[0001] # WIRELESS COMMUNICATION METHODS AND COMPONENTS THAT IMPLEMENT HANDOFF IN WIRELESS LOCAL AREA NETWORKS

[0002] ## FIELD OF INVENTION

[0003] The present invention relates to wireless local area networks (WLANs) and to methods and apparatus that facilitate a wireless transmit/receive unit (WTRU) to "roam" by switching from communication via one communication station to another. In particular, the invention is advantageously employed by WTRUs configured to operate in WLANs compliant with the IEEE 802 standards where the WTRUs are able to conduct wireless communications with WLAN access points (APs) and to continue a wireless communication while switching from a wireless link with one AP to a wireless link with another AP.

[0004] ## BACKGROUND

[0005] Wireless communication systems are well known in the art. Generally, such systems comprise communication stations, which transmit and receive wireless communication signals between each other. Depending upon the type of system, communication stations typically are one of two types of wireless transmit/receive units (WTRUs): one type is the base station, the other is the subscriber unit, which may be mobile.

[0006] The term base station as used herein includes, but is not limited to, a base station, access point, Node B, site controller, or other interfacing device or WTRU in a wireless environment, that provides other WTRUs with wireless access to a network with which the AP is associated.

[0007] The term wireless transmit/receive units (WTRU) as used herein includes, but is not limited to, a user equipment, mobile station, fixed or mobile subscriber unit, pager, or any other type of device capable of operating in a wireless environment. Such WTRUs include personal communication devices, such as phones, video phones, and Internet ready phones that have network connections. In addition, WTRUs include portable personal

computing devices, such as PDAs and notebook computers with wireless modems that have similar network capabilities. WTRUs that are portable or can otherwise change location are referred to as mobile units.

[0008] Typically, a network of base stations is provided wherein each base station is capable of conducting concurrent wireless communications with appropriately configured WTRUs, as well as multiple appropriately configured base stations. Some WTRUs may alternatively be configured to conduct wireless communications directly between each other, i.e., without being relayed through a network via a base station. This is commonly called peer-to-peer wireless communications. Where a WTRU is configured to communicate directly with other WTRUs it may itself also be configured as and function as a base station. WTRUs can be configured for use in multiple networks, with both network and peer-to-peer communications capabilities.

[0009] One type of wireless system, called a wireless local area network (WLAN), can be configured to conduct wireless communications with WTRUs equipped with WLAN modems that are also able to conduct peer-to-peer communications with similarly equipped WTRUs. Currently, WLAN modems are being integrated into many traditional communicating and computing devices by manufacturers. For example, cellular phones, personal digital assistants, and laptop computers are being built with one or more WLAN modems.

[0010] Popular WLAN environments with one or more WLAN base stations, typically called access points (APs), include those constructed according to one or more of the IEEE 802 family of standards. Access to these networks usually requires user authentication procedures. Protocols for such systems are presently being standardized in the WLAN technology area. One such framework of protocols is represented by the IEEE 802 family of standards.

[0011] A basic service set (BSS) is the basic building block of an IEEE 802.11 WLAN, which comprises WTRUs also referred to as stations (STAs). A set of STAs which can talk to each other can form a BSS. Multiple BSSs are

interconnected through an architectural component called a distribution system (DS), to form an extended service set (ESS). An access point (AP) is a WTRU that provides access to the DS by providing DS services, and generally allows concurrent access to the DS by multiple STAs.

[0012] A network of WTRUs operating with peer to peer communications in an IEEE 802.11 environment, typically referred to as "ad hoc" mode, is also called an "independent BSS." In an independent BSS, two or more WTRUs establish communication among themselves without the need of a coordinating network element. No AP-to-network infrastructure is required. However, an AP can be configured to use the ad hoc protocols and act as the WTRUs do in peer to peer communications. In such case an AP may act as a bridge or router to another network or to the Internet.

[0013] A WTRU that starts an ad hoc network selects the ad hoc network's operating parameters, such as the service set identifier (SSID), channel, and beacon timing, and transmits this information in communication frames, for example, in beacon frames. As other WTRUs join the ad hoc network, they detect and use the ad hoc network's operating parameters.

[0014] Where a network infrastructure is used and wireless communications are controlled through APs, parameters such as the SSID are normally specified by a network controller associated with the APs. The APs periodically broadcast beacon frames to enable WTRUs to identify the APs and attempt to establish communications with them.

[0015] The SSID in an IEEE 802 based system can be a 32-character unique identifier attached to a header of packets sent over a WLAN. The SSID then acts as a password when a WTRU attempts to connect to a BSS or an independent BSS. The SSID differentiates one WLAN from another, so all base stations and all other devices connected to or attempting to connect to a specific WLAN normally use the same SSID. A device will not normally be permitted to join a BSS unless it can provide the correct SSID.

[0016] In an AP-based WLAN, a mobile WTRU communicates wirelessly with a specific AP when in the geographic service area of that AP. The WTRU

is said to be associated with the AP through which it is conducting wireless communications. It is sometimes necessary or desirable for a WTRU to change the AP with which it is associated. For example, the WTRU may be experiencing poor signal conditions because it is moving out of the geographic area served by the AP with which it is associated. The need to associate to another AP can also be caused by congestion arising in the basic service set (BSS) served by that AP. Re-association is also referred to as roaming, particularly if the WTRU has an assigned "home" AP (or network of APs) and then "roams" when the WTRU communicates via a different AP (or different network's AP).

[0017] In WLANs compliant with the current 802.11 standards, the re-association of a WTRU to a new AP is initiated entirely by the WTRU. To accomplish this, a WTRU must first identify APs in its vicinity that can potentially provide network services to the WTRU. This is conventionally achieved by a scanning process, which may be active or passive.

[0018] In active scanning, the WTRU transmits probe requests on one or more channels on which the WTRU is configured to communicate. The WTRU selects a new AP from among the APs from which it receives probe responses. In passive scanning, the WTRU dwells on the channels it can use in an attempt to receive beacon packets transmitted by APs which serve the geographic location where the WTRU is then located. The WTRU then selects a new AP from among the APs from which it receives beacon packets. Both active and passive scanning can take a significant amount of time in terms of being able to maintain an ongoing communication, particularly when the WTRU is moving.

[0019] The inventors have recognized that it is sometimes desirable that an AP take the initiative of reassociating a WTRU. For example, APs (or some other node controlling the WTRU's behavior) may determine a current "load" condition based on the collective volume of wireless communication traffic due to the number of WTRUs associated with the AP an/or the types of communications being conducted. Also a WTRU may be located at location

served by several neighboring APs each of which may be using a different channel from among the set of channels over which the WTRU can communicate. Where the collective traffic volume is relatively high (heavy load) for one AP and the volume of traffic on one or more neighboring APs is relatively low (light load), it would be desirable that one or more WTRUs associated with the heavily loaded AP re-associate with a neighboring lightly loaded AP.

[0020] In WLANs compliant with the current 802.11 standards, however, these re-associations take place only if WTRUs associated with the heavily loaded AP are equipped with a sophisticated algorithm allowing them to autonomously decide re-association to another available AP is desirable, based on traffic estimations on the channels. It is difficult to be certain that all WTRUs would be equipped with such an algorithm, and the design and implementation of such an algorithm can be quite complex. Even if all WTRUs operating in a given geographical area are equipped with such an algorithm, it is difficult to guarantee that the WTRUs would not re-associate to other APs in a disorderly fashion, possibly resulting in multiple re-associations taking place back and forth between the same APs.

[0021] To avoid these issues, the inventors have considered potential solutions. For example, a heavily loaded AP could forcefully disassociate some selected WTRUs, hoping that these WTRUs would then find another AP with which they can re-associate. It could also induce disassociations indirectly by reducing the transmission power level of certain key packets it transmits, for example, beacon or probe response packets. The problem with these disassociation techniques is that they can result in a disruption of service unacceptable to certain WTRU users, for example, users of real-time services such as voice or video. This disruption is caused by the WTRU having to scan for a new AP after disassociation, a process which can take a significant amount of time. In consideration of the overall problems, the inventors have recognized it would be desirable to provide for allowing an AP to initiate the re-association of a WTRU from one AP to another without loss of performance.

[0022] SUMMARY

[0023] A communication method, system and components are provided that includes a hand-shaking procedure allowing a WTRU communicating with a network station via a first set of communication parameters, to handoff to another network station for communication via a second set of communication parameters. Preferably, an original access point (AP) of a wireless local area network (WLAN) requests or commands the WTRU to handoff to a target AP. As an alternative, a target AP of a WLAN can request or command the WTRU to handoff to the target AP from an original AP with which the WTRU is communicating.

[0024] Preferably, in an IEEE 802 type WLAN context, four distinct scenarios are provided for, which may be implemented individually or in combination for a particular WLAN, namely:

[0025] 1. An original AP requests a WTRU to handoff to a target AP. The WTRU then decides whether to handoff or not, and communicates its decision to the original AP. In the case where the WTRU decides to go forward with the handoff, the WTRU reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0026] 2. An original AP commands a WTRU to handoff to a target AP. The WTRU then reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0027] 3. A target AP commands a WTRU to handoff to the target AP. The WTRU then notifies an original AP with which it is communicating of its imminent handoff, reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0028] 4. A target AP requests the WTRU to handoff to the target AP. The WTRU decides whether to handoff or not, and communicates its decision

to the target AP. In the case where the WTRU decides to go forward with the handoff, the WTRU notifies an original AP with which it is communicating of its imminent handoff, reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0029] A more detailed understanding of the invention may be had from the following description of a preferred embodiment, given by way of example, and to be understood in conjunction with the accompanying drawings, wherein like elements are designated by like numerals.

[0030] BRIEF DESCRIPTION OF THE DRAWING(S)

[0031] Figure 1 is a system overview diagram illustrating WLAN communication.

[0032] Figure 2 is a diagram showing an overview of a system in accordance with the present invention, in which a mobile WTRU is exiting the service area of an original AP and is entering the service area of a target AP.

[0033] Figure 3 is a diagram showing the signaling exchange for a first scenario in which an original AP requests a WTRU to handoff to a target AP.

[0034] Figure 4 is diagram showing the signaling exchange for a second scenario in which an original AP commands a WTRU to handoff to a target AP.

[0035] Figure 5 is a diagram showing the signaling exchange for a third scenario in which a target AP commands a WTRU to handoff to a target AP.

[0036] Figure 6 is a diagram showing the signaling exchange for a fourth scenario in which a target AP requests a WTRU to handoff to a target AP.

[0037] TABLE OF ACRONYMS

AP	Access Point
BSS	Base Station System
BSSID	Base Station System Identifier
DRI	Directed Re-association Indication
DRCf	Directed Re-association Confirmation
DRCm	Directed Re-association Command
DRRq	Directed Re-association Request
DRRsp	Directed Re-association Response
DS	Distribution System
ESS	Extended Service Set
PDA	Personal Digital Assistant
STA	Station
WLAN	Wireless Local Area Network
WTRU	Wireless Transmitter/Receiver Unit

[0038] DETAILED DESCRIPTION OF PREFERRED EMBODIMENT(S)

[0039] The terms access point (AP), original AP, target AP, and wireless transmit/receive unit (WTRU) are used as described above. The present invention provides a wireless radio access network having a plurality of networked APs through which wireless network services are provided for one or more WTRUs. The invention is particularly useful when used in conjunction with mobile WTRUs, as they travel across the respective geographic areas of service coverage provided by respective APs. The WTRUs can have an integrated or installed wireless WLAN device, such as 802.11(a), 802.11(b), 802.11(g) or 802.11(n) compliant device, in order to communicate. However, the invention is applicable in any wireless system.

[0040] The term directed re-association request (DRRq) means a signal directed to a WTRU requesting the WTRU reconfigure itself for communication with a different network station such as a target AP. In a WLAN IEEE 802.11 context, the DRRq can be sent by either the original AP or the target AP.

[0041] The information contained in the DRRq preferably includes data sufficient to identify a target AP and to enable the WTRU to communicate with the target AP. This information preferably includes the channel of the target AP, an identifier of the target AP (MAC address, IP address, etc.), the

target BSSID, the target AP capabilities, etc. The DRRq preferably also includes timing information as to when handoff is scheduled. A flag or special value for a timing field can be used to indicate that handoff is meant to be immediate. The DRRq can also include signaling-specific information such as which signaling steps are needed in the exchange. For example, the DRRq can indicate if the target AP expects to receive a directed re-association confirmation, or if the original AP expects to receive a directed re-association indication.

[0042] In the case where a DRRq is sent from a target AP, the target AP preferably uses the same channel to send the DRRq to the WTRU as is being used by the WTRU and an original AP with which the WTRU is communicating. In a preferred embodiment, the DRRq is implemented as a unicast frame, more specifically as a control frame, as a management frame or as the payload of a data frame. In alternative embodiments, this signaling can also be implemented using a multicast or broadcast message.

[0043] The term directed re-association response (DRRsp) means a signal, from the WTRU to which the DRRq was sent, directed to the network station which sent the DRRq. The DRRsp preferably indicates whether the WTRU accepts or rejects the request to reconfigure itself for communication with a different network station such as a target AP.

[0044] The term directed re-association command (DRCm) means a signal from a network station directed to a WTRU, commanding the WTRU to reconfigure itself for communication with a different network station such as a target AP. In the IEEE 802.11 context, the DRCm can be sent by either an original AP or a target AP. The WTRU is expected to follow the DRCm and thus need not send a DRRsp to the network station that sent the DRCm. The DRCm preferably contains the same target AP information as described above for the DRRq.

[0045] In the case where the DRCm is sent from a target AP, the target AP preferably uses the same channel to send the DRCm to the WTRU as is being used by the WTRU and an original AP with which the WTRU is

communicating. In a preferred embodiment, the DRCm is implemented as a unicast frame, more specifically as a control frame, as a management frame or as the payload of a data frame. In alternative embodiments, this signaling can also be implemented using a multicast or broadcast message.

[0046] The term directed re-association confirmation (DRCf) means a signal from a WTRU to a network station such as a target AP after the WTRU has reconfigured itself to communicate with that station. The DRCf confirms that the WTRU has reconfigured itself. The DRCf is used to prevent the undesirable scenario in which a target AP starts sending packets to the WTRU before the WTRU has successfully re-associated to the target AP. This can result in a target AP needlessly transmitting and retransmitting frames to a WTRU that was expected to reconfigure itself to the target AP, but did not do so. In such a case, the number of frames buffered in the target AP could be substantial, and could lead to a reduction in the efficiency of the wireless medium due to the exponentially increasing back off window associated with multiple retransmissions. Also, if a target AP does not receive a DRCf indicating that re-association was successful within a desired time out period, the target AP can eventually release any radio resources that it may have reserved for the WTRU.

[0047] The information contained in a DRCf preferably includes data sufficient to identify an original AP with which the WTRU is communicating, a target AP, and the WTRU. In an IEEE 802.11 context, the DRCf preferably includes indications of the communication channels, identifiers (MAC addresses, IP addresses, etc.), and BSSIDs used by each, and the capabilities of the target and original APs. The DRCf may also include timing information as to when handoff occurred. In a preferred embodiment, the DRCf is implemented as a unicast frame, more specifically as a control frame, a management frame or as payload of a data frame. In alternative embodiments, this signaling can also be implemented using a multicast or broadcast message.

[0048] The term directed re-association indication (DRI) means a signal from a WTRU to a network station with which the WTRU had been in communication, such as an original AP, after the WTRU has been requested or commanded by another station, such as a target AP, to reconfigure itself and the WTRU is proceeding to do so. The DRI is preferably used to indicate to an original AP that the WTRU will reconfigure itself to a target AP. The DRI allows an original AP to stop transmitting packets to the WTRU (which would result in inefficient use of the wireless medium) and to forward any buffered packets to the target AP. The DRI also allows an original AP to release any radio resources that it may have reserved for the WTRU.

[0049] In an IEEE 802.11 context, the information contained in the DRI preferably includes the channel of the target AP, an identifier of the target AP (MAC address, IP address, etc.), the target BSSID, the target AP capabilities, etc. The DRI can also include timing information as to when handoff is scheduled. A flag or special value for a timing field can be used to indicate that the handoff is meant to be immediate. In a preferred embodiment, the DRI is implemented as a unicast frame, more specifically as a control frame, a management frame or as payload of a data frame. In alternative embodiments, this signaling could also be implemented using a multicast or broadcast message.

[0050] Referring to Figure 1, a WLAN is illustrated in which WTRUs conduct wireless communications via a network station, in this case an AP. The AP is connected with a DS. The AP is shown as conducting communications with five WTRUs. Such a configuration is also called a basic service set (BSS) within WLAN contexts. Generally, the WLAN system supports WTRUs with different data rates. In some cases an AP is configured to support multiple types of WTRUs, such as 802.11(b) and 802.11(g) compliant WTRUs.

[0051] Referring to Figure 2, a WLAN is illustrated having two APs, denoted original and target. A WTRU is shown conducting wireless communications via the original AP. The WTRU is disposed in an area served

by both the original AP and the target AP so that it is possible for the WTRU to "hand off" its communication from via the original AP to the target AP.

[0052] Conventionally in an IEEE 802.11 WLAN, the WTRU will initiate a handover operation from the original AP to the target AP when, for example, the WTRU begins to move further away from the original AP and towards the target AP. For such WTRU initiated handover, the handover operation must be complete before the WTRU is out of range of the original AP in order to avoid interruption of an ongoing wireless communication being conducted by the WTRU.

[0053] In accordance with the present invention, the WLAN is provided with further functionality by permitting the APs to also decide if and when handoff should occur. This functionality permits the WLAN to address congestion issues arising due to differing traffic in the respective cells or services areas of the respective APs. This is beneficial to improve the robustness of the network by enabling efficient load balancing and congestion control algorithms without compromising the user experience. It also enables more efficient roaming. Depending on the implementation of the invention, the original AP and/or the target AP can request and/or command the WTRU to handoff to the target AP. Preferably, in an IEEE 802 type WLAN context four distinct scenarios are provided for, which may be implemented individually or in combination for a particular WLAN.

[0054] Referring to Figure 3, a first scenario is depicted where the original AP requests the WTRU to handoff to the target AP. The WTRU then decides whether to handoff or not, and communicates its decision to the original AP. In the case where the WTRU decides to go forward with the handoff, the WTRU then reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association. The reconfiguration process itself is preferably essentially the same as for a conventional WTRU initiated handover, but one of the APs preferably provides the reconfiguration data concerning the target AP in DRRq messaging.

[0055] As a first step, the original AP determines that the WTRU should be redirected to a target AP. This decision can be based on the type and amount of communication traffic the original AP is conducting in comparison with the target AP. The original AP then sends a DRRq to the WTRU requesting that the WTRU handoff to the target AP. The WTRU determines if it accepts the redirection request, and communicates its decision to the original AP via a DRRsp. This option permits, for example, the WTRU to determine if a desired Quality of Service is available from the target AP. In the case where the WTRU accepts the request to handoff to the target AP, the WTRU reconfigures itself to the target AP, and sends to the target AP a DRCf, confirming that it has handed off.

[0056] Referring to Figure 4, a second scenario is depicted where the original AP commands a WTRU to handoff to a target AP. Based on this command, the WTRU reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0057] In this scenario, when the original AP determines that the WTRU should be redirected to a target AP, it sends to the WTRU a DRCm commanding that it handoff to the target AP. The WTRU reconfigures itself to the target AP, and sends to the target AP a DRCf. Where DRCm messaging is used, it is preferred that the WLAN make a determination that a desired Quality of Service is available from the target AP before issuing such a command. Such a determination can be based upon geolocation information of the WTRU either obtained from the WTRU via signaling or calculated by the WLAN based on signals or measurement reports received from the WTRU.

[0058] Referring to Figure 5, a third scenario is depicted where the target AP commands a WTRU to handoff to the target AP. The WTRU then notifies an original AP with which it is communicating of its imminent handoff, reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0059] In this scenario, the target AP preferably determines that the WTRU should be redirected to the target AP. The target AP can, for example, be configured to make a determination that a desired Quality of Service is available from the target AP before issuing such a command based on intercepting signals from the WTRU that are directed to the original AP or based on the target AP obtaining measurements reports from the original AP through inter-AP signaling. Intercepting signals from the WTRU may not be effective if the WTRU is using a directional antenna for its signaling to the original AP. The target AP sends to the WTRU a DRCm commanding that the WTRU handoff to the target AP. Preferably, the target AP uses the channel currently used by the WTRU in communicating via the original AP for sending the DRCm. After sending the DRCm, further communication between the target AP and the WTRU is then preferably on the target AP's operating channel. The WTRU sends to the original AP a DRI communicating that it will reconfigure to the target AP. The WTRU then reconfigures itself to the target AP, and sends to the target AP a DRCf, confirming that it has handed off.

[0060] Referring to Figure 6, a fourth scenario is depicted where the target AP requests the WTRU to handoff to the target AP. The WTRU decides whether to handoff or not, and communicates its decision to the target AP. In the case where the WTRU decides to go forward with the handoff, the WTRU notifies the original AP with which it is communicating of its imminent handoff, reconfigures its channel, BSSID, etc. for the target AP, and sends to the target AP a confirmation message indicating that it has completed the re-association.

[0061] In this fourth scenario, the target AP determines that the WTRU should be redirected to the target AP. Preferably, the target AP uses the channel being used by the WTRU in communicating with the original AP to send to the WTRU a DRRq requesting that the WTRU handoff to the target AP. The target AP subsequently communicates with the WTRU on the target AP's preferred operating channel. The WTRU determines if it accepts the

redirection request. It communicates its decision to the target AP via a DRRsp, preferably on the target AP's operating channel. In the case where the WTRU accepts the request to handoff to the target AP, the WTRU sends to the original AP a DRI communicating its decision, preferably on the original channel that had been used in communications with the original AP. The WTRU then reconfigures itself to the target AP, and sends to the target AP a DRCf, confirming that it has handed off.

[0062] One alternative in the fourth scenario is to combine the DRRsp with the DRCf (or treat the DRCf as the DRRsp) where the WTRU determines to accept the redirection request from the target AP. This alternative eliminates the need for the WTRU to switch between communication parameters multiple times during handover. This alternative implies that either the origin AP or the target AP are using the same channel or that, after sending the DRRq, the target AP remains on the origin AP channel until it received the DRCf.

[0063] The method by which the AP driving the handoff procedure determines which AP is a suitable or desired candidate to be the target AP can include, for example, the WTRU reporting a list of candidate APs, inter-AP signaling, centralized decision-making performed at a central controller, or any other suitable method.

[0064] In implementation, a preferred WTRU includes a transceiver and a processor selectively configured to implement handoff of wireless communication from via a first access point (AP) using a first set of communication parameters to via a second AP using a second set of communication parameters based on AP initiated messaging. The transceiver is preferably configured to receive a re-association message using the first set of communication parameters, which identifies the second AP and second set of communication parameters. The processor is operatively associated with the transceiver and is preferably configured to selectively reconfigure the transceiver to communicate via the second set of communication parameters in response to a received re-association message such that the transceiver is

enabled to transmit a reconfiguration confirmation to the second AP using the second set of communication parameters. Preferably, the WTRU is configured to operate in an IEEE 802.11 compliant system so that the transceiver is configured to communicate in a predetermined frame format. A re-association message from the first AP is then preferably received in a directed re-association command frame and the reconfiguration confirmation to the second AP is transmitted in a directed re-association confirmation frame.

[0065] The WTRU wherein the processor can be configured to direct the transceiver to transmit to the first AP a re-association indication message in connection with processing a received re-association message which is a re-association command sent by the second AP before reconfiguring the transceiver to communicate via the second set of communication parameters. Where the WTRU is configured to operate in an IEEE 802.11 compliant system using a predetermined frame format, the processor is preferably configured to direct the transceiver to receive a re-association message from the second AP in a directed re-association command frame, to transmit the re-association indication to the first AP in a directed re-association indication frame, and to transmit the reconfiguration confirmation to the second AP in a directed re-association confirmation frame.

[0066] The WTRU processor can be configured to make a decision regarding reconfiguration to communicate via the second set of communication parameters in response to a received re-association request. In such case the processor is preferably configured to direct the transceiver to transmit the decision to the AP from which the re-association request was received in a directed re-association response message such that the processor directs the transceiver to be reconfigured to communicate via said second set of communication parameters where the decision is to proceed with re-association. Where the WTRU is configured to operate in an IEEE 802.11 compliant system using predetermined frame formats, the processor is preferably configured to direct the transceiver to receive a re-association request in a directed re-association request (DRRq) frame from the first AP, to

transmit the decision regarding re-association in a directed re-association response (DRRsp) frame using the first set of communication parameters, and to transmit the reconfiguration confirmation in a directed re-association confirmation (DRCf) frame using the second set of communication parameters.

[0067] The WTRU processor can be further configured to direct the transceiver to use the second set of communication parameters to send the directed reconfiguration response message in connection with processing an association request received from the second AP. The processor can also be configured to direct the transceiver to transmit to the first AP a re-association indication using the first set of communication parameters in connection with processing an association request received from the second AP where the decision is to proceed with re-association. Where the WTRU is configured to operate in an IEEE 802.11 compliant system using predetermined frame formats, the processor is preferably configured to direct the transceiver to receive a re-association request in a directed re-association request (DRRq) frame, to transmit the re-association indication in a directed re-association indication (DRI) frame and to transmit the reconfiguration confirmation in a directed re-association confirmation (DRCf) frame. The WTRU processor can then also be configured to direct the transceiver to transmit the decision regarding re-association in a directed re-association response (DRRsp) frame in advance of the DRI frame.

[0068] Implementation on the network side is preferably through providing WLAN APs that each include a transceiver and a processor selectively configured to assist in handoff of a wireless communications with such WTRUs to or from via particular APs. The AP transceiver is preferably configured to provide wireless network access for wireless transmit/receive units (WTRUs) using a defined set of communication parameters. The AP processor is preferably configured to make a decision regarding handing off, from or to the AP, of a wireless communication conducted by a WTRU using a pre-handoff set of parameters. The processor is configured to direct the transceiver to transmit a re-association message, when a handoff decision is

made, that identifies an AP for handoff and a post-handoff set of communication parameters using the pre-handoff set of communication parameters. The AP's transceiver is preferably configured to receive from a WTRU, that has received a re-association message and is proceeding with handoff, a reconfiguration confirmation where the AP is the AP identified for handoff in the re-association message received by the WTRU.

[0069] For implementation of the second scenario above, the AP is preferably configured to operate in an IEEE 802.11 compliant system wherein the transceiver is configured to use a predetermined frame format to transmit re-association messages to WTRUs in directed re-association command frames and to receive reconfiguration confirmations from WTRUs in directed re-association confirmation frames.

[0070] The transceiver can be configured to receive from a WTRU, that is conducting a wireless communication via the AP, a re-association indication message indicating a handoff of the communication to via another AP to implement the third scenario. The processor is preferably configured to release resources allocated for the communication in connection with receiving the re-association indication message. Also for implementation of the third scenario, the AP is preferably configured to operate in an IEEE 802.11 compliant system wherein the transceiver is configured to communicate in a predetermined frame format and the processor is configured to direct the transceiver to transmit re-association messages in directed re-association command frames, to receive re-association indications in directed re-association indication frames, and to receive reconfiguration confirmations in directed re-association confirmation frames.

[0071] To implement the first scenario, the AP processor is preferably configured to direct the transceiver to transmit a re-association message, when a handoff decision is made, in the form of a received re-association request and the transceiver is configured to receive from WTRUs that have received a re-association request from the AP, a directed re-association response message reflecting a responsive WTRU decision regarding

proceeding with re-association. The AP is preferably configured to operate in an IEEE 802.11 compliant system wherein the transceiver is configured to use predetermined frame formats and the processor is configured to direct the transceiver to transmit re-association requests in directed re-association request (DRRq) frames, to receive decisions regarding re-association in directed re-association response (DRRsp) frames, and to receive reconfiguration confirmations in directed re-association confirmation (DRCf) frames.

[0072] For the fourth scenario, the AP transceiver is preferably configured to use the post-handoff set of communication parameters to receive a directed reconfiguration response message where the AP processor has directed the transceiver to transmit a re-association message using a pre-handoff set of communication parameters to a WTRU that identifies the AP for handoff as the AP itself and identifies the post-handoff set of communication parameters as said first set of communication parameters. The AP transceiver is also preferably configured to receive from a WTRU, that is conducting a wireless communication via the AP, a re-association indication message indicating a handoff of the communication to via another AP and the processor is configured to release resources allocated for the communication in connection with receiving the re-association indication message.

[0073] For the first and fourth scenarios, the AP is preferably configured to operate in an IEEE 802.11 compliant system wherein the transceiver is configured to use predetermined frame formats. The processor is then preferably configured to direct the transceiver to transmit re-association requests in directed re-association request (DRRq) frames, to receive re-association indications in directed re-association indication (DRI) frames, to receive reconfiguration confirmations in directed re-association confirmation (DRCf) frames and to receive decisions regarding re-association in directed re-association response (DRRsp) frames.

[0074] EMBODIMENTS

[0075] 1. An access point (AP) comprising a transceiver and a processor.

[0076] 2. The AP of any preceding embodiment for use in a wireless local area network (WLAN).

[0077] 3. The AP of any preceding embodiment configured to operate in accordance with a standard which is in compliance with an IEEE 802.11 family of standards.

[0078] 4. The AP of any preceding embodiment configured to communicate with at least one wireless transmit/receive unit (WTRU).

[0079] 5. The AP of any preceding embodiment configured to use predetermined frame formats.

[0080] 6. The AP of any preceding embodiment configured to assist in implementing handoff of a wireless communications to or from via the AP.

[0081] 7. The AP of any preceding embodiment wherein the transceiver is configured to provide wireless network access for at least one WTRU using a first set of communication parameters.

[0082] 8. The AP of any preceding embodiment wherein a processor is configured to make a decision regarding handing off, from or to the AP, of a wireless communication conducted by a WTRU for which a pre-handoff set of communication parameters is used.

[0083] 9. The AP of any preceding embodiment wherein a processor is configured to direct the transceiver to transmit a re-association message using a pre-handoff set of communication parameters, when a handoff decision is made, that identifies an AP for handoff and a post-handoff set of communication parameters.

[0084] 10. The AP of any preceding embodiment wherein the transceiver is configured to receive from a WTRU, that has received a re-association message and is proceeding with handoff, a reconfiguration confirmation where the AP is an AP identified for handoff in a re-association message received by the WTRU.

[0085] 11. The AP of any preceding embodiment configured to transmit re-association messages to WTRUs in directed re-association command frames

[0086] 12. The AP of any preceding embodiment configured to receive reconfiguration confirmations from WTRUs in directed re-association confirmation frames.

[0087] 13. The AP of any preceding embodiment configured to receive from a WTRU, that is conducting a wireless communication via the AP, a re-association indication message indicating a handoff of the communication to via another AP.

[0088] 14. The AP of any preceding embodiment configured to release resources allocated for a communication being handed off in connection with receiving a re-association indication message.

[0089] 15. The AP of any preceding embodiment wherein the processor is configured to direct the transceiver to transmit re-association messages in directed re-association command frames, to receive re-association indications in directed re-association indication frames, and to receive reconfiguration confirmations in directed re-association confirmation frames.

[0090] 16. The AP of any preceding embodiment wherein the processor is configured to direct the transceiver to transmit a re-association message, when a handoff decision is made, in the form of a re-association request and the transceiver is configured to receive from WTRUs that have received a re-association request from the AP, a directed re-association response message reflecting a responsive WTRU decision regarding proceeding with re-association.

[0091] 17. The AP of any preceding embodiment configured to transmit re-association requests in directed re-association request (DRRq) frames, to receive decisions regarding re-association in directed re-association response (DRRsp) frames, and to receive reconfiguration confirmations in directed re-association confirmation (DRCf) frames.

[0092] 18. The AP of any preceding embodiment configured to use a post-handoff set of communication parameters to receive a directed reconfiguration response message where the AP processor has directed the transceiver to transmit a re-association message using a pre-handoff set of communication parameters to a WTRU that identifies the AP for handoff as the AP itself and identifies the post-handoff set of communication parameters as a first set of communication parameters.

[0093] 19. The AP of any preceding embodiment configured to receive from a WTRU, that is conducting a wireless communication via the AP, a re-association indication message indicating a handoff of the communication to via another AP.

[0094] 20. The AP of any preceding embodiment configured to release resources allocated for a communication being handed off in connection with receiving a re-association indication message.

[0095] 20. The AP of any preceding embodiment configured to transmit re-association requests in directed re-association request (DRRq) frames.

[0096] 21. The AP of any preceding embodiment configured to receive re-association indications in directed re-association indication (DRI) frames.

[0097] 22. The AP of any preceding embodiment configured to receive reconfiguration confirmations in directed re-association confirmation (DRCf) frames.

[0098] 23. The AP of any preceding embodiment configured to receive decisions regarding re-association in directed re-association response (DRRsp) frames.

[0099] 24. A method for implementing handoff of wireless communication of a wireless transmit/receive unit (WTRU) from via a first access point (AP) using a first set of communication parameters to via a second AP using a second set of communication parameters in a wireless local area network (WLAN), the method comprising transmitting to the WTRU a

re-association message using the first set of communication parameters that identifies the second AP and second set of communication parameters

[00100] 25. The method of embodiment 24, further comprising receiving from the WTRU a reconfiguration confirmation by the second AP using the second set of communication parameters.

[00101] 26. The method of any one of embodiments 24-25, where the WLAN is an IEEE 802.11 compliant system that operates using predetermined frame formats.

[00102] 27. The method of any one of embodiments 24-26, wherein the re-association message is a command transmitted by the first AP in a directed re-association command (DRCm) frame and a reconfiguration confirmation is received by the second AP in a directed re-association confirmation (DRCf) frame.

[00103] 28. The method of any one of embodiments 24-27 wherein the re-association message is a command transmitted from the second AP, further comprising receiving by the first AP a re-association indication before receiving a reconfiguration confirmation by the second AP using the second set of communication parameters.

[00104] 29. The method of any one of embodiments 24-28 wherein a re-association indication is received in a directed re-association indication (DRI) frame.

[00105] 30. The method of any one of embodiments 24-29 wherein a reconfiguration confirmation is received in a directed re-association confirmation (DRCf) frame.

[00106] 31. The method of any one of embodiments 24-30 wherein a re-association request is transmitted by an AP, further comprising receiving a WTRU decision regarding re-association by the AP from which the re-association request was transmitted in a directed re-association response message

[00107] 32. The method of any one of embodiments 24-31 wherein receiving of a reconfiguration confirmation by the second AP is done only where a decision is made to proceed with re-association.

[00108] 33. The method of any one of embodiments 24-32 wherein a re-association request is transmitted in a directed re-association request (DRRq) frame from the first AP.

[00109] 34. The method of any one of embodiments 24-33 wherein a decision regarding re-association is received in a directed re-association response (DRRsp) frame using the first set of communication parameters

[00110] 35. The method of any one of embodiments 24-34 wherein a reconfiguration confirmation is received in a directed re-association confirmation (DRCf) frame using the second set of communication parameters.

[00111] 36. The method of any one of embodiments 24-35 wherein a re-association request is transmitted from the second AP, further comprising using the second set of communication parameters to receive the directed reconfiguration response message.

[00112] 37. The method of any one of embodiments 24-36 further comprising receiving by the first AP a re-association indication using the first set of communication parameters where the decision is to proceed with re-association.

[00113] 38. The method of any one of embodiments 24-37 wherein a re-association request is transmitted in a directed re-association request (DRRq) frame.

[00114] 39. The method of any one of embodiments 24-38, wherein a re-association indication is received in a directed re-association indication (DRI) frame.

[00115] 40. The method of any one of embodiments 24-39, wherein a reconfiguration confirmation is received in a directed re-association confirmation (DRCf) frame.

[00116] 41. The method of any one of embodiments 24-40, wherein a decision regarding re-association is received in a directed re-association response (DRRsp) frame.

[00117] 42. The method of embodiment 41 wherein the DRRsp frame is received in advance of a DRI frame.

[00118] 43. A wireless transmit/receive unit (WTRU) comprised of a transceiver and a processor.

[00119] 44. The WTRU of embodiment 43 for use in a wireless local area network (WLAN).

[00120] 45. The WTRU of any one of embodiments 43-44 configured to operate in accordance with a standard which is in compliance with an IEEE 802.11 family of standards.

[00121] 46. The WTRU of any one of embodiments 43-45 configured to communicate with at least one access point (AP).

[00122] 47. The WTRU of any one of embodiments 43-46 configured to use predetermined frame formats.

[00123] 48. The WTRU of any one of embodiments 43-47 configured to implement handoff of wireless communication from via a first access point (AP) using a first set of communication parameters to via a second AP using a second set of communication parameters.

[00124] 49. The WTRU of embodiment 48, wherein the transceiver is configured to receive a re-association message using the first set of communication parameters, which identifies the second AP and second set of communication parameters.

[00125] 50. The WTRU of any one of embodiments 48-49, wherein the processor is configured to selectively reconfigure the transceiver in response to a received re-association message to communicate via the second set of communication parameters such that the transceiver is enabled to transmit a reconfiguration confirmation to the second AP using the second set of communication parameters.

[00126] 51. The WTRU of any one of embodiments 48-50 wherein the transceiver is configured to receive a re-association message from the first AP in a directed re-association command frame.

[00127] 52. The WTRU of any one of embodiments 48-51 wherein the transceiver is configured to transmit a reconfiguration confirmation to the second AP in a directed re-association confirmation frame.

[00128] 53. The WTRU of any one of embodiments 48-52 configured to transmit to the first AP a re-association indication message in connection with processing a received re-association message which is a re-association command sent by the second AP before reconfiguring the transceiver to communicate via the second set of communication parameters.

[00129] 54. The WTRU of any one of embodiments 48-53 configured to receive a re-association message from the second AP in a directed re-association command frame, to transmit the re-association indication to the first AP in a directed re-association indication frame, and to transmit the reconfiguration confirmation to the second AP in a directed re-association confirmation frame.

[00130] 55. The WTRU of any one of embodiments 48-54 configured to make a decision regarding reconfiguration to communicate via the second set of communication parameters in response to a received re-association request and to direct the transceiver to transmit the decision to the AP from which the re-association request was received in a directed re-association response message such that the processor directs the transceiver to be reconfigured to communicate via said second set of communication parameters where the decision is to proceed with re-association.

[00131] 56. The WTRU of any one of embodiments 48-55 configured to receive a re-association request in a directed re-association request (DRRq) frame from the first AP, to transmit the decision regarding re-association in a directed re-association response (DRRsp) frame using the first set of communication parameters, and to transmit the reconfiguration confirmation

in a directed re-association confirmation (DRCf) frame using the second set of communication parameters.

[00132] 57. The WTRU of any one of embodiments 48-56 configured to send a directed reconfiguration response message in connection with processing an association request received from the second AP.

[00133] 58. The WTRU of any one of embodiments 48-57 configured to direct the transceiver to transmit to the first AP a re-association indication using the first set of communication parameters in connection with processing an association request received from the second AP where the decision is to proceed with re-association.

[00134] 59. The WTRU of any one of embodiments 48-58 configured to receive a re-association request in a directed re-association request (DRRq) frame, to transmit the re-association indication in a directed re-association indication (DRI) frame and to transmit the reconfiguration confirmation in a directed re-association confirmation (DRCf) frame.

[00135] 60. The WTRU of any one of embodiments 48-59 configured to transmit the decision regarding re-association in a directed re-association response (DRRsp) frame in advance of a DRI frame.

[00136] 61. A method for a WTRU in a WLAN to implement handoff of wireless communication from via a first AP using a first set of communication parameters to via a second AP using a second set of communication parameters, comprising receiving a re-association message using the first set of communication parameters that identifies the second AP and second set of communication parameters.

[00137] 62. The method of embodiment 61, further comprising the WTRU reconfiguring to communicate via said second set of communication parameters.

[00138] 63. The method of any of embodiments 61-62, further comprising transmitting a reconfiguration confirmation to the second AP using the second set of communication parameters.

[00139] 64. The method of any of embodiments 61-63 wherein the re-association message is a command received from the first AP.

[00140] 65. The method of any of embodiments 61-64 wherein the WTRU is configured to operate in an IEEE 802.11 compliant system using predetermined frame formats.

[00141] 66. The method of any of embodiments 64-65 wherein the re-association command is received in a directed re-association command (DRCm) frame, and a reconfiguration confirmation is transmitted in a directed re-association confirmation (DRCf) frame.

[00142] 67. The method of any of embodiments 61-66 wherein the re-association message is a command received from the second AP, further comprising transmitting to the first AP a re-association indication before reconfiguring to communicate via the second set of communication parameters.

[00143] 68. The method of any of embodiments 61-68 wherein a re-association command is received in a directed re-association command (DRCm) frame, a re-association indication is transmitted in a directed re-association indication (DRI) frame, and a reconfiguration confirmation is transmitted in a directed re-association confirmation (DRCf) frame.

[00144] 69. The method of any of embodiments 61-63 wherein the re-association message is a request, further comprising the WTRU processing the re-association request by making a decision regarding re-association.

[00145] 70. The method of embodiment 69 further comprising the WTRU transmitting the decision to the AP from which the re-association request was received in a directed re-association response message.

[00146] 71. The method of any of embodiments 69-70 further comprising the WTRU reconfiguring to communicate via the second set of communication parameters where the decision is to proceed with re-association.

[00147] 72. The method of any of embodiments 69-71 wherein the re-association request is received in a directed re-association request (DRRq)

frame from the first AP, the decision regarding re-association is transmitted in a directed re-association response (DRRsp) frame using the first set of communication parameters, and the reconfiguration confirmation is transmitted in a directed re-association confirmation (DRCf) frame using the second set of communication parameters.

[00148] 73. The method of any of embodiments 69-72 wherein the re-association request is received from the second AP, further comprising the WTRU using the second set of communication parameters to send the directed reconfiguration response message.

[00149] 74. The method of any of embodiments 69-73 further comprising the WTRU transmitting to the first AP a re-association indication using the first set of communication parameters where the WTRU decides to proceed with re-association.

[00150] 75. The method of any of embodiments 69-74 wherein the re-association request is received in a directed re-association request (DRRq) frame, the re-association indication is transmitted in a directed re-association indication (DRI) frame, and the reconfiguration confirmation is transmitted in a directed re-association confirmation (DRCf) frame.

[00151] 76. The method of any of embodiments 69-75 wherein the decision regarding re-association is transmitted by the WTRU in a directed re-association response (DRRsp) frame in advance of a DRI frame.

[00152] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone (without the other features and elements of the preferred embodiments) or in various combinations with or without other features and elements of the present invention.

* * *

CLAIMS

1. An access point (AP), comprising:

a transceiver, configured to:

transmit a transition request message to a wireless transmit/receive unit (WTRU) using a first set of communication parameters, wherein the transition request message includes a Basic Service Set ID (BSSID) of a second AP, a second set of communication parameters used by the second AP, a transition time field, and a flag indicating immediate disassociation of the WTRU from the first AP;

receive a transition response message in response to the transmission request message, the transition response message indicating whether the WTRU will transition to the second AP.

2. The AP of claim 1 wherein the transition request message includes information related to a Basic Service Set ID (BSSID) of the second AP.

3. The AP of claim 1 wherein the transition request message includes information related to capabilities of the second AP.

4. A method for use in an access point (AP), the method comprising:

transmiting a transition request message to a wireless transmit/receive unit (WTRU) using a first set of communication parameters, wherein the transition request message includes a Basic Service Set ID (BSSID) of a second AP, a second set of communication parameters used by the second AP, a transition time field, and a flag indicating immediate disassociation of the WTRU from the first AP; and

receiving a transition response message in response to the transmission request message, the transition response message indicating whether the WTRU will transition to the second AP.

5. The method of claim 4 wherein the transition request message includes information related to a Basic Service Set ID (BSSID) of the second AP.

6. The method of claim 4 wherein the transition request message includes information related to capabilities of the second AP.