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(71) Applicant: NOKIA SOLUTIONS AND NETWORKS
OY [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(72) Inventors: BALAN, Irina-Mihaela; Schwannseestrasse
79a, 81549 Munich (DE). SCHWARZBAUER, Hanns
Juergen; Edelweissstraße 2A, 82194 Gröbenzell (DE).
MARKWART, Christian; Metzstrasse 14 a, 81667 Mu-
nich (DE).

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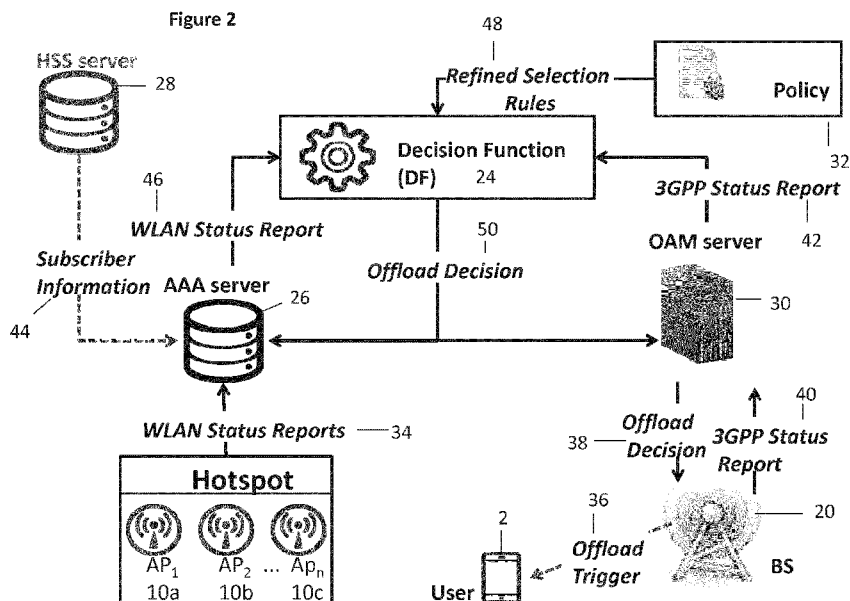
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(54) Title: A METHOD AND APPARATUS



(57) Abstract: A method comprises receiving first load information from at least one access point of a first wireless network, receiving second load information from at least one access point of a second different wireless network, and in dependence on said first load information and said second load information, determining if a user equipment is to be attached to the first wireless network or the second wireless network.

DESCRIPTION

TITLE

A METHOD AND APPARATUS

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This disclosure relates to a method and apparatus and in particular but not exclusively to method and apparatus for traffic steering to and/or from a wireless network.

10 A communication system can be seen as a facility that enables communication sessions between two or more entities such as fixed or mobile communication devices, base stations, servers, machine type communication devices and/or other communication nodes. A communication system and compatible communicating entities typically operate in accordance with a given standard or specification which sets out what the various entities associated with the system are permitted to do and how that should be achieved. For example, the standards, specifications and related protocols can define the manner how various aspects
15 of communication such as access to the communication system and feedback messaging shall be implemented between communicating devices. The various development stages of the standard specifications are referred to as releases.

A communication can be carried on wired or wireless carriers. In a wireless communication system at least a part of communications between stations occurs over a wireless
20 link. Examples of wireless systems include public land mobile networks (PLMN) such as cellular networks, satellite based communication systems and different wireless local networks, for example wireless local area networks (WLAN), also referred to as Wi-Fi. A wireless system can be divided into cells or other radio coverage or service areas provided by a station. Radio service areas can overlap, and thus a communication device in an area can send and
25 receive signals from more than one station. Each radio service area is controlled by an appropriate controller apparatus. Higher level control may be provided by another control apparatus controlling a plurality of radio service areas.

A wireless communication system can be accessed by means of an appropriate communication device. A communication device of a user is often referred to as user equipment (UE) or terminal. A communication device is provided with an appropriate signal receiving and transmitting arrangement for enabling communications with other parties. Typically a communication device is used for enabling receiving and transmission of communications such as speech and data. In wireless systems a communication device provides a transceiver station that can communicate with another communication device such as e.g. a base
30 station and/or another user equipment.
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According to an aspect, there is provided a method comprising; receiving first load information from at least one access point of a first wireless network; receiving second load information from at least one access point of a second different wireless network; and in dependence on said first load information and said second load information, determining if a user equipment is to be attached to the first wireless network or the second wireless network.

The method may comprise receiving operator information from an operator of said second wireless network and using said operator information in said determining.

The operator information may comprise one or more of: keeping said user equipment in said second wireless network as long as possible; diverting traffic of said user equipment from said first network to said network when possible; priority for diverting traffic of said user equipment from said second network to said first network; and using type of traffic of said user equipment to determine if the traffic of said user equipment is to be diverted to the first or the second wireless network.

The first load information from said at least one access point may comprise load information for a plurality of user equipment, at least two user equipment being associated with a plurality of different operators. In some embodiments, the access point information may reflect the total load generated by all user equipment from all operators using that access point.

The first wireless network may be a wireless local area network.

The method may comprise receiving group information about a plurality of access points of said first wireless network, said plurality of access points defining a group, and using said group information in said determining.

The group may be a hotspot.

In some embodiments, access point specific information is grouped to form hot spot information.

The method may comprise receiving said first load information via a server of said second wireless network.

The server of said second wireless network may be an authentication, authorization and accounting server.

The second wireless network may be a wireless cellular network.

The wireless cellular network may be a 3GPP network.

According to another aspect, there is provided a method comprising; determining load information for a least one access point of a first wireless network, said load information

associated with a plurality of user equipment, at least two user equipment being associated with different operators; and causing said load information to be provided to an apparatus associated with one of said different operators.

5 The load information may comprise total load of said at least one access point or amount of available resource of said at least one access point.

According to another embodiment, there is provided an apparatus which is configured to perform the previous method (s).

10 According to another embodiment, there is provided an apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: receive first load information from at least one access point of a first wireless network; receive second load information from at least one access point of a second different wireless network; and in dependence on said first load information and said second load information, determine if a user equipment is to be attached to the first
15 wireless network or the second wireless network.

The at least one memory and the computer code may be configured, with the at least one processor, to receive operator information from an operator of said second wireless network and using said operator information in said determining.

20 The operator information may comprise one or more of: keeping said user equipment in said second wireless network as long as possible; diverting traffic of said user equipment from said first network to said network when possible; priority for diverting traffic of said user equipment from said second network to said first network; and using type of traffic of said user equipment to determine if the traffic of said user equipment is to be diverted to the first or the second wireless network.

25 The first load information from said at least one access point may comprise load information for a plurality of user equipment, at least two user equipment being associated with a plurality of different operators. In some embodiments, the access point information may reflect the total load generated by all user equipment from all operators using that access point.

30 The first wireless network may be a wireless local area network.

The at least one memory and the computer code may be configured, with the at least one processor, to receive group information about a plurality of access points of said first wireless network, said plurality of access points defining a group, and using said group information in said determining.

35 The group may be a hotspot.

In some embodiments, access point specific information is grouped to form hot spot information.

The at least one memory and the computer code may be configured, with the at least one processor, to receive said first load information via a server of said second wireless
5 network.

The server of said second wireless network may be an authentication, authorization and accounting server.

The second wireless network may be a wireless cellular network.

The wireless cellular network may be a 3GPP network.

10 According to another embodiment, there is provided an apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: determine load information for a least one access point of a first wireless network, said load information associated with a plurality of user equipment,
15 at least two user equipment being associated with different operators; and cause said load information to be provided to an apparatus associated with one of said different operators.

According to another aspect, there is provided an apparatus comprising; means for receiving first load information from at least one access point of a first wireless network; means for receiving second load information from at least one access point of a second dif-
20 ferent wireless network; and means for determining if a user equipment is to be attached to the first wireless network or the second wireless network in dependence on said first load information and said second load information.

The apparatus may comprise means for receiving operator information from an operator of said second wireless network, said determining means being for using said operator
25 information in said determining.

The operator information may comprise one or more of: keeping said user equipment in said second wireless network as long as possible; diverting traffic of said user equipment from said first network to said network when possible; priority for diverting traffic of said user equipment from said second network to said first network; and using type of traffic of said
30 user equipment to determine if the traffic of said user equipment is to be diverted to the first or the second wireless network. The first load information from said at least one access point may comprise load information for a plurality of user equipment, at least two user equipment being associated with a plurality of different operators. In some embodiments, the access point information may reflect the total load generated by all user equipment from all opera-
35 tors using that access point.

The first wireless network may be a wireless local area network.

The apparatus may comprise means for receiving group information about a plurality of access points of said first wireless network, said plurality of access points defining a group, and using said group information in said determining.

5 The group may be a hotspot.

In some embodiments, access point specific information is grouped to form hot spot information.

The means for receiving the first load information may be for receiving said first load information via a server of said second wireless network.

10 The server of said second wireless network may be an authentication, authorization and accounting server.

The second wireless network may be a wireless cellular network.

The wireless cellular network may be a 3GPP network.

15 According to another aspect, there is provided an apparatus comprising; means for determining load information for a least one access point of a first wireless network, said load information associated with a plurality of user equipment, at least two user equipment being associated with different operators; and means for causing said load information to be provided to an apparatus associated with one of said different operators.

20 A computer program comprising program code means adapted to perform the method(s) may also be provided. The computer program may be stored and/or otherwise embodied by means of a carrier medium.

In the above, many different embodiments have been described. It should be appreciated that further embodiments may be provided by the combination of any two or more of the embodiments described above.

25 Various other aspects and further embodiments are also described in the following detailed description and in the attached claims.

Embodiments will now be described in further detail, by way of example only, with reference to the following examples and accompanying drawings, in which:

Figure 1 shows an access point which is shared by two mobile network operators;

30 Figure 2 shows an architecture in which some embodiments may be used, with information passed between the architectural elements;

Figure 3 shows an example, where a decision function (DF) is implemented in a server;

Figure 4 shows the message flow in some embodiments;

Figure 5 shows a vendor specific attribute to transport WLAN status information; and Figure 6 shows a control apparatus.

Growing traffic demands over recent years have been forcing Mobile Network Operators (MNOs) of wireless cellular networks to look at how to handle user traffic. In the complex landscape of Heterogeneous Networks (HetNets), MNOs are investigating possibilities of steering traffic to different Radio Access Technologies (RATs) and/or layers (macro cells, small cells, etc.). An aim is to improve the end user experience and the network performance. This may be achieved if the available network assets can be effectively used while minimizing additional complexity.

One option for satisfying the demands of data hungry user equipment is Traffic Steering (TS) towards a WLAN (Wireless Local Area Network). A WLAN may have one or more of the following advantages: simple and widespread deployment; cost efficiency; and publicly available spectrum.

However, in order to take advantage of these benefits, the interworking between the wireless cellular networks and WLAN networks should be controlled.

In order for an MNO to steer traffic between a wireless cellular network and WLAN, two issues may be addressed. Firstly, the MNO needs to determine the performance of both networks in order to attempt to always provide a good level of user experience. Secondly, a method to distribute the user equipment traffic by steering mechanisms needs to be provided. In some embodiments, a solution may be based on existing protocols and standards.

Efficient TS decisions may need to take into account the load of possible networks to which the user equipment traffic is steered.

Some 3GPP proposals assume little to no information on WLAN load. In 3GPP networks, load can be easily quantified and exchanged between nodes for load balancing and TS purposes. However, the assessment of the WLAN load is a more complex issue as not only individual APs need to be taken into account, but also the grouping of these APs into a hotspot. WLAN load measurements performed by the UE may be used, but these measurements may not be reliable.

Some embodiments may provide more complete and accurate WLAN load information to a DF (Decision Function). In some embodiments, this information may be provided directly from the source (WLAN AP (access point)) that is used for the TS decisions.

3GPP prefers EAP (Extensible Authentication Protocol) authentication, especially EAP-SIM (Extensible Authentication Protocol - Subscriber Identity Module) and EAP-AKA (Extensible Authentication Protocol - Authentication and Key Agreement) when an UE connects via non-3GPP radio technologies such as WLAN to the Core Network. EAP authenti-

cation uses the RADIUS (Remote Authentication Dial In User Service) protocol to provide UE specific information (for example data amount, login time, logout time and/or the like), i.e. this information is available for the MNO at any point in time.

However, to rely only on the number of concurrently logged in user equipment (i.e. UEs that are connected and authenticated via a WLAN AP, sometimes referred to as stations (STA) in WLAN specifications) at the WLAN Access Point (AP) may not be a good measure for load. The reason for this is that there are different WLAN AP types and/or vendors. For example some APs are arranged to support many concurrent user equipment whilst others provide better throughput, but support less user equipment. These settings may not be easy to determine, for example in large Hotspots consisting of a large number of indoor and outdoor AP types.

Furthermore, some Hotspots (e.g. WLAN APs in airports or hotels) need to support services for the user equipment of two or more MNOs.

In Figure, 1 a simplified example for such a situation is shown, where operator MNO1 and MNO2 have a contract with a Wireless Internet Service Provider (WISP) to share a WLAN AP 10 at least in one geographical area. Each WLAN AP will broadcast a plurality of SSIDs, one for each mobile operator (in this case, SSID1 used by user equipment 16 and SSID2 used by user equipment 18). It should be appreciated that SSIDs are bound to a specific authentication method, i.e. typically it may be that an operator has to broadcast more than one SSID.

Via the information provided during the authentication and accounting procedure, each MNO will be aware of the number of its own UE that are currently logged in and their resource consumption (load) at the WLAN AP. However, the MNO will not be aware of the other MNO's load on the AP, since this user specific data belongs to the other operator to which the other user equipment are subscribed.

TS decisions in some embodiments take into account the load of both the wireless cellular network and the WLAN network. Based on defined KPI (Key Performance Indicator) measurement data, the load conditions may be known in a 3GPP network. For the WLAN network, there may be a plurality of operators. An operator may be an MNO, an Internet Service Provider (ISP) or a partner HS (Hotspot). A partner HS is a HS that is operated by a WISP but not by the MNO. In situations where the HS is operated by a WISP, information that is necessary for determining the total load of the AP in a HS, is typically protected and not provided to any other operator having sharing rights for this HS. Some embodiments may provide a mechanism for translating this plurality of operator specific data to global load indicator information for APs that belong to the HS.

Reference is made to Figure 2 which shows the architecture in which some embodiments may be provided.

A base station 20 is provided. The base station belongs to a cellular network and may for example be a 3GPP base station. The base station is arranged to communicate with a user equipment 2. A WLAN network is also provided. Schematically shown in Figure 2 are three access points (APs) 10a, 10b and 10c grouped together forming a WLAN hotspot. Each access point is configured to communicate with an AAA (Authentication Authorization and Accounting) server 26. The AAA server is part of the MNO's wireless cellular network and is configured to communicate with an HSS (Home Subscriber Server) 28.

The Decision Function 24 is configured to communicate with the AAA server 26 and with an OAM (Operation Maintenance and Administration) server 30. It should be appreciated that the base station 20 is also configured to communicate with this OAM server 30. An offload decision function DF 24 will be described in more detail.

The Decision Function (DF) receives, via interfaces, status information from the 3GPP network and the WLAN. The DF uses this information with additional MNO input (for example policies 32) in order to control which network currently should accommodate the user traffic. The DF may be triggered whenever the Base Station or an Access Point of the Hotspot sends new status information.

In an example, the BS may be connected via the interface Itf-S (southbound interface as defined by 3GPP) to the OAM server 30. The OAM server 30 may be connected to the AAA server 26 via an XML SOAP (extensible markup language – simple object access protocol), LDAP (lightweight directory access protocol), RADIUS or Diameter interface. The AAA server 26 is connected to the APs in the HS via RADIUS interfaces. Additionally, the AAA server provides an SS7 or Diameter interface to the HSS for the EAP-SIM and EAP-AKA authentication of WLAN users.

Based on one or more predefined conditions, the 3GPP base station (BS) or the OAM server to which the BS is connected, generates status information and sends it to the DF. The BS may provide a status report 40 to the OAM server which in turn provides that report 42 to the DF 24. In some embodiments, the OAM server 30 may provide additional information with the information received from the BS. In other embodiments the OAM server may simply forward the information received from the BS. In some embodiments, the report is not generated by the BS but instead is generated by the OAM server. In this latter case, the OAM server may use information from BS.

The one or more predefined conditions may be one or more of the following: timer expiry, triggering condition fulfilment or the like.

From the WLAN side, WLAN Status Reports 34 are sent from each AP belonging to the HS to the DF 24 using an interface that also supports the communication between the MNO and the WISP. In Figure 2, an example is shown where the delivery path has two components. Each access point 10a, 10b or 10c delivers the WLAN information to the MNO network and in particular the AAA server 26 using the standardized RADIUS protocol. Once inside the MNO network, RADIUS or any other suitable protocol can be used to deliver these reports from the AAA server to the DF.

For overload detection of an AP, the WLAN Status Information contains any suitable measure of the AP load. For example, the information may be a direct measure of load of the AP such as CPU usage, free resources or the like. The information may additionally or alternatively include low layer load indicators such as channel resource utilization, throughput, queuing delay, or the like. This information takes into account the total load of the AP, regardless whether the UEs generating this load belong to one MNO or another operator.

Depending on the AP implementation, there may be a single load indicator that quantifies the free or used current capacity of the AP.

To transport the WLAN status information to the MNO network, the RADIUS protocol between the AP and the AAA Server of the MNO is used. More specifically, the RADIUS Authentication (including re-authentication) and Accounting messages are used. When the WLAN status information is required more frequently, RADIUS interim Accounting messages may be used to transport that information. When the AAA Server 26 of the MNO receives the RADIUS messages with the WLAN Status Report 34, the AAA server optionally provides additional load information for the AP and the HS to which the AP belongs. Such additional load information, for example the total number of concurrent logged in user equipment of all operators using that AP and/or their traffic behaviour for the HS and the AP may already be known in the AAA server due to the RADIUS Authentication and RADIUS Accounting tickets. All WLAN Status Report (optionally including the additional load information) 46 is forwarded to the DF using any suitable interface. For example in some embodiments, the existing RADIUS protocol may be re-used. In other words the AAA server works for the DF as a RADIUS proxy server.

Whenever status information (3GPP or WLAN status information) is received from either system (e.g. OAM and/or AAA server), the DF checks the load status of both networks and reacts accordingly as presented in Table 1 below.

Case	3GPP load	HS load	DF behaviour
1.	Not overloaded	Not overloaded	Do nothing
2.	Not overloaded	Overloaded	Offload user equipment from WLAN to 3GPP
3.	Overloaded	Not overloaded	Offload user equipment from 3GPP to WLAN
4.	Overloaded	Overloaded	Use configurable policy provided by MNO

Table 1: 3GPP and WLAN load status and required DF behaviour

More specifically, an Offload Decision 50 is reached by the DF and pushed to the AAA sever 26 and BS 20. The BS 20 may be addressed directly or via the OAM server 30, which acts as a mediation function.

When an UE wants to connect to any one of the WLAN AP 10a, 10b, or 10c of the HS the EAP authentication procedure is started and the respective AP adds the WLAN load information as a WLAN Status Report 34 to the RADIUS Access Request message. When the RADIUS Access Request is received by the AAA Server 26, the WLAN Status Report is extracted and optionally modified with additional load information before being forwarded as a WLAN Status Report 46 to the DF 24. The DF checks the AP load, the HS load, and the BS load (3GPP load).

When the AP is overloaded, the DF informs the AAA Server to reject the authentication request of the user equipment and sets the AP status to overloaded. When the AP is not overloaded, the DF sets the AP status to having free capacity and performs HS load detection. Only when the HS also has free capacity the DF 24 informs the AAA Server 26 to accept the authentication request of the user equipment. If the HS is overloaded, the AAA server 26 is informed that it should reject the authentication request.

In some situations, it may be difficult to rate and detect an overload situation of a HS based on performance indicators of a single AP, especially when the HS is operated by a WISP and the WISP does not provide such information. To address this, the DF may calculate the overload indication of the HS based on information received from the APs that belongs to the HS. Via a configurable threshold (e.g. 80% of APs in HS are in overload) the HS overload indicator is determined by checking the overload status of each single AP and

checking the rate of overloaded APs against the threshold. A second threshold may be configured as an ON/OFF hysteresis to avoid toggling between HS overload and not overloaded detection. It is also possible to assign different weights to the APs according to their average throughput in uplink and downlink per logged-in user equipment.

5 The DF 24 may be arranged to provide an offload decision 50 which is provided as required to one or other or both of the AAA server and OAM server. The OAM server will provide the offload decision to the BS which will, if required, broadcast an offload trigger. The AAA server will provide the offload decision if required to the concerned AP in the hot-spot.

10 In the above table, case 1 is the situation in which neither network is overloaded. In this case, user equipment are allowed to enter the WLAN and 3GPP network and other already logged in user equipment can continue being served in their current network or, based on refined selection rules 48 provided by a policy server 32, some of them be pulled back to the 3GPP network via the re-authentication mechanism.

15 If the DF detects case 2, i.e. the HS is overloaded, the DF offloads user equipment that are connected to an AP that is overloaded. The offload may be performed whenever a re-authentication has provided the WLAN Status Information as described above. The DF may also use additional load information provided by the AAA Server or Subscriber related information to offload specific subscriber types to the 3GPP network. For this the AAA server
20 will obtain subscriber information 44 from the HSS server 28 and may send that to the DF. That information may be sent separately or with the WLAN status information. It should be appreciated that any other suitable mechanism may be used to provide the subscriber information to the DF.

 In case 3, the DF informs the BS 20 that the Offload Trigger 36 should be broad-
25 casted to user equipment 2. On reception of this broadcast, the user equipment will most likely try to access the WLAN. The exact behaviour of the user equipment is determined by its internal logic and the WLAN interface status (e.g. ON/ OFF) over which the MNO has limited or no control.

 With every access request or re-authentication to an AP of a HS, the AAA Server of
30 the MNO may ask the DF to decide the current load for the AP and the HS. If an AP or the HS becomes overloaded, further log in attempts into this AP will be rejected. Thus user equipment may be forced to try to connect to a different AP and determine the load to be distributed between the APs of the HS.

 In case 4, the DF may decide to reassess the HS overload based on a second load
35 threshold (e.g. 95% of APs in HS are overloaded) and try to offload more user equipment

from 3GPP to WLAN. If, as a result, both networks are still overloaded, no further actions are taken and the offload trigger may be cleared in the BS.

The actions that need to be performed on the 3GPP side at the transition between the four cases are as follows:

- 5 • If entering a state with 3GPP overload (case 3 and 4), the DF has to inform the BS to send the Offload Trigger
- When entering a state with no 3GPP overload (cases 1 and 2), this trigger has to be cleared
- If transitioning between states with no 3GPP load change, no further actions regarding the Offload Trigger are needed.
- 10 • Depending on how case 4 is handled by the operator policy, the Offload Trigger may also be cleared in this case

The offload decision 50 derived by the DF can be further refined using the selection rules 48 provided by policy server 32. On the AAA server side, these refined rules are enforced using Subscriber Information provided by the Home Subscriber Server (HSS) or another system that provides subscriber related information to the MNO network (e.g. User Repository or Billing Database).

The refined selection rules may for example be keep user equipment in 3GPP as long as possible and pull them back from WLAN once the 3GPP overload situation has cleared. Another example may be to have priorities for offloading (i.e. gold user equipment first) and/or to offload only certain types of traffic (e.g. streaming) to WLAN.

The DF can be implemented on a dedicated server, in a centralized manner or in a decentralized way, split between two or more entities (OAM, AAA server, BS, and SON (self-organising network) servers).

25 The DF may be extended to support one or more additional networks, e.g. a second WLAN network and/or a 3GPP small cell network and/or parallel UMTS and LTE networks to provide load balancing between the networks.

The DF may be used for offloading user equipment from 3GPP to WLAN networks due to energy saving decisions in 3GPP or WLAN. For this case, the status information in the alarm messages and RADIUS VSAs (Vendor Specific Attributes) may be provided to allow the DF to receive and react on the additional information. In this regard, reference is made to Figure 5 which shows an example of a VSA to transport the WLAN status information from a WLAN AP to the AAA server via its inclusion in the WISP vendor specific attribute RADIUS list.

When an overload situation is detected for an individual AP or all APs in a HS or/and 3GPP BS, the traffic of the currently logged-in user equipment may be shaped as requested by the DF. The DF triggers the policy server 32 which provides the respective actions to the WLAN and/or 3GPP network. The data rate of the user equipment may be limited, for example.

The BS sends may send status Information via alarms according to, for example, ITU-T Rec.X.733 specification. The load status (e.g. overloaded, not overloaded) may be set with the event type of QoS and the probable cause as congestion or threshold crossed, while associated information (e.g. KPIs and current user count) may be provided via an additional information field.

In one example which will now be described with reference to Figure 4, the BS is designed to handle 100 user equipment. Of course, this number can vary based on the user profiles (e.g. 80 data heavy user equipment or 120 http serving user equipment). A threshold to supervise the number of concurrent user equipment at the BS may be configured with an on/ off hysteresis to avoid frequent toggling between alarm generation and alarm clearing situations at the BS.

One known interface in the 3GPP system is an alarm mechanism used by e.g. fault management application. This mechanism allows an alarm to be sent either directly from the BS to the DF or via further OAM systems using standardized alarm forwarding mechanisms. The alarm is to include the overload indicator (for overload detection) and may include additional information (e.g. number of current user equipment at the BS, KPIs, etc.) to allow a fine granular evaluation at the DF. Additionally, the Network entity that generates the alarms (BS or OAM) provides the corresponding alarm cleared message, once the overload is cleared. The alarm cleared messages are also sent to the DF. This may be used in some embodiments and is used in the embodiments described in relation to Figure 4.

When the system is started, in step S1, the DF stays in the previously detected case, for example case 1 as described in Table 1.

In step S2, the BS detects an overload situation (e.g. 80 served user equipment).

In step S3, as soon as the overload situation is detected, an alarm, containing the 3GPP Status Information, is generated by the BS 20 and sent to the DF.

In step S4, assuming no further information is received from the WLAN side at the DF, case 3 will be detected.

As a consequence, in steps S5, as described before, the DF will provide the offload decision to the BS which in turn causes the offload trigger to be broadcast by the BS.

In step S6, the BS detects that the overload is cleared (e.g. 70 served user equipment).

In step S7, in response to the overload being cleared, the overload cleared indication will be generated and sent as the alarm cleared to the OAM.

5 In step S8, this triggers the DF to detect case 1 or 2.

In step S9, the DF sends a clear-offload decision which is to cause the BS to stop broadcasting the offload trigger.

Reference is made to Figure 3 which schematically shows an example of a system where the DF and the OAM server are implemented as part of an OSS (Operations Support
10 System) 22.

In one example, there are three access points AP1, AP2, and AP3 belonging to the HS. It should be appreciated that there may be more or less than three access points belonging to the HS. The association of APs to HS is known by the AAA server and also forwarded to the DF. Each AP may support a function that updates a WLAN status indicator
15 which is calculated using an internal lower layer measurement (e.g. number of logged in user equipment at the AP when providing to each user at least 64 kb/s or some other threshold). Each AP in the HS has the capability to serve up to 25 (or some other number) concurrent logged in user equipment before the throughput drops below 64 kb/s or some other threshold. The HS overload detection in the DF is set when e.g. two out of three APs
20 are reporting overload. The WLAN status indicator can be accessed by the RADIUS client of the AP and has two states:

- WLAN AP is overloaded, set when 25 user equipment are logged in at the AP and the CPU load of the AP is above a first value for example 80%
- WLAN AP is not overloaded, set when less than 20 user equipment are logged in at
25 the AP and the CPU load is less than a second value for example 50%

To avoid toggling between the WLAN overloaded and not overloaded states, the WLAN system will not change its previous state between the two values mentioned above (i.e. if overload was detected, the WLAN will declare no overloading only when it reaches 20 or less user equipment and CPU load is less than 50%).

30 Whenever a user equipment connects to an AP, an authentication procedure is started. The AP reads the WLAN status indicator and adds this information as a VSA to the RADIUS Authentication Request that is sent to the AAA server.

The AAA server will then forward this message via a direct soap XML interface to the DF.

The WLAN status indicator may be sent with every RADIUS Authentication and Accounting message. RADIUS Authentication messages passed to the DF are used to decide if access is granted to the requesting user based on the method described previously. RADIUS Accounting messages are used only to update the HS load state.

5 The traffic steering may require that on the WLAN the re-authentication option is enabled. This may be achieved by using the Session-Timeout and Termination-Action attributes number 27 and 29 as defined by GSM Association (GSMA) in IR.61. The re-authentication is steered by the AAA Server via the RADIUS Authentication Reply message and forces the user equipment to send a new RADIUS Authentication Request as soon as
10 the session timeout expires.

Some embodiments may have advantages that may require no changes in protocols or standards and/or enable real-time traffic steering to WLAN and 3GPP networks for MNOs. Since the 3GPP status Information may only be used inside the MNO network and the WLAN Status Information contains global information only, no sensitive load and/or performance information is leaked. In some embodiments, the MNO has direct control on the end-to-end TS procedure between the WLAN and 3GPP network, offering bi-directional offload capabilities.

Figure 6 shows a control apparatus. The apparatus 300 comprises at least one memory 301, at least one data processing unit 302 and an input/output interface 304. Via
20 the interface the apparatus can be coupled to receive information and/or commands and/or provide as output information and/or commands.

The DF may be implemented with the apparatus of Figure 6. The apparatus 300 can be configured to execute an appropriate software code to provide the DF functions.

The apparatus of Figure 6 can alternatively or additionally be used to provide the
25 WLAN status reports and may determine the loading in one or more access points and/or hotspot. The apparatus may be provided in one or more access points and/or an access point controller.

An example of wireless communication systems are architectures standardized by the 3rd Generation Partnership Project (3GPP). A latest 3GPP based development is often
30 referred to as the long-term evolution (LTE) of the Universal Mobile Telecommunications System (UMTS) radio-access technology. The various development stages of the 3GPP LTE specifications are referred to as releases. More recent developments of the LTE are often referred to as LTE Advanced (LTE-A). The LTE employs a mobile architecture known as the Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

Embodiments have been described in relation to WLAN and 3GPP networks. It should be appreciated that these two networks are by way of example only. In some embodiments, other cellular communication networks may be used instead of 3GPP networks. Other suitable wireless local networks can be used instead of the WLAN network. Some
5 embodiments may be used with any two or more suitable networks.

Some of the embodiments have described certain threshold values and/or or numbers of user equipment. These numbers are by way of example only and any other suitable values and/or numbers may alternatively or additionally be used.

An appropriate user equipment may be provided by any device capable of sending
10 and receiving radio signals. Non-limiting examples include a mobile station (MS) or mobile device such as a mobile phone or what is known as a 'smart phone', a computer provided with a wireless interface card or other wireless interface facility, personal data assistant (PDA) provided with wireless communication capabilities, or any combinations of these or the like.

The described functions may be provided by separate processors or by an integrated
15 processor. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASIC), gate level circuits and processors based on multi core processor architecture,
20 as non limiting examples. The data processing may be distributed across several data processing modules. A data processor may be provided by means of, for example, at least one chip. Appropriate memory capacity can also be provided in the relevant devices. The memory or memories may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor
25 based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory.

An appropriately adapted computer program code product or products may be used for implementing the embodiments, when loaded or otherwise provided on an appropriate data processing apparatus. The program code product for providing the operation may be
30 stored on, provided and embodied by means of an appropriate carrier medium. An appropriate computer program can be embodied on a computer readable record medium. A possibility is to download the program code product via a data network. In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Embodiments may be practiced in various components such as
35 integrated circuit modules. The design of integrated circuits is by and large an automated

process. Complex and powerful tools are available for converting a logic level design into a semiconductor circuit design ready to be formed on a semiconductor substrate.

5 The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. For example, a combination of one or more of
10 any of the other embodiments previously discussed can be provided. All such and similar modifications of the teachings of this invention will still fall within the scope of this invention as defined in the appended claims.

CLAIMS:

1. A method comprising;
receiving first load information from at least one access point of a first wireless net-
5 work;
receiving second load information from at least one access point of a second differ-
ent wireless network; and
in dependence on said first load information and said second load information, de-
termining if a user equipment is to be attached to the first wireless network or the second
10 wireless network.
2. A method as claimed in claim 1, comprising receiving operator information from an
operator of said second wireless network and using said operator information in said deter-
mining.
15
3. A method as claimed in claim 2, wherein said operator information comprises one or
more of:
keeping said user equipment in said second wireless network as long as possible; di-
verting traffic of said user equipment from said first network to said network when possible;
20 priority for diverting traffic of said user equipment from said second network to said
first network; and
using type of traffic of said user equipment to determine if the traffic of said user
equipment is to be diverted to the first or the second wireless network.
4. A method as claimed in any preceding claim, wherein said first load information from
25 said at least one access point comprises load information for a plurality of user equipment, at
least two user equipment being associated with a plurality of different operators.
5. A method as claimed in any preceding claim, wherein said first wireless network is a
wireless local area network.
30
6. A method as claimed in any preceding claim, comprising receiving group information
about a plurality of access points of said first wireless network, said plurality of access points
defining a group, and using said group information in said determining.

7. A method as claimed in claim 6, when appended to claim 5, wherein said group is a hotspot.

8. A method as claimed in any preceding claim, comprising receiving said first load information via a server of said second wireless network.

9. A method as claimed in claim 8, wherein said server of said second wireless network is an authentication, authorization and accounting server.

10. A method as claimed in any preceding claim, wherein said second wireless network is a wireless cellular network.

11. A method as claimed in claim 10, wherein said wireless cellular network is a 3GPP network.

12. A method comprising;
determining load information for a least one access point of a first wireless network, said load information associated with a plurality of user equipment, at least two user equipment being associated with different operators; and

causing said load information to be provided to an apparatus associated with one of said different operators.

13. A computer program product comprising computer executable instructions which when run cause the method of any one of claims 1 to 12 to be performed.

14. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: receive first load information from at least one access point of a first wireless network; receive second load information from at least one access point of a second different wireless network; and in dependence on said first load information and said second load information, determine if a user equipment is to be attached to the first wireless network or the second wireless network.

15. An apparatus as claimed in claim 14, wherein the at least one memory and the computer code are configured, with the at least one processor, to receive operator information from an operator of said second wireless network and using said operator information in said determining.

5

16. An apparatus as claimed in claim 15, wherein the operator information comprises one or more of: keeping said user equipment in said second wireless network as long as possible; diverting traffic of said user equipment from said first network to said network when possible; priority for diverting traffic of said user equipment from said second network to said first network; and using type of traffic of said user equipment to determine if the traffic of said user equipment is to be diverted to the first or the second wireless network.

10

17. An apparatus as claimed in any of claims 14 to 16, wherein the first load information from said at least one access point comprises load information for a plurality of user equipment, at least two user equipment being associated with a plurality of different operators.

15

18. An apparatus as claimed in any of claims 14 to 17, wherein the first wireless network is a wireless local area network.

19. An apparatus as claimed in any of claims 14 to 18, wherein the at least one memory and the computer code are configured, with the at least one processor, to receive group information about a plurality of access points of said first wireless network, said plurality of access points defining a group, and using said group information in said determining.

20

20. An apparatus as claimed in claim 19, wherein the group is a hotspot.

25

21. An apparatus as claimed in any of claims 14 to 20, wherein the at least one memory and the computer code are configured, with the at least one processor, to receive said first load information via a server of said second wireless network.

22. An apparatus as claimed in claim 21, wherein the server of said second wireless network is an authentication, authorization and accounting server.

30

23. An apparatus as claimed in any of claims 14 to 22, wherein the second wireless network is a wireless cellular network.

24. An apparatus as claimed in any of claims 14 to 23, wherein the wireless cellular network is a 3GPP network.

- 5 25. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured, with the at least one processor, to cause the apparatus at least to: determine load information for a least one access point of a first wireless network, said load information associated with a plurality of user equipment, at least two user equipment being associated with different operators; and cause said load information to be provided to an apparatus
10 associated with one of said different operators.

Figure 1

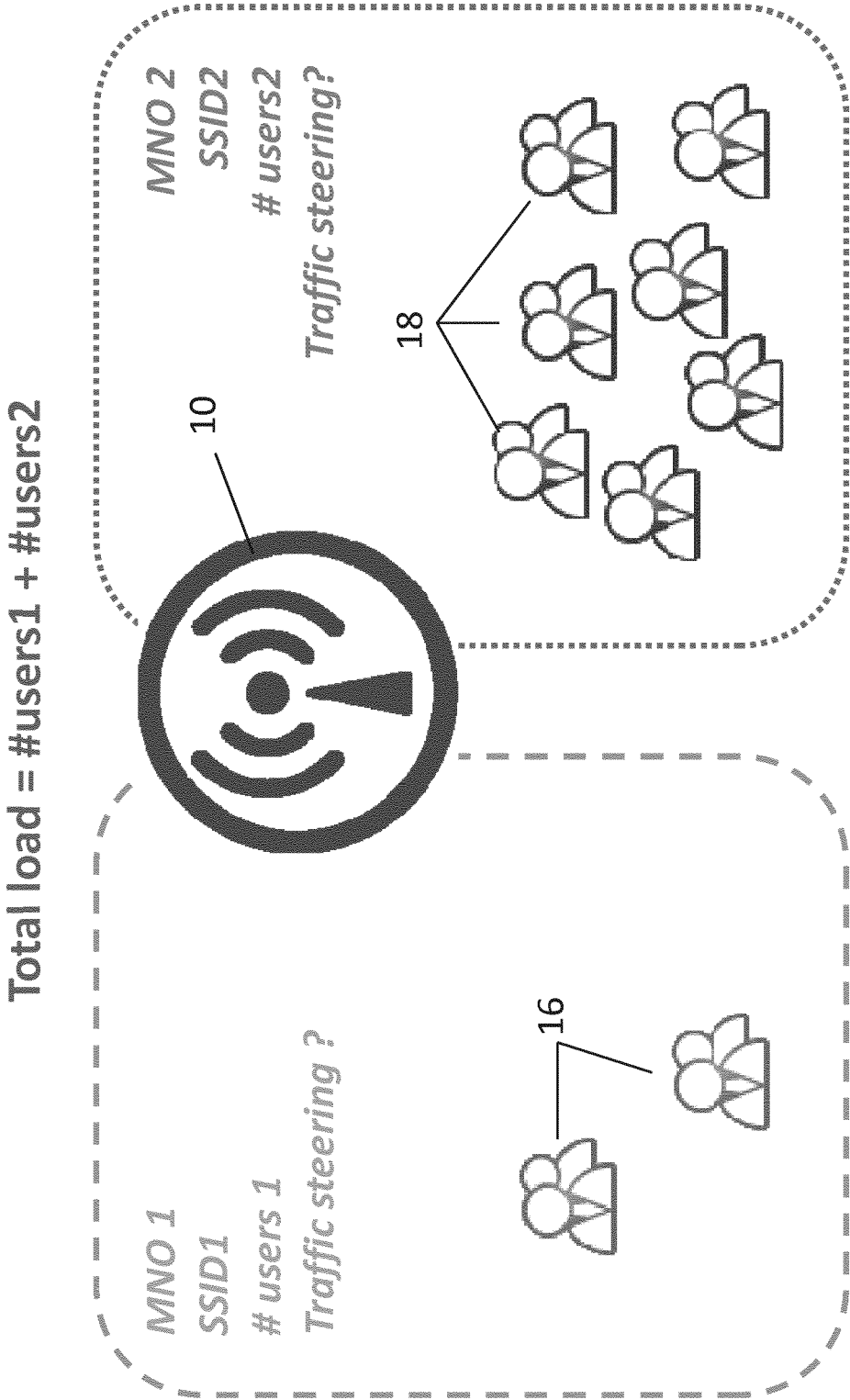
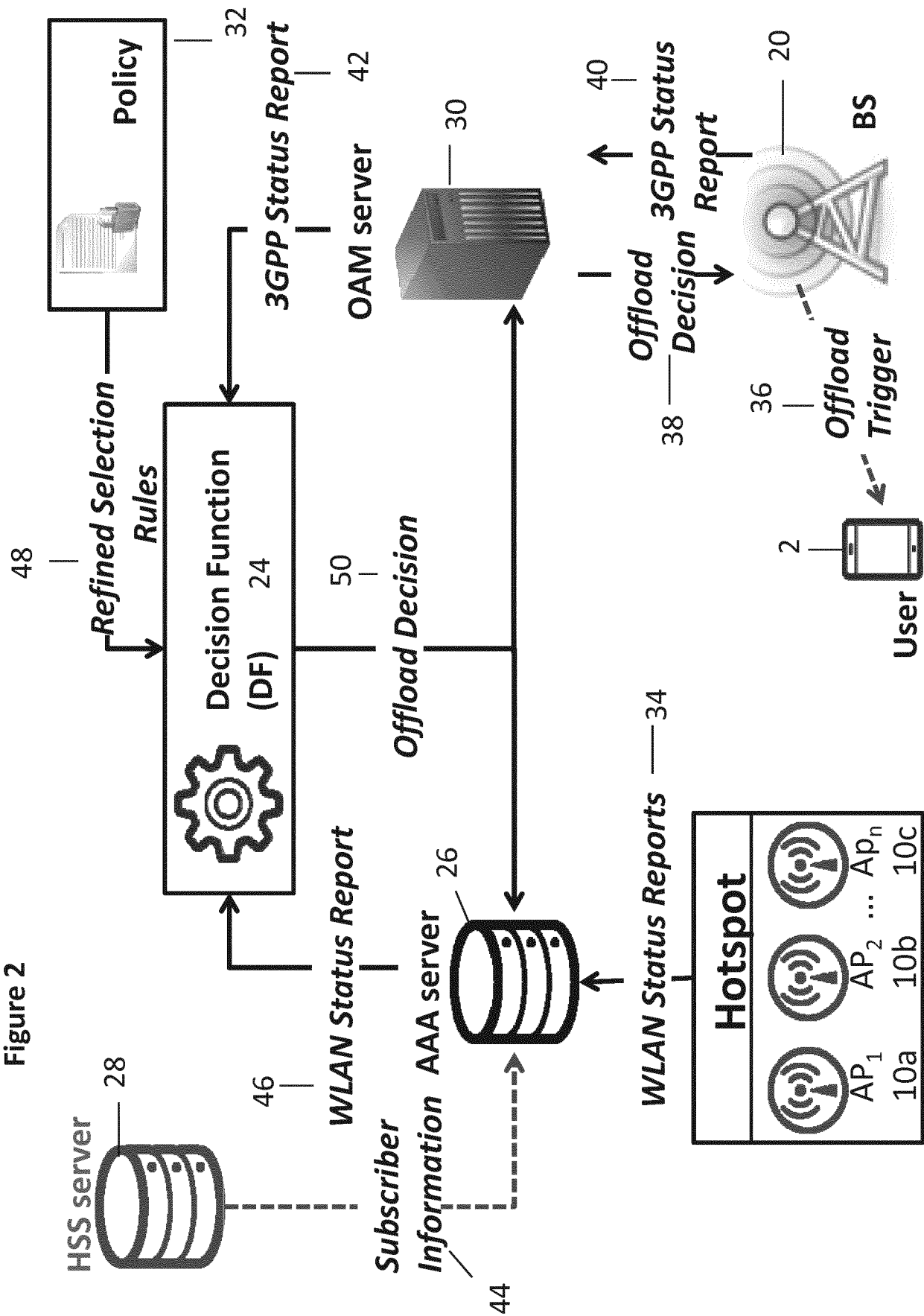
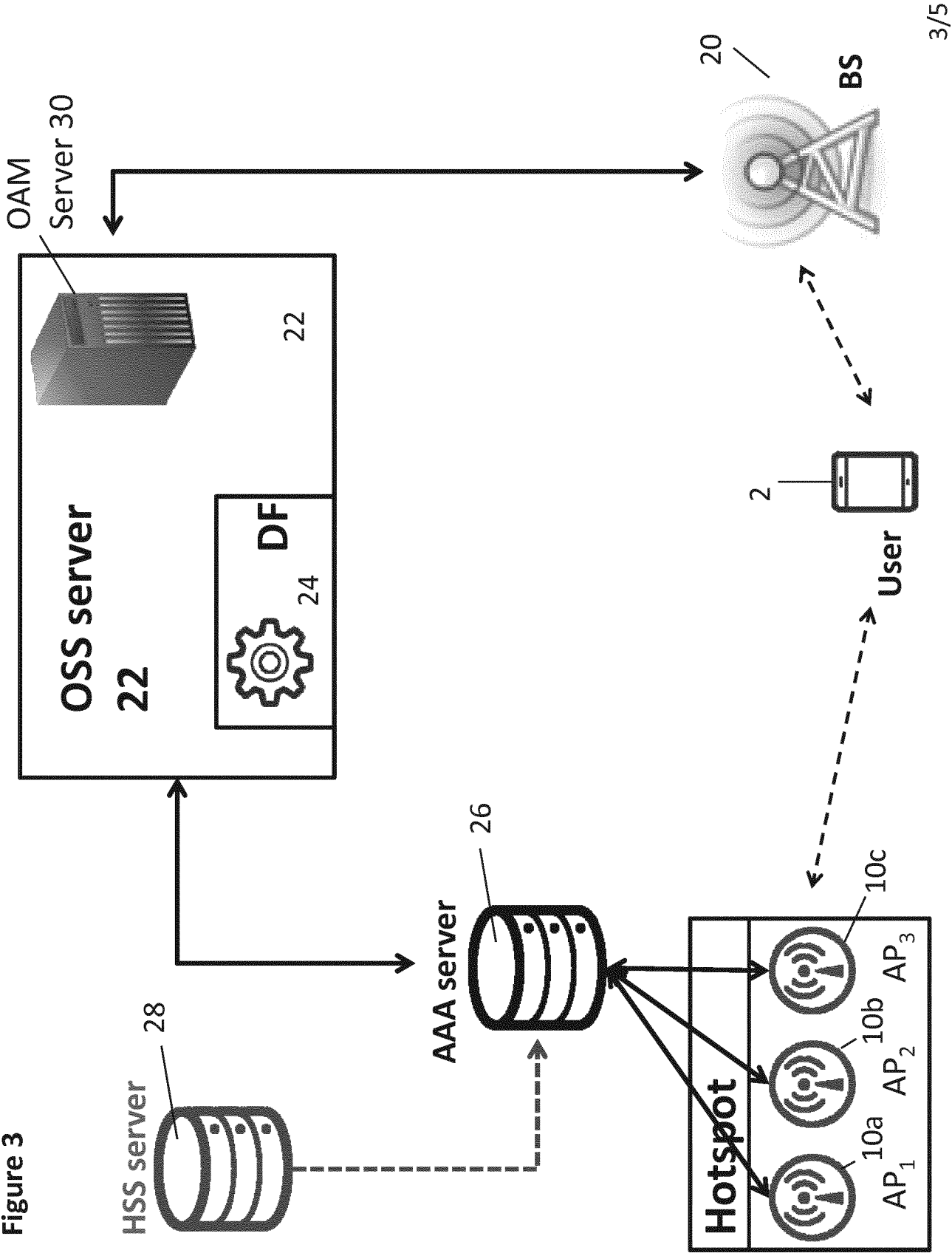


Figure 2





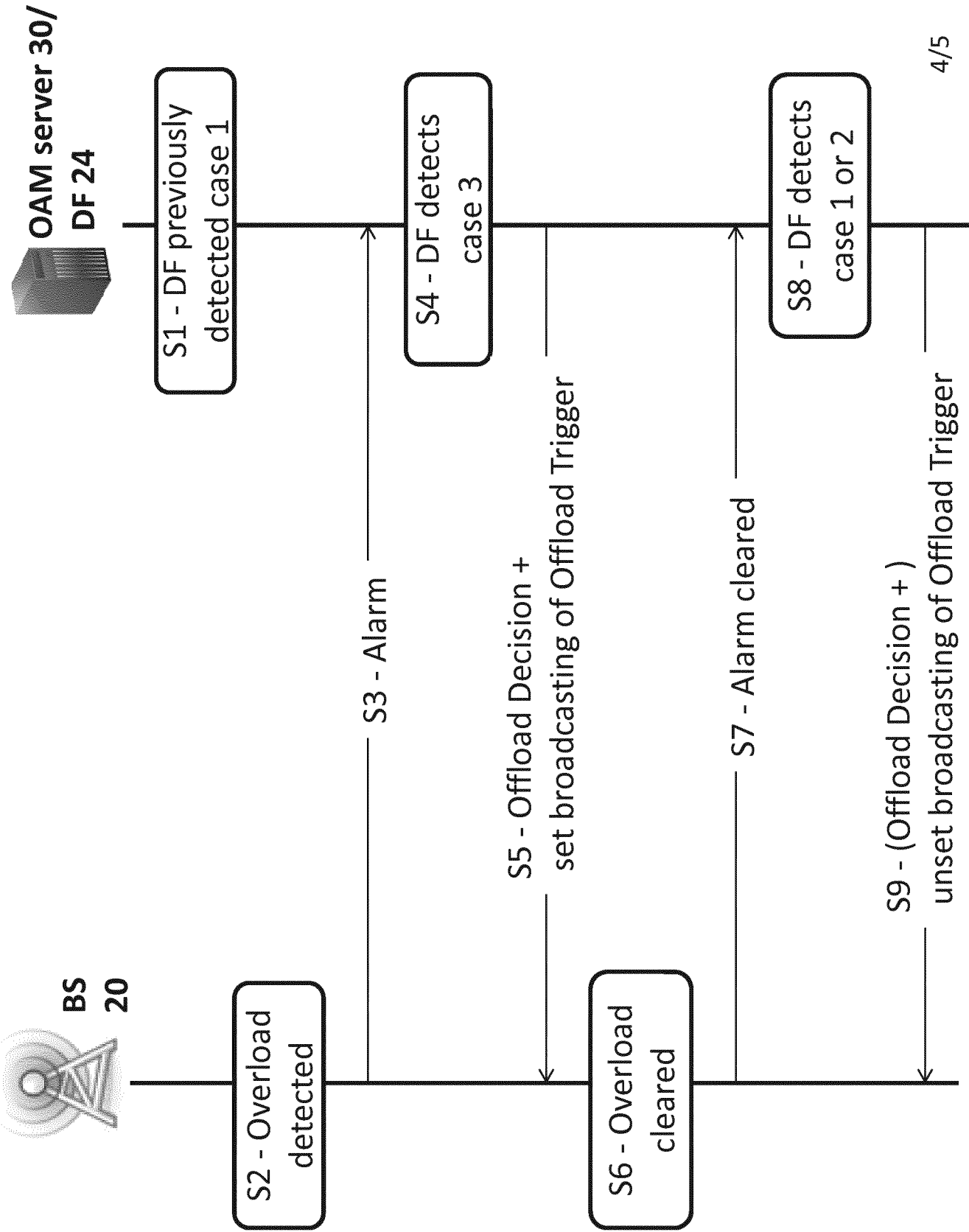


Figure 4

Figure 5

Vendor Specific Attributes	#	Type	Auth_Req	Auth_Reply	Acctg_Req	Comment
Load_status		String	X		(X)	WLAN Status Report

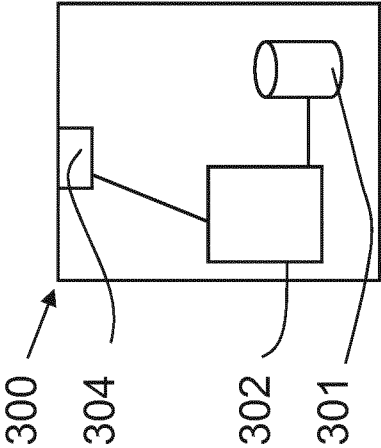


Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/066616A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W28/08
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ERICSSON ET AL: "Idle mode access selection solution for WLAN/3GPP radio interworking", 3GPP DRAFT; R2-131390 - IDLE MODE ACCESS SELECTION SOLUTION FOR WLAN 3GPP RADIO INTERWORKING, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SO ; vol. RAN WG2, no. Chicago, IL, USA; 20130415 - 20130419 6 April 2013 (2013-04-06), XP050699517, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_81bis/Docs/ [retrieved on 2013-04-06] attaching to an access point of system using broadcasted load information; receiving load information from first and -/--	1,5, 10-14, 18,23-25



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

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"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

3 June 2014

Date of mailing of the international search report

12/06/2014

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Tsapelis, Athanasios

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/066616

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	second access point/system before attachment; the whole document -----	
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X	HUAWEI ET AL: "Comparison of network selection solutions", 3GPP DRAFT; R2-131955 COMPARISON OF NETWORK SELECTION SOLUTIONS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG2, no. Fukuoka, Japan; 20130520 - 20130524 10 May 2013 (2013-05-10), XP050699950, Retrieved from the Internet: URL: http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_82/Docs/ [retrieved on 2013-05-10] steering traffic between wlan and 3gpp networks; UE monitors load in both systems and makes decision based on load and ANDSF -----	1,12-14, 25
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International application No

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