

[0001] METHOD AND APPARATUS FOR
DISTRIBUTING BEACON INFORMATION

[0002] FIELD OF INVENTION

[0003] The present invention relates to wireless communication systems, such as Wireless Local Area Networks (WLANs). In particular, the present invention relates to a method and apparatus of distributing beacon information in a wireless communication system.

[0004] BACKGROUND

[0005] In 802.11 systems, a station (STA) can associate with an access point (AP) by active or passive scanning. In active scanning, the STA sends a probe request and the AP responds with a probe response. In passive scanning, the STA actively listens for the beacon. Both the probe response packet and the beacon contain similar information, such as Timestamp, Beacon Interval, SSID, Supported Data Rate, FH parameter, CF Parameter, DS parameter set and Capability Information set. In either case, the STA associates with the AP after receiving a beacon or a probe response.

[0006] Typically, a mobile STA connects to a new AP by acquiring the beacon information and then associating with it. However, this process may take on the order of several hundred milliseconds, which can be a very long gap for certain applications. Some solutions to this problem propose that the STA should pre-authenticate to more than one AP in a certain area to reduce the time needed for authentication. However, these solutions do not reduce the time required to get beacon information via either a beacon or probe response as a beacon generally has approximately a 100 millisecond periodicity.

[0007] Typically, a probe request/response mechanism sends multiple probe request messages and the STA waits for the response from the AP(s). Accordingly, collecting the beacon information itself may take anywhere from tens of milliseconds to 100 milliseconds. This time delay may be detrimental to the functioning of certain applications the STA is running.

[0008] Therefore, it would be beneficial to provide a method and apparatus for distributing beacon information to STAs without the limitations of conventional mechanisms.

[0009] SUMMARY

[0010] The present invention is directed to a method and apparatus for distributing beacon information. A first WTRU modifies a physical layer convergence protocol (PLCP) header in a physical protocol data unit (PHY PDU) frame to include beacon information. The first WTRU transmits the modified PLCP header to a second WTRU. The second WTRU receives the modified PLCP header and extracts beacon information from the modified PLCP header. The second WTRU associates with the first WTRU.

[0011] BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The foregoing summary, as well as the following detailed description of the preferred embodiments of the present invention will be better understood when read with reference to the appended drawings, wherein:

[0013] Figure 1 is a prior art frame format of an 802.11a OFDM PLCP frame;

[0014] Figure 2 shows an exemplary wireless communication system, including a plurality of wireless transmit/receive units (WTRUs), configured in accordance with the present invention;

[0015] Figure 3 is a functional block diagram of a pair of WTRUs of the wireless communication system of Figure 2; and

[0016] Figure 4 is a flow diagram of a method for distributing beacon information, in accordance with the present invention;

[0017] Figure 5 is a depiction of a variable information frame, containing variable elements of data in accordance with the present invention; and

[0018] Figure 6 is a depiction of a fixed information frame, containing fixed elements of data in accordance with the present invention.

[0019] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Hereafter, a wireless transmit/receive unit (WTRU) includes but is not limited to a user equipment (UE), a mobile station (STA), 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, a base station includes but is not limited to a Node-B, a site controller, an access point (AP), a WTRU, or any other type of interfacing device in a wireless environment.

[0021] Figure 1 is a prior art frame format of an IEEE 802.11a PHY protocol data unit (PDU) 100. The PHY PDU 100 includes a physical layer convergence protocol (PLCP) preamble field 117, a signal field 118, and a data field 150. The signal field 118 includes a rate field 111, a reserved field 112, a length field 113, a parity field 114, and a tail field 115. The data field 150 includes a service field 116, a PSDU field 120, a tail field 130, and a pad bits field 140. The rate field 111, reserved field 112, length field 113, parity field 114, tail field 114 and service field 116 comprise a PLCP header 110. The signal field 118 and the data field 150 are coded/OFDM fields. Generally, the signal field 118 provides information, such as rate, length, and parity, about the format of the data field that follows.

[0022] Although embodiments of the present invention will be described in greater detail below, the present invention, in general, relates to a method and apparatus for distributing beacon information by adding additional fields to the PLCP header that will identify the beacon information element and the information itself.

[0023] Figure 2 shows an exemplary wireless communication system 200, including a WTRU 210 and a plurality of WTRUs 220, configured in accordance with the present invention. The WTRUs 220, in a preferred embodiment of the present invention are in wireless communication with the WTRU 210, however, it should be noted that any of the WTRUs 220 may be in wireless communication with one another as well. Additionally, the WTRU 210 may be connected to an external network 230 such as the Internet, a public switched telephone network (PSTN), and the like. In a preferred embodiment of the present invention, the

WTRU 210 may be an AP. The WTRU 210 and the WTRU 220 may also be substantially similar to one another.

[0024] Figure 3 is a functional block diagram of a WTRU 210 and a WTRU 220 of the wireless communication system 200 of Figure 2. As shown in Figure 2, the WTRU 210 and the WTRU 220 are in wireless communication with one another, and are configured to transmit and receive beacon information in accordance with the present invention. It should be understood that any type of wireless devices may be used to perform the method of transmitting and receiving beacon information.

[0025] In addition to the components that may be found in a typical WTRU, the WTRU 210 includes a processor 215, a receiver 216, a transmitter 217, and an antenna 218. The processor 215 is configured to distribute beacon information in accordance with the present invention. The receiver 216 and the transmitter 217 are in communication with the processor 215. The antenna 218 is in communication with both the receiver 216 and the transmitter 217 to facilitate the transmission and reception of wireless data. Additionally, the processor 215 may be connected to the external network 230.

[0026] Similarly, in addition to the components that may be found in a typical WTRU, the WTRU 220 includes a processor 225, a receiver 226, a transmitter 227, and an antenna 228. The processor 225 is configured to distribute beacon information in accordance with the present invention. The receiver 226 and the transmitter 227 are in communication with the processor 225. The antenna 228 is in communication with both the receiver 226 and the transmitter 227 to facilitate the transmission and reception of wireless data.

[0027] Figure 4 is a flow diagram of a method 400 for distributing beacon information, in accordance with the present invention. In a preferred embodiment of the present invention, the beacon information is distributed by the WTRU 210 to WTRUs 220 that wish to attach to the WTRU 210 and begin communicating with it. However, any wireless device may perform the method 400 of distributing beacon information.

[0028] In step 410, the WTRU 210 modifies a PLCP header to include beacon information. The WTRU 210 includes variable information in a variable information frame 500 and fixed information in a fixed information frame 600.

[0029] Figure 5 is a depiction of the variable information frame 500, containing variable elements of data in accordance with the present invention. The frame 500 includes an element ID field 510, a length field 520, and a service set identifier (SSID) field 530.

[0030] Figure 6 is a depiction of the fixed information frame 600, containing fixed elements of data in accordance with the present invention. The frame 600 includes an element field 610 and time stamp field 620. In general, the variable information frame 500 and the fixed information frame 600 are somewhat similar. However, since the variable information frame 500 is variable in length, it includes the length field 520 to specify the length.

[0031] Table 1 below depicts each beacon information element. These information elements can be added to the PHY PDU frame 100 after the PLCP preamble 117, and before or after the PLCP header 110. In a preferred embodiment, an additional field is added to the PLCP header 110 in the PHY PDU 110 that identifies the presence of the beacon information element and the information itself. This additional field may be a single bit that indicates the presence of the information element in the PHY PDU 110 and several bits indicating the actual type of information element (e.g. the "ID" in Table 1).

TABLE 1

Information Element	ID	Number of Bytes needed
Time Stamp	1	8
Beacon Interval	2	2
SSID	3	Variable
Capability	4	2
Supported Rate	5	Variable
FH Parameter	6	7
CF parameter	7	8
DS Parameter	8	1

[0032] Referring now to Table 1 above, information elements that are necessary or desirable for WTRU 220 association with WTRU 210 are typically transmitted in the beacon. However, these information elements may be attached to non-beacon control and data packets by the WTRU 210, in an embodiment of the present invention. Beacon information elements such as time stamp, beacon interval, service set identifier (SSID), capability, supported data rate, FH parameter, CF parameter, and DS parameter are generally transmitted separately in different management, control and data packets. Any other information elements added to the beacon are also transmitted as part of the packet.

[0033] Some of these elements are system parameters utilized by a STA that is attempting to associate with an AP. For example, the SSID identifies the identity of a basic service set (BSS). The FH parameter element provides synchronization parameters for STAs that utilize a frequency hopping (FH) physical layer, and the CF parameter element provides parameters for the point coordination function (CF) mode of operation. The DS parameter element provides information on channel number identification for STAs using a direct sequence spread spectrum (DSSS) physical layer.

[0034] Furthermore, the WTRU 210 may add these information elements either in the physical layer header, media access control (MAC) layer header or as part of the MAC payload. In a preferred embodiment of the present invention, a physical layer addition is preferable as it allows usage of lower data rates for these elements and can be received by WTRUs 220 farther away than the one addressed. For example the signal field 118 currently defined in the IEEE 802.11a standard may be expanded to include these information elements. Furthermore, any part of a single information element, a full information element, or several information elements may be transmitted in each packet. Each element may also be transmitted with its own cyclic redundancy check (CRC) or transmitted with the last information element containing the CRC of all the elements.

[0035] Accordingly, each packet contains information regarding its source (e.g. WTRU 210 or WTRU220). This information may also be transmitted in the PLCP preamble 117 or MAC header. For example, an indicator such as a bit or a field in the PLCO preamble or the MAC header may identify whether the transmitting WTRU is an AP or not. Accordingly, any WTRU monitoring the transmission medium for packets can know whether the packet is from an AP in case the WTRU wishes to associate with an AP. If the WTRU does wish to associate with an AP, the WTRU can then examine the beacon information.

[0036] The WTRU 210 then transmits the modified PLCP frame to the WTRU 220 (step 420), which receives the modified PLCP frame and extracts the beacon information from it (step 430). Apart from the beacon and probe, the WTRU 220 preferably gets each information element about the WTRU 210 from the packets. Once it has all the information, the WTRU 220 is able to associate with that WTRU 210 (step 440).

[0037] The present invention may be implemented in any type of wireless communication system, as desired. Additionally, the features of the present invention may implemented by software, may be incorporated into an integrated circuit (IC) or be configured in a circuit comprising a multitude of interconnecting components. Additionally, the processors 215/225 of the WTRU 210 and WTRU 220, respectively, may be configured to perform the steps of the method 400 described above. The processors 215/225 may also utilize the receivers 216/226, transmitters 217/227, and antennas 218/228, respectively, to facilitate wirelessly receiving and transmitting data.

[0038] The present invention may be implemented in any type of wireless communication system, as desired. By way of example, the present invention may be implemented in any type of 802 type system, OFDM-MIMO or any other type of wireless communication system, at the physical layer and data link layer. The present invention may also be implemented as software or hardware for radio resource management or a radio resource controller on an integrated circuit, such as an application specific integrated circuit (ASIC), multiple integrated circuits, logical programmable gate array (LPGA), multiple LPGAs,

discrete components, or a combination of integrated circuit(s), LPGA(s), and discrete component(s).

[0039] While the present invention has been described in terms of various embodiments, other variations, which are within the scope of the invention, as outlined in the claims below, will be apparent to those skilled in the art. Further, although the features and elements of the present invention are described in the various 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.

[0040] Embodiments

1. A method for distributing beacon information in a wireless communication system comprising a plurality of wireless transmit/receive units (WTRUs).

2. The method of embodiment 1, further comprising a first WTRU modifying a physical layer convergence protocol (PLCP) header in a physical protocol data unit (PHY PDU) frame to include beacon information.

3. A method as in any preceding embodiment, further comprising a first WTRU transmitting a modified PLCP header to a second WTRU.

4. A method as in any preceding embodiment, further comprising a second WTRU receiving a modified PLCP header.

5. A method as in any preceding embodiment, further comprising a second WTRU extracting beacon information from a received modified PLCP header.

6. A method as in any preceding embodiment, further comprising a second WTRU associating with a first WTRU.

7. A method as in any preceding embodiment wherein beacon information is included in a non-beacon control packet.

8. A method as in any preceding embodiment wherein beacon information is included in a data packet.

9. A method as in any preceding embodiment wherein beacon information is included in a management packet.

10. A method as in any preceding embodiment wherein a PLCP frame includes a PLCP preamble field.

11. A method as in any preceding embodiment wherein a PLCP frame includes a signal field.

12. A method as in any preceding embodiment wherein a PLCP frame includes a data field.

13. A method as in any preceding embodiment wherein a signal field comprises a rate field.

14. A method as in any preceding embodiment wherein a signal field comprises a length field.

15. A method as in any preceding embodiment wherein a signal field comprises a parity field.

16. A method as in any preceding embodiment wherein a signal field comprises a tail field.

17. A method as in any preceding embodiment wherein a data field comprises a service field.

18. A method as in any preceding embodiment wherein a data field comprises a PSDU field.

19. A method as in any preceding embodiment wherein a data field comprises a tail field.

20. A method as in any preceding embodiment wherein a data field comprises a pad bits field.

21. A method as in any preceding embodiment wherein beacon information includes fixed beacon information elements.

22. A method as in any preceding embodiment wherein beacon information includes variable beacon information elements.

23. A method as in any preceding embodiment wherein a variable beacon information element is included in a variable information frame.

24. A method as in any preceding embodiment wherein a variable information frame includes an element ID field.

25. A method as in any preceding embodiment wherein a variable information frame includes a length field.

26. A method as in any preceding embodiment wherein a variable information frame includes an SSID field.

27. A method as in any preceding embodiment wherein a variable information element includes SSID and supported rate.

28. A method as in any preceding embodiment wherein a fixed beacon information element is included in a fixed information frame.

29. A method as in any preceding embodiment wherein a fixed information frame includes an element field.

30. A method as in any preceding embodiment wherein a fixed information frame includes a time stamp field.

31. A method as in any preceding embodiment wherein a first WTRU adds beacon information elements in a physical layer header.

32. A method as in any preceding embodiment, further comprising expanding a signal field to include beacon information elements.

33. A method as in any preceding embodiment wherein a first WTRU includes beacon information elements in a medium access control (MAC) header.

34. A method as in any preceding embodiment wherein a first WTRU includes beacon information elements in a MAC payload.

35. A method as in any preceding embodiment wherein a first WTRU includes beacon information elements after a PLCP preamble.

36. A method as in any preceding embodiment wherein a signal field and a service field comprise a PLCP header.

37. A method as in any preceding embodiment wherein a first WTRU includes beacon information elements before a PLCP header.

38. A method as in any preceding embodiment wherein a first WTRU includes beacon information elements after a PLCP header.

39. A method as in any preceding embodiment wherein a beacon information element is transmitted with a cyclic redundancy check (CRC).

40. The method of embodiment 39 wherein each beacon information element is transmitted with its own CRC.

41. A method as in any preceding embodiment wherein a last beacon information element includes a CRC for all information elements.

42. A method as in any preceding embodiment wherein beacon information elements are segregated and transmitted in different management, control, and data packets.

43. A method as in any preceding embodiment wherein a part of an individual beacon information element is transmitted in a single packet.

44. A method as in any preceding embodiment wherein an entire beacon information element is transmitted in a single packet.

45. A method as in any preceding embodiment wherein a plurality of beacon information elements are transmitted in a single packet.

46. A method as in any preceding embodiment wherein a second WTRU extracts a beacon information element from a packet to associate with a first WTRU.

47. A method as in any preceding embodiment wherein each of a packet contains information relating to a source of the packet.

48. A method as in any preceding embodiment wherein a first WTRU is an access point (AP) and a second WTRU is a station (STA).

49. A method as in any preceding embodiment wherein an AP is connected to an external network.

50. A method as in any of embodiments 1-47 wherein a first and second WTRU are STAs.

51. An access point (AP) configured to perform a method as in any preceding embodiment.

52. The AP of embodiment 51, further comprising a receiver.

53. An AP as in any of embodiments 51-52, further comprising a transmitter.

54. An AP as in any of embodiments 51-53, further comprising a processor in communication with a receiver and a transmitter.

55. The AP of embodiment 54 wherein a processor is configured to modify a PLCP header in a PHY PDU frame to include beacon information elements.

56. An AP as in any of embodiments 54-55 wherein a processor is configured to transmit a modified PLCP header to at least one wireless transmit/receive unit (WTRU).

57. An AP as in any of embodiments 54-56 wherein a processor is configured to associate with a WTRU.

58. An AP as in any of embodiments 54-57 wherein a processor is configured to include variable beacon information elements in a variable information frame.

59. An AP as in any of embodiments 54-58 wherein a processor is configured to include fixed beacon information elements in a fixed information frame.

60. An AP as in any of embodiments 54-59 wherein a processor is configured to transmit a plurality of beacon information elements in a single packet.

61. A wireless transmit/receive unit (WTRU) configured to perform a method as in any of embodiments 1-50.

62. The WTRU embodiment 61, further comprising a receiver.

63. A WTRU as in any of embodiments 61-62, further comprising a transmitter.

64. A WTRU as in any of embodiments 61-63, further comprising a processor in communication with a receiver and a transmitter.

65. A WTRU of embodiment 64 wherein a processor is configured to modify a PLCP header in a PHY PDU frame to include beacon information elements.

66. A WTRU as in any of embodiments 64-65 wherein a processor is configured to transmit a modified PLCP header to at least one other WTRU.

67. A WTRU as in any of embodiments 64-66 wherein a processor is configured to associate with another WTRU.

68. A WTRU as in any of embodiments 64-67 wherein a processor is configured to include variable beacon information elements in a variable information frame.

69. A WTRU as in any of embodiments 64-68 wherein a processor is configured to include fixed beacon information elements in a fixed information frame.

70. A WTRU as in any of embodiments 64-69 wherein a processor is configured to transmit a plurality of beacon information elements in a single packet.

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CLAIMS

What is claimed is:

1. In a wireless communication system comprising a plurality of wireless transmit/receive units (WTRUs), a method for distributing beacon information, the method comprising:

a first WTRU modifying a physical layer convergence protocol (PLCP) header in a physical protocol data unit (PHY PDU) frame to include beacon information;

the first WTRU transmitting the modified PLCP header to a second WTRU;

the second WTRU receiving the modified PLCP header and extracting beacon information from the modified PLCP header; and

the second WTRU associating with the first WTRU.

2. The method of claim 2 wherein the beacon information is included in a non-beacon control packet.

3. The method of claim 2 wherein the beacon information is included in a data packet.

4. The method of claim 2 wherein the beacon information is included in a management packet.

5. The method of claim 1 wherein the beacon information includes beacon information elements relating to any one of the following: time stamp, beacon interval, service set identifier (SSID) capability, supported data rate, FH parameter, CF parameter, and DS parameter.

6. The method of claim 1 wherein a PLCP frame includes a PLCP preamble field, a signal field, and a data field.

7. The method of claim 6 wherein the signal field further comprises a rate field, a reserved field, a length field, a parity field, and a tail field.

8. The method of claim 7 wherein the data field further comprises a service field, a PSDU field, a tail field, and a pad bits field.

9. The method of claim 8 wherein the beacon information includes fixed beacon information elements and variable beacon information elements.

10. The method of claim 9 wherein a variable beacon information element is included in a variable information frame.

11. The method of claim 10 wherein the variable information frame includes an element ID field, a length field, and an SSID field.

12. The method of claim 10 wherein a variable beacon information element includes SSID and supported rate.

13. The method of claim 9 wherein a fixed beacon information element is included in a fixed information frame.

14. The method of claim 13 wherein the fixed information frame includes an element field and a time stamp field.

15. The method of claim 8 wherein the first WTRU adds the beacon information elements in a physical layer header.

16. The method of claim 15, further comprising expanding the signal field to include the beacon information elements.

17. The method of claim 8 wherein the first WTRU includes the beacon information elements in a medium access control (MAC) header.

18. The method of claim 8 wherein the first WTRU includes the beacon information elements in the MAC payload.

19. The method of claim 8 wherein the first WTRU includes the beacon information elements after the PLCP preamble.

20. The method of claim 8 wherein the signal field and the service field comprise the PLCP header.

21. The method of claim 20 wherein the first WTRU includes the beacon information elements before the PLCP header.

22. The method of claim 20 wherein the first WTRU includes the beacon information elements after the PLCP header.

23. The method of claim 8 wherein each beacon information element is transmitted with its own cyclic redundancy check (CRC).

24. The method of claim 8 wherein a last beacon information element includes a CRC for all information elements.

25. The method of claim 8 wherein the beacon information elements are segregated and transmitted in different management, control, and data packets.

26. The method of claim 25 wherein a part of an individual beacon information element is transmitted in a single packet.

27. The method of claim 25 wherein an entire beacon information element is transmitted in a single packet.

28. The method of claim 25 wherein a plurality of beacon information elements are transmitted in a single packet.

29. The method of claim 25 wherein the second WTRU extracts a beacon information element from the packet to associate with the first WTRU.

30. The method of claim 29 wherein each packet contains information relating to a source of the packet.

31. The method of claim 1 wherein the first WTRU is an access point (AP) and the second WTRU is a station (STA).

32. The method of claim 31 wherein the AP is connected to an external network.

33. The method of claim 1 wherein the first and second WTRUs are STAs.

34. An access point (AP) configured to perform a method of distributing beacon information, the AP comprising:

a receiver;

a transmitter; and

a processor in communication with the receiver and the transmitter,

wherein the processor is configured to modify a physical layer convergence protocol (PLCP) header in a physical protocol data unit (PHY PDU) frame to include beacon information elements, transmit the modified PLCP header to at least one wireless transmit/receive unit (WTRU), and associate with the WTRU.

35. The AP of claim 34 wherein the processor is further configured to include variable beacon information elements in a variable information frame.

36. The AP of claim 34 wherein the processor is further configured to include fixed beacon information elements in a fixed information frame.

37. The AP of claim 34 wherein the processor is further configured to transmit a plurality of beacon information elements in a single packet.

38. A wireless transmit/receive unit (WTRU) configured to perform a method of distributing beacon information, the WTRU comprising:

a receiver;

a transmitter; and

a processor in communication with the receiver and the transmitter, wherein the processor is configured to modify a physical layer convergence protocol (PLCP) header in a physical protocol data unit (PHY PDU) frame to include beacon information elements, transmit the modified PLCP header to at least one other WTRU, and associate with the at least one other WTRU.

39. The WTRU of claim 38 wherein the processor is further configured to include variable beacon information elements in a variable information frame.

40. The WTRU of claim 38 wherein the processor is further configured to include fixed beacon information elements in a fixed information frame.

41. The WTRU of claim 38 wherein the processor is further configured to transmit a plurality of beacon information elements in a single packet.

42. The WTRU of claim 38 wherein the processor is further configured to receive a modified PLCP header from at least one other WTRU, extract beacon

information from the receive modified PLCP header, and associate with the at least one other WTRU.