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Method and apparatus for performing a handoff in an inter-extended service set (I-ESS)

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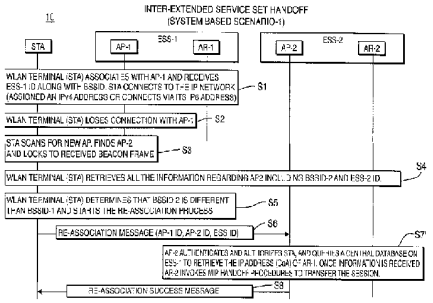
(54) Title: METHOD AND APPARATUS FOR PERFORMING A HANDOFF IN AN INTER-EXTENDED SERVICE SET (I-ESS)



(57) Abstract: Method and apparatus for handoff between two stations of a wireless local area network/wireless wide area network (WLAN/WWAN) wherein a terminal, communicating with a first station, scans for a second station when its connection with said first station is lost, or for any other reasons, and establishes communication with a second station. The establishment of communication with the second station includes determining that the second station is different from the first station; associating with the second station; forwarding the identity of the first station to the second station; and using the identity of the first station to continue the original session through the second station. The handoff is equally successful when the stations involved in the handoff are both in the same network or wherein the stations are in different networks.

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METHOD AND APPARATUS FOR PERFORMING A HANDOFF IN AN INTER-EXTENDED SERVICES SET (I-ESS)

FIELD OF THE INVENTION

The present application relates to Inter-Extended Service Sets (I-ESSs), and more particularly, to a method and apparatus for performing a handoff between ESSs.

BACKGROUND TO THE INVENTION

Scenarios exist wherein a wireless terminal (STA), in moving about a wireless local area network (WLAN) or a wireless wide area network (WW AN), comprised of a plurality of extended service sets (ESSs) may, due to its movement, lose contact with an access point (AP) in one ESS and thus desire to establish communication with another ESS. The ESSs may either be in the same network, i.e., either a WLAN network or a WWAN network, or may be in different networks, i.e., one in a WLAN network and the other in a WWAN network. It is thus desirable to provide a simple and yet effective method and apparatus for performing such a handoff, with or without loss of the original connection.

SUMMARY OF THE INVENTION

The present invention is characterized by utilizing an access router (AR) of the ESB originally communicating with the STA to achieve an effective handoff.

According to a first aspect, the present invention provides a method for managing mobility of a wireless station (STA), the STA capable of functioning in a network of Extended Service Sets (ESS) including a first ESS having a first Access Router (AR-1) and a second ESS having a second Access Router (AR-2), the method including:

the AR-2 authenticating and authorizing the STA;

the AR-2 notifying the AR-1 of the authentication of the STA based upon a home address of the STA in the first ESS and a care-of-address of the STA in the second ESS received from the STA, wherein the STA has an active session with the first ESS;

the AR-2 receiving rerouted traffic from the AR-1 in response to the notification to the AR-1 and a Mobile Internet Protocol (MIP) handoff procedure initiated by the AR-1; and

the AR-2 restoring the active session to the STA.

BRIEF DESCRIPTION OF THE FIGURES

The present invention will be understood from a consideration of the accompanying figures, wherein like elements are designated by like numerals and, wherein:

Figures 1A and 1B, taken together, represent a schematic diagram of a handoff in an inter-extended service set (I-EBB) employing a terminal-based procedure.

[0011] Figure 2 shows a schematic diagram representing a handoff in an I-ESS employing a system-based handoff procedure.

[0012] Figures 3A and 3B, taken together, show another system-based handoff procedure within I-ESSs.

[0013] Figures 4A and 4B, taken together, comprise a schematic diagram representing a handoff in an I-ESS which is terminal-based and wherein the connection of the STA with ESS-1 is not lost.

[0014] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Making reference to Figs. 1A and 1B there is shown therein a network of I-ESSs and a wireless STA capable of communication therewith. Although it should be understood that there may be any number of extended service sets (ESSs) and wireless stations (STAs) capable of communicating therewith, for purposes of simplicity, Figs. 1A and 1B have been limited to a showing of two such extended service sets, ESS-1 and ESS-2, and a single wireless STA, it being understood that the method and apparatus disclosed herein may be employed with equal success in a network having a greater number of ESSs and wireless STAs.

[0016] Initially the STA, at step S1, associates with the access point (AP-1) of a first extended service set ESS-1, further having an access router AR-1.

[0017] At step S1, the STA receives the identification of ESS-1 (ESS-1 ID) along with the basic service set identifier (BSS ID). The STA is then connected to the internet protocol (IP) network and is assigned either an IP address (IPv4) address or alternatively is connected by way of its IP version 6 (IPv6) address.

[0018] At step S2, it is assumed that the STA loses its connection with AP-1 due to change of location of STA, noise, natural or manmade barriers, or for any other reason, whereby the STA, at step S3, scans for a new AP, finds AP-2 which is part of the extended service set ESS-2, and locks on to a received beacon frame from ESS-2. At step S4, the STA retrieves information regarding AP-2 including the basic service set identifier (BSSID-2) and the ID for ESS-2 (ESS-2 ID).

[0019] At step S5, the STA determines that BSSID-2 is not the same as BSSID-1 and thereby starts a re-association process whereupon, at step S6, the STA sends a re-association message which includes the AP-1 ID, the AP-2 ID and the ESSID. AP-2 of ESS-2, at step S7, authenticates and authorizes the STA, but the distribution system in ESS-2 fails to recognize AP-1. At step S8, AP-2 sends a re-association success message to the STA. At step S9, the STA acquires access to the IP network and initiates a handoff procedure deploying either mobile IPv4 (MIPv4) or mobile IPv6 (MIPv6) by providing the old IP address, also known as the care of address (CoA), which is typically used by a mobile user when roaming into a foreign IP network. At step S10, access router-2 (AR-2) contacts access router-1 (AR-1), invoking the MIP (4 or 6) procedures and, at S11, AR-1 reroutes the traffic to AR-2 and releases the states of the STA in AP-1 and ESS-1. At step S12, the handoff procedure is completed and the session traffic is redirected to the STA via AP-2 whereupon, at step S13, the original session is continued. Whereas the embodiment of Figures 1A-1B shows the manner in which a handoff is made from an ESS-1 to an ESS-2 in a WLAN network, it should be understood that handoffs of WWAN to WWAN, WLAN to WWAN and WWAN to WLAN may be performed with equal success employing the algorithm of the present invention. The above combinations also apply to the embodiments of Figures 2 to 4B.

[0020] Figure 2 shows a system-based handoff wherein only those steps which distinguish from the steps in Figures 1A/1B are designated with a "prime". Making reference to Figure 2, steps S1 through steps S6 are substantially identical to steps S1 through steps S6 as shown in Fig. 1A. At step S7', AP-2, in addition to authenticating and authorizing the STA, queries an essential data base in ESS-1 to retrieve the IP address (i.e., the CoA) of AR-1 and, upon receipt of this information, AR-2 invokes an MIP handoff procedure to transfer the session thereafter sending a re-association success message at S8. It should be understood steps S9 through S13 shown in Figure 1B or steps similar thereto should follow step S8 of Figure 2. These steps have been omitted in Figure 2 for simplicity.

[0021] Figures 3A and 3B show another scenario wherein a modified system-based handoff is provided and the ESS-2 queries the STA.

[0022] Making reference to Figs. 3A and 3B, steps similar to those shown in Figs. 1A and 1B are shown "unprimed"; steps similar to the "primed" steps in Fig. 2 are shown "primed" and steps different from those shown in Figs. 1A, 1B and 2 are designated with a "double prime".

[0023] Making reference to Figs. 3A and 3B steps S1 through S6 are substantially identical to steps S1 through S6 of Fig. 1, for example. At step S7", AP-2 of ESS-2 authenticates and authorizes the STA and queries the STA to retrieve the IP address (CoA) of AR-1 and, at step S8", queries the STA as to the IP address of AR-1. The STA, at step S9", responds by providing the IP address of AR-1. AR-2, at step S10 contacts AR-1 and invokes the MIP (4 or 6) procedures. Steps S11 and S12 follow step S10 whereupon AP-2 sends the STA a re-association success message at step S12', followed by restoration of the session traffic, at S13".

[0024] Figures 4A and 4B show a terminal-based handoff scenario in which the original connection is not lost.

[0025] Steps S1 through S9 are substantially the same as steps S1-S9 of Figures 1A/1B except that step S2 is omitted. However, although the session established through ESS-1 has not been interrupted, it is assumed that the STA desires (for whatever reason) to initiate a handoff. At step S9, the STA contacts AP-1 to initiate a handoff.

[0026] After step S9, AR-1, at step S10, contacts AR-2 to invoke the MIP (4 or 6) procedures. The remaining steps S11-S13 are the same as in Figures 1A/1B. However, since the STA is still connected to ESS-1, AR-1, at step S10', initiates the handoff.

[0027] Station-initiated handoffs in scenarios when the session is not lost are performed in a manner similar to that in Figures 3A/3B. More particularly, in Figures 3A/3B, step S2 is omitted when the connection is not lost and step S10 is modified wherein AR-1 contacts AR-2 and invokes the MIP (4 or 6) procedures. The remaining steps S11-S13 remain unchanged.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for managing mobility of a wireless station (STA), the STA capable of functioning in a network of Extended Service Sets (ESS) including a first ESS having a first Access Router (AR-1) and a second ESS having a second Access Router (AR-2), the method including:

the AR-2 authenticating and authorizing the STA;

the AR-2 notifying the AR-1 of the authentication of the STA based upon a home address of the STA in the first ESS and a care-of-address of the STA in the second ESS received from the STA, wherein the STA has an active session with the first ESS;

the AR-2 receiving rerouted traffic from the AR-1 in response to the notification to the AR-1 and a Mobile Internet Protocol (MIP) handoff procedure initiated by the AR-1; and

the AR-2 restoring the active session to the STA.

2. The method of claim 1, wherein the notification of the AR-1 is further based on a Basic Service Set Identifier (BSS ID) and Extended Service Set identity (ESS-ID).

3. The method of claim 1, further including:

querying a database of the first ESS to retrieve an address of the STA.

4. The method of claim 3, wherein the address of the STA is an Internet protocol (IP) address.

5. The method of claim 3, wherein the address of the STA is a Mobile Internet Protocol (MIP) address.

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6. A method for managing mobility of a wireless station (STA), the STA capable of functioning in a network of Extended Service Sets (ESS) including a first ESS having a first Access Router (AR-1) and a second ESS having a second Access Router (AR-2) according to claim 1 and substantially as hereinbefore described with reference to the drawings.

INTERDIGITAL TECHNOLOGY CORPORATION

WATERMARK PATENT & TRADE MARK ATTORNEYS

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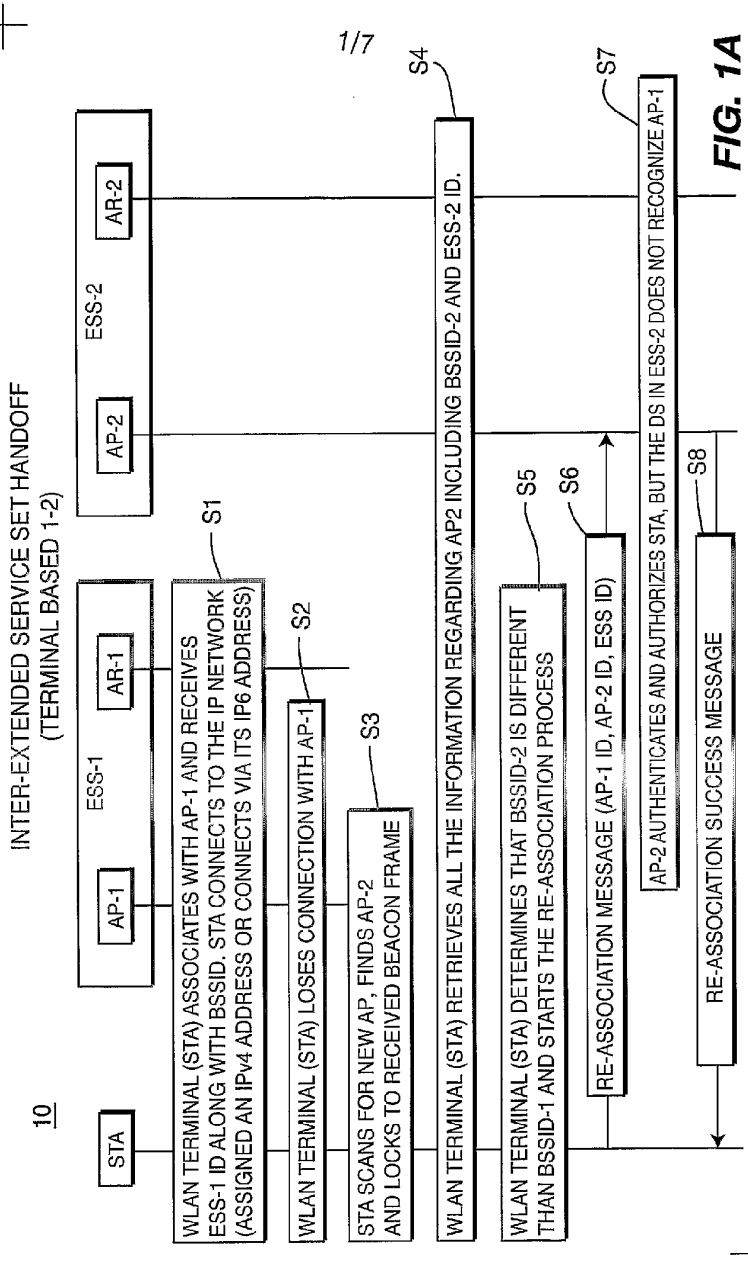
10
INTER-EXTENDED SERVICE SET HANDOFF
(TERMINAL BASED 1-2)
STA
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
S1
WLAN TERMINAL (STA) ASSOCIATES WITH AP-1 AND RECEIVES ESS-1 ID ALONG WITH BSSID. STA CONNECTS TO THE IP NETWORK (ASSIGNED AN IPv4 ADDRESS OR CONNECTS VIA ITS IP6 ADDRESS)
S2
WLAN TERMINAL (STA) LOSES CONNECTION WITH AP-1
S3
STA SCANS FOR NEW AP, FINDS AP-2 AND LOCKS TO RECEIVED BEACON FRAME
S4
WLAN TERMINAL (STA) RETRIEVES ALL THE INFORMATION REGARDING AP2 INCLUDING BSSID-2 AND ESS-2 ID.
S5
WLAN TERMINAL (STA) DETERMINES THAT BSSID-2 IS DIFFERENT THAN BSSID-1 AND STARTS THE RE-ASSOCIATION PROCESS
S6
RE-ASSOCIATION MESSAGE (AP-1 ID, AP-2 ID, ESS ID)
S7
AP-2 AUTHENTICATES AND AUTHORIZES STA, BUT THE DS IN ESS-2 DOES NOT RECOGNIZE AP-1
S8
RE-ASSOCIATION SUCCESS MESSAGE

FIG. 1A

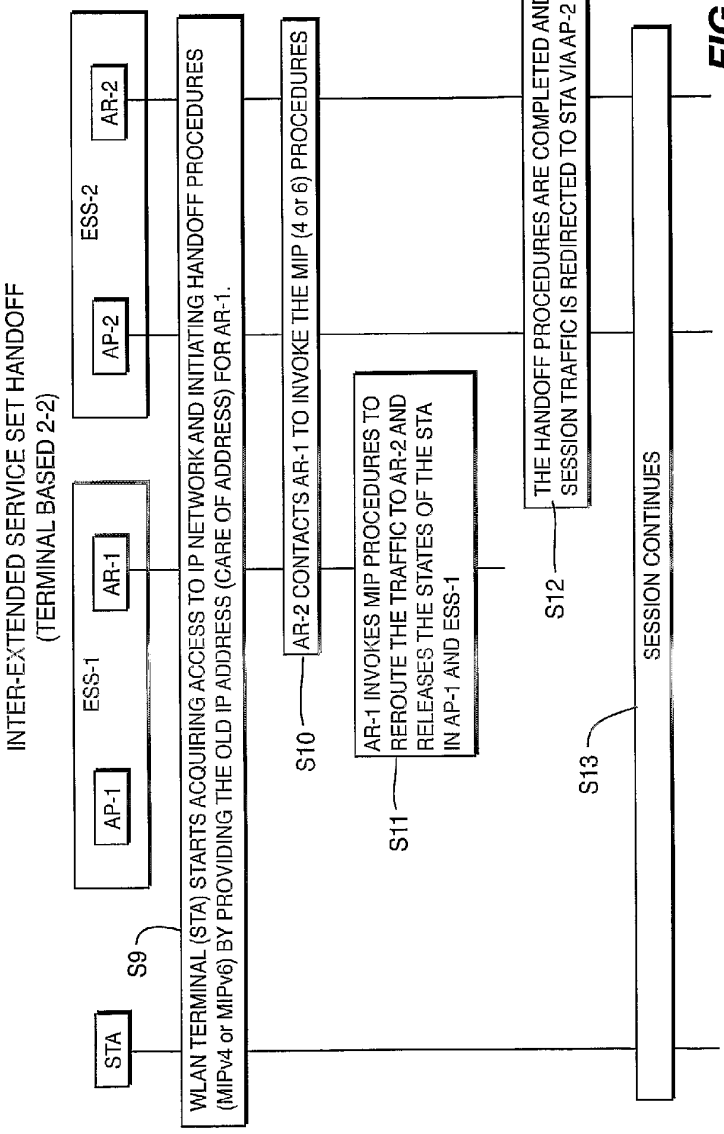
INTER-EXTENDED SERVICE SET HANDOFF
(TERMINAL BASED 2-2)
STA
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
S9
WLAN TERMINAL (STA) STARTS ACQUIRING ACCESS TO IP NETWORK AND INITIATING HANDOFF PROCEDURES (MIPv4 or MIPv6) BY PROVIDING THE OLD IP ADDRESS (CARE OF ADDRESS) FOR AR-1.
S10
AR-2 CONTACTS AR-1 TO INVOKE THE MIP (4 or 6) PROCEDURES
S11
AR-1 INVOKES MIP PROCEDURES TO REROUTE THE TRAFFIC TO AR-2 AND RELEASES THE STATES OF THE STA IN AP-1 AND ESS-1
S12
THE HANDOFF PROCEDURES ARE COMPLETED AND THE SESSION TRAFFIC IS REDIRECTED TO STA VIA AP-2
S13
SESSION CONTINUES

FIG. 1B

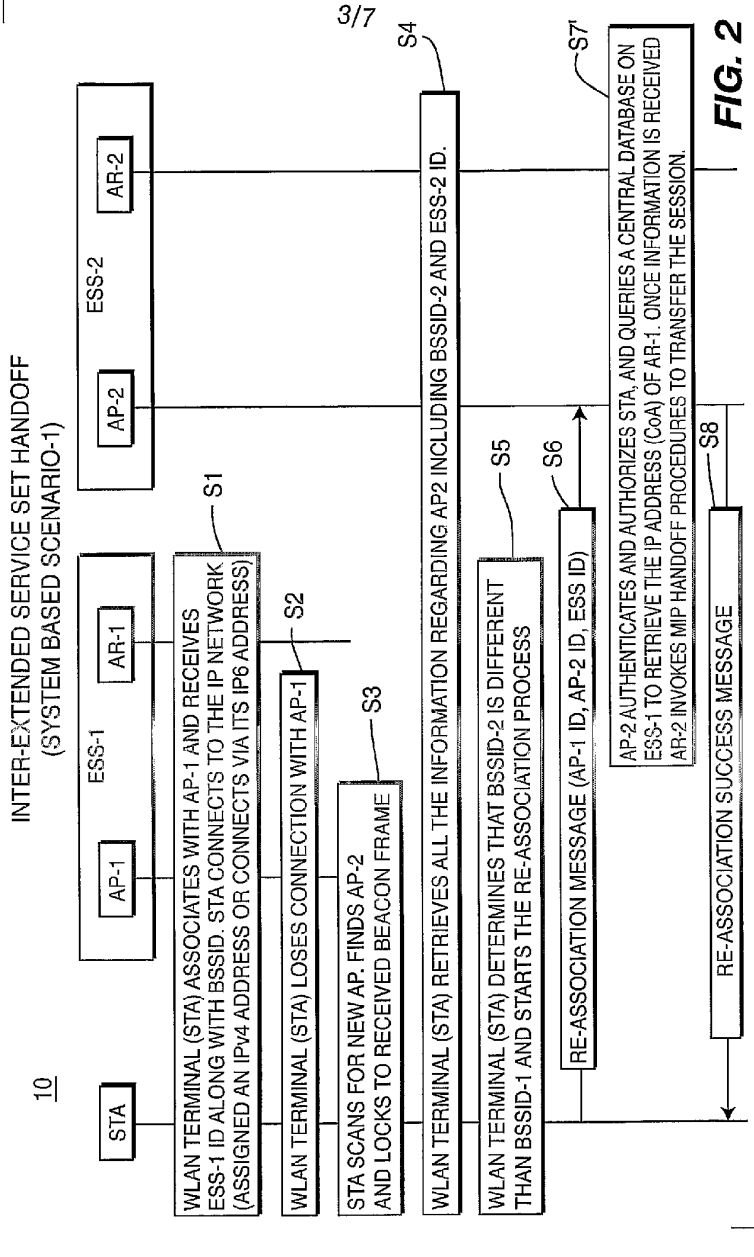
INTER-EXTENDED SERVICE SET HANDOFF
(SYSTEM BASED SCENARIO-1)
10
STA
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
S1
WLAN TERMINAL (STA) ASSOCIATES WITH AP-1 AND RECEIVES ESS-1 ID ALONG WITH BSSID. STA CONNECTS TO THE IP NETWORK (ASSIGNED AN IPv4 ADDRESS OR CONNECTS VIA ITS IP6 ADDRESS)
S2
WLAN TERMINAL (STA) LOSES CONNECTION WITH AP-1
S3
STA SCANS FOR NEW AP, FINDS AP-2 AND LOCKS TO RECEIVED BEACON FRAME
S4
WLAN TERMINAL (STA) RETRIEVES ALL THE INFORMATION REGARDING AP2 INCLUDING BSSID-2 AND ESS-2 ID.
S5
WLAN TERMINAL (STA) DETERMINES THAT BSSID-2 IS DIFFERENT THAN BSSID-1 AND STARTS THE RE-ASSOCIATION PROCESS
S6
RE-ASSOCIATION MESSAGE (AP-1 ID, AP-2 ID, ESS ID)
S7'
AP-2 AUTHENTICATES AND AUTHORIZES STA, AND QUERIES A CENTRAL DATABASE ON ESS-1 TO RETRIEVE THE IP ADDRESS (CoA) OF AR-1. ONCE INFORMATION IS RECEIVED AR-2 INVOKES MIP HANDOFF PROCEDURES TO TRANSFER THE SESSION.
S8
RE-ASSOCIATION SUCCESS MESSAGE

FIG. 2

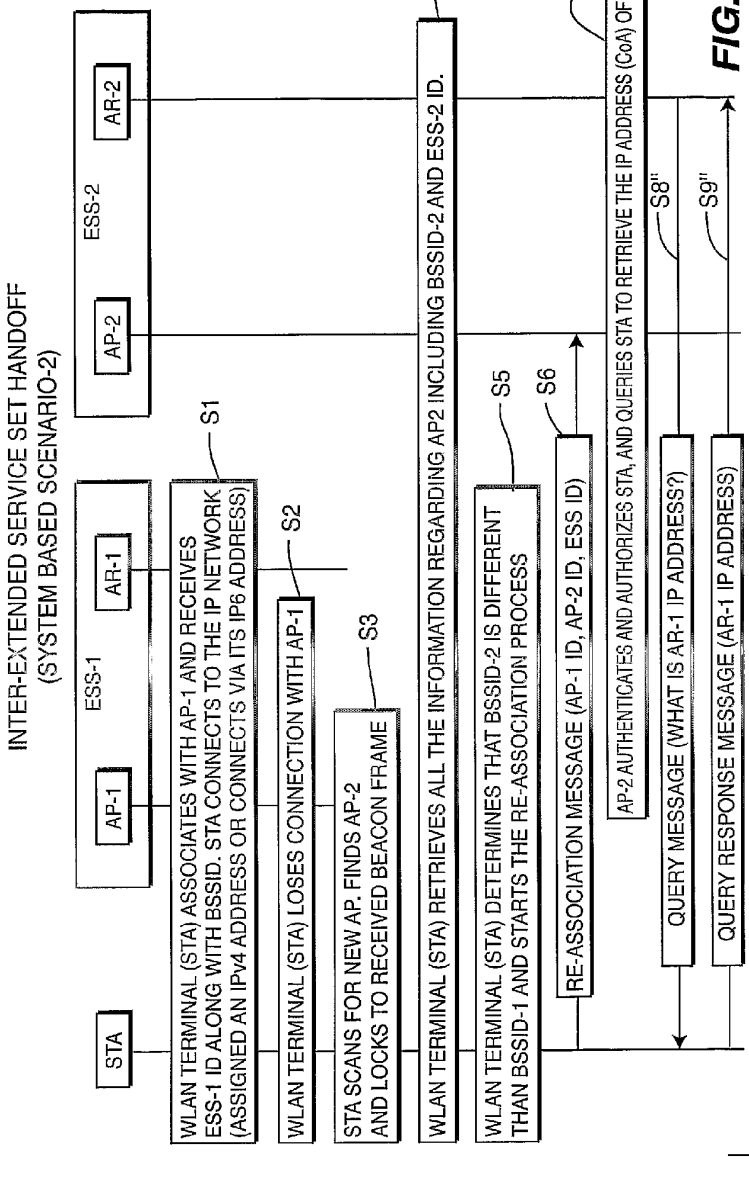
INTER-EXTENDED SERVICE SET HANDOFF
(SYSTEM BASED SCENARIO-2)
STA
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
WLAN TERMINAL (STA) ASSOCIATES WITH AP-1 AND RECEIVES ESS-1 ID ALONG WITH BSSID. STA CONNECTS TO THE IP NETWORK (ASSIGNED AN IPv4 ADDRESS OR CONNECTS VIA ITS IP6 ADDRESS)
S1
WLAN TERMINAL (STA) LOSES CONNECTION WITH AP-1
S2
STA SCANS FOR NEW AP, FINDS AP-2 AND LOCKS TO RECEIVED BEACON FRAME
S3
WLAN TERMINAL (STA) RETRIEVES ALL THE INFORMATION REGARDING AP2 INCLUDING BSSID-2 AND ESS-2 ID.
S4
WLAN TERMINAL (STA) DETERMINES THAT BSSID-2 IS DIFFERENT THAN BSSID-1 AND STARTS THE RE-ASSOCIATION PROCESS
S5
RE-ASSOCIATION MESSAGE (AP-1 ID, AP-2 ID, ESS ID)
S6
AP-2 AUTHENTICATES AND AUTHORIZES STA, AND QUERIES STA TO RETRIEVE THE IP ADDRESS (CoA) OF AR-1.
S7"
QUERY MESSAGE (WHAT IS AR-1 IP ADDRESS?)
S8"
QUERY RESPONSE MESSAGE (AR-1 IP ADDRESS)
S9"

FIG. 3A

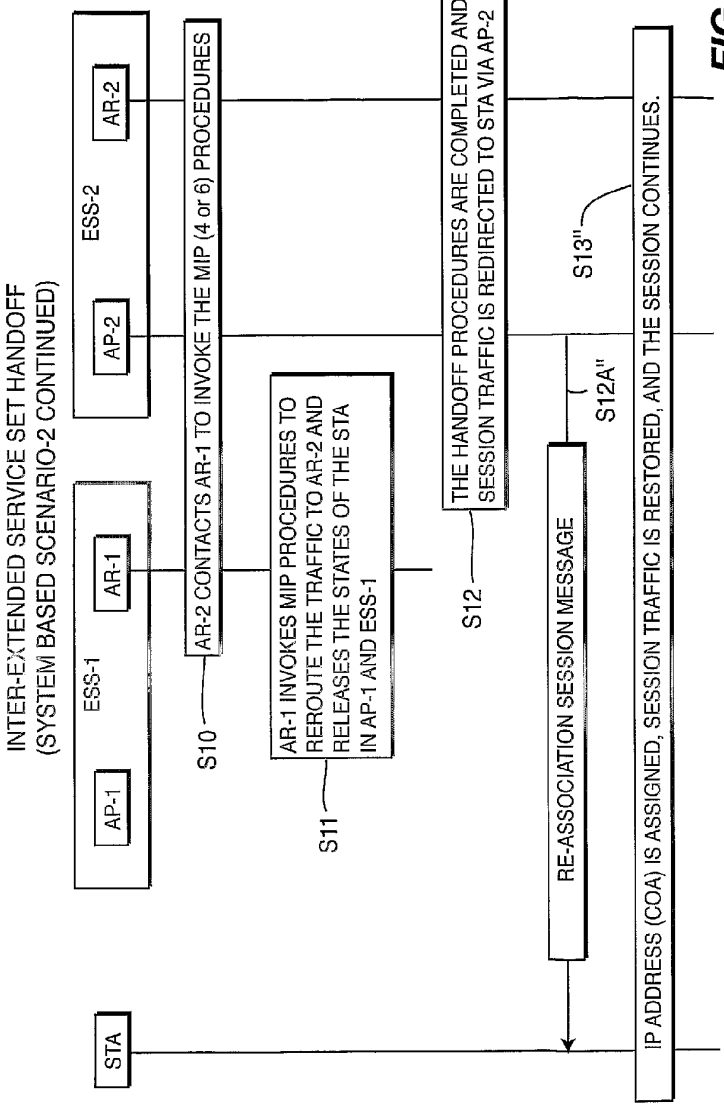
INTER-EXTENDED SERVICE SET HANDOFF
(SYSTEM BASED SCENARIO-2 CONTINUED)
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
STA
S10
AR-2 CONTACTS AR-1 TO INVOKE THE MIP (4 or 6) PROCEDURES
S11
AR-1 INVOKES MIP PROCEDURES TO REROUTE THE TRAFFIC TO AR-2 AND RELEASES THE STATES OF THE STA IN AP-1 AND ESS-1
S12
THE HANDOFF PROCEDURES ARE COMPLETED AND THE SESSION TRAFFIC IS REDIRECTED TO STA VIA AP-2
S12A"
RE-ASSOCIATION SESSION MESSAGE
S13"
IP ADDRESS (COA) IS ASSIGNED, SESSION TRAFFIC IS RESTORED, AND THE SESSION CONTINUES.

FIG. 3B

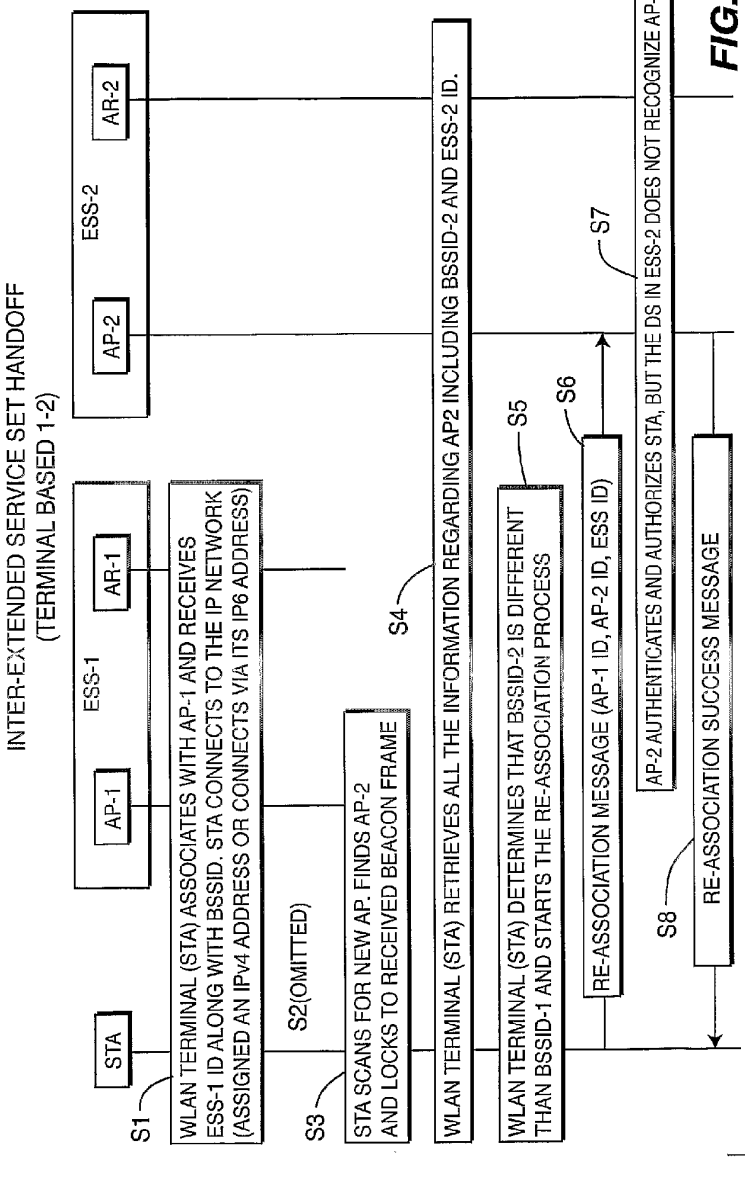
INTER-EXTENDED SERVICE SET HANDOFF
(TERMINAL BASED 1-2)
STA
ESS-1
AP-1
AR-1
ESS-2
AP-2
AR-2
S1
WLAN TERMINAL (STA) ASSOCIATES WITH AP-1 AND RECEIVES ESS-1 ID ALONG WITH BSSID. STA CONNECTS TO THE IP NETWORK (ASSIGNED AN IPv4 ADDRESS OR CONNECTS VIA ITS IP6 ADDRESS)
S2(OMITTED)
S3
STA SCANS FOR NEW AP. FINDS AP-2 AND LOCKS TO RECEIVED BEACON FRAME
S4
WLAN TERMINAL (STA) RETRIEVES ALL THE INFORMATION REGARDING AP2 INCLUDING BSSID-2 AND ESS-2 ID.
S5
WLAN TERMINAL (STA) DETERMINES THAT BSSID-2 IS DIFFERENT THAN BSSID-1 AND STARTS THE RE-ASSOCIATION PROCESS
S6
RE-ASSOCIATION MESSAGE (AP-1 ID, AP-2 ID, ESS ID)
S7
AP-2 AUTHENTICATES AND AUTHORIZES STA, BUT THE DS IN ESS-2 DOES NOT RECOGNIZE AP-1
S8
RE-ASSOCIATION SUCCESS MESSAGE

FIG. 4A

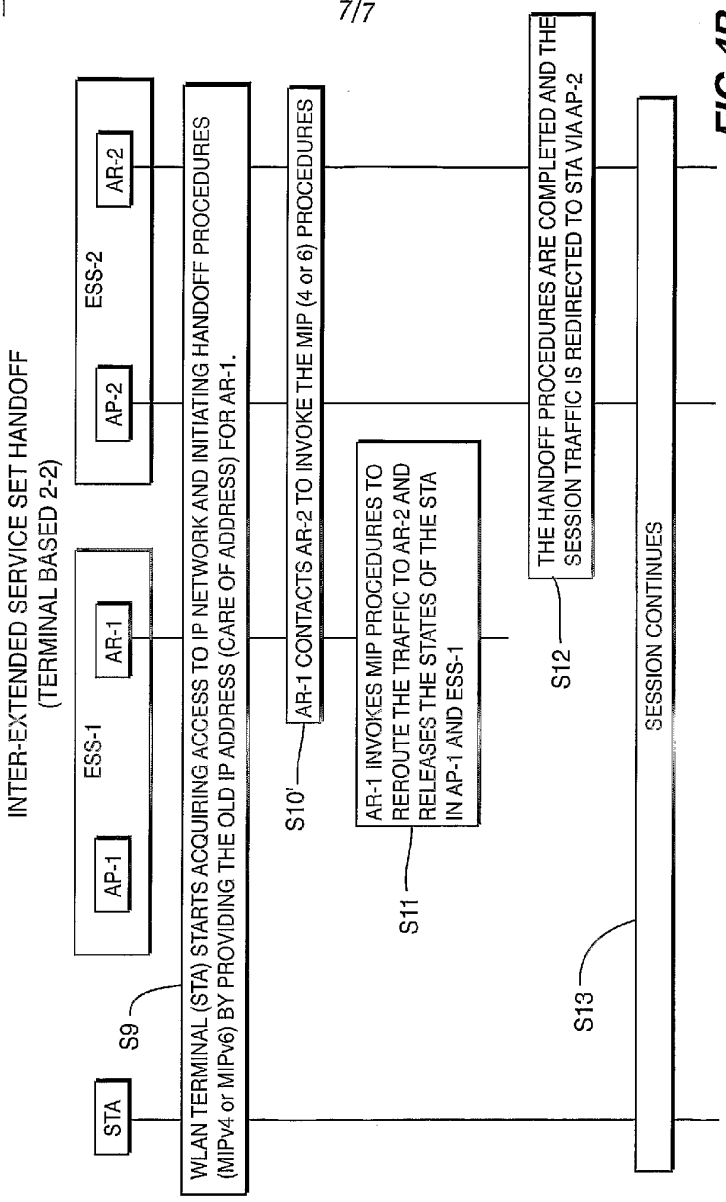
INTER-EXTENDED SERVICE SET HANDOFF
(TERMINAL BASED 2-2)
STA
AP-1
ESS-1
AR-1
AP-2
ESS-2
AR-2
S9
WLAN TERMINAL (STA) STARTS ACQUIRING ACCESS TO IP NETWORK AND INITIATING HANDOFF PROCEDURES (MIPv4 or MIPv6) BY PROVIDING THE OLD IP ADDRESS (CARE OF ADDRESS) FOR AR-1.
S10'
AR-1 CONTACTS AR-2 TO INVOKE THE MIP (4 or 6) PROCEDURES
S11
AR-1 INVOKES MIP PROCEDURES TO REROUTE THE TRAFFIC TO AR-2 AND RELEASES THE STATES OF THE STA IN AP-1 AND ESS-1
S12
THE HANDOFF PROCEDURES ARE COMPLETED AND THE SESSION TRAFFIC IS REDIRECTED TO STA VIA AP-2
S13
SESSION CONTINUES

FIG.4B