(12) STANDARD PATENT (11) Application No. AU 2005285278 B2
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Measurement support for a smart antenna in a wireless communication system

(51) International Patent Classification(s)
H01Q 3/26 (2006.01) ***H04B 17/00*** (2006.01)

(21) Application No: **2005285278** (22) Date of Filing: **2005.09.07**

(87) WIPO No: **WO06/031499**

(30) Priority Data

(31) Number	(32) Date	(33) Country
60/609,212	**2004.09.10**	**US**
11/022,709	**2004.12.27**	**US**

(43) Publication Date: **2006.03.23**
(44) Accepted Journal Date: **2009.09.03**

(71) Applicant(s)
Interdigital Technology Corporation

(72) Inventor(s)
Marinier, Paul;Iacono, Ana Lucia;Roy, Vincent;Cha, Inhyok;Chandra, Arty

(74) Agent / Attorney
Watermark Patent & Trademark Attorneys, 302 Burwood Road, Hawthorn, VIC, 3122

(56) Related Art
WO 2004/042983
US 2001/034236
US 6564036
US 6721569
US 6738020
US 6438389

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 March 2006 (23.03.2006)

PCT

(10) International Publication Number
WO 2006/031499 A3

(51) International Patent Classification:
H01Q 3/26 (2006.01)

(21) International Application Number:
PCT/US2005/031655

(22) International Filing Date:
7 September 2005 (07.09.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/609,212 10 September 2004 (10.09.2004) US
11/022,709 27 December 2004 (27.12.2004) US

(71) Applicant *(for all designated States except US)*: **INTERDIGITAL TECHNOLOGY CORPORATION** [US/US]; 300 Delaware Avenue, Suite 527, Wilmington, Delaware 19801 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **IACONO, Ana Lucia** [US/US]; 16 Clinch Avenue, Garden City, New York 11530 (US). **CHANDRA, Arty** [IN/US]; 31 Jeffrey Place, Manhasset Hills, New York 11040 (US). **CHA, Inhyok** [US/US]; 3600 Manassas Avenue, Melbourne, Florida 32934 (US). **MARINIER, Paul** [CA/CA]; 1805 Stravinski, Brossard, Québec J4X 2J7 (CA). **ROY, Vincent** [CA/CA]; 6254 De La Roche, Montreal, Québec H2S 2E1 (CA).

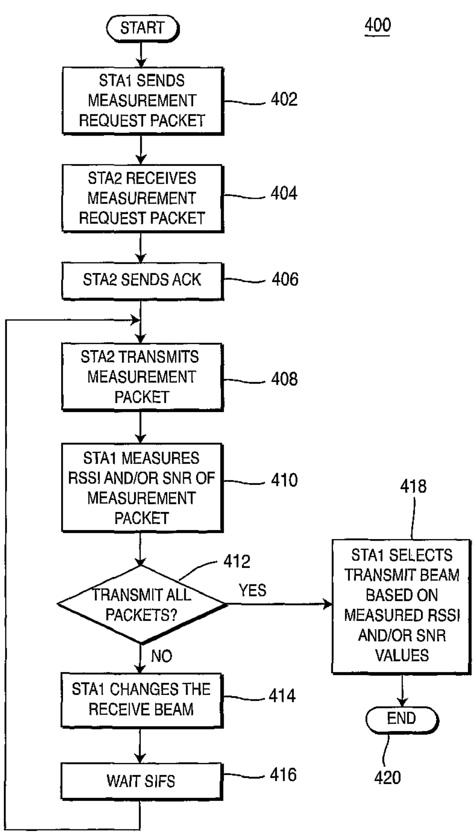
(74) Agent: **BALLARINI, Robert, J.**; VOLPE AND KOENIG, P.C., United Plaza, Suite 1600, 30 S. 17th Street, Philadelphia, Pennsylvania 19103 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH,

[Continued on next page]

(54) Title: MEASUREMENT SUPPORT FOR A SMART ANTENNA IN A WIRELESS COMMUNICATION SYSTEM



(57) **Abstract:** A method for taking measurements with a smart antenna in a wireless communication system having a plurality of STAs begins by sending a measurement request from a first STA to a second STA. At least two measurement packets are transmitted from the second STA to the first STA. Each measurement packet is received at the first STA using a different antenna beam. The first STA performs measurements on each measurement packet and selects an antenna beam direction based on the measurement results.

WO 2006/031499 A3

GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
13 July 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

[0001] MEASUREMENT SUPPORT FOR A SMART ANTENNA IN A WIRELESS COMMUNICATION SYSTEM

[0002] FIELD OF INVENTION

[0003] The present invention generally relates to wireless communication systems, and more particularly, to a method and apparatus for efficient measurements in utilizing a smart antenna in the wireless communication system.

[0004] BACKGROUND

[0005] In a wireless local area network (WLAN), an access point (AP) and a station (STA) may be equipped with smart antenna features; for example, a multiple beam/directional antenna system. Both the AP and the STA need to perform measurements to decide the best beam for transmitting to or receiving from another STA. STAs with multiple beams typically perform scanning on different beams in order to estimate which is the best beam to serve them. Scanning performed by the AP and/or STAs may use either a dummy packet, a data packet, an 802.11 acknowledgement (ACK), or broadcast packets. The measurements need to be updated frequently.

[0006] At an AP, the beam switching algorithm uses packets from a STA for the antenna measurements. The best beam (based on the received packet measurements, e.g., a received power or signal to interference plus noise ratio (SINR)) is then used to transmit packets to that STA. At the STA, the current beam switching algorithm may use the data packet or beacon to decide the correct receive and transmit antenna/beam for that AP. This method for antenna measurement is not very efficient, due to the amount of time needed to obtain enough measurements to decide the correct beam for each STA.

[0007] Another problem with this beam selection method is that the beam selection, for both receive and transmit, is based on measurements made on the received packets. However, in reality, the best beam for transmission might not be the same as the best beam for reception (especially for a frequency division duplex system).

[0008] SUMMARY

[0009] A method for taking measurements with a smart antenna in a wireless communication system having a plurality of STAs begins by sending a measurement request from a first STA to a second STA. At least two measurement packets are transmitted from the second STA to the first STA. Each measurement packet is received at the first STA using a different antenna beam. The first STA performs measurements on each measurement packet and selects an antenna beam direction based on the measurement results.

[0010] A method for taking measurements with a smart antenna in a wireless communication system having a plurality of STAs begins by sending a measurement request from a first STA to a second STA. At least two measurement packets are transmitted from the first STA to the second STA, each measurement packet being transmitted using a different antenna beam. The second STA receives each measurement packet and performs measurements on each measurement packet. The second STA generates a measurement report based on the measurement results and sends the measurement report to the first STA. The first STA selects an antenna beam direction based on the measurement report.

[0011] A system for taking measurements with a smart antenna in a wireless communication system, including a first STA and a second STA. The first STA includes a first transmitter/receiver; a first antenna, connected to the first transmitter/receiver; a measurement packet request device, connected to the first transmitter/receiver; a measurement packet analysis device, connected to the first transmitter/receiver; and a beam change device, connected to the first transmitter/receiver and the measurement packet analysis device. The second STA includes a second transmitter/receiver; a second antenna, connected to the second transmitter/receiver; a measurement packet request receive device, connected to the second transmitter/receiver; and a measurement packet

2005285278 23 Jun 2009

transmit device, connected to the second transmitter/receiver and the measurement packet request receive device.

[0012] A system for taking measurements with a smart antenna in a wireless communication system, including a first STA and a second STA. The first STA includes a first transmitter/receiver; a first antenna, connected to the first transmitter/receiver; a measurement packet request device, connected to the first transmitter/receiver; a measurement packet transmit device, connected to the first transmitter/receiver and the measurement packet request device; a beam change device, connected to the first transmitter/receiver and the measurement packet transmit device; and a measurement report analysis device, connected to the first transmitter/receiver and the beam change device. The second STA includes a second transmitter/receiver; a second antenna, connected to the second transmitter/receiver; a measurement packet request receive device, connected to the second transmitter/receiver; a measurement packet analysis device, connected to the second transmitter/receiver; and a measurement report generating device, connected to the second transmitter/receiver and the measurement packet analysis device.

[0012a] In one aspect the present invention provides a method for antenna selection for a wireless communication, the method including initiating an antenna selection procedure prior to data transmission;

receiving two measurement packets consecutively;

using a different antenna for each packet;

measuring each of the two measurement packets; and

selecting an antenna based on the measuring of each of the two measurement packets.

[0012b] In another aspect the present invention provides a method for antenna selection for wireless communication, the method including:

initiating an antenna selection procedure from a STA prior to data transmission;

transmitting two measurement packets consecutively, wherein the two measurement packets are transmitted using a different antenna for each of the two measurement packets;

receiving a measurement report from a STA; and;

2005285278 23 Jun 2009

selecting an antenna based on the measurement report.

[0012c] In a further aspect the present invention provides a station (STA), including:

a transmitter configured to initiate an antenna selection prior to data transmission;

a first antenna configured to receive a first measurement packet;

a second antenna configured to receive a second measurement packet after the first antenna receives the first measurement packet;

a processor configured to measure each of the two measurement packets; and

a selector configured to select a transmitting antenna based on the measurements.

[0013] BRIEF DESCRIPTION OF THE DRAWINGS

[0014] 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:

[0015] Figure 1 is a diagram of a measurement request packet;

[0016] Figure 2 is a diagram of a measurement packet;

[0017] Figure 3 is a diagram of a measurement report packet;

[0018] Figure 4 is a flowchart of a method for taking antenna measurements;

[00419] Figure 5 is a signal diagram of the method shown in Figure 4;

[0020] Figure 6 is a flowchart of a second method for taking antenna measurements;

[0021] Figure 7 is a signal diagram of the method shown in Figure 6;

[0022] Figure 8 is a diagram of a physical layer convergence protocol (PLCP) frame format; and

[0023] Figure 9 is a diagram of a system for communicating measurement information in accordance with the methods shown in Figures 4 and 6.

[0024] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] 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.

[0026] The present invention solves the problem of not having measurement support for smart antennas and may be implemented in an AP, a non-AP STA, or both. The present invention provides a signaling mechanism to obtain received signal strength indicator (RSSI) or SINR measurements for each transmit or receive antenna between any two stations. A mechanism to correctly update the received measurements between scanning is also provided.

[0027] The present invention uses an action frame for antenna measurements by creating a new category of action frame called "Antenna Measurement". This category of action frame includes an action field for measurement request packets, measurement response packets, and dummy measurement packets. Action frames are currently defined in the WLAN standards (i.e., 802.11k, 802.11e). The measurement packets of the present invention can also be part of a separate control packet or a management packet.

[0028] Figure 1 shows a measurement request packet 100 in accordance with the present invention. The measurement request packet 100 includes fields for the number of transmit or receive packets 102, transmit antenna information 104, request type 106, and request for measurement report 108. The number of transmit or receive packets 102 depends on parameters such as the fading

2005285278 29 Jun 2007

environment and the time to select an antenna. In one embodiment, a preferred value is 10 packets per antenna. The transmit antenna information 104 includes the antenna beam identity or any other information that can be used to identify an antenna or set of antennas. Two possible request types 106 will be explained hereinafter in connection with Figures 4 and 6. However, it is noted that there are many possible ways of sending measurements and getting the response that can be indicated in the request type field 106. The request for measurement report field 108 includes a parameter for SNR measurement and a parameter for RSSI measurement.

Figure 2 shows a measurement packet 200 in accordance with the present invention. The measurement packet 200 includes antenna identity information 202 and sequence number of the current packet 204. The antenna identity information 202 includes the antenna beam identity or any other element that can be used to identify an antenna or set of antennas.

Figure 3 shows a measurement report packet 300 in accordance with the present invention. The measurement report packet 300 includes sequence information 302 (the sequence number of the packet), antenna information 304 (i.e., antenna identity information), the measured RSSI value 306, and the measured SNR value 308.

The measurement request and response can be initiated by the STA or the AP. The measurement request packet 100 and the measurement report packet 300 may be sent anytime while the STA is associated to the AP. The STA may be allowed to use these techniques of measuring the signal from each antenna and to each antenna before associating to the AP.

Figure 4 is a flowchart of a method 400 for measurement packet exchange between two STAs, STAI and STA2, in accordance with a first embodiment of the present invention. The method 400 begins with STA1 sending a measurement request packet to STA2 (step 402). STA2 receives the measurement request packet (step 404) and sends an ACK to STA1 (step 406). STA2 then transmits a measurement packet to STAI (step 408). STA1 receives the measurement packet and measures the RSSI and/or the SNR of the measurement packet (step 410). A determination is made if all of the packets, as specified in the measurement request packet, have been transmitted (step 412).

[0033] If all of the packets have not been transmitted, then STA1 changes its receive beam (step 414). STA2 waits for a short interframe space (SIFS; step 416) before transmitting the next packet (step 408). In a preferred embodiment, STA2 waits for the SIFS; however, the wait time can vary and be either more or less than the SIFS. The variable nature of the wait period relates to the length of time needed to switch antenna beams, the accuracy of the system clock, and any other implementation-specific timing issues. If all of the packets have been transmitted (step 412), then STA1 selects the transmit beam based on all of the measured RSSI and/or the SNR values (step 418) and the method terminates (step 420).

[0034] Figure 5 is a signal diagram of the method 400, showing the packet exchange between STA1 502 and STA2 504. STA1 502 sends a measurement request packet 506 to STA2 504. STA2 504 waits for a SIFS 508 before sending an ACK 510 in response to the measurement request packet 506. STA2 504 then sends multiple measurement packets 512_1 ... 512_n consecutively, each measurement packet 512 being separated by a SIFS 514. During the SIFS, STA1 502 changes its receive beam, such that each of the packets 512_1 ... 512_n is received on a different beam. STA1 502 then uses the received signal strength of each packet 512 to select the correct beam.

[0035] Figure 6 is a flowchart of a method 600 for measurement packet exchange between two STAs, STA1 and STA2, in accordance with a second embodiment of the present invention. The method 600 begins with STA1 sending a measurement request packet to STA2 (step 602). STA2 receives the measurement request packet (step 604) and sends an ACK to STA1 (step 606). STA1 sends a measurement packet from a beam (step 608). STA2 receives the measurement packet and measures the RSSI and/or the SNR of the packet (step 610). A determination is made whether all of the measurement packets specified by the measurement request packet have been transmitted (step 612). If all of the measurement packets have not been transmitted, the STA1 changes the transmit beam (step 614), waits for a SIFS (step 616), and sends a packet from the new beam (step 608). In a preferred embodiment, STA1 waits for the SIFS; however, the wait time can vary and be either more or less than the SIFS. The variable nature of the wait period relates to the length of time needed to switch antenna beams, the accuracy of the system clock, and any other implementation-specific timing issues.

[0036] If all of the measurement packets have been transmitted (step 612), then STA2 generates a measurement report based on all of the received measurement packets (step 620). STA2 sends the measurement report to STA1 (step 622) and STA1 sends an ACK to STA2 for the measurement report (step 624). STA1 selects a transmit beam based on the measurement report (step 626) and the method terminates (step 628).

[0037] Figure 7 is a signal diagram of the method 600, showing the packet exchange between STA1 702 and STA2 704. STA1 702 sends a measurement request packet 706 to STA2 704. STA2 704 waits for a SIFS 708 before sending an ACK 710 in response to the measurement request packet 706. STA1 702 waits for a SIFS 712 before sending a measurement packet $714_1 \ldots 714_n$ from a beam to STA2 704. Each measurement packet 714 is sent from a different beam, and STA1 702 waits for a SIFS 716 before sending a measurement packet 714 on another beam. STA2 704 receives the measurement packets 714 and measures each packet. After all of the measurement packets 714 have been received by STA2 704, STA2 704 generates a measurement report packet 718 and sends it to STA1 702. STA1 702 then sends an ACK to STA2 704 upon receipt of the measurement report packet 718. STA1 702 then selects a beam direction in accordance with the measurement report packet 718.

[0038] The measurement request and report information can be piggybacked on a data packet, a management packet, or a control packet. Physical layer signaling can be sent from different beams. This signaling can be sent such that it identifies different beams through some physical layer signature (such as a preamble) or beam information. These measurement signals can be sent in one packet (without waiting for a SIFS).

[0039] Passive measurement to update the received signal strength is also possible. The received signal strength from a transmitter may change based on the switched beam or the diversity techniques. A receiver may end up making inaccurate decisions on the correct beam for reception (or transmission) in the absence of any notification about the antenna usage of the transmitter node. The transmitted packet contains the beam identity or diversity method indication. This information can be used by the receiver to update the received measurement information.

[0040] The transmit antenna information is sent immediately after the physical layer convergence protocol (PLCP) header or in the medium access control (MAC) header. The information can be a pre-defined signal pattern indicating an omni-directional beam or antenna beam identity. The pattern can also be used to indicate diversity technique (if any).

[0041] Figure 8 is a diagram of a PLCP frame format 800 in accordance with the present invention. The PLCP frame 800 includes a preamble 802, a signal field 804, a header error check (HEC) 806, and a physical layer service data unit (PSDU) 810. The present invention adds a new field to the PLCP frame 800, a transmit/receive antenna identifier 808. Backward compatibility is maintained by adding transmit antenna information after the PLCP header. An additional information field may also be included in the MAC header to indicate the transmit antenna identity.

[0042] The present invention provides an efficient method to measure signal strength to/from a beam or directional antenna. The current 802.11 standards have no defined method for antenna measurement. The use of dummy packets or beacons is inefficient and time consuming. Also, it limits the use of a directional antenna in fading environments and roaming. The present invention allows a STA to use different beams for transmission and reception.

[0043] Figure 9 is a diagram of a system 900 configured to communicate measurement information in accordance with the methods 400 and 600, as described above in connection with Figures 4 and 6, respectively. The system 900 includes a first STA (STA 1) 902 and a second STA (STA 2) 904. While the system

900 is shown as two separate STAs for purposes of discussion, each STA can be constructed with all of the components shown.

[0044] The first STA 902 includes a measurement packet request device 910 connected to a transmitter/receiver 912, which is connected to an antenna 914. A measurement packet transmit device 916 is connected to the measurement packet request device 910 and the transmitter/receiver 912. A measurement packet analysis device 918 is connected to the transmitter/receiver 912. A beam change device 920 is connected to the transmitter/receiver 912, the measurement packet transmit device 916, and the measurement packet analysis device 918. A measurement report analysis device 922 is connected to the transmitter/receiver 912 and the beam change device 920.

[0045] The second STA 904 includes an antenna 930 connected to a transmitter/receiver 932. A measurement packet request receive device 934 is connected to the transmitter/receiver 932. A measurement packet transmit device 936 is connected to the transmitter/receiver 932 and the measurement packet request receive device 934. A measurement packet analysis device 938 is connected to the transmitter/receiver 932. A measurement report generating device 940 is connected to the transmitter/receiver 932 and the measurement packet analysis device 938.

[0046] When implementing the method 400, the system 900 is configured to operate as follows. The measurement packet request device 910 generates a measurement packet request, which is sent to transmitter/receiver 912 for transmission to the second STA 904. The transmitter/receiver 932 receives the measurement packet request and forwards it to the measurement packet request receive device 934. The measurement packet request receive device 934 generates an ACK which is sent to the first STA 902.

[0047] After sending the ACK, the measurement packet request receive device 934 signals the measurement packet transmit device 936 to begin sending measurement packets to the first STA 902. When measurement packets are received at the first STA 902, the transmitter/receiver 912 forwards the measurement packets to the measurement packet analysis device 918, where the

2005285278 29 Jun 2007

RSSI and/or SNR of the measurement packet is measured. If all of the requested measurement packets have not been received, the measurement packet analysis device 918 signals the beam change device 920 to change the receive beam of the first STA 902 to receive additional measurement packets.

If all of the requested measurement packets have been received, the measurement packet analysis device selects an appropriate transmit beam based on the previously measured values and then signals a selected transmit beam to the beam change device 920.

When implementing the method 600, the system 900 is configured to operate as follows. The measurement packet request device 910 generates a measurement packet request, which is sent to transmitter/receiver 912 for transmission to the second STA 904. The transmitter/receiver 932 receives the measurement packet request and forwards it to the measurement packet request receive device 934. The measurement packet request receive device 934 generates an ACK which is sent to the first STA 902.

Upon receipt of the ACK, the measurement packet request device 910 signals the measurement packet transmit device 916 to begin transmitting measurement packets to the second STA 904. Upon receipt of a measurement packet, the transmitter/receiver 932 forwards the measurement packet to the measurement packet analysis device 938 where the packet is measured. If all of the requested measurement packets have not been transmitted, the measurement packet transmit device 916 signals the beam change device 920 to change the transmit beam prior to sending the next measurement packet.

If all of the requested measurement packets have been transmitted, then the measurement report generating device 940 generates a measurement report which is sent to the first STA 902. The measurement report is forwarded to the measurement report analysis device 922, which selects a transmit beam for the first STA 902 based on the measurement report. The measurement report analysis device 922 then signals the selected beam to the beam change device 920 to change the transmit beam for the first STA 902

While the present invention has been described in terms of a WLAN, the principles of the present invention are equally applicable to any type of wireless communication system. 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.

2005285278 23 Jun 2009

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for antenna selection for a wireless communication, the method including initiating an antenna selection procedure prior to data transmission;

receiving two measurement packets consecutively;

using a different antenna for each packet;

measuring each of the two measurement packets; and

selecting an antenna based on the measuring of each of the two measurement packets.

2. The method according to claim 1, wherein the initiating antenna selection procedure includes requesting a number of measurement packets.

3. The method according to claim 1, wherein the receiving of the two measurement packets consecutively includes waiting for an interframe space between receiving each of the two measurement packets.

4. The method according to claim 3, wherein the interframe space is a short interframe space (SIFS).

5. The method according to claim 1, wherein the measuring each of the two measurement packets includes measuring a received signal strength indicator (RSSI) of each of the two measurement packets.

6. The method according to claim 5, wherein the selecting an antenna includes selecting a transmit antenna based on the measured RSSI of each of the two measurement packets.

7. The method according to claim 1, wherein the measuring each of the two measurement packets includes measuring a signal to noise ratio (SNR) of each of the two measurement packets.

2005285278 23 Jun 2009

8. The method according to claim 9, wherein the selecting an antenna includes selecting a transmit antenna based on the measured SNR of each of the two measurement packets.

9. The method according to claim 1, wherein the measuring each of the two measurement packets includes measuring a received signal strength indicator (RSSI) and a signal to noise ratio (SNR) of each of the two measurement packets.

10. The method according to claim 9, wherein the selecting an antenna includes selecting a transmit antenna based on the measured RSSIs and SNRs of each of the two measurement packets.

11. The method according to claim 1, further including receiving an acknowledgement in response to the initiating an antenna selection procedure.

12. A method for antenna selection for wireless communication, the method including:

initiating an antenna selection procedure from a STA prior to data transmission;

transmitting two measurement packets consecutively, wherein the two measurement packets are transmitted using a different antenna for each of the two measurement packets;

receiving a measurement report from a STA; and;

selecting an antenna based on the measurement report.

13. The method according to claim 12, wherein the initiating antenna selection procedure includes requesting a number of measurement packets to transmit.

14. The method according to claim 12, wherein the transmitting the two measurement packets includes waiting for an interframe space between transmitting each of the two measurement packets.

15. The method according to claim 14, wherein the interframe space is a short interframe space (SIFS).

16. The method according to claim 12, further including receiving an acknowledgement in response to the initiating antenna selection procedure.

17. The method according to claim 12, further including transmitting an acknowledgement upon receipt of the measurement report.

18. The method according to claim 15, wherein the measurement report includes results from measurements performed on each measurement packet at the second STA.

19. A station (STA), including:

a transmitter configured to initiate an antenna selection prior to data transmission;

a first antenna configured to receive a first measurement packet;

a second antenna configured to receive a second measurement packet after the first antenna receives the first measurement packet;

a processor configured to measure each of the two measurement packets; and

a selector configured to select a transmitting antenna based on the measurements.

20. The method of claim 1, wherein the initiating an antenna selection is performed by transmitting a measurement request.

21. The method of claim 15, wherein the initiating an antenna selection is performed by transmitting a measurement request.

22. The method of claim 1 or claim 12 substantially as hereinbefore described with reference to the accompanying figures.

2005285278 23 Jun 2009

23. The station of claim 19 substantially as hereinbefore described with reference to the accompanying figures.

INTERDIGITAL TECHNOLOGY CORPORATION

WATERMARK PATENT & TRADE MARK ATTORNEYS

P28462AU00

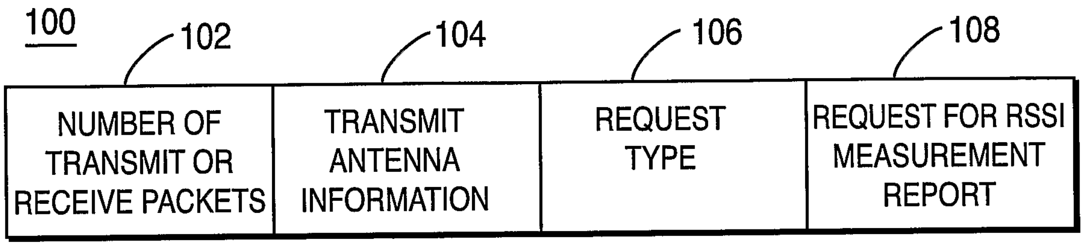


FIG. 1

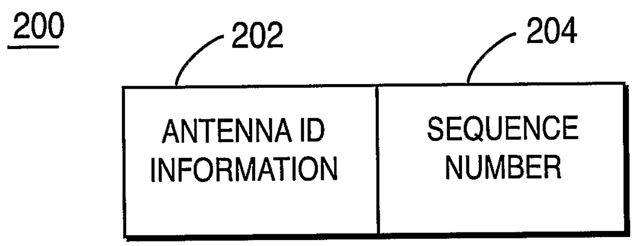


FIG. 2

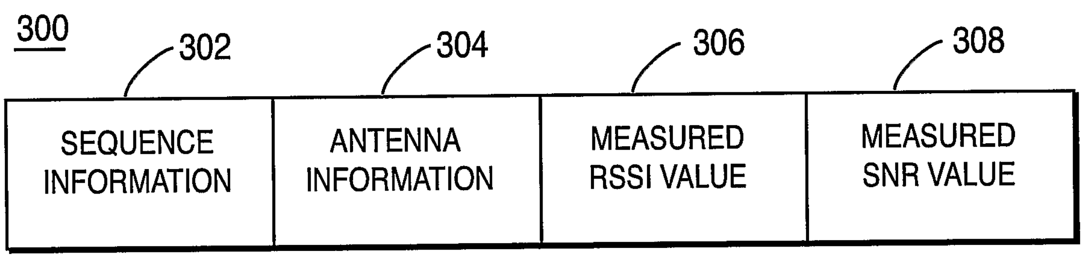


FIG. 3

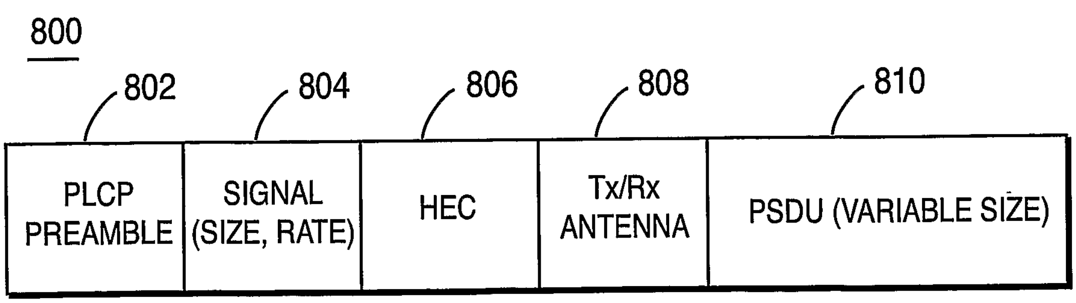


FIG. 8

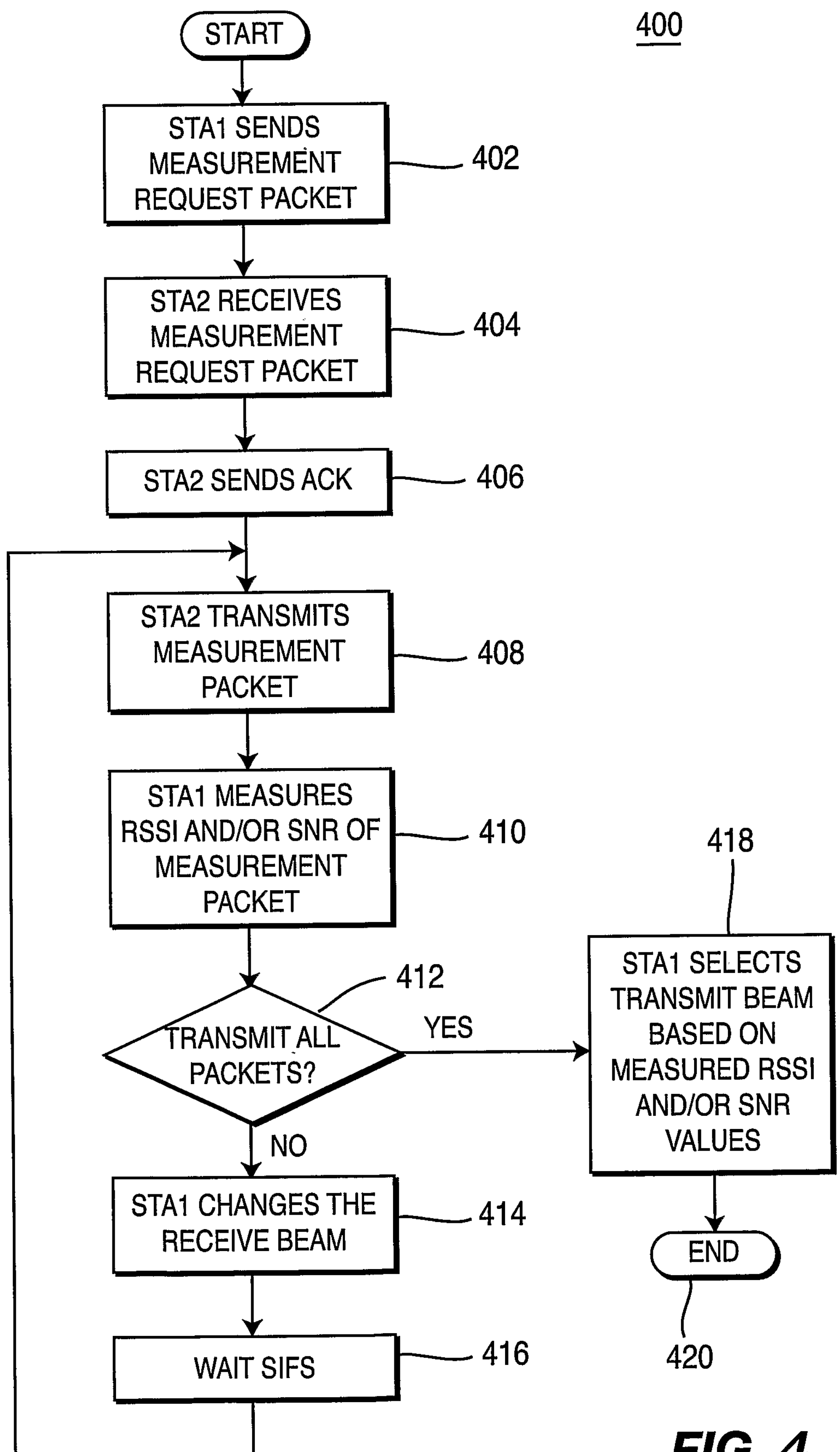
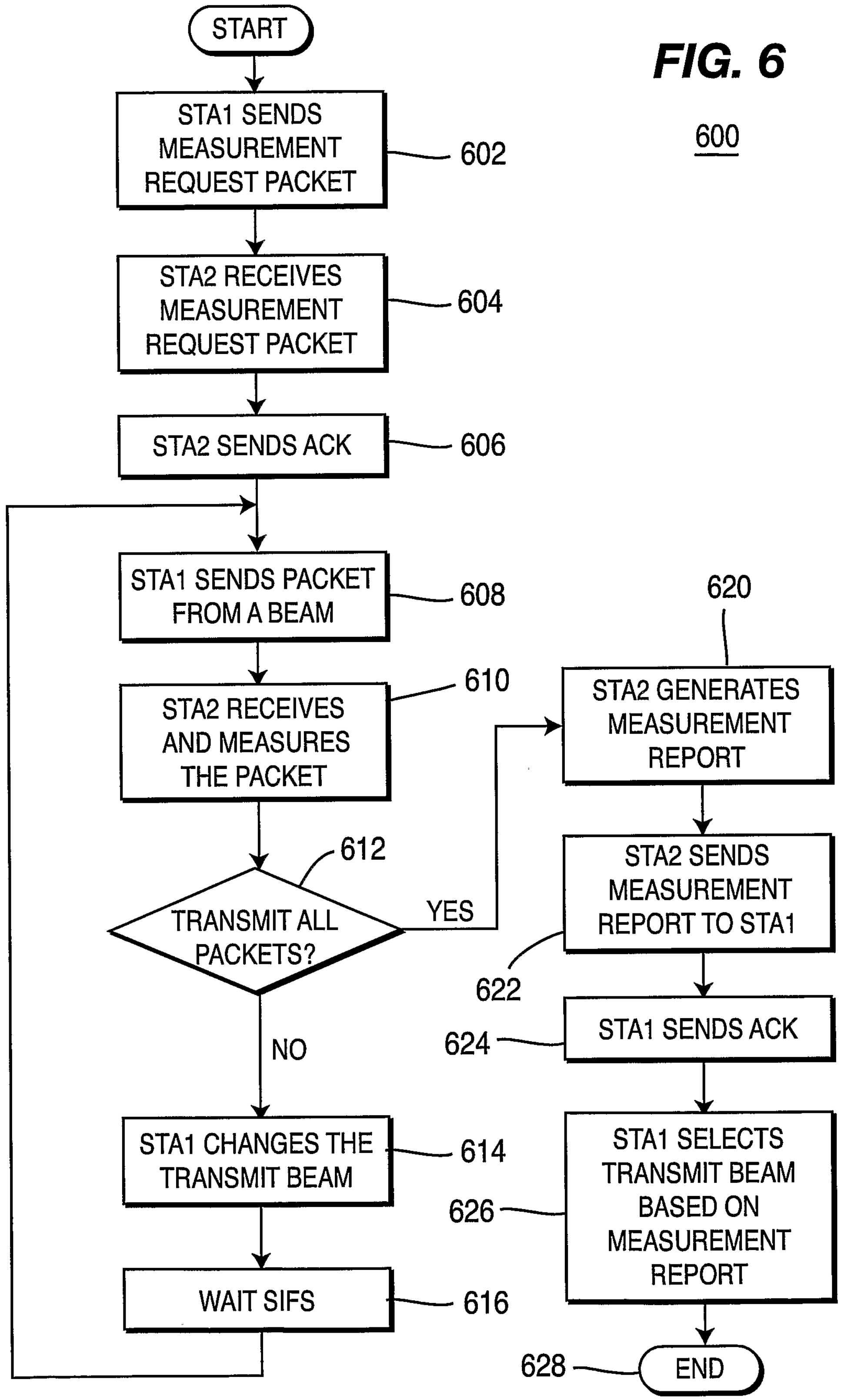

400
START
STA1 SENDS MEASUREMENT REQUEST PACKET
402
STA2 RECEIVES MEASUREMENT REQUEST PACKET
404
STA2 SENDS ACK
406
STA2 TRANSMITS MEASUREMENT PACKET
408
STA1 MEASURES RSSI AND/OR SNR OF MEASUREMENT PACKET
410
TRANSMIT ALL PACKETS?
412
YES
NO
STA1 CHANGES THE RECEIVE BEAM
414
WAIT SIFS
416
STA1 SELECTS TRANSMIT BEAM BASED ON MEASURED RSSI AND/OR SNR VALUES
418
END
420

FIG. 4

FIG. 6


600
START
STA1 SENDS MEASUREMENT REQUEST PACKET
602
STA2 RECEIVES MEASUREMENT REQUEST PACKET
604
STA2 SENDS ACK
606
STA1 SENDS PACKET FROM A BEAM
608
STA2 RECEIVES AND MEASURES THE PACKET
610
TRANSMIT ALL PACKETS?
612
YES
NO
STA1 CHANGES THE TRANSMIT BEAM
614
WAIT SIFS
616
STA2 GENERATES MEASUREMENT REPORT
620
STA2 SENDS MEASUREMENT REPORT TO STA1
622
STA1 SENDS ACK
624
STA1 SELECTS TRANSMIT BEAM BASED ON MEASUREMENT REPORT
626
END
628

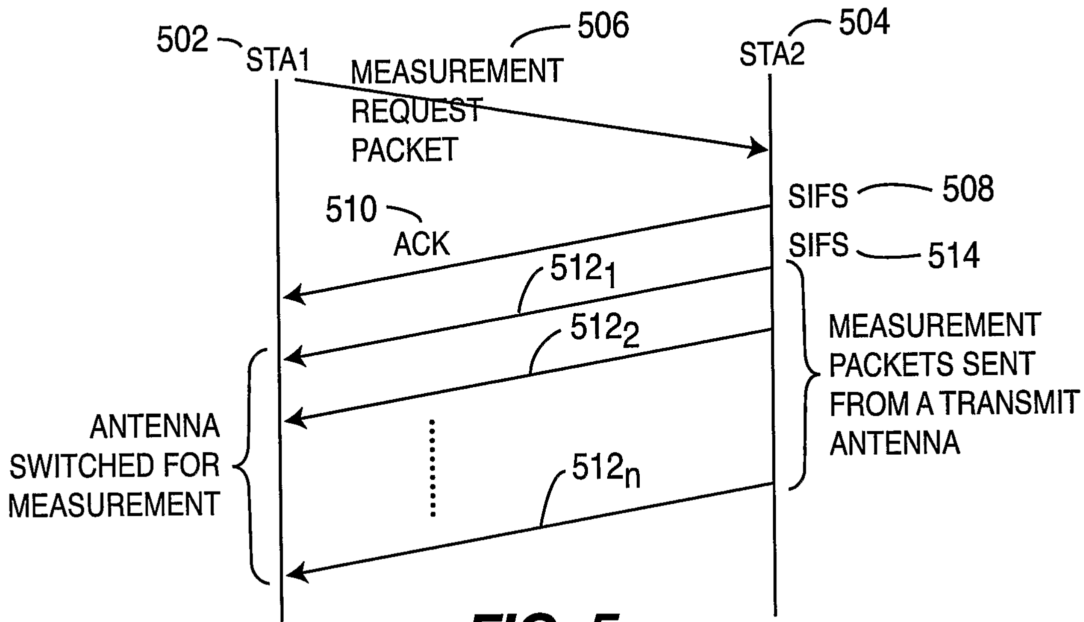

502
STA1
506
MEASUREMENT
REQUEST
PACKET
STA2
504
SIFS
508
510
ACK
SIFS
514
512_1
512_2
512_n
MEASUREMENT
PACKETS SENT
FROM A TRANSMIT
ANTENNA
ANTENNA
SWITCHED FOR
MEASUREMENT

FIG. 5

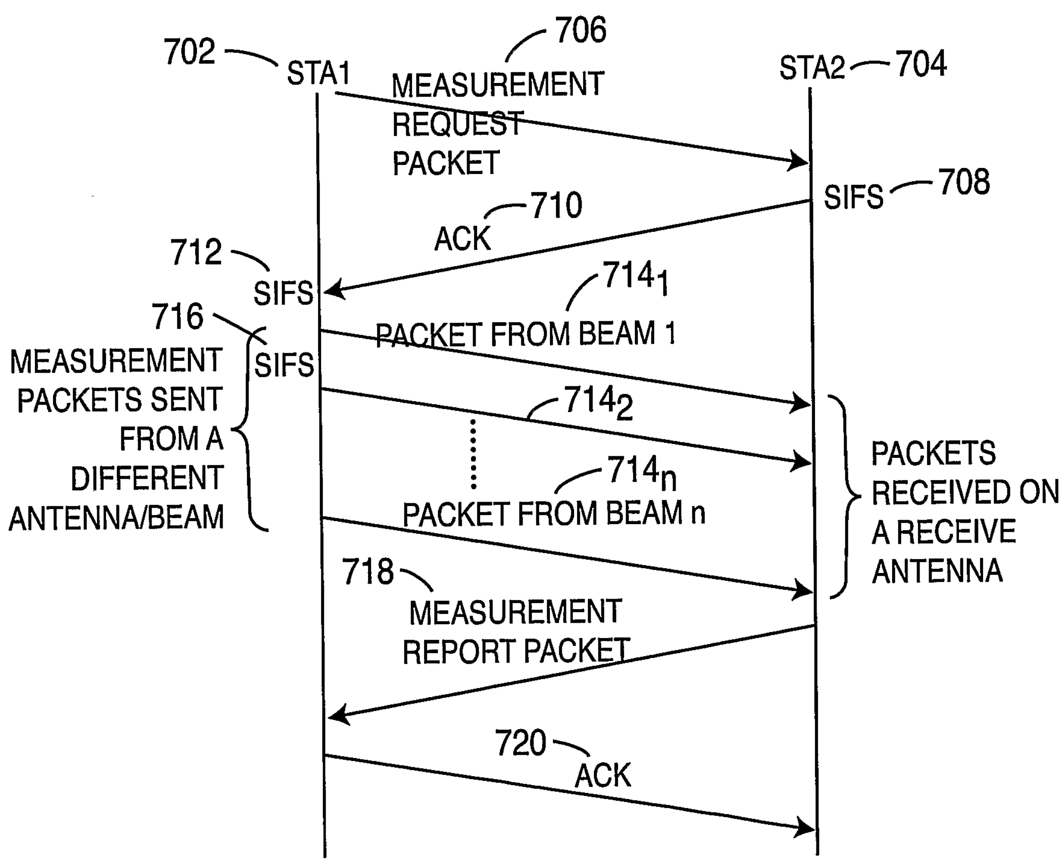

702
STA1
706
MEASUREMENT
REQUEST
PACKET
STA2
704
SIFS
708
710
ACK
712
SIFS
714_1
PACKET FROM BEAM 1
716
SIFS
MEASUREMENT
PACKETS SENT
FROM A
DIFFERENT
ANTENNA/BEAM
714_2
714_n
PACKET FROM BEAM n
PACKETS
RECEIVED ON
A RECEIVE
ANTENNA
718
MEASUREMENT
REPORT PACKET
720
ACK

FIG. 7

5/5

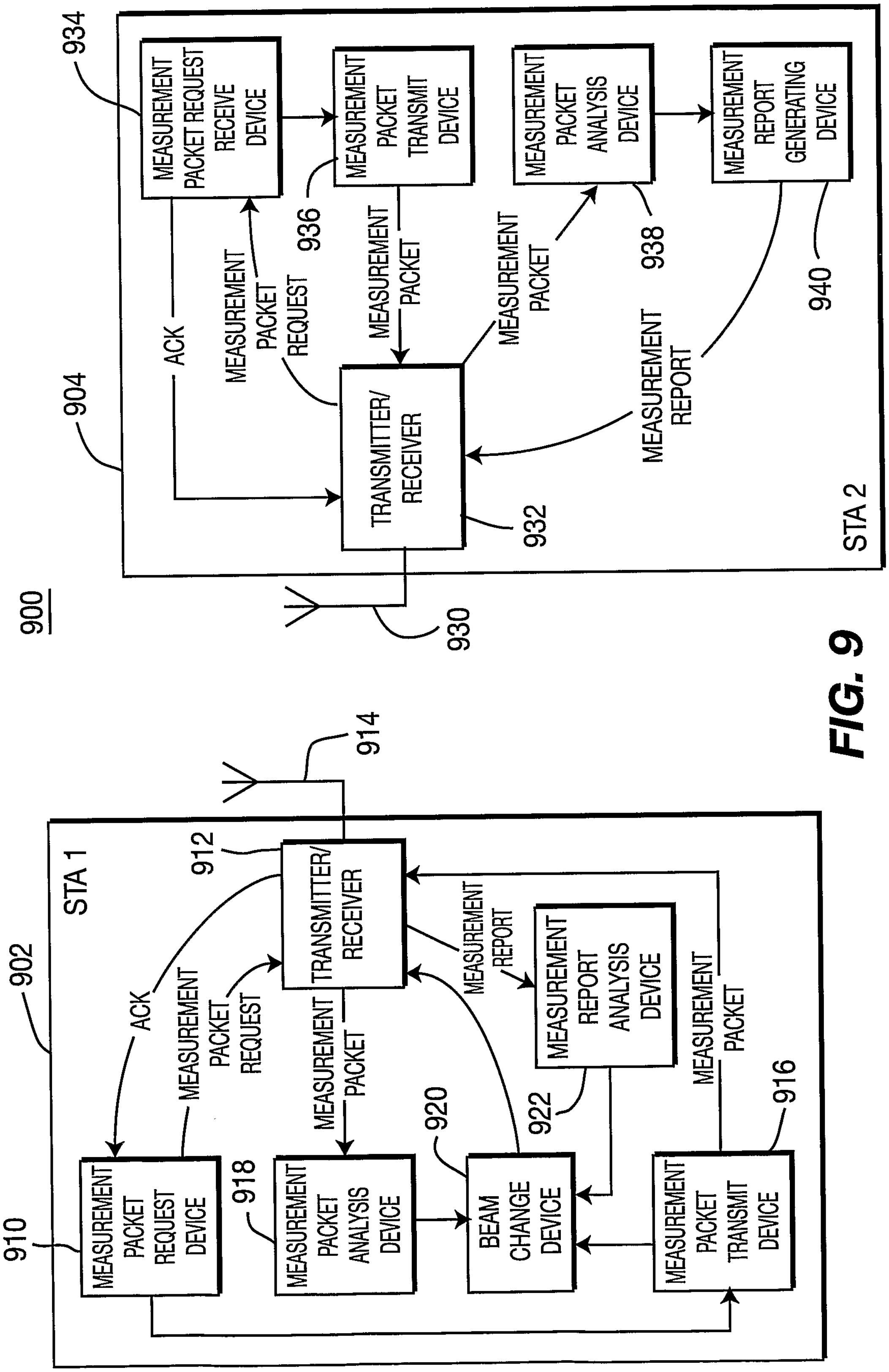

900
STA 1
902
910
MEASUREMENT PACKET REQUEST DEVICE
912
TRANSMITTER/ RECEIVER
914
ACK
MEASUREMENT PACKET REQUEST
MEASUREMENT PACKET
918
MEASUREMENT PACKET ANALYSIS DEVICE
920
BEAM CHANGE DEVICE
922
MEASUREMENT REPORT
MEASUREMENT REPORT ANALYSIS DEVICE
MEASUREMENT PACKET
916
MEASUREMENT PACKET TRANSMIT DEVICE
STA 2
904
930
932
TRANSMITTER/ RECEIVER
934
MEASUREMENT PACKET REQUEST RECEIVE DEVICE
ACK
MEASUREMENT PACKET REQUEST
936
MEASUREMENT PACKET TRANSMIT DEVICE
MEASUREMENT PACKET
MEASUREMENT PACKET
938
MEASUREMENT PACKET ANALYSIS DEVICE
MEASUREMENT REPORT
940
MEASUREMENT REPORT GENERATING DEVICE

FIG. 9