[0001] # SYSTEM AND METHOD FOR IMPLEMENTING A MEDIA INDEPENDENT HANDOVER

[0002] ## FIELD OF INVENTION

[0003] The present invention generally relates to wireless communication systems, and more particularly, to a method and system for implementing a media independent handover between different wireless network types.

[0004] ## BACKGROUND

[0005] Typical mobile systems have two main operating modes: Idle mode and Connected mode. In Idle mode, the station (STA) characteristics include: no user service (i.e., no call or transaction in progress); monitoring of paging channels; available service request channels; 100% of the receiver is available for downlink measurements of the radio environment; background coordination; and unscheduled access point (AP) and/or technology reselection. In Connected mode, the STA characteristics include: an active user service (e.g., a call is in progress); handover is possible; limited receiver availability for measurements (since the user service takes priority); and fully coordinated, scheduled AP and/or technology handover.

[0006] Prior to entering Idle mode (e.g., at power-up), the STA must perform selection in order to determine the best AP and technology available for the requested user service. While in the Idle mode, the STA continuously examines neighboring APs and APs with different technologies. Upon determination of a "better" AP, the STA will transition over (i.e., perform "reselection") to the new AP.

[0007] While in the Connected mode, a handover occurs upon transition from one AP to another AP offering "better" service, including switching to an AP using a different technology. In an ideal case, handover occurs without noticeable interruption of the active user service.

[0008] One goal is to achieve a seamless handover (i.e., to permit mobility of a STA) between different wireless network types, such as between different

wireless local area network (WLAN) types or between a WLAN and a cellular system. Current technology does not provide for this type of handover.

[0009] Figure 1 is a diagram of an existing cellular mobility model 100, showing a centralized radio resource management (RRM) approach to the mobility issue. A cellular STA 102 (e.g., a 2G mobile station or a 3G user equipment) is freely mobile among a plurality of APs 104. The APs 104 can include, but are not limited to, GSM base stations and FDD/CDMA Node Bs. The APs 104 are connected together via a radio network 106. A handover policy function (HPF) 108 is used to direct the handover of the STA 102 among the APs 104 as the STA 102 moves about. The HPF 108 is centrally located (e.g., in a 2G base station controller (BSC) or a 3G radio network controller (RNC)) and is connected to a network 110 (e.g., a switch or a server).

[0010] The HPF 108 provides coordination as the STA 102 moves about the different APs 104. The STA 102 sends measurements to the HPF 108, and the HPF 108 makes the final decision regarding handover and which AP 104 the STA 102 should be on.

[0011] In the model 100, semi-static frequency assignments are made to each AP 104 and some radio planning is required. In Idle mode, both intra-technology (e.g., GSM to GSM) and inter-technology (e.g., GSM to FDD/WCDMA) AP selection/reselection decisions are made in the STA 102 and are supported by system information (from the network 110) broadcast by the HPF 108. In Connected mode, AP handover decisions are made in the HPF 108 and are supported by measurements made by the STA 102 that are sent to the HPF 108 via L3 signaling.

[0012] Figure 2 is a diagram of an existing WLAN mobility model 200, showing a distributed RRM approach to the mobility issue. An 802.x STA 202 is freely mobile among a plurality of APs 204, which can include, but are not limited to 802.11a and 802.16 APs. The APs 204 communicate via a radio network 206 and to a network 208 (e.g., a gateway or router).

[0013] In the model 200, dynamic frequency assignments are made to each AP 204 and radio planning is not required. The only type of handover supported

in the mobility model 200 is an intra-technology (e.g., 802.11a to 802.11a) Idle mode handover, where the AP selection/reselection decision is made autonomously in the STA 202. The other handover types (Idle mode with inter-technology and Connected mode) are not supported in the mobility model 200.

[0014] In this distributed RRM approach, the APs 204 can be deployed anywhere and they dynamically manage themselves. There is no centralized point through which RRM is performed, and therefore, no element in the architecture to execute a handover.

[0015] Figure 3 is a diagram of existing mobile system architectures for cellular and WLAN network types. A GPRS (2G) STA 300 includes a physical layer 302, a data link layer 304, and a network layer 306. The data link layer 304 includes a medium access control (MAC) sublayer 310 and a radio link control (RLC) sublayer 312. The network layer 306 includes a GSM radio resource (RR) manager 314, a mobility management (MM) protocol manager 316, and an Internet Protocol (IP)/convergence manager 318.

[0016] A 3GPP (3G) STA 320 includes a physical layer 322, a data link layer 324, and a network layer 326. The data link layer 324 includes a MAC sublayer 330 and a RLC sublayer 332. The network layer 326 includes a 3G RR controller 334, a MM protocol manager 336, and an IP/convergence manager 338.

[0017] An 802.xx STA 340 includes a physical layer 342, a data link layer 344, and a network layer 346. The data link layer 344 includes a MAC sublayer 350 and a logical link (LLC) sublayer 352. The network layer 346 includes a mobile IP manager 354 and an IP/convergence manager 356.

[0018] The RR manager/controller (314, 334) manages the instantaneous radio link, handling all of the information regarding a radio link. The MM protocol (316, 336, 354) handles network level issues, such as registration and location updating as the STA moves about the system (i.e., issues outside of the call itself).

[0019] Current WLAN systems offer only a limited mobility capability. Intra-technology (e.g., 802.11 to 802.11) and inter-technology (e.g., 802.11 to 802.16) user transitions are supported using a "break before make" strategy that

can be characterized as a reselection operation, as opposed to a handover operation in a typical full mobility system (e.g., GSM). This problem limits the growth of WLAN technologies, as this approach is unsatisfactory for supporting real time services such as voice and video streaming.

[0020] SUMMARY

[0021] The present invention is a solution to implement a full mobility solution for both intra-technology and inter-technology transition scenarios, and satisfies the requirements of both real time and non-real time services. The invention is a device-agnostic handover policy function that places few limitations on the physical implementation. The invention supports WLAN to WLAN transitions as well as WLAN to wireline LAN transitions and may be integrated with a typical mobile cellular system (e.g., GSM), allowing the realization of a full mobility WLAN/cellular solution.

[0021a] One aspect of the present invention provides a wireless transmit/receive unit (WTRU) comprising: an IEEE 802.xx medium access control (MAC) management entity (ME); an IEEE 802.xx physical (PHY) ME; and a media independent handover (MIH) component configured to communicate with the MAC ME and the PHY ME, and to receive mobility protocol information and resource control protocol information from a handover policy function (HPF) of a network infrastructure component.

[0021b] A further aspect of the present invention provides a method for use in a wireless transmit/receive unit (WTRU), the method comprising: communicating, via a media independent handover (MIH) component, with an IEEE 802.xx media access control (MAC) management entity (ME) and an IEEE 802.xx physical (PHY) ME; transmitting measurement information from the MIH component to a handover policy function (HPF) of a network infrastructure component; receiving, at the MIH component, a handover command from the

HPF of the network infrastructure component; and performing a make-then-break handover from a first wireless network to a second wireless network.

[0022] A system for implementing a media independent handover in a station in a wireless communication system includes a physical sublayer management entity, a medium access control sublayer management entity, a management information base, and a handover policy function. The handover policy function is capable of receiving measurements and system information from the physical sublayer management entity, the medium access control sublayer management entity, and the management information base. The handover policy function is capable of then autonomously determining whether to execute a handover.

[0023] A system implements a media independent handover in a wireless communication system having a station and an access point. The station includes a physical sublayer management entity, a medium access control sublayer management entity, and a media independent handover (MIH) layer. The MIH layer communicates with the physical sublayer management entity and the medium access control sublayer management entity. The access point includes a handover policy function communicating with the MIH layer and determining whether the station should execute a handover.

[0024] A method for implementing a media independent handover in a station in a wireless communication system begins by providing a handover policy function. System measurements and information are provided from the station to the handover policy function. A determination whether to execute a handover is based on the system measurements and information.

[0025] A method for implementing a media independent handover in a wireless communication system begins by providing a media independent handover (MIH) layer in a station and a handover policy function in an access point. Station measurements are sent from the station to the access point via the MIH layer. The handover policy function determines whether the station should execute a handover. The handover is controlled via information sent via the MIH layer.

[0026] A station for implementing a media independent handover in a wireless communication system includes a physical sublayer management entity, a medium access control sublayer management entity, a management information base, and a handover policy function. The handover policy function is capable of receiving measurements and system information from the physical sublayer management entity, the medium access control sublayer management entity, and the management information base. The handover policy function is capable of then autonomously determining whether to execute a handover.

[0027] An integrated circuit for implementing a media independent handover in a station in a wireless communication system includes a physical sublayer management entity, a medium access control sublayer management entity, a management information base, and a handover policy function. The handover policy function is capable of receiving measurements and system information from the physical sublayer management entity, the medium access control sublayer management entity, and the management information base. The handover policy function is capable of then autonomously determining whether to execute a handover.

[0028] BRIEF DESCRIPTION OF THE DRAWINGS

[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:

[0030] Figure 1 is a diagram of an existing cellular mobility model;

[0031] Figure 2 is a diagram of an existing WLAN mobility model;

[0032] Figure 3 is a diagram of existing mobile system architectures for cellular and WLAN network types;

[0033] Figure 4 is a diagram of a mobility architecture in a WLAN in accordance with the present invention and how it compares to cellular network types;

[0034] Figure 5 is a diagram of a WLAN mobility model in accordance with the present invention;

[0035] Figure 6 is a diagram showing construction of a STA architecture to implement a distributed handover policy function of the present invention; and

[0036] Figure 7 is a diagram showing construction of a STA architecture to implement a centralized handover policy function of the present invention.

[0037] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] Hereafter, the term "station" (STA) includes, but is not limited to, a wireless transmit/receive unit, a user equipment, a fixed or mobile subscriber unit, a pager, or any other type of device capable of operating in a wireless environment. When referred to hereafter, the term "access point" (AP) includes, but is not limited to, a base station, a Node B, a site controller, or any other type of interfacing device in a wireless environment.

[0039] Figure 4 is a diagram of a mobility architecture in a WLAN and how it compares to cellular network types. The GPRS STA 300 and the 3GPP STA 320 are identical to the STAs described above in connection with Figure 3. An 802.xx STA 400 includes a physical layer 402, a data link layer 404, and a network layer 406. The data link layer 404 includes a MAC sublayer 410 and a LLC sublayer 412. The network layer 406 includes a media independent handover layer 414, a

mobile IP manager 416, and an IP/convergence manager 418. The remainder of the discussion focuses on the media independent handover (MIH) layer 414 and how it operates within a mobility model. The MIH layer 414 performs functions similar to the GSM RR 314 and the 3G RRC 334.

[0040] Figure 5 is a diagram of a WLAN mobility model 500 in accordance with the present invention, showing two basic HPF options, distributed and centralized. These options relate to the situations not previously addressed by mobility models, i.e., Idle mode with inter-technology handover and Connected mode handover.

[0041] An 802.x STA 502 is freely mobile among a plurality of APs 504, which can include, but are not limited to 802.11a and 802.16 APs. The APs 504 communicate via a radio network 506 and to a network 508 (e.g., a gateway or router).

[0042] The model 500 can implement a distributed HPF 510 at the STA 502 and/or a centralized HPF 520 at the network 508.

[0043] In a distributed HPF setting, the STA makes the selection, reselection, and handover decisions autonomously. This includes Idle mode, inter-technology selection/reselection and both Connected mode handover types.

[0044] In a centralized HPF setting, the HPF located on the system side assists in the selection and reselection processes, and makes the handover decisions supported by information gathered by the STA. The information is communicated from the STA to the HPF via the signaling mechanisms of the present invention (i.e., the MIH layer). This includes Idle mode, inter-technology selection/reselection and both Connected mode handover types.

[0045] Figure 6 is a block diagram of a functional architecture for a STA 600 utilizing the distributed HPF of the present invention. The STA 600 includes a physical sublayer management entity (ME) 602 and a MAC sublayer ME 604. A HPF 606 communicates with both the physical sublayer ME 602 and the MAC sublayer ME 604. A local management information base 608 stores information accessed by the HPF 606 in making the handover decision. The physical sublayer ME 602 includes a physical layer convergence procedure (PLCP) sublayer 610

and a physical medium dependant (PMD) sublayer 612. The MAC sublayer ME 604 includes a MAC sublayer 614.

[0046] Reselection and handover decisions are made autonomously by the STA 600. The HPF 606 receives measurements and other events (information typically used in making a handover decision) from the MAC sublayer ME 604 and the physical sublayer ME 602. The HPF 606 processes this information and makes an autonomous decision whether to perform a handover.

[0047] This is a limited handover solution, and is really just an extension of the reselection procedure and would be characterized as such in a typical mobile system. This is an adequate, but sub-optimal solution, mainly due to the use of a "break then make" strategy. With this strategy, when a STA knows that its radio link is deteriorating, it breaks the current link or the link independently fails before the new link is established. The resource availability to complete the handover is not guaranteed, and could lead to dropped calls of the new AP lacks the resources to accommodate the handover. The possibility of dropped calls is an adequate solution for non-real time services, but is an unacceptable solution for real time services such as voice communications. Furthermore, this is a poorly scalable solution, for the same reasons; i.e., as more STAs are added to the system, the performance will deteriorate.

[0048] Figure 7 is a block diagram of a functional architecture for a STA 700 utilizing the centralized HPF. The STA 700 includes a physical sublayer ME 702 and a MAC sublayer ME 704. A media independent handover (MIH) layer 706 communicates with both the physical sublayer ME 702 and the MAC sublayer ME 704. The MIH layer 706 communicates with a MIH layer 708 on the system side. The MTH layer 708 communicates with a system HPF 710. The physical sublayer ME 702 includes a PLCP sublayer 712 and a PMD sublayer 714. The MAC sublayer ME 704 includes a MAC sublayer 716.

[0049] The MIH layer 706 and the system HPF 710 communicate via the MIH layer 708. The MIH layer 706 sends measurements to the HPF 710 and the HPF 710 sends system information to the MIH layer 706. The reselection and handover decisions are coordinated between the MIH layer 706 and the HPF 710

based on this exchange of information. This use of both the MIH layer 706, the MIH layer 708, and the HPF 710 is analogous to a cellular system type of handover.

[0050] Reselection and handover decisions are coordinated by the HPF 710 and are supported by measurement reports and system signaling received via the MIH layers 706, 708. This is a fast, optimal handover solution due to the centralized decision-making which uses a make then break strategy, guaranteeing resource availability to complete the handover. This is an adequate solution for non-real time services, an acceptable solution for real time services, and is easily scalable, providing a full mobility solution.

[0051] In order to support a full mobility solution, both a mobility protocol (e.g., MM, mobile IP, SIP, etc.) and a resource control protocol (e.g., RRC or MIH layer) are required. The mobility protocol supports functions such as discovery, registration, tunneling, termination (or paging), handover at the network level (between two switches), and security. The resource control protocol supports functions such as system information, termination (or paging), cell selection/reselection, establishment, release, measurement reporting, power control, and handover at the radio level (between two radios). Handover support provided at both levels is required to support a full mobility solution.

[0052] On the network side, both the MIH layer 708 and the HPF 710 can be positioned in any centralized entity, such as an AP, a server, a database, or a router. In a preferred embodiment, the MIH layer 708 and the HPF 710 are located in an AP or an AP controller. The MIH layer 708 and the HPF 710 are separate logical entities. The MIH layer 708 acts as a state machine, gathering the necessary information and passing it to the HPF 710. The HPF 710 makes the handover decision based upon the information received.

[0053] While the present embodiment has been described in terms of a WLAN, the principles of the present embodiment are equally applicable to any type of wireless communication system. The centralized HPF architecture can be extended to support wireless to wired interworking scenarios, such as a handover policy when connecting a wireless device to a wireline system. An example of this

would be using an 802.11-enabled laptop and then docking the laptop and using handover to take advantage of an Ethernet connection to the laptop docking station.

[0054] Although the elements shown in Figures 6 and 7 are illustrated as separate elements, these elements may be implemented on a single integrated circuit (IC), such as an application specific integrated circuit (ASIC), multiple ICs, discrete components, or a combination of discrete components and IC(s). In certain implementations, the functionality of embodiments and features of the invention may be present in discrete component(s)/IC(s) and may be partially/totally disabled or deactivated.

[0055] 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.

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CLAIMS

What is claimed is:

1. A wireless transmit/receive unit (WTRU) comprising:

an IEEE 802.xx medium access control (MAC) management entity (ME);

an IEEE 802.xx physical (PHY) ME; and

a media independent handover (MIH) component configured to communicate with the MAC ME and the PHY ME, and to receive mobility protocol information and resource control protocol information from a handover policy function (HPF) of a network infrastructure component.

2. The WTRU of claim 1, wherein the MIH component is further configured to transmit measurement information to the HPF.

3. The WTRU of claim 1, wherein the MIH component is further configured to communicate with an IEEE 802.xx logical link control (LLC) component in the WTRU.

4. The WTRU of claim 1, wherein the network infrastructure component is a component in a wireless network.

5. The WTRU of claim 1, wherein the mobility protocol information includes a handover command and wherein the WTRU is further configured to perform handover from a first network to a second network in response to the handover command.

6. The WTRU of claim 5, wherein the first network is a cellular network and the second network is an IEEE 802.xx network.

7. The WTRU of claim 5, wherein the first network is an IEEE 802.xx network and the second network is a cellular network.

8. The WTRU of claim 5, wherein the first network is an IEEE 802.xx network and the second network is an IEEE 802.xx network.

9. The WTRU of claim 8, wherein the first network is an IEEE 802.16 network and the second network is an IEEE 802.11 network.

10. The WTRU of claim 8, wherein the first network is an IEEE 802.11 network and the second network is an IEEE 802.16 network.

11. A method for use in a wireless transmit/receive unit (WTRU), the method comprising:

communicating, via a media independent handover (MIH) component, with an IEEE 802.xx media access control (MAC) management entity (ME) and an IEEE 802.xx physical (PHY) ME;

transmitting measurement information from the MIH component to a handover policy function (HPF) of a network infrastructure component;

receiving, at the MIH component, a handover command from the HPF of the network infrastructure component; and performing a make-then-break handover from a first wireless network to a second wireless network.

12. The method of claim 11, further comprising:

communicating, via the MIH component, with an IEEE 802.xx logical link control (LLC) component in the WTRU.

13. The method of claim 11, wherein the first network is a cellular network and the second network is an IEEE 802.xx network.

14. The method of claim 11, wherein the first network is an IEEE 802.xx network and the second network is a cellular network.

15. The method of claim 11, wherein the first network is an IEEE 802.xx network and the second network is an IEEE 802.xx network.

16. The method of claim 11, wherein the first network is an IEEE 802.16 network and the second network is an IEEE 802.11 network.

17. The method of claim 11, wherein the first network is an IEEE 802.11 network and the second network is an IEEE 802.16 network.