known or future developed programming language, such as e.g. Java, C++, C, and Assembler, as long as the functionality defined by the method steps is preserved. Such hardware may be hardware type independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components. A device/apparatus may be represented by a semiconductor

chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of a device/apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor. A device may be regarded as a device/apparatus or as an assembly of more than one device/apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

Apparatuses and/or units/means or parts thereof can be implemented as individual devices, but this does not exclude that they may be implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

The present invention also covers any conceivable combination of method steps and operations described above, and any conceivable combination of nodes, apparatuses, modules or elements described above, as long as the above-described concepts of methodology and structural arrangement are applicable.

In view of the above, there are provided measures for enabling/realizing efficient and dynamic mobility set configuration for RAN-WLAN aggregation. Such measures exemplarily comprise that, for construction of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, is requested at a control node of the wireless local area network, the control node configures the mobility set group identifier to

access points which are capable of being members of the mobility set, and the access node configures the mobility set to the terminal node on the basis of at least the mobility set group identifier, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

Even though the invention is described above with reference to the examples according to the accompanying drawings, it is to be understood that the invention is not restricted thereto. Rather, it is apparent to those skilled in the art that the present invention can be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

List of acronyms and abbreviations

3GPP	3rd Generation Partnership Project
AC	Access Controller
AP	Access Point
BSS(ID)	Basic Service Set (Identifier)
eNB	evolved NodeB
ESS(ID)	Extended Service Set (Identifier)
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
HESS(ID)	Homogenous Extended Service Set (Identifier)
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
I/F	Interface
LTE	Long Term Evolution
LTE-A	Long Term Evolution Advanced
LWA	LTE WLAN aggregation
MD(ID)	Mobility Domain (Identifier)
MS	Mobility Set
OAM	Operation and Management
RAN	Radio Access Network
RNC	Radio Network Controller
SON	Self-Organizing Network

SS(ID)	Service Set (Identifier)
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network
WLAN	Wireless Local Area Network
WT	WLAN termination
Xw	eNB-WT interface

Claims

1. A method comprising:

initiating, at an access node of a cellular radio access network, construction of a mobility set for usage by terminal nodes in the coverage of the access node,

issuing, at the access node, a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network,

acquiring, at the access node, a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, and

configuring, by the access node, the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set group identifier.

2. The method according to claim 1, wherein issuing a request comprises:

transmitting the request from the access node to the control node, said request including one or more identifiers of access points and/or one or more group identifiers of a group of access points for specifying access points to be included in the mobility set.

3. The method according to claim 2, wherein

the request further includes an indication of an applicable scope of the mobility set with respect to access points to be included in the mobility set, indicating whether the mobility set is to include at least the specified access points or at most the specified access points.

4. The method according to claim 2 or 3, further comprising:

gathering, at the access node, identifiers of access points which are in the coverage of the access node and/or under control of the control node, including the one or more identifiers of access points and/or the one or more group identifiers of a group of access points.

5. The method according to claim 4, wherein gathering identifiers comprises:

obtaining the identifiers from information provided by one or more of the control node, one or more terminal nodes in the coverage of the access node and an operation and management node.

6. The method according to any one of claims 1 to 5, wherein configuring the mobility set comprises:

signaling at least the mobility set group identifier for the mobility set to the at least one terminal node in the coverage of the access node.

7. The method according to any one of claims 1 to 6, further comprising:

issuing, at the access node, a request for configuration of the access points to be included in the mobility set as the members of the mobility set, by the control node.

8. A method comprising:

detecting, at a control node of a wireless local area network, a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node,

configuring, by the control node, the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and

issuing, at the control node, a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

9. The method according to claim 8, wherein detecting a request comprises:

receiving the request from the access node at the control node, said request including one or more identifiers of access points and/or one or more group identifiers of a group of access points for specifying access points to be included in the mobility set.

10. The method according to claim 9, wherein configuring a mobility set group identifier comprises:

resolving any group identifier in the request into one or more identifiers of the access points included in the group, and

configuring the mobility set group identifier for the access points on the basis of their respective identifiers.

11. The method according to claim 9 or 10, wherein

the request further includes an indication of an applicable scope of the mobility set with respect to access points to be included in the mobility set, indicating whether the mobility set is to include at least the specified access points or at most the specified access points.

12. The method according to claim 11, wherein configuring mobility set functionality comprises:

configuring the mobility set group identifier with at least the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of access points which are not identified in the request, if it is indicated that the mobility set is to include at least the specified access points, or

configuring the mobility set group identifier with at most the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of only the access points which are identified in the request, if it is indicated that the mobility set is to include at most the specified access points.

13. The method according to any one of claims 8 to 12, further comprising:

detecting, at the control node, a request for configuration of access points to be included in the mobility set as the members of the mobility set, by the control node, and

configuring, at the control node, mobility set functionality to the access points on the basis of the request.

14. The method according to any one of claims 8 to 13, wherein configuring comprises:

constructing, at the control node, an extended service set or a homogeneous extended service set or a mobility domain, including the access points to be configured as the members of the mobility set.

15. The method according to any one of claims 8 to 14, further comprising:

providing, by the control node, information on identifiers of access points which are under control of the control node, to the access node.

16. The method according to any one of claims 1 to 15, wherein

an identifier of an access point comprises at least a service set identifier or a basic service set identifier, and/or

a group identifier of a group of access points comprises at least an extended service set identifier or a homogeneous extended service set identifier, and/or

the mobility set group identifier comprises at least an extended service set identifier or a homogeneous extended service set identifier or a mobility domain identifier.

17. The method according to any one of claims 1 to 16, wherein

the access node comprises at least a base station of the cellular radio access network, such as an eNB of a LTE or LTE-A system, and/or

the control node comprises at least an access controller entity of the wireless local area network, such as a WLAN termination entity, and/or

any terminal node in the coverage of the access node has dual connectivity via the cellular radio access network and the wireless local area network.

18. 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 to perform at least the following:

initiating, at an access node of a cellular radio access network, construction of a mobility set for usage by terminal nodes in the coverage of the access node,

issuing, at the access node, a request for configuration of a mobility set group identifier for access points of a wireless local area network, which are to be configured as members of the mobility set, by a control node of the wireless local area network,

acquiring, at the access node, a configuration result from the control node, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, and

configuring, by the access node, the mobility set to at least one terminal node in the coverage of the access node on the basis of at least the mobility set group identifier.

19. The apparatus according to claim 18, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

transmitting the request from the access node to the control node, said request including one or more identifiers of access points and/or one or more group identifiers of a group of access points for specifying access points to be included in the mobility set.

20. The apparatus according to claim 19, wherein

the request further includes an indication of an applicable scope of the mobility set with respect to access points to be included in the mobility set, indicating whether the mobility set is to include at least the specified access points or at most the specified access points.

21. The apparatus according to claim 19 or 20, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

gathering, at the access node, identifiers of access points which are in the coverage of the access node and/or under control of the control node, including the one or more identifiers of access points and/or the one or more group identifiers of a group of access points.

22. The apparatus according to claim 21, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

obtaining the identifiers from information provided by one or more of the control node, one or more terminal nodes in the coverage of the access node and an operation and management node.

23. The apparatus according to any one of claims 18 to 22, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

signaling at least the mobility set group identifier for the mobility set to the at least one terminal node in the coverage of the access node.

24. The apparatus according to any one of claims 18 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 to perform:

issuing, at the access node, a request for configuration of the access points to be included in the mobility set as the members of the mobility set, by the control node.

25. 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 to perform at least the following:

detecting, at a control node of a wireless local area network, a request for configuration of a mobility set group identifier for access points of the wireless local area network, which are to be configured as members of a mobility set for usage by terminal nodes in the coverage of an access node of a cellular radio access network, from the access node,

configuring, by the control node, the mobility set group identifier to access points which are capable of being members of the mobility set on the basis of the request, and

issuing, at the control node, a delivery of a configuration result, including the mobility set group identifier and one or more identifiers of the access points which are to be configured as the members of the mobility set, to the access node.

26. The apparatus according to claim 25, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

receiving the request from the access node at the control node, said request including one or more identifiers of access points and/or one or more group identifiers of a group of access points for specifying access points to be included in the mobility set.

27. The apparatus according to claim 26, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

resolving any group identifier in the request into one or more identifiers of the access points included in the group, and

configuring the mobility set group identifier for the access points on the basis of their respective identifiers.

28. The apparatus according to claim 26 or 27, wherein

the request further includes an indication of an applicable scope of the mobility set with respect to access points to be included in the mobility set, indicating whether the mobility set is to include at least the specified access points or at most the specified access points.

29. The apparatus according to 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 to perform:

configuring the mobility set group identifier with at least the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of access points which are not identified in the request, if it is indicated that the mobility set is to include at least the specified access points, or

configuring the mobility set group identifier with at most the access points identified by the one or more identifiers and/or the one or more group identifiers in the request, allowing inclusion of only the access points which are identified in the request, if it is indicated that the mobility set is to include at most the specified access points.

30. The apparatus according to any one of claims 25 to 29, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

detecting, at the control node, a request for configuration of access points to be included in the mobility set as the members of the mobility set, by the control node, and

configuring, at the control node, mobility set functionality to the access points on the basis of the request.

31. The apparatus according to any one of claims 25 to 30, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

constructing, at the control node, an extended service set or a homogeneous extended service set or a mobility domain, including the access points to be configured as the members of the mobility set.

32. The apparatus according to any one of claims 25 to 31, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to perform:

providing, by the control node, information on identifiers of access points which are under control of the control node, to the access node.

33. The apparatus according to any one of claims 18 to 32, wherein

an identifier of an access point comprises at least a service set identifier or a basic service set identifier, and/or

a group identifier of a group of access points comprises at least an extended service set identifier or a homogeneous extended service set identifier, and/or

the mobility set group identifier comprises at least an extended service set identifier or a homogeneous extended service set identifier or a mobility domain identifier.

34. The apparatus according to any one of claims 18 to 33, wherein

the access node comprises at least a base station of the cellular radio access network, such as an eNB of a LTE or LTE-A system, and/or

the control node comprises at least an access controller entity of the wireless local area network, such as a WLAN termination entity, and/or

any terminal node in the coverage of the access node has dual connectivity via the cellular radio access network and the wireless local area network.

35. A computer program product comprising computer program code which, when the computer program code is executed on a computer, is configured to cause the computer to carry out the method according to any one of claims 1 to 7 or any one of claims 8 to 17.

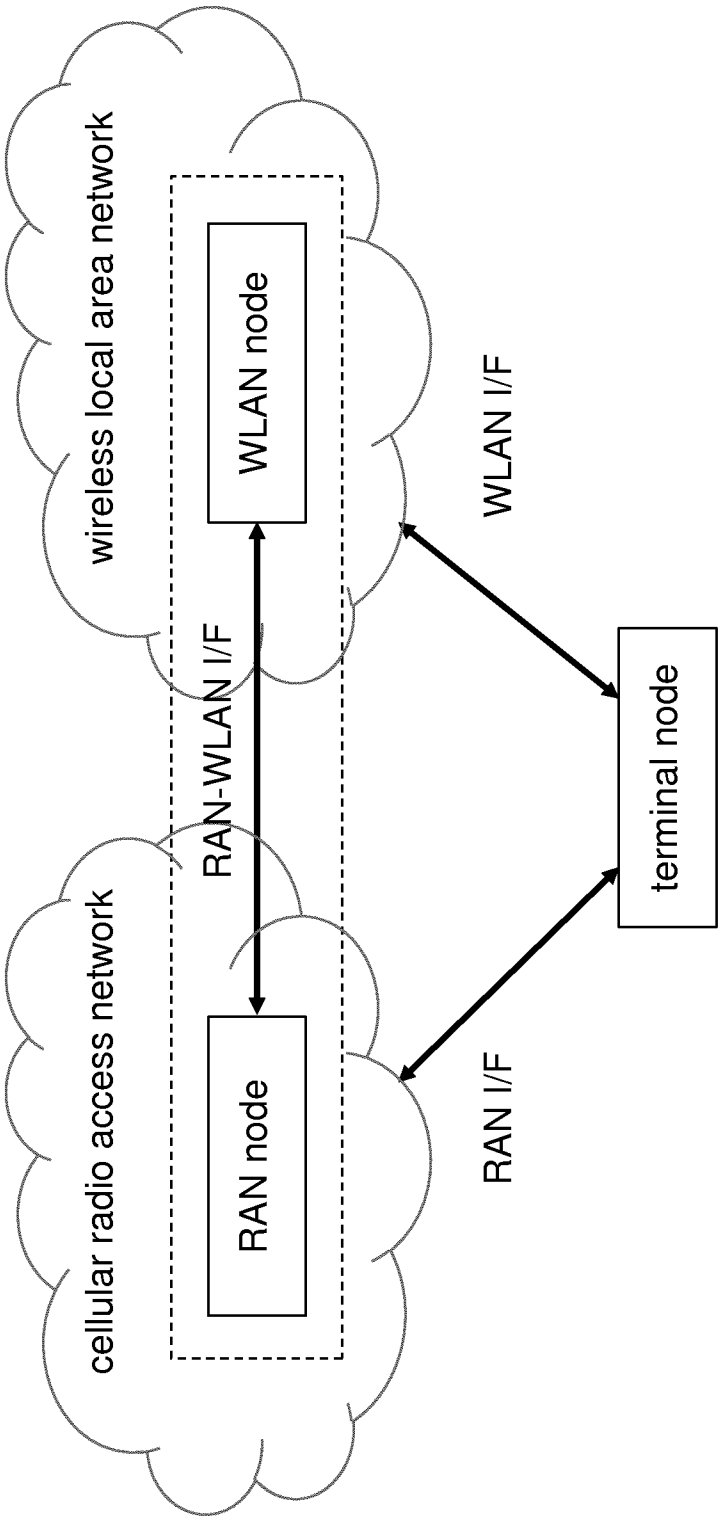

wireless local area network
WLAN node
WLAN I/F
RAN-WLAN I/F
terminal node
cellular radio access network
RAN node
RAN I/F

Figure 1

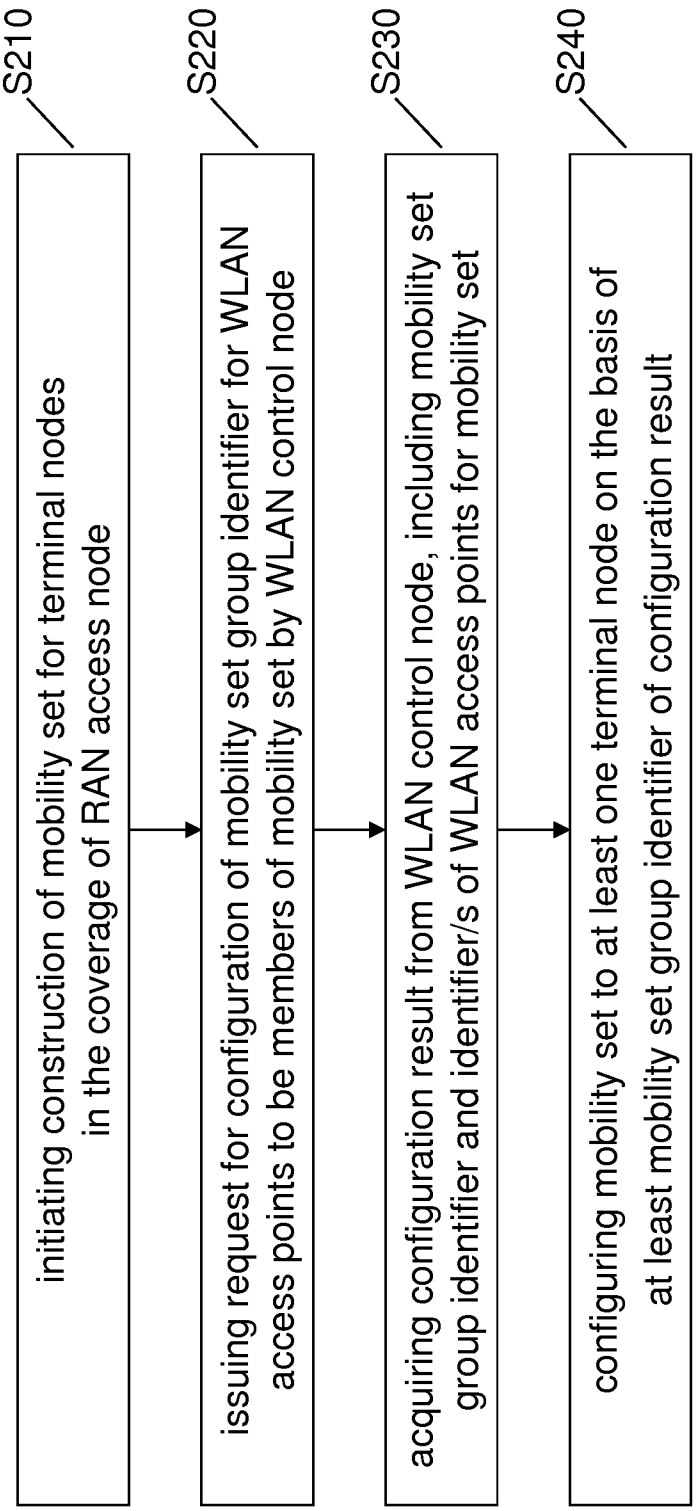

S210
initiating construction of mobility set for terminal nodes in the coverage of RAN access node
S220
issuing request for configuration of mobility set group identifier for WLAN access points to be members of mobility set by WLAN control node
S230
acquiring configuration result from WLAN control node, including mobility set group identifier and identifier/s of WLAN access points for mobility set
S240
configuring mobility set to at least one terminal node on the basis of at least mobility set group identifier of configuration result

Figure 2

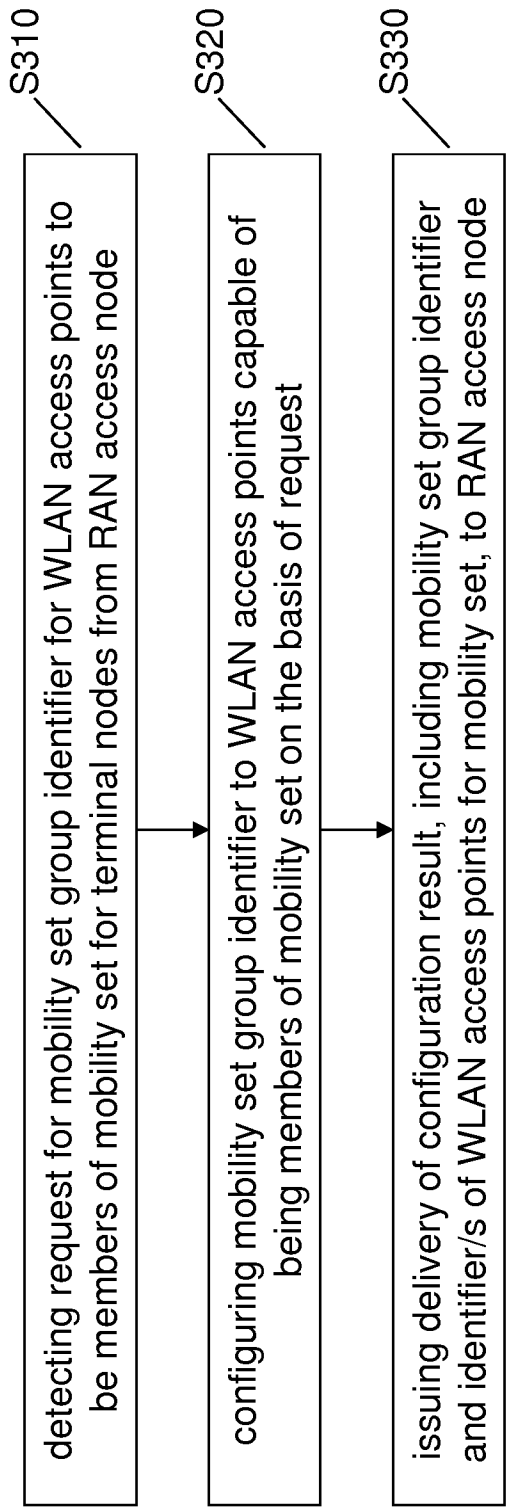

S310
detecting request for mobility set group identifier for WLAN access points to be members of mobility set for terminal nodes from RAN access node
S320
configuring mobility set group identifier to WLAN access points capable of being members of mobility set on the basis of request
S330
issuing delivery of configuration result, including mobility set group identifier and identifier/s of WLAN access points for mobility set, to RAN access node

Figure 3

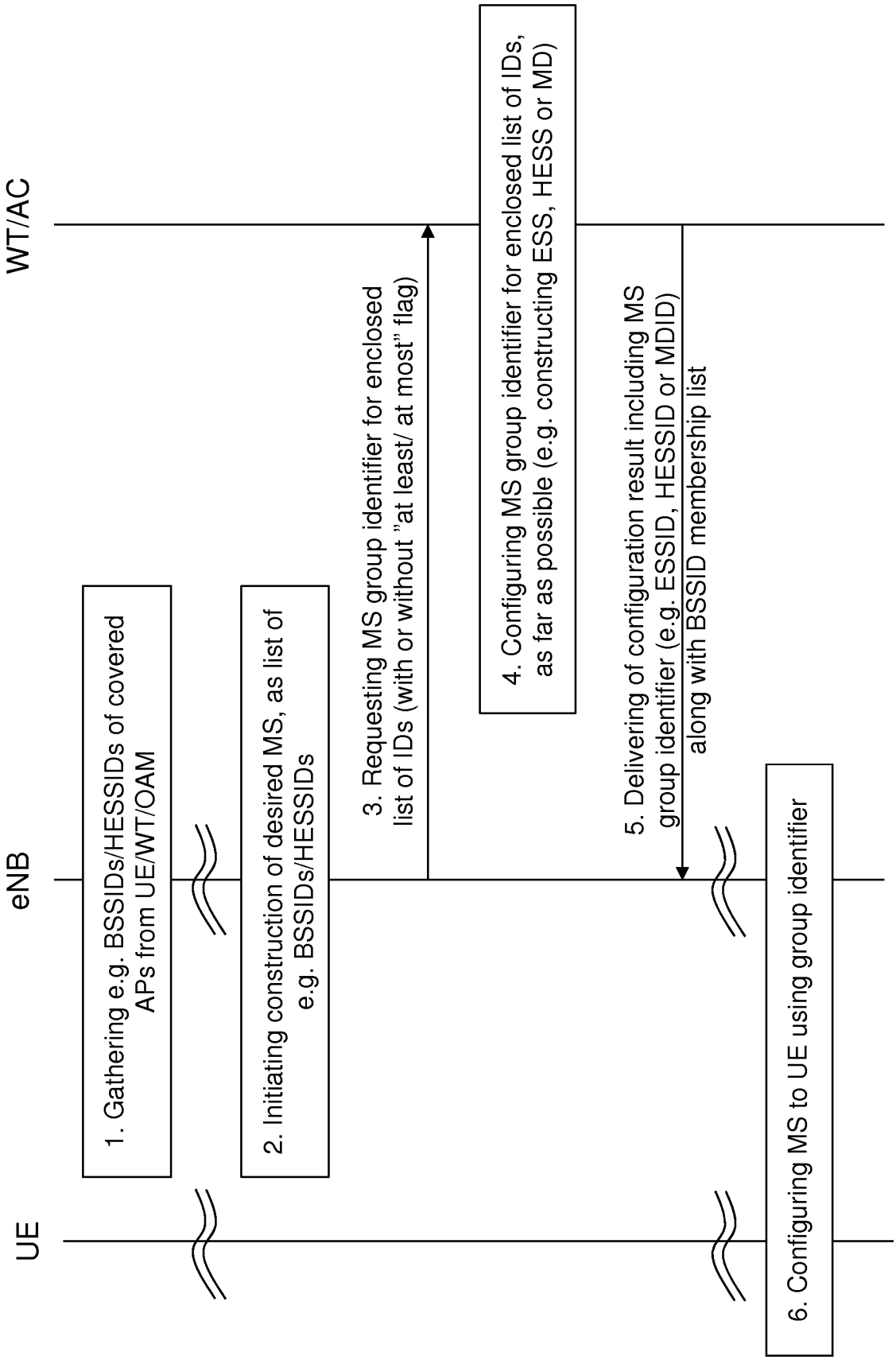

UE
eNB
WT/AC
1. Gathering e.g. BSSIDs/HESSIDs of covered APs from UE/WT/OAM
2. Initiating construction of desired MS, as list of e.g. BSSIDs/HESSIDs
3. Requesting MS group identifier for enclosed list of IDs (with or without "at least/ at most" flag)
4. Configuring MS group identifier for enclosed list of IDs, as far as possible (e.g. constructing ESS, HESS or MD)
5. Delivering of configuration result including MS group identifier (e.g. ESSID, HESSID or MDID) along with BSSID membership list
6. Configuring MS to UE using group identifier

Figure 4

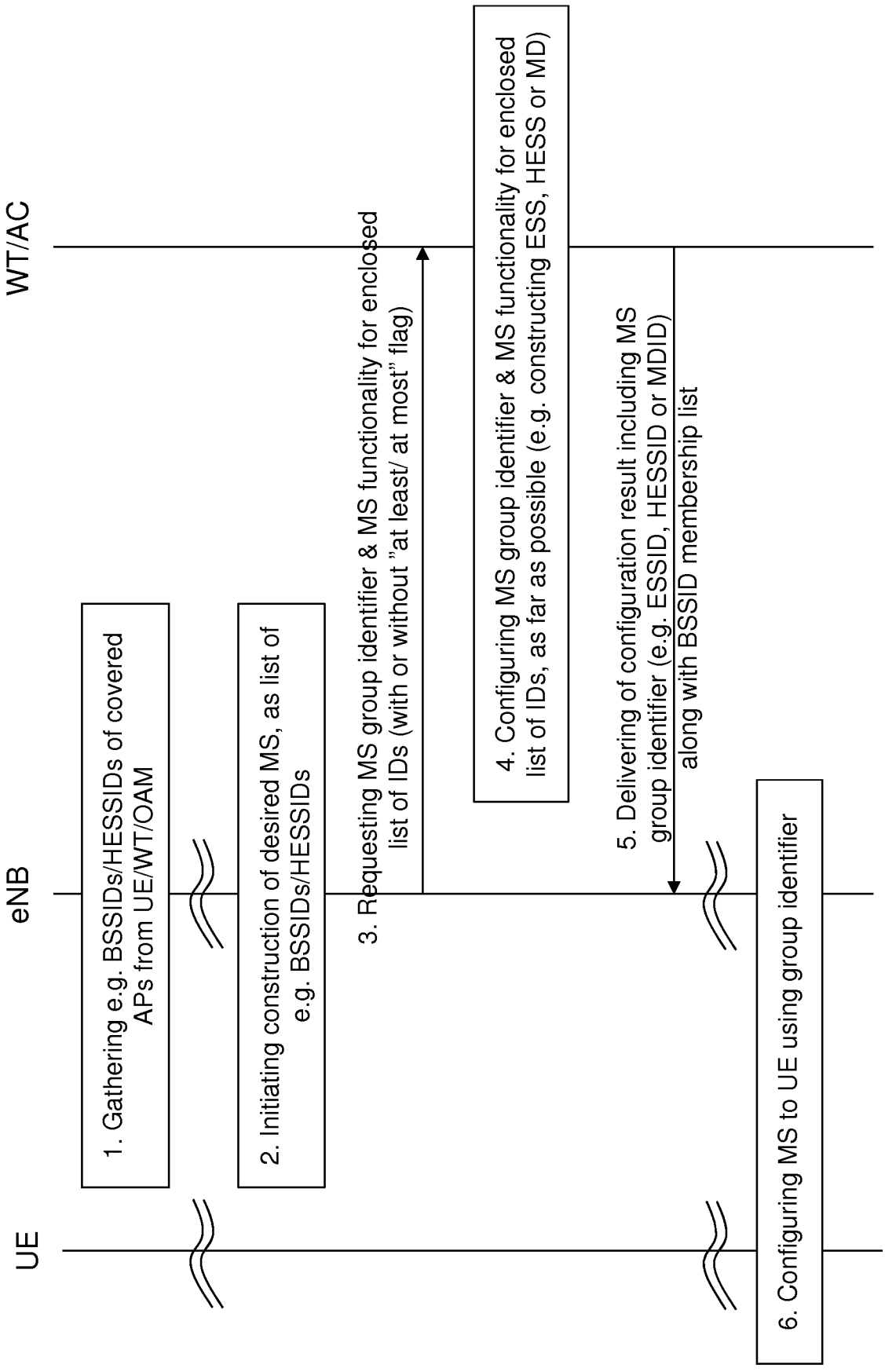

UE
eNB
WT/AC
1. Gathering e.g. BSSIDs/HESSIDs of covered APs from UE/WT/OAM
2. Initiating construction of desired MS, as list of e.g. BSSIDs/HESSIDs
3. Requesting MS group identifier & MS functionality for enclosed list of IDs (with or without "at least/ at most" flag)
4. Configuring MS group identifier & MS functionality for enclosed list of IDs, as far as possible (e.g. constructing ESS, HESS or MD)
5. Delivering of configuration result including MS group identifier (e.g. ESSID, HESSID or MDID) along with BSSID membership list
6. Configuring MS to UE using group identifier

Figure 5

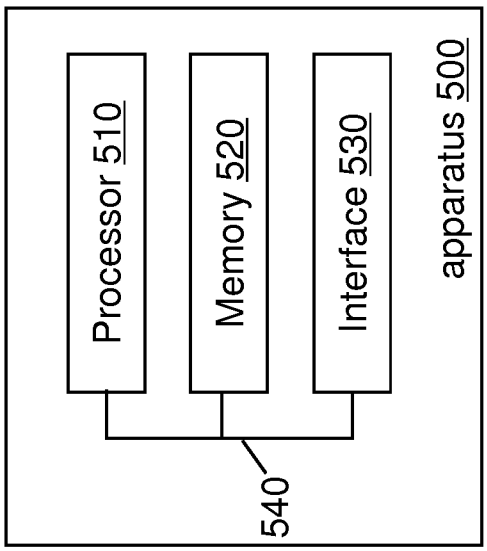


Figure 6

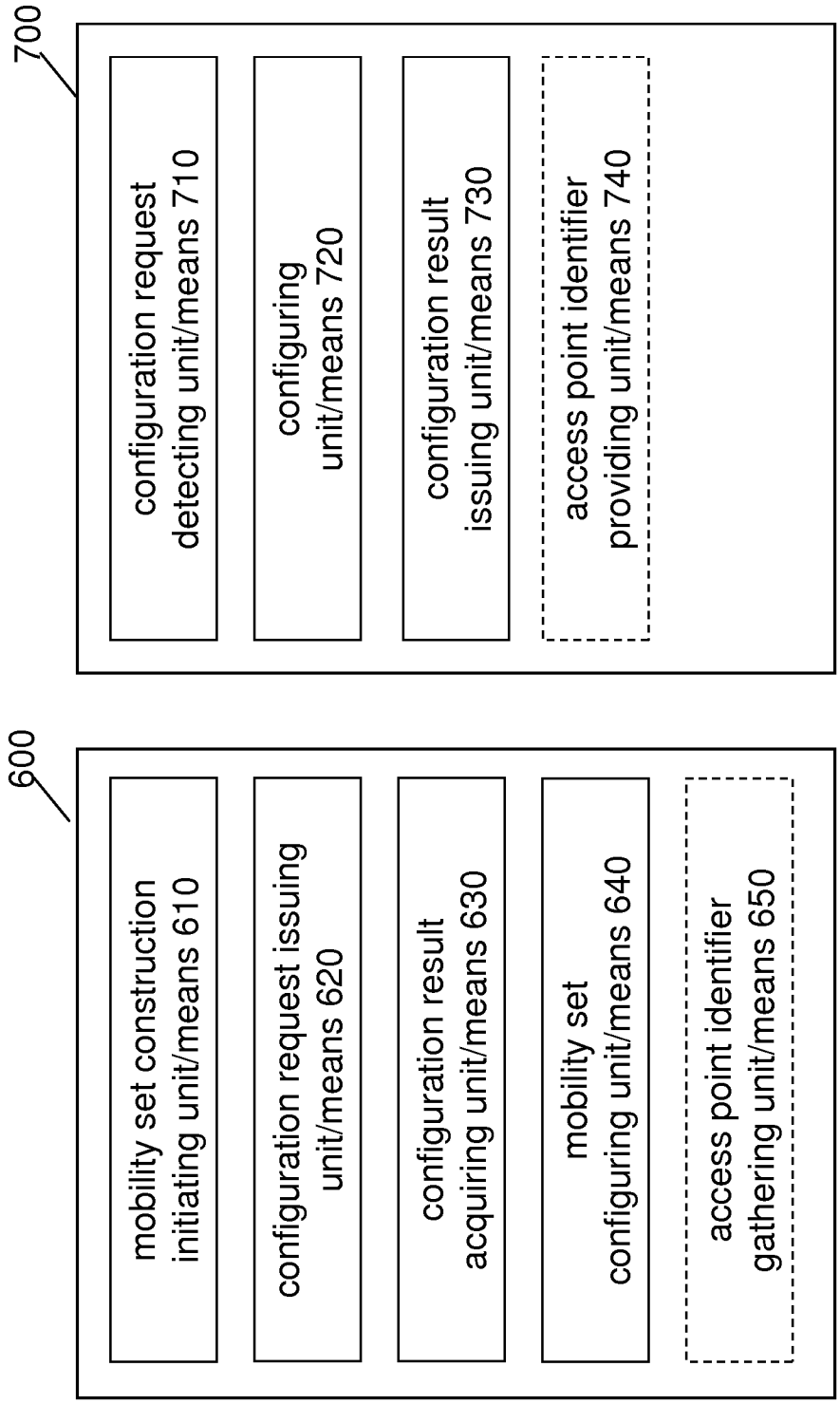

700
configuration request detecting unit/means 710
configuring unit/means 720
configuration result issuing unit/means 730
access point identifier providing unit/means 740
600
mobility set construction initiating unit/means 610
configuration request issuing unit/means 620
configuration result acquiring unit/means 630
mobility set configuring unit/means 640
access point identifier gathering unit/means 650

Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/052255

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W4/00
ADD.

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.
Y	ERICSSON: "Mobility procedures for LTE-WLAN aggregation", 3GPP DRAFT; R2-153689 - MOBILITY PROCEDURES FOR LTE-WLAN AGGREGATION, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; F , vol. RAN WG2, no. Beijing, China; 20150824 - 20150828 14 August 2015 (2015-08-14), XP050993952, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_91/Docs/ [retrieved on 2015-08-14] pages 1-5 figure 2 ----- -/--	1-35

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

[ ] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2016	01/04/2016

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	Pandolfi, Alessandra

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CATT: "RRM Measurements for WLAN", 3GPP DRAFT; R2-154071-RRM MEASUREMENTS FOR LWA AND LWI, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG2, no. Malmo, Sweden; 20151005 - 20151009 4 October 2015 (2015-10-04), XP051004683, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN2/Docs/ [retrieved on 2015-10-04] pages 1-7 -----	1-35
A	MEDIATEK INC: "On configuring mobility sets and measurement reporting for LWA and RCLWI", 3GPP DRAFT; R2-156711 ON CONFIGURING MOBILITY SETS AND MEASUREMENT REPORTING FOR LWA AND RCLWI, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 , vol. RAN WG2, no. Anaheim, USA; 20151116 - 20151120 7 November 2015 (2015-11-07), XP051042469, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_92/Docs/ [retrieved on 2015-11-07] pages 1-2 -----	1-35

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