US 20030060224A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2003/0060224 A1

Nelson, JR. et al. (43) Pub. Date: Mar. 27, 2003

(54) REVERSE LINK INITIAL POWER SETTING USING EFFECTIVE RADIATED POWER MESSAGE TO COMPUTE PATH LOSS

(75) Inventors: **George R. Nelson JR.**, Merritt Island, FL (US); **James A. Proctor JR.**, Indialantic, FL (US); **John E. Hoffmann**, Indialantic, FL (US); **Antoine J. Rouphael**, Escondido, CA (US)

Correspondence Address:
HAMILTON, BROOK, SMITH & REYNOLDS, P.C.
530 VIRGINIA ROAD
P.O. BOX 9133
CONCORD, MA 01742-9133 (US)

(73) Assignee: **Tantivy Communications, Inc.**

(21) Appl. No.: **09/792,870**

(22) Filed: **Feb. 23, 2001**

Related U.S. Application Data

(60) Provisional application No. 60/184,223, filed on Feb. 23, 2000.

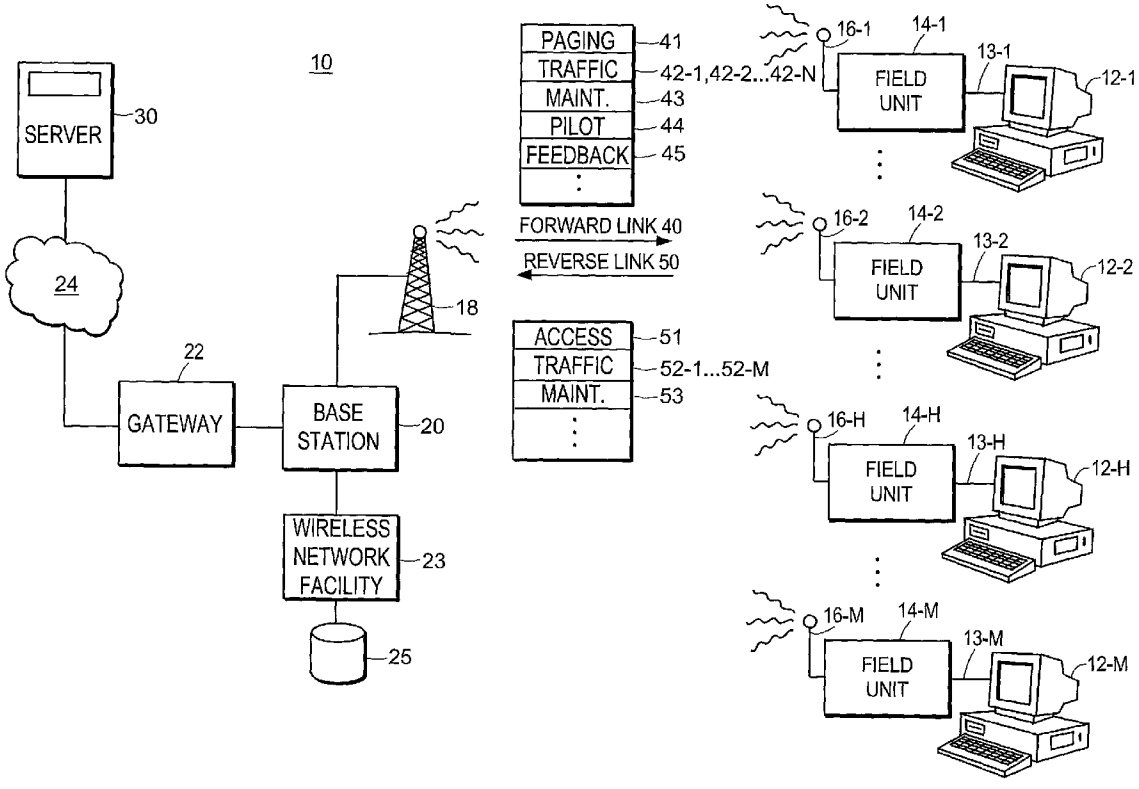
Publication Classification

(51) **Int. Cl.**[7] **H04B 1/00**

(52) **U.S. Cl.** **455/522**; 455/69; 370/335; 370/342

(57) ABSTRACT

In an illustrative embodiment of the present invention, a reference signal including pilot information is transmitted from a base station to one or multiple field units over a pilot channel. A message is also sent to the field units over a paging channel to indicate an effective radiated power level at which the reference signal is transmitted on the pilot channel. Based on a received power level of the reference signal at a field unit and the effective radiated power level of the reference signal, a forward path loss is estimated at the field unit for the forward link between the base station and field unit. Assuming the path loss in the reverse link is approximately the same as the estimated forward link path loss, the field unit can transmit a reply message in the reverse link so that the base station generally receives a message at a desired power level.



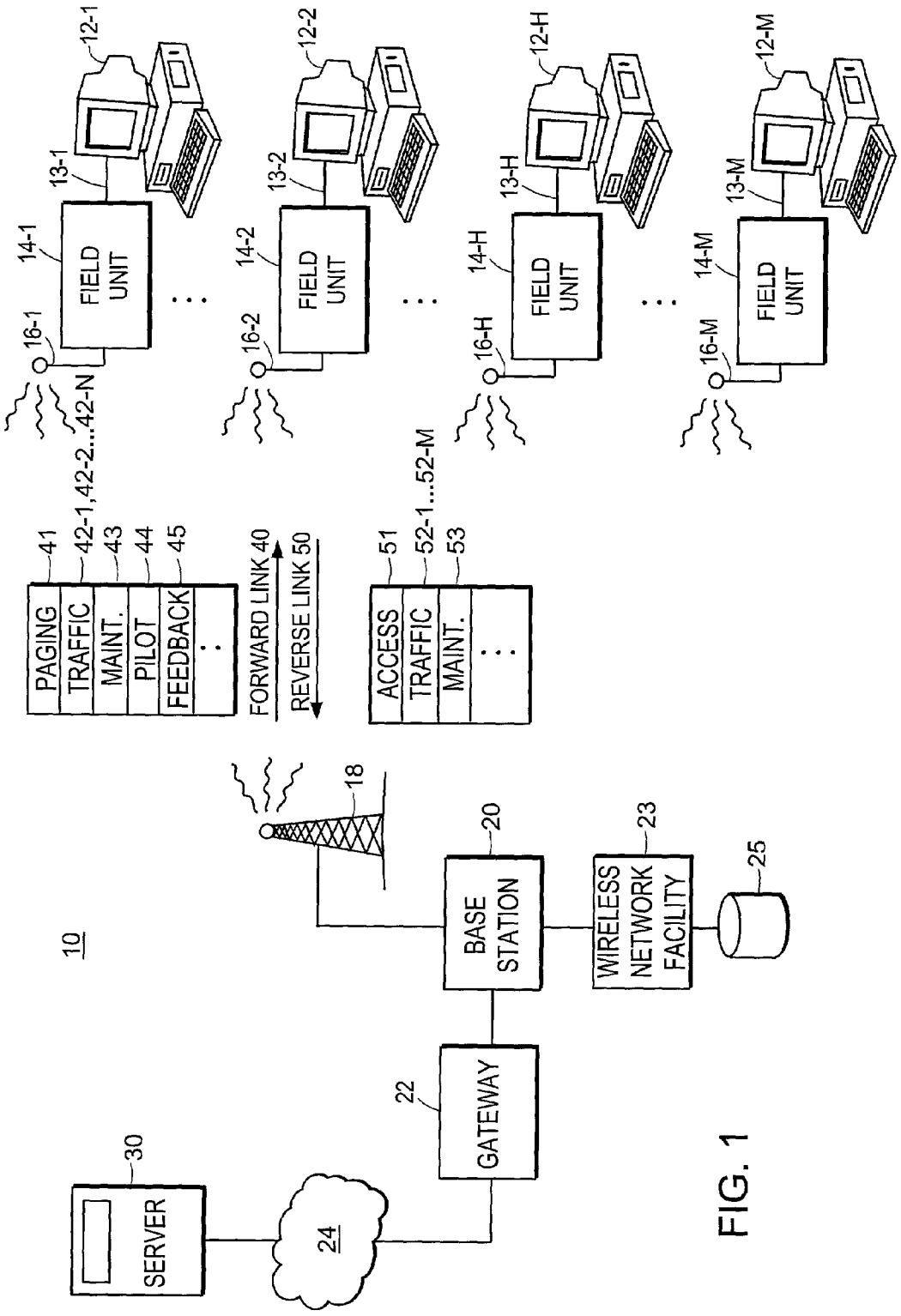

10
SERVER
30
24
GATEWAY
22
BASE STATION
20
18
WIRELESS NETWORK FACILITY
23
25
FORWARD LINK 40
REVERSE LINK 50
PAGING
TRAFFIC
MAINT.
PILOT
FEEDBACK
41
42-1,42-2...42-N
43
44
45
ACCESS
TRAFFIC
MAINT.
51
52-1...52-M
53
FIELD UNIT
14-1
14-2
14-H
14-M
16-1
16-2
16-H
16-M
13-1
13-2
13-H
13-M
12-1
12-2
12-H
12-M

FIG. 1

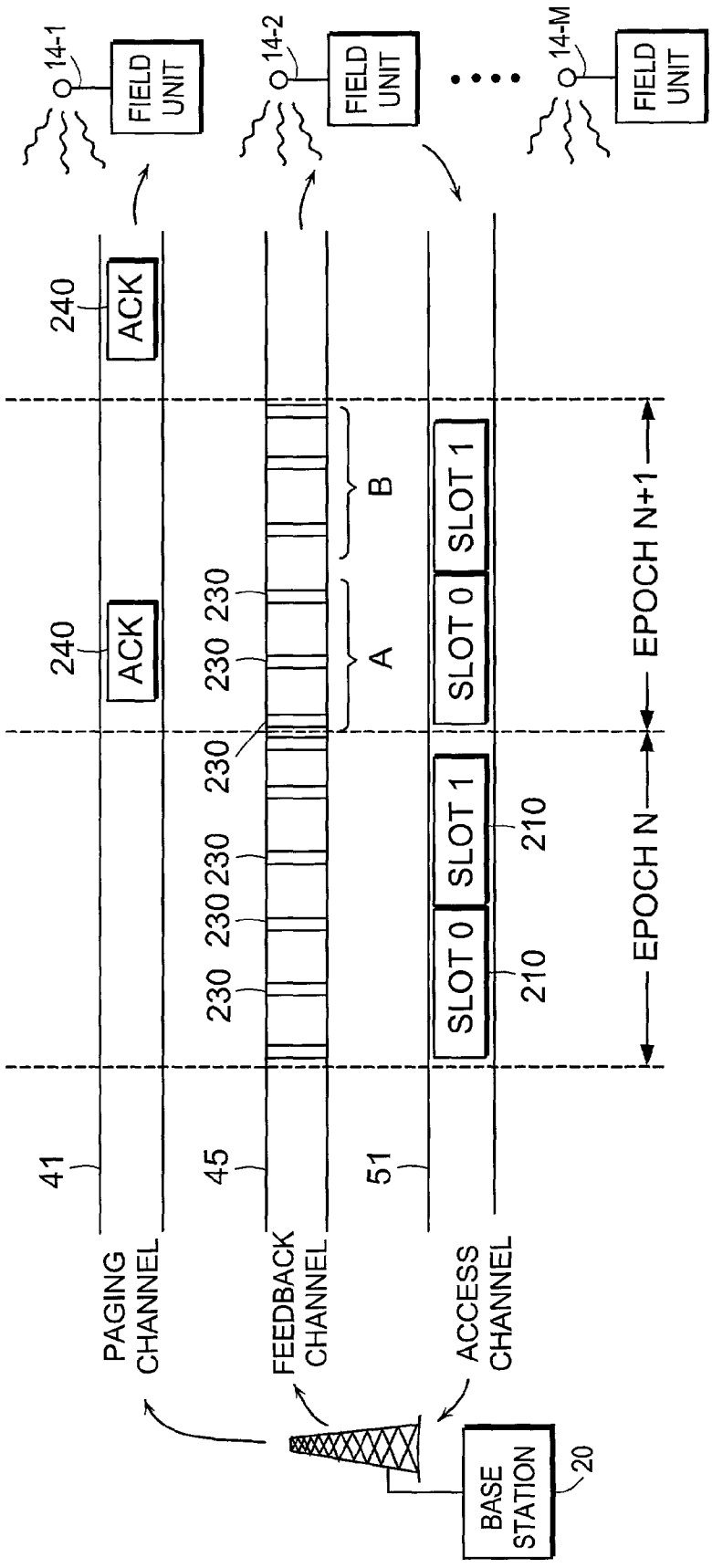

14-1
FIELD UNIT
14-2
FIELD UNIT
14-M
FIELD UNIT
240
ACK
240
ACK
230
230
230
230
230
230
A
B
SLOT 0
SLOT 1
SLOT 0
SLOT 1
SLOT 0
SLOT 1
210
210
EPOCH N
EPOCH N+1
TIME
41
45
51
PAGING CHANNEL
FEEDBACK CHANNEL
ACCESS CHANNEL
BASE STATION
20

FIG. 2

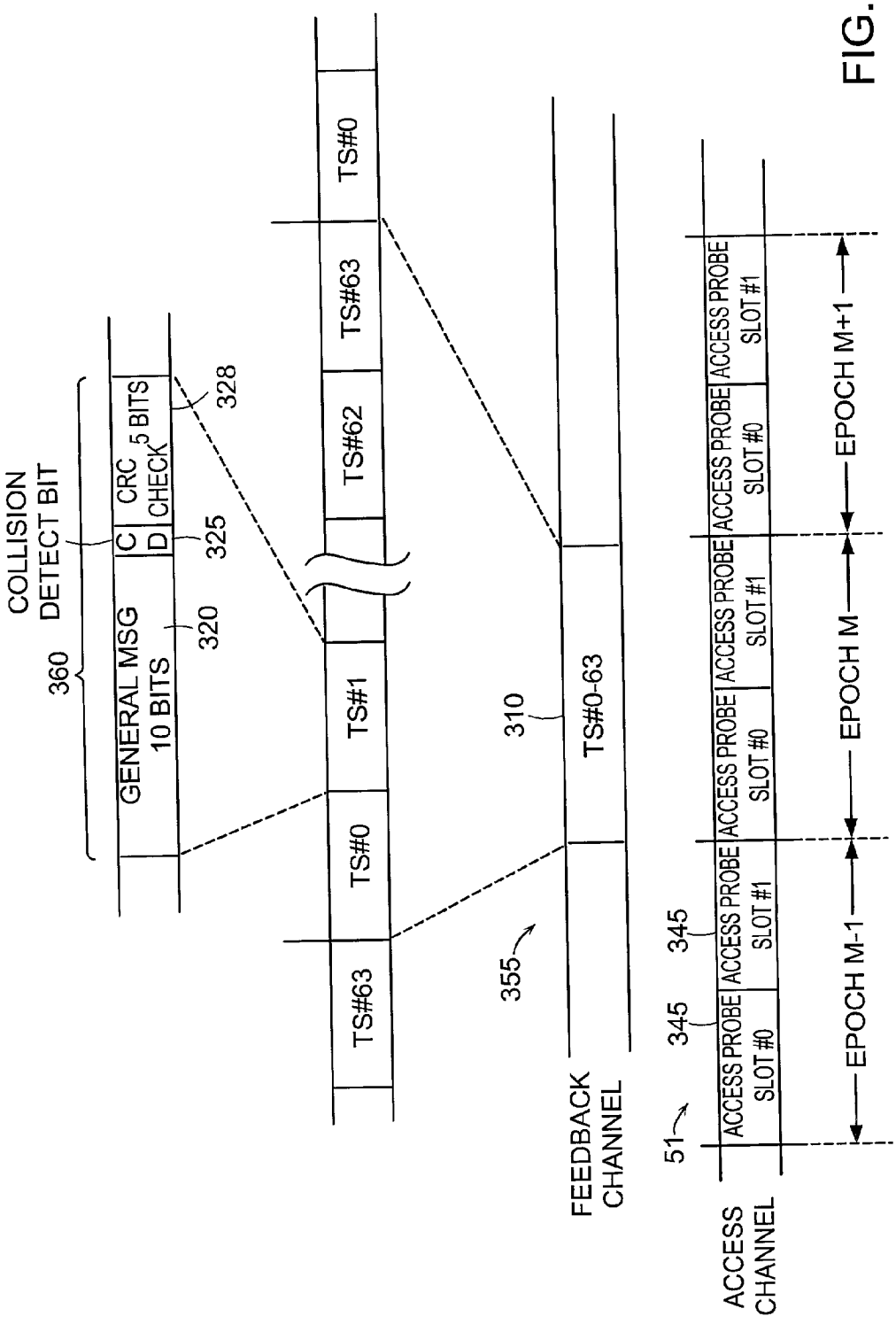

COLLISION DETECT BIT
360
GENERAL MSG 10 BITS
320
CRC CHECK 5 BITS
325
328
TS#0
TS#1
TS#62
TS#63
310
TS#0-63
355
FEEDBACK CHANNEL
51
345
345
ACCESS PROBE
SLOT #0
SLOT #1
ACCESS CHANNEL
EPOCH M-1
EPOCH M
EPOCH M+1

FIG. 3

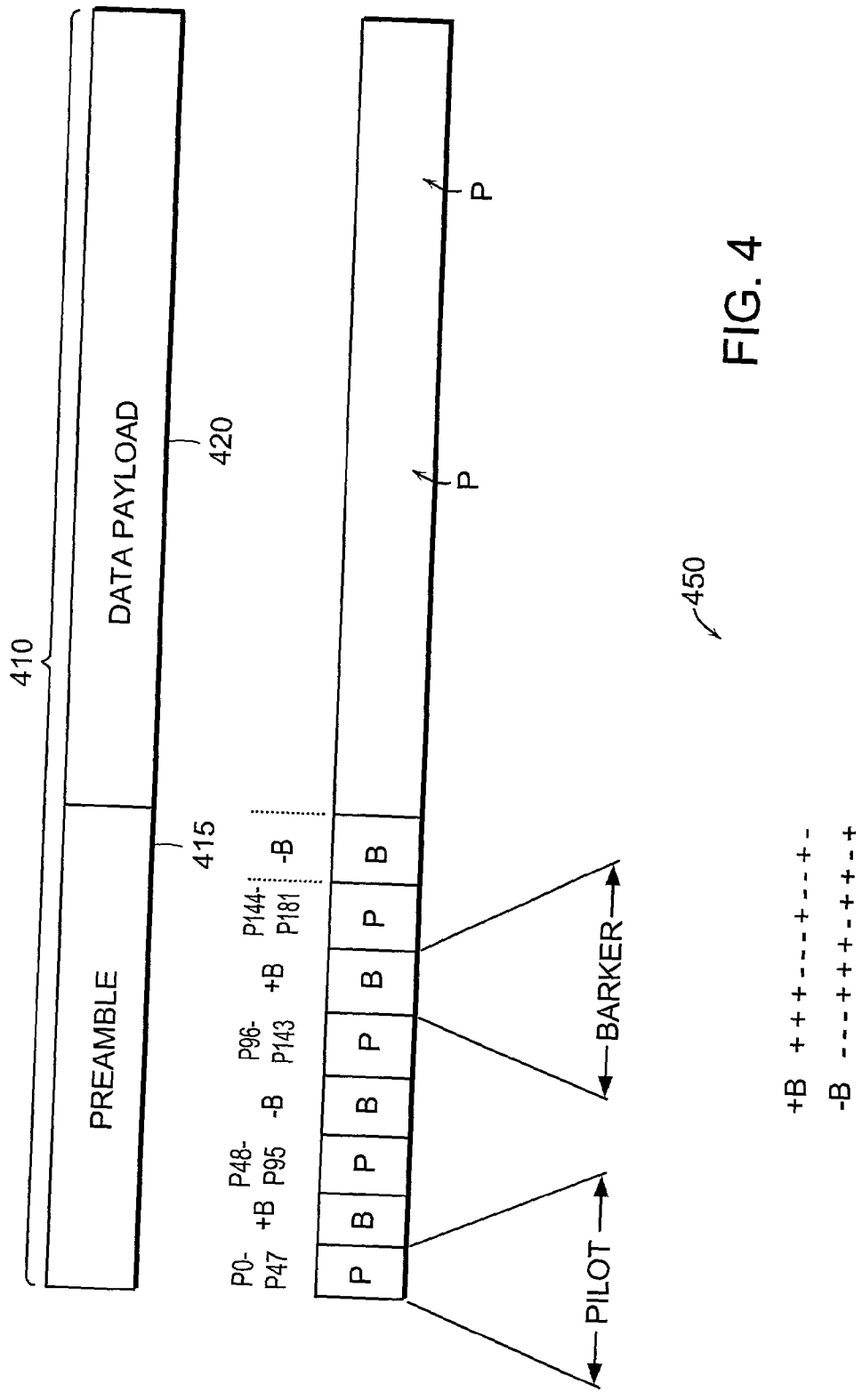

410
PREAMBLE
DATA PAYLOAD
415
420
P0-P47
+B
P48-P95
-B
P96-P143
+B
P144-P181
-B
P
B
P
B
P
B
P
B
P
P
BARKER
PILOT
450
+B + + + - - - + - - + -
-B - - - + + + - + + - +

FIG. 4

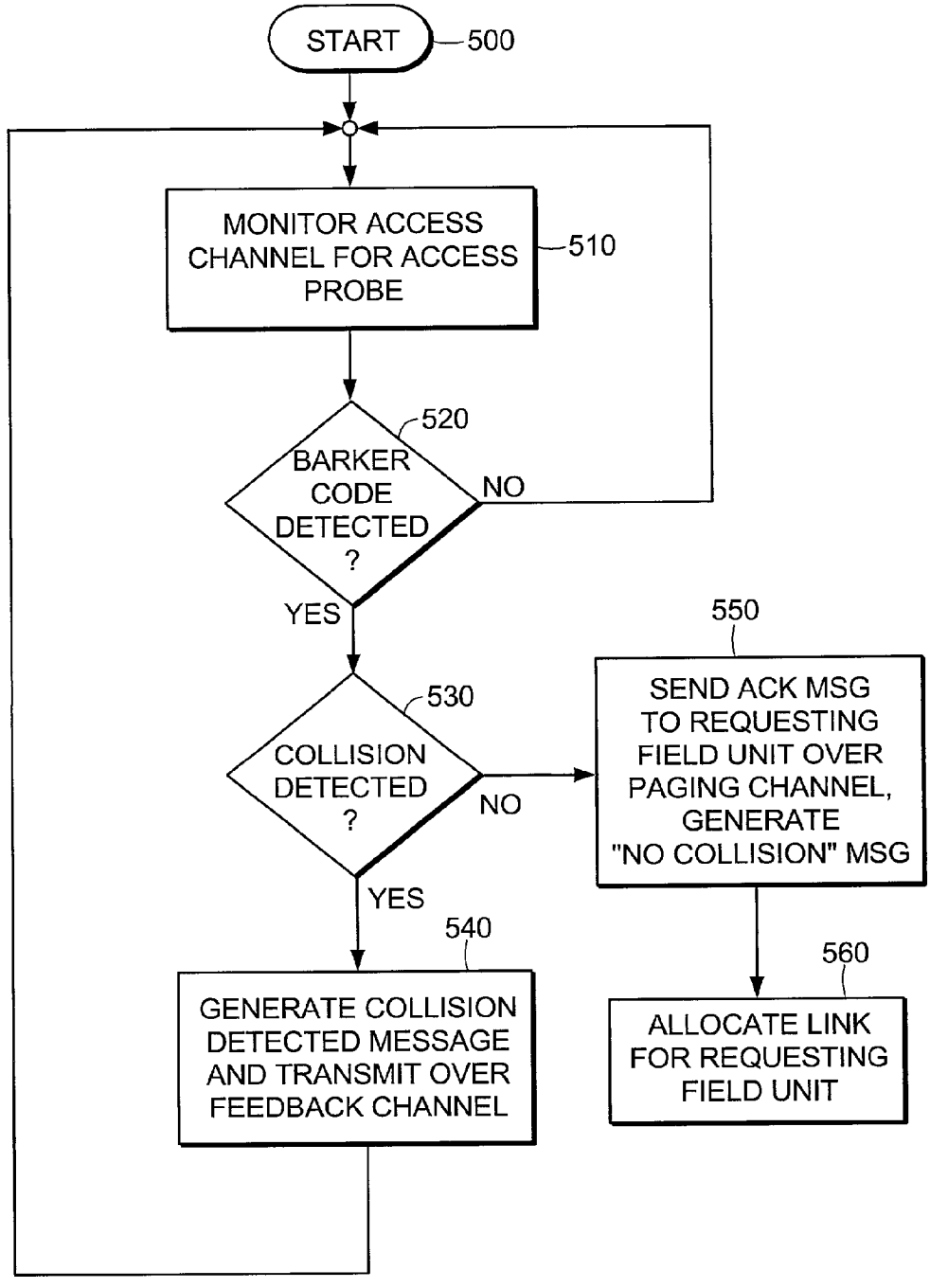

START
500
MONITOR ACCESS CHANNEL FOR ACCESS PROBE
510
520
BARKER CODE DETECTED ?
NO
YES
530
COLLISION DETECTED ?
NO
YES
550
SEND ACK MSG TO REQUESTING FIELD UNIT OVER PAGING CHANNEL, GENERATE "NO COLLISION" MSG
560
ALLOCATE LINK FOR REQUESTING FIELD UNIT
540
GENERATE COLLISION DETECTED MESSAGE AND TRANSMIT OVER FEEDBACK CHANNEL

FIG. 5

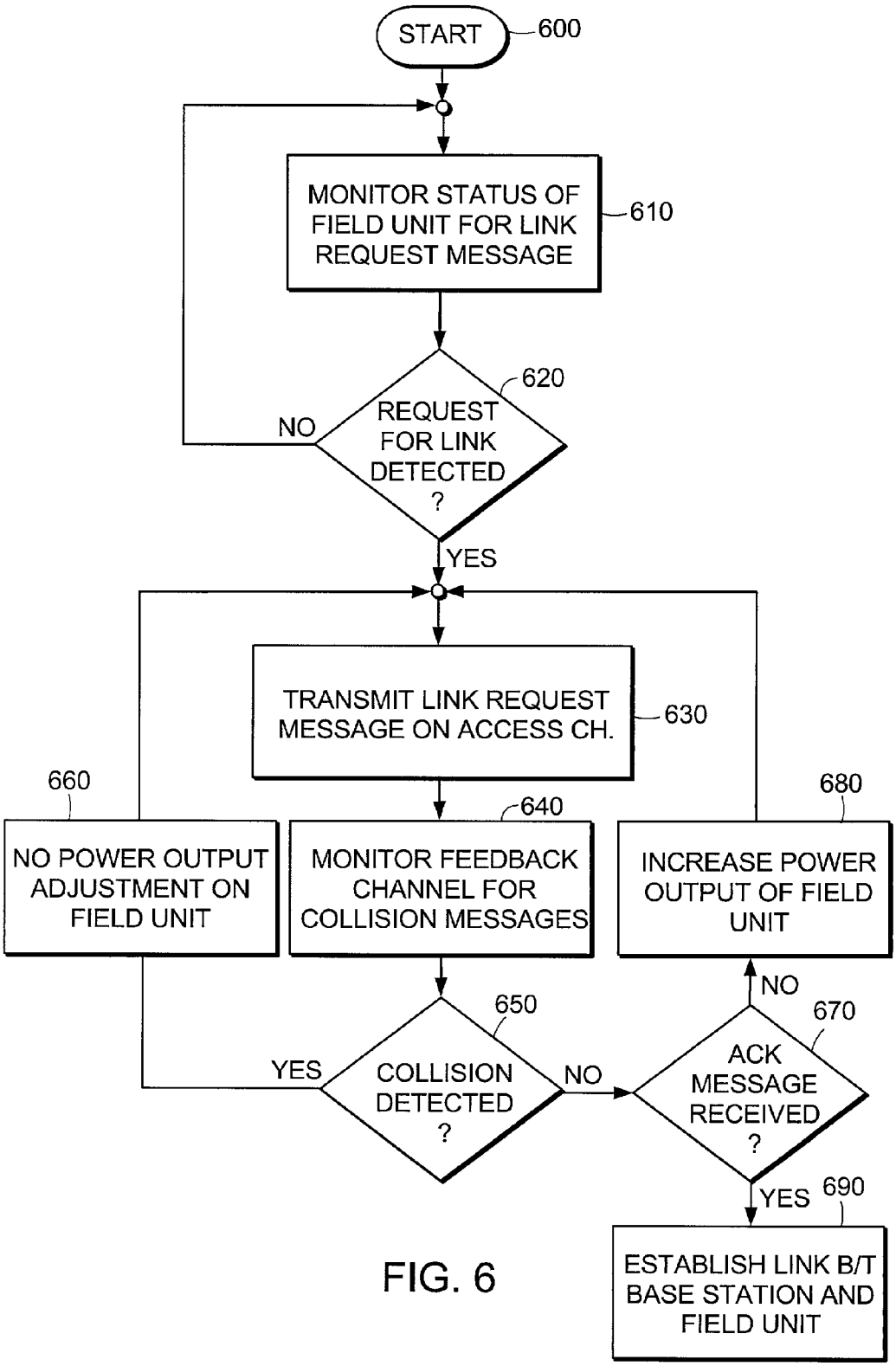

START
600
MONITOR STATUS OF FIELD UNIT FOR LINK REQUEST MESSAGE
610
620
REQUEST FOR LINK DETECTED ?
NO
YES
TRANSMIT LINK REQUEST MESSAGE ON ACCESS CH.
630
660
NO POWER OUTPUT ADJUSTMENT ON FIELD UNIT
640
MONITOR FEEDBACK CHANNEL FOR COLLISION MESSAGES
680
INCREASE POWER OUTPUT OF FIELD UNIT
650
COLLISION DETECTED ?
YES
NO
670
ACK MESSAGE RECEIVED ?
NO
YES
690
ESTABLISH LINK B/T BASE STATION AND FIELD UNIT

FIG. 6

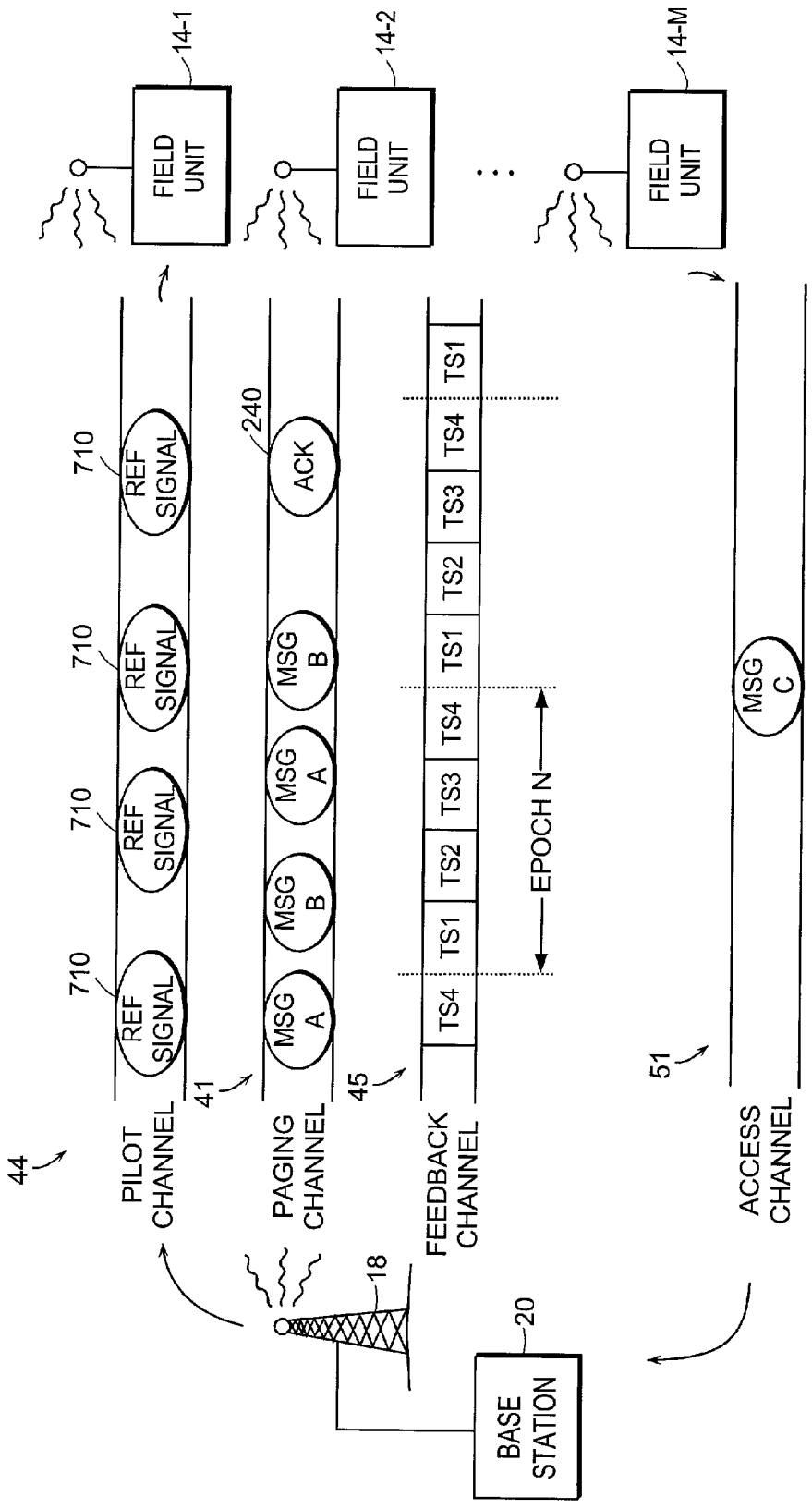

FIELD UNIT
14-1
14-2
14-M
710
REF SIGNAL
240
ACK
MSG A
MSG B
MSG C
TS1
TS2
TS3
TS4
EPOCH N
PILOT CHANNEL
PAGING CHANNEL
FEEDBACK CHANNEL
ACCESS CHANNEL
41
45
51
44
18
20
BASE STATION

FIG. 7

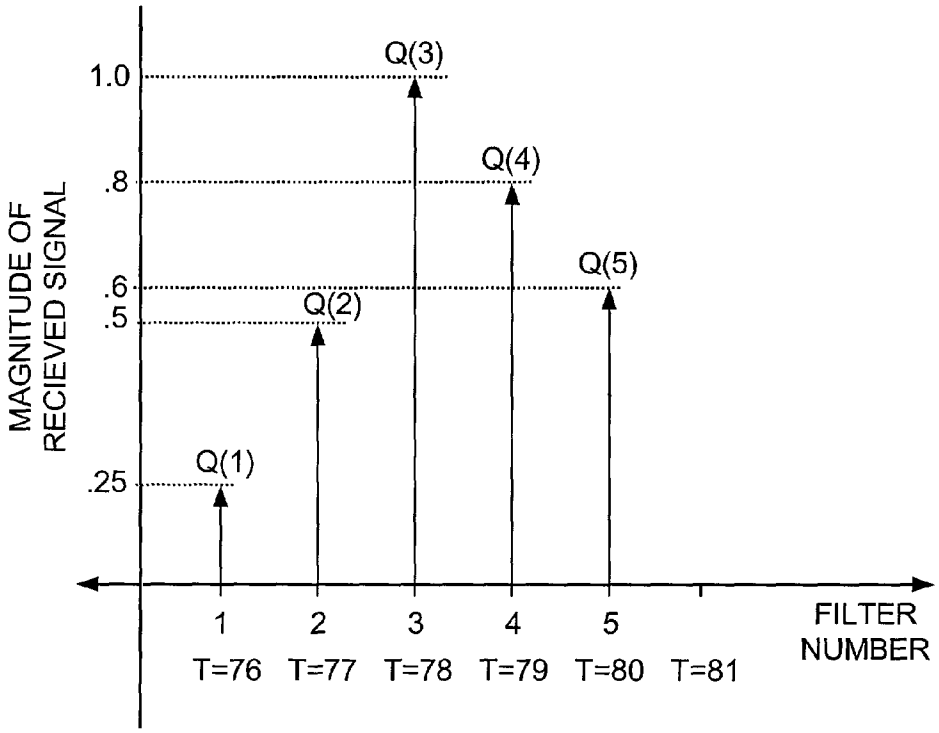

MAGNITUDE OF RECIEVED SIGNAL
1.0
.8
.6
.5
.25
Q(1)
Q(2)
Q(3)
Q(4)
Q(5)
1
2
3
4
5
FILTER NUMBER
T=76
T=77
T=78
T=79
T=80
T=81

FIG. 8

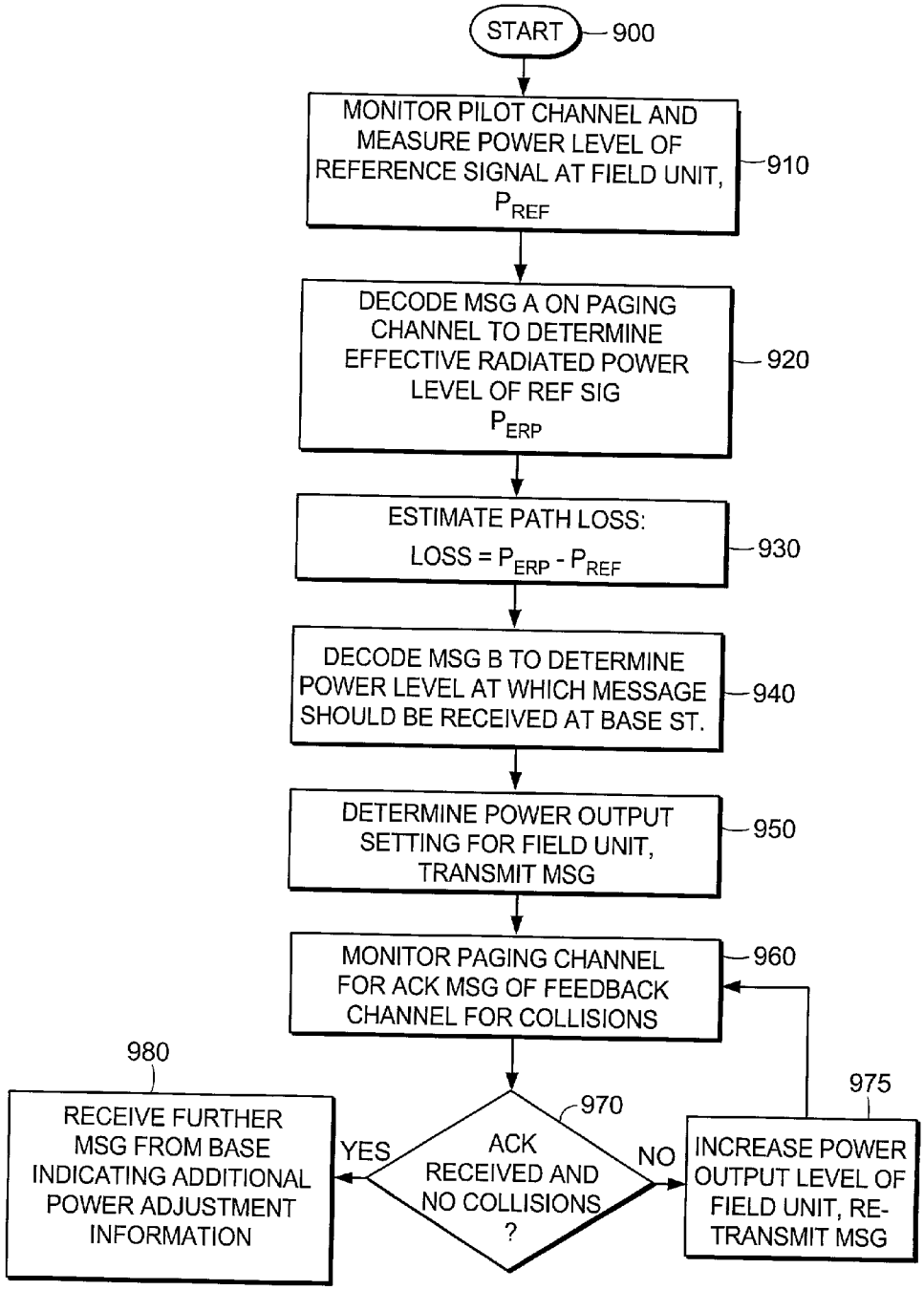

START
900
MONITOR PILOT CHANNEL AND MEASURE POWER LEVEL OF REFERENCE SIGNAL AT FIELD UNIT, P_{REF}
910
DECODE MSG A ON PAGING CHANNEL TO DETERMINE EFFECTIVE RADIATED POWER LEVEL OF REF SIG P_{ERP}
920
ESTIMATE PATH LOSS: LOSS = P_{ERP} - P_{REF}
930
DECODE MSG B TO DETERMINE POWER LEVEL AT WHICH MESSAGE SHOULD BE RECEIVED AT BASE ST.
940
DETERMINE POWER OUTPUT SETTING FOR FIELD UNIT, TRANSMIT MSG
950
MONITOR PAGING CHANNEL FOR ACK MSG OF FEEDBACK CHANNEL FOR COLLISIONS
960
970
ACK RECEIVED AND NO COLLISIONS ?
YES
NO
980
RECEIVE FURTHER MSG FROM BASE INDICATING ADDITIONAL POWER ADJUSTMENT INFORMATION
975
INCREASE POWER OUTPUT LEVEL OF FIELD UNIT, RE-TRANSMIT MSG

FIG. 9

REVERSE LINK INITIAL POWER SETTING USING EFFECTIVE RADIATED POWER MESSAGE TO COMPUTE PATH LOSS

RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. Provisional Application No. 60/184,223 filed on Feb. 23, 2000, the entire teachings of which is incorporated herein by this reference.

BACKGROUND OF THE INVENTION

[0002] A specific protocol has been developed for allowing multiple users to transmit over a shared radio channel. For example, the IEEE (Institute of Electrical and Electronics Engineers) 802.11 Standard generally supports access to radio channels based on a method known as Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

[0003] In simple terms, this method is based on a "listen before talk" scheme. A transmitter device monitors traffic on a shared radio channel to determine if another transmitter device is presently transmitting on the same channel. If the radio channel is in use, the transmitter device will continue to monitor the channel until it is clear. When the radio channel is finally clear, the transmitter will then transmit over the radio channel.

[0004] Ideally, another transmitter device will not simultaneously transmit during the same time. However, a collision can occur on the radio channel when two or more transmitter devices transmit on the radio channel simultaneously. Consequently, neither message transmission would be intelligible and both transmitter devices must re-transmit their messages again to a corresponding target device.

[0005] Based on this CSMA/CA scheme, re-transmission of data due to a collision cannot occur before a minimum time gap. After the minimum time gap has passed, the transmitter device selects a random "backoff interval," which is the wait time before the radio channel is again monitored to determine whether the radio channel is clear to transmit. If the channel is still busy, another shorter "backoff interval," is selected for a subsequent message transmission. This process is repeated until the transmitter device is able to transmit data.

[0006] Another standard for transmitting data on a shared radio channel is based on IS-95, in which multiple field units can transmit at the same time.

[0007] The IS-95 standard suggests a method of ramping RF power of a field unit until a message from the field unit is transmitted at a power level that is detectable at a base station. According to this method, a field unit transmits an access request message to a base station for the assignment of wireless resources on a reverse link.

[0008] After transmitting an access request message on an access channel, the field unit monitors a paging channel for an acknowledgment message from the base station indicating that the access request message was properly received. If no acknowledgment message is sent to the requesting field unit, it is presumed that the message from the field unit was not transmitted at an appropriate power level. That is, the power output level of the field unit is so low that the base station did not detect a previously transmitted access request message. The access request message is then re-transmitted over the access channel at a higher power level.

[0009] This process is subsequently repeated until the field unit transmits a message at a power level that is high enough for the base station to properly receive the message. Similar to the IEEE 802.11 standard, a collision can occur on the shared radio channel when two or more field units simultaneously transmit a message.

SUMMARY OF THE INVENTION

[0010] The present invention is generally directed towards an apparatus and method for enhancing the utilization of resources in a wireless communication system. In an illustrative embodiment, a reference signal is transmitted from a first transceiver to a second transceiver or group of target transceivers. The first transceiver also transmits a first message, which includes information indicating an effective radiated power level at which the first transceiver transmits the reference signal. The received power level of the reference signal is then measured at the second transceiver to estimate a path loss between the first transceiver and second transceiver. More specifically, a path loss can be calculated by comparing the received power level of the reference signal with the effective radiated power level information as indicated by the first message.

[0011] A second message is optionally sent from the first transceiver to the second transceiver. This second message can include information indicating a desired power level at which subsequent messages in a reverse direction should be received at the first transceiver.

[0012] In certain applications, the forward path loss between the first transceiver and second transceiver is approximately the same as a reverse path loss for message transmissions from the second transceiver back to the first transceiver. Consequently, the second transceiver can adjust its power output level so that the first transceiver receives a message at the desired power level taking into account the estimated path loss as previously discussed. Of course, the path loss can be different in the reverse link direction than that of the forward link and an estimated power setting at which the second transceiver transmits a message can be a starting point for transmitting subsequent messages. For example, the power output level of the second transceiver can be increased for subsequent message transmissions until the first transceiver detects the message.

[0013] In a specific application of the present invention, the reference signal is transmitted over a pilot channel of a CDMA (Code Division Multiple Access) communication system. The reference signal itself optionally includes a marker such as pilot symbols that are monitored at a second transceiver. The first message as transmitted by the first transceiver can be transmitted over a paging channel, while a reply message from the second transceiver to the first transceiver can be transmitted over an access channel in which multiple transceivers compete to transmit messages to the first transceiver. The access channel is optionally divided into time slots in which a transceiver sends a message to the first transceiver.

[0014] One message type that can be transmitted on the access channel is an access request message. Such a message is an indication to the first transceiver that a more formal

communication link should be established between the first transceiver and second transceiver. Consequently, the more formal communication link can be allocated to support more efficient, on-demand data transfers.

[0015] An access request message is optionally encoded so that it includes timing alignment information. For example, the first transceiver can analyze a reply message such as an access request message including a timing marker and provide feedback indicating whether the reply is appropriately transmitted within a time slot. Other types of reply messages can also include a reference marker for timing alignment. In one application, a reference marker is a string including pilot information such as one or multiple pilot symbols.

[0016] In addition to monitoring the timing of a reply message, the received power level of a reply message can be monitored to determine whether a transceiver is transmitting a message so that it is received at a desired power level. This can be achieved by comparing a power level at which a reply message is received to a desired power level at which the reply message should be received. Based on this comparison, a power adjustment message is optionally transmitted to a corresponding target transceiver. Thus, subsequent message transmissions from a second transceiver to the first transceiver can be optimally adjusted based on operating conditions of the wireless communication system at an instant in time.

[0017] Certain aspects of the present invention reduce co-channel interference and generally increase the throughput capability of a wireless communication system. As previously discussed, an initial power output level of a field unit can be adjusted so that it minimally interferes with others when it initially transmits messages or transmits subsequent messages. When message transmissions on an allocated channel such as an access channel are minimized, more wireless resources can otherwise be allocated for supporting higher speed data transfers in a wireless communication system.

[0018] Of course, the initial power output level of a field unit can be so low that a message transmission is not detected at a target device such as a base station. In this case, a power output level can be increased accordingly for subsequent message transmissions until the message is detected at a target transceiver. This process of incrementally increasing the power level can be a time consuming process, especially if the power output of the transceiver were to start transmitting at a lowest possible power level. Thus, it can take a considerable amount of time to successfully transmit a message to a target receiver such as a base station.

[0019] The principles of the present invention can be used to simultaneously reduce the effective time it takes to transmit a message to a base station while minimally interfering with other channels of the wireless communication system. This is achieved, at least in part, by approximating a path loss between a field unit and base station and transmitting a message from the field unit so that a message is received at a desired power level at the base station. Since the initial power setting of the field unit is approximately set to a detectable power level for data transmissions to a target receiver, it typically requires less time to transmit an initial message to a target receiver when power is incrementally increased so that a message is eventually detected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] **FIG. 1** is a bock diagram of an illustrative wireless communication system according to certain principles of the present invention.

[0021] **FIG. 2** is a timing diagram illustrating multiple channels on which messages are transmitted according to certain principles of the present invention.

[0022] **FIG. 3** is a timing diagram illustrating a use of data fields within a time-slotted channel according to certain principles of the present invention.

[0023] **FIG. 4** is a pictorial diagram illustrating details of a message according to certain principles of the present invention.

[0024] **FIG. 5** is a flow chart for processing messages at a target receiver according to certain principles of the present invention.

[0025] **FIG. 6** is a flow chart for transmitting messages to a target receiver according to certain principles of the present invention.

[0026] **FIG. 7** is a timing diagram illustrating multiple channels on which messages are transmitted according to certain principles of the present invention.

[0027] **FIG. 8** is a diagram of a monitored reference signal according to certain principles of the present invention.

[0028] **FIG. 9** is a flow chart for setting an initial power output level of a transmitter device according to certain principles of the present invention.

[0029] The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0030] A description of preferred embodiments of the invention follows.

[0031] **FIG. 1** is a block diagram illustrating a wireless communication system supporting the transmission of data information over multiple allocated communication channels according to certain aspects of the present invention. As in many wireless communication systems, users compete for wireless bandwidth allocation. Hence, it is desirable that the wireless communication **10** is optimized for data throughput and, in certain applications, hi-speed bursts of data throughput.

[0032] Certain aspects of the present invention are based on the recognition that the power output of a field unit transmitting over a wireless channel can be controlled so that it minimally interferes with other field units using the same general wireless airspace. In particular, a power output level of a newly transmitting field unit is initially set so low that a base station may not detect messages transmitted by the field unit. This initially low power setting of a field unit reduces co-channel interference because the transmitter

device is not transmitting at excessive power levels. During subsequent communication attempts with the base station, the power output of a field unit is then ramped up until messages are acknowledged at the base station.

[0033] In one application, one or multiple field units randomly transmit messages on a first allocated channel. When two field units transmit a message simultaneously on this first allocated channel, there can be a message collision at the base station. The base station may be able to detect that a message was transmitted by a field unit and there was a message collision. However, the base station may not be able to decipher the contents of the message and determine from which field unit transmitted a message. Thus, in certain situations, the base station can not transmit a message directed specifically to a particular field unit indicating that a collision occurred for a previous message transmission.

[0034] One aspect of the present invention involves providing general feedback information to the field units indicating that a collision was detected. Consequently, a previous undetected message can be re-transmitted by a field unit. If there was no collision detected and no acknowledgment received by the filed unit, the field unit can successively ramp up its power output setting for subsequent message transmission attempts to ensure that a message will eventually be acknowledged by the base station.

[0035] According to the following description of a preferred embodiment, communication system **10** is described as a wireless communication link such as a CDMA radio channel utilizing shared channel resources. However, it should be noted that the techniques described herein can be applied in other applications supporting shared access. For example, the principles of the present invention can be applied to other general applications such as telephone connections, computer network connections, cable connections, or other physical media to which allocation of resources such as data channels are granted on an as-needed basis.

[0036] As shown, communication system **10** includes a number of Personal Computer (PC) devices **12-1**, **12-2**, . . . **12**-h, . . . **12**-m, corresponding field units or terminals **14-1**, **14-2**, . . . **14**-h, . . . **14**-m, and associated directional antenna devices **16-1**, **16-2**, . . . **16**-h, . . . **16**-m. Centrally located equipment includes a base station antenna **18**, and a corresponding base station **20** that includes high speed processing capability.

[0037] Base station **20** and related infrastructure provides connections to and from a network gateway **22**, network **24** such as the Internet, and network file server **30**. Communication system **10** is preferably a demand access, point to multi-point wireless communication system such that the PC devices **12** can transmit data to and receive data from network server **30** based on a logical connection including bi-directional wireless connections implemented over forward links **40** and reverse links **50**. That is, in the point to multi-point multiple access wireless communication system **10** as shown, a given base station **20** typically supports communication with a number of different field units **14** in a manner which is similar to a cellular telephone communication network. Accordingly, system **10** can provide a framework for a CDMA wireless communication system where digital information is relayed on-demand between multiple mobile cellular users and a hardwired network **24** such as the Internet.

[0038] PC devices **12** are typically laptop computers, handheld units, Internet-enabled cellular telephones, Personal Digital Assistant (PDA)-type computers, digital processors or other end user devices, although almost any type of processing device can be used in place of PC devices **12**. One or multiple PC devices **12** are each connected to a respective subscriber unit **14** through a suitable hard wired connection such as an Ethernet-type connection via cable **13**.

[0039] Each field unit **14** permits its associated PC device **12** access to network file server **30**. In the reverse link **50** direction, that is, for data traffic transmitted from the PC **12** towards the server **30**, the PC device **12** transmits information to field unit **14** based on, for example, an Internet Protocol (IP) level network packets. The field unit **14** then encapsulates the wired framing, i.e., Ethernet framing, with appropriate wireless connection framing so that data packets can be transmitted over the wireless link of communication system **10**. Based on a selected wireless protocol, the appropriately formatted wireless data packet then travels over one of the radio channels that comprise the reverse link **50** through field unit antenna **16** to base station antenna **18**. At the central base station location, the base station **20** then extracts the radio link framed data packets and reformats the packets into an IP format. The packets are then routed through gateway **22** and any number or type of networks **24** to an ultimate destination such as a network file server **30**.

[0040] In one application, information generated by PC device **12** is based on a TCP/IP protocol. Consequently, a PC device **12** has access to digital information such as web pages available on the Internet. It should be noted that other types of digital information can be transmitted over channels of communication system **10** based on the principles of the present invention.

[0041] Data information can also be transferred from the network file server **30** to PCs **12** on forward link **40**. In this instance, network data such as IP (Internet Protocol) packets originating at file server **30** travel on network **24** through gateway **22** to eventually arrive at base station **20**. As previously discussed for reverse link data transmissions, appropriate wireless protocol framing is then added to raw data such as IP packets for communication of the packets over wireless forward link **40**. The newly framed packets then travel via an RF signal through base station antenna **18** and field unit antenna **16** to the intended target field unit **14**. An appropriate target field unit **14** decodes the wireless packet protocol layer, and forwards the packet or data packets to the intended PC device **12** that performs further processing such as IP layer processing.

[0042] A given PC device **12** and file server **30** can therefore be viewed as the end points of a logical connection at the IP level. Once a connection is established between the base station processor **20** and corresponding field unit **14**, a user at the PC device **12** can then transmit data to and receive data from file server **30** on an as-needed basis.

[0043] Reverse link **50** optionally includes different types of logical and/or physical radio channels such as an access channel **51**, multiple traffic channels **52-1**, . . . **52**-m, and a maintenance channel **53**. The reverse link access channel **51** is typically used by the subscriber units **14** to request an allocation of traffic channels by the base station **20**. For example, traffic channels **52** can be assigned to users on an

as-needed basis. The assigned traffic channels **52** in the reverse link **50** then carry payload data from field unit **14** to base station **20**.

[**0044**] Notably, a given link between base station **20** and field unit **14** can have more than one traffic channel **52** assigned to it at a given instant in time. This enables the transfer of information at higher rates.

[**0045**] Maintenance channel **53** can be used to carry maintenance information such as synchronization and power control messages to further support transmission of digital information over both reverse link **50** and forward link **40**.

[**0046**] Forward link **40** can include a paging channel **41**, which is used by base station **20** to inform a field unit **14** of general information such as that one or multiple forward link traffic channels **42** have been allocated to it for forward link data transmissions. Traffic channels **42-1** . . . **42**-n on the forward link **40** are used to carry payload information from base station **20** to a corresponding target subscriber unit **14**.

[**0047**] Maintenance channel **43** can be used to transmit synchronization and power control information on forward link **40** from base station processor **20** to field units **14**. Additionally, paging channel **41** can be used to inform a field unit **14** of allocated traffic channels **52** in the reverse link **50** direction.

[**0048**] Traffic channels **42** of the forward link **40** can be shared among multiple subscriber units **14** based on a Time Division Multiplexing scheme. Specifically, a forward link traffic channel **42** is optionally partitioned into a predetermined number of periodically repeating time slots for transmission of data packets from the base station **20** to multiple subscriber units **14**. It should be understood that a given subscriber unit **14** can, at any instant in time, have multiple time slots or no time slots assigned to it for use. In certain applications, an entire time-slotted forward or reverse link traffic channel can also be assigned for use by a particular field unit **14** on a continuous basis.

[**0049**] **FIG. 2** is a timing diagram illustrating multiple channels on which messages are transmitted between a base station **20** and field units **14** according to certain principles of the present invention. As shown, field units **14** can transmit messages to base station **20** over a dedicated channel such as access channel **51**. Access channel **51** supports a transmission of access request messages from a field unit **14** to base station **20**. An access request message can indicate a request by field unit **14** for a high speed bi-directional communication link.

[**0050**] Message transmissions over access channel **51** need not be limited to access request type messages. For example, access channel **51** can be structured to support other types of messages.

[**0051**] In the illustrative timing diagram as shown in **FIG. 2**, access channel **51** is optionally partitioned into periodically repeating time slots **210** in which messages are transmitted from a field unit **14** to base station **20**. More specifically, an Epoch on the order of 26.6 mS in duration can be partitioned to include time slot #0 and time slot #1 as shown. In this application, a field unit or multiple field units **14** can randomly send messages to base station **20** in either time slot of an Epoch. Providing multiple time slots **210** in which a field unit **20** can transmit a message renders it less likely that two randomly transmitting field units **14** will transmit a message in a same time slot **210**. Depending on an application, a field unit **14** can be synchronized with base station **20** using pilot channel **44** so that messages can be transmitted in a particular time slot **210**.

[**0052**] When a collision occurs, i.e., two field units **14** transmit a message in the same time slot **210**, a device monitoring access channel **51** for such messages may not be able to properly decode or decipher the content of either transmitted message. An indication of this condition is transmitted to field units **14**.

[**0053**] Feedback channel **45** is provided so that base station **20** can send feedback messages **230** to field units **14**. At least a portion of the feedback channel **45** as shown is reserved for transmitting general messages to the collective field units **14** whether or not a message collision occurred on access channel **51** in a previous Epoch and, more particularly, that a message occurred in a particular time slot **210**.

[**0054**] A feedback message **230** is optionally a sequence of encoded information or single bit indicating whether a collision occurred for a message transmitted to base station **20** in a time slot **210**. As shown, multiple feedback messages **230** can be generated during a given time duration such as an Epoch or half Epoch. For example, feedback information such as feedback messages **230** can be transmitted in duration A of Epoch N+1 to indicate that a collision occurred for the reception of a message **210** in time slot #0 of Epoch N at base station **20**. More specifically, a logic 1 transmitted in each of three feedback messages **230** of duration A can indicate that a collision was detected while a logic 0 setting can indicate that no collision was detected.

[**0055**] Transmitting multiple, spaced feedback messages **230** as shown for duration A provides redundancy to some extent. For example, multiple messages **230** transmitted in a given duration, such as duration A, can be part of a redundantly transmitted message to increase the chance that a field unit **14** will be properly notified whether a collision occurs. Hopefully, at least one of the multiple feedback messages **230** can be identified at a field unit **14** even if a message transmission failure occurs for some of the messages **230** in, for example, duration A.

[**0056**] In a similar manner as previously discussed, feedback messages **230** of feedback channel **45** transmitted in duration B of Epoch N+1 can indicate whether a message collision is detected in time slot #1 of Epoch N as monitored by base station **20**.

[**0057**] In a reverse link direction, a message transmitted by a field unit **14** to base station **20** on access channel **51** includes unique information such as the identification number of the field unit **14** transmitting the message. In forward link direction, paging channel **41** supports message transmissions from base station **20** to field units **14**, where the message transmissions are typically directed to a specific field unit **14**. Thus, base station **20** can respond to a field unit **14** that sent a message on access channel **51** by transmitting a reply message to the field unit **14** over paging channel **41**. Other link information forwarded on the paging channel **41** can be forwarded to a field unit **14** to establish a formal bi-directional link between base station **20** and field unit **14**.

[**0058**] One type of message transmitted on paging channel **41** is an ACK (acknowledgment) message **240**. ACK mes-

sages **240** are sent by base station **20** to indicate that a message received in a time slot **210** of access channel **51** was properly received. Similar to the feedback messages **230** on feedback channel **45**, ACK messages transmitted to a field unit **14** are also feedback messages. However, an ACK message **240** indicates that a previous access request message transmitted by a field unit **14** was properly received. ACK message **240** can also indicate that a formal communication link will be established with the access requesting field unit **14**. For instance, traffic channels can be assigned to field unit **14** for transmitting or receiving a data payload.

[**0059**] It should be noted that field units **14** optionally transmit at such a low power output level that messages transmitted in a particular time slot **210** are not detected at base station **20**. In this instance, a field unit **14** can adjust its power output level for a subsequent message transmission based on feedback information received from base station **20**. More specifically, a field unit **14** can adjust its power output level depending on a feedback message **230** or ACK message **240** received on feedback channel **45** or paging channel **41** respectively. Accordingly, the power output level of a field unit **14** can be optimized so that it minimally interferes with other field units **14** transmitting information over a common radio frequency.

[**0060**] Although other message types can be supported, the messages transmitted in a time slot **210** of access channel **51** are typically access request messages indicating that a field unit **14** would like to receive or transmit data payload information on reverse link traffic channels **52** or forward traffic channels **42**.

[**0061**] One aspect of adjusting the power output of a field unit **14** is to determine whether or not a collision was detected for a previous message transmission from the field unit **14** to base station **20**. For example, if a collision is not detected for a previously transmitted message from a particular field unit **14**, the power output level for a subsequent message transmission from the field unit **14**, if any, can be increased so that base station **20** is more likely to detect the message transmission. More specifically, the power output level of a field unit **14** can be increased a predetermined amount such as +0.5 dB for a subsequent message transmission if no collision was detected for a previous message transmission.

[**0062**] In the event that a message transmission by a field unit **14** does result in a collision due to multiple field units **14** transmitting in a same time slot **210**, the power output level of the field unit **14** can be unchanged or potentially reduced for a subsequent message transmission since it is not known whether the message transmission by a field unit **14** would have otherwise been detected at base station **20** if only one field unit **14** transmitted a message within a particular time slot **210**. Hence, one aspect of the present invention involves adjusting the power output level of a field unit **14** so that it minimally interferes with others using the same radio channel.

[**0063**] This method of transmitting messages can be particularly useful when a user first powers a field unit **14** and must communicate with base station **20**. For example, it is undesirable in certain situations to transmit a message at such a high power output level that such message transmissions cause other data transmissions on the radio channel to become corrupted due to excessive noise.

[**0064**] In a similar manner as previously discussed, the power output level of a field unit **14** can be adjusted depending on whether base station **20** acknowledges receipt of a message on access channel **51**. Thus, if field unit **14** does not detect a reply ACK message **240**, the power output level of field unit **14** can be increased for subsequent message transmissions.

[**0065**] A maximum power adjustment level such as 60 dBm can be selected in which the field unit **14** will discontinue transmitting if no ACK message is received even at this level.

[**0066**] A more sophisticated application of the present invention can involve adjusting a power output level of a field unit **14** depending on both a feedback message **230** indicating whether a collision was detected and an ACK message **240** indicating that an access message was acknowledged by base station **20**. More specifically, a field unit **14** can adjust its power output level for subsequent message transmissions if no collision is detected and no ACK message is received for a previously transmitted message from a field unit **14**. Otherwise, the field unit **14** can re-transmit at a previous power output level.

[**0067**] Regardless of which method is used to adjust the power output level, the power level setting at which base station **20** acknowledges receipt of a message from a field unit **14** can be used to determine power level settings at which the field unit **14** must transmit other information to base station **20**. For example, a message from a field unit **14** can be transmitted using a particular modulation rate during the initial message transmission. The power output level of subsequent transmissions from the field unit **14** can be adjusted to accommodate transmitting messages at different modulation rates. For example, it can be determined at what power level a field unit should transmit on allocated traffic channels using a different modulation rate. A history of the power level output adjustments are optionally maintained to track power adjustments and determine at what power level a monitoring device such as base station **20** detects the transmission of a message.

[**0068**] As previously discussed, one aspect of the present invention involves re-transmitting a message from a field unit **14** so that it can be detected at base station **20**. A re-transmission is optionally based on a random back off time so that a collision is less likely to occur on a subsequent attempt to transmit a message.

[**0069**] Consider a situation where two or more field units **14** transmit a message over access channel **51** and a collision is detected at base station **20**. As previously discussed, a feedback message will be transmitted to the field units **14** indicating that a collision occurred. Both field units **14** must then re-transmit their corresponding messages to base station **20**.

[**0070**] To avoid another collision, the field units **14** randomly choose a back off time relative to the previous message transmission in which the collision occurred and transmit in another time slot **210**. For example, if field unit A and field unit B transmit a message in time slot #0 of Epoch N, field unit A will choose a back off time such as 3 Epochs and re-transmit a message to base station **20** in time slot #1 of Epoch N+3 while field unit B re-transmits a message based on a random back off time in time slot #0 of

Epoch N+2. Accordingly, field units A and B are less likely to cause another collision for a message re-transmission.

[0071] **FIG. 3** is a timing diagram illustrating another embodiment of the present invention for transmitting feedback messages to field units **14**. An access channel **51** is partitioned so that a field unit **14** can transmit an access probe or other message in a time slot **345**. As shown, feedback channel **355** is partitioned to include 64 time slots TS#0, TS#1, TS#2 . . . TS#63 that repeat every Epoch.

[0072] Each time slot **315** of feedback channel **355** preferably includes a data field supporting 16 bits of information. In the specific application as shown, ten bits of information are reserved for a general message, one bit is reserved as a collision detect bit **325** and five bits are reserved for CRC (Cyclical Redundancy Check) data **328**.

[0073] General message **320** is optionally a message directed to a particular field unit **14**. For example, each of multiple field units **14** can be assigned use of a particular time slot **315** for receiving feedback information from base station **20** to field units **14**. When assigned, a corresponding field unit **14** monitors an appropriate time slot **315** to receive messages from base station **20**. One type of specific message in a time slot **315** is feedback information to a field unit **14** indicating how its timing or power should be adjusted so that messages transmitted from a field unit **14** are properly received at base station **20**.

[0074] Time slots **315** are optionally unassigned and the message itself can include an address to which field unit **14** a message is directed. Thus, in a modified embodiment, feedback messages can be transmitted asynchronously to a field unit **14**.

[0075] Collision detect bit **325** in a time slot **315** is a single bit indicating whether a collision occurred in a monitored time slot **345**. More specifically, collision detect bits **325** of time slot TS#0, TS#1 . . . TS#31 of Epoch M can be used to indicate that a collision occurred in access probe slot #0 of Epoch M-1. Accordingly, this string of individual collision detect bits **328** over multiple time slots can be set to a same logic state indicating that a collision was detected.

[0076] In a similar manner, TS#32, TS#33 . . . TS#63 of Epoch M can be set appropriately to indicate whether a collision occurred on access probe slot #1 of Epoch M-1. Thus, a monitoring field unit **14** can determine whether a collision occurred at base station **20** based on a single bit, a sequence of multiple bits, or a sequence of spaced bits.

[0077] CRC data **328** is also provided in a feedback message **360**. The CRC data **328** is optionally decoded at the field unit **14** to ensure that a message **360** is properly received at a field unit **14** and, more specifically, that a particular collision detect bit **325** is properly received. Other methods can also be used to ensure and verify that a message and data is properly received at field unit **14**. For example, a message can be transmitted based on an FEC (Forward Error Correction) code.

[0078] **FIG. 4** is a diagram illustrating a format for transmitting messages over the access channel from a field unit to a target receiver according to the principles of the present invention.

[0079] In one application, message **410** is transmitted by a field unit **14** over access channel **51** and includes two parts. As shown, a first part or preamble **415** of message **410** is a coded message indicating a request by the field unit **14** for a communication link. Each field unit **14** can transmit a message **410** having a commonly coded preamble **415**. Thus, if two field units **14** transmit a message including the same preamble message **415**, base station **20** can determine that at least a preamble message **415** was sent by at least one field unit **14**. That is, the preamble message **415** as transmitted by one field unit can overlap with the preamble message **415** as transmitted by another field unit **14** when multiple messages **410** are transmitted in the same time slot.

[0080] Message **410** optionally includes a data payload **420** that is transmitted to base station **20**. In one application, data payload **420** includes the serial number of the field unit **14** transmitting message **410**. Typically, some form of redundancy check information such as CRC data is included with message **410** so that base station **20** can determine whether message **410** is properly received without errors.

[0081] If message **410** is received without errors, base station **20** can respond accordingly to establish a link with a field unit **14** and transmit a "non-collision" message on feedback channel **45** to the field units **14**. Alternatively, if message **410** includes an error free preamble **415** but improperly received data payload information **420**, base station **20** can deduce that two or more transmitters sent a message at the same time. A collision detection message is then transmitted over feedback channel **45** indicating that a collision occurred. Thus, a target receiver such as base station **20** monitoring messages **410** can provide valuable feedback to multiple transmitting field units **14** whether a message collision occurs.

[0082] Another aspect of the present invention involves coding a preamble **415** using pilot block **53** and Barker code block **54**. Based on this coding or use of a sequence of symbols, a field unit **14** can transmit a message **410** to base station **20**.

[0083] As shown, a preamble message **415** can include four pilot blocks **53** and four Barker code blocks **54**. The Barker code blocks **54** assist base station **20** identify a point where preamble **415** of a message **410** starts. In other words, the information in the preamble **415** can be used for timing purposes at the base station **20** to asynchronously receive a message. Thus, it is not necessary that a field unit **14** transmit a message **410** in a time slot **210** because base station **20** can be modified to receive asynchronous messages.

[0084] However, in an application where messages **410** include Barker code blocks **54** that are transmitted in a time slot **210**, base station **20** can identify a received message **410** even if a collision occurs because the preamble **415** of a message **410** simultaneously transmitted by multiple field units **14** in a time slot will overlap and, thus, will be detectable at base station **20**.

[0085] Each pilot block **53** includes a number of repeating pilot symbols. Preferably, a pilot block includes **48** symbols that are used by a target receiver to decode message **410**.

[0086] The second portion of a message **410** can include a data payload **420** that is sent to base station **20**. Preferably, pilot symbols are also inserted in the data payload **420** portion of message **410** for assisting in coherent demodulation of data at a target receiver. Pilot symbols typically

include a series of positive data bits and therefore do not themselves inherently include timing information.

[0087] A Barker code block **54** as shown includes a predetermined pattern of bit information. Use of BPSK (Binary Phase Shift Keying) can be used to generate a positive barker sequence **450**, +B, such as three positive bits, followed by three negative bits, a positive bit, a pair of negative bits, a positive bit and then a negative bit respectively. A Barker code sequence can alternatively be negative such as a negative Barker sequence, −B, further assisting in message processing at a monitoring device.

[0088] Further details for processing message **410** including pilot blocks **53** and Barker code blocks **54** can be found in co-pending U.S. patent application Ser. No. 09/766,875 filed on Jan. 19, 2001 entitled "Access Channel Structure for Wireless Communication System," the entire teachings of which are incorporated herein by reference.

[0089] **FIG. 5** is a flow chart illustrating a process for monitoring a channel for messages according to the principles of the present invention.

[0090] Step **500** generally indicates an entry point into the flow chart. In step **510**, an access channel **51** is monitored for message transmissions such as access request messages transmitted by a field unit **14**. It is then determined in step **520** whether the message includes a Barker code or an appropriately received preamble **415** of a message **410**. If no Barker code or preamble **415** is detected in step **520**, process flow resumes at step **510** again. Alternatively, if a Barker code is detected in step **520**, the message **410** is further analyzed to determine if a collision occurs in a time slot. That is, it is determined whether at least a portion of data in a received message **410** is corrupted.

[0091] One way to determine if a message collision occurs is to verify that data in a message **410** was properly received. This can be achieved by analyzing the received message **410** according to redundancy check information. If the data in a message **410** is not properly received at base station **20**, a feedback message is transmitted by base station **20** over feedback channel **45** indicating that a collision was detected for a previous access request message in step **540**. Following step **540**, process flow resumes again at step **510**.

[0092] If a collision is not detected for a particular message in step **530**, the message **410** is analyzed to determine which of multiple field units **14** sent the message. Following in step **550**, an ACK message **240** is sent to the requesting field unit **14** over the paging channel **41**. Also, a message is sent over the feedback channel **45** indicating that no message collision occurred for the corresponding previous time slot **210** of access channel **51**. Finally, a more formal link is established with the access requesting field unit in step **560**.

[0093] **FIG. 6** is a flow chart illustrating a process flow at a field unit for transmitting a message to a target receiver according to the principles of the present invention. Step **600** generally indicates an entry point into the flow chart.

[0094] In step **620**, the status of field unit **14** is monitored for an input by a user indicating that the field unit **14** desires to establish a communication link with a target receiver such as base station **20**. It is then determined in step **620** whether the input indicates that a field unit **14** desires to establish a communication link. If not, process flow again resumes at step **610**. If so, field unit **14** transmits an access request message on the access channel **51** in step **630**. Thereafter, the feedback channel **45** is monitored by a field unit **14** in step **640** for feedback information such as collision detection messages.

[0095] If a collision is detected for a previous transmission by a field unit **14** in step **650**, process flow continues at step **660** where the power output level is not adjusted for the field unit **14** and a message **410** is subsequently re-transmitted in step **630**.

[0096] If a collision is not detected in step **650** as indicated by a collision feedback message, it is determined in step **670** whether an ACK message **240** is received at the field unit **14** over paging channel **41**. If so, a link is established between the field unit **14** and base station **20** in step **690**. If not, the power output level of the field unit **14** is increased in step **680** and process flow continues at step **630** to re-transmit a message from the field unit **14** to base station **20**.

[0097] **FIG. 7** is a timing diagram illustrating multiple channels on which messages are transmitted among transceivers according to the principles of the present invention.

[0098] As previously discussed, one aspect of the present invention involves setting a field unit **14** to an initial power level so that it minimally interferes with other users during a message transmission. Since power is ramped up based on whether an access message is detected at base station **20**, it is preferable that the initial power level of the field unit is reasonably near a power level at which base station **20** will receive a message at a desired power level. Consequently, a field unit **14** will be able to transmit a message to base station **20** and establish a more formal communication link in less time since a power level output of field unit **14** will need only minimal adjustments so that a message is received at base station **20**.

[0099] One method for initially setting a power output level of a field unit **14** involves transmitting a reference signal **710** on pilot channel **44** from base station **20**. Preferably, the reference signal **710** is transmitted at an appropriate power level so that multiple field units **14** in a wireless airspace monitoring the pilot channel **44** can identify the reference signal **710** and measure a power level at which it is received. In one application, reference signal includes pilot information such as a sequence of pilot symbols, where the pilot symbols are defined by PN (Pseudo Noise) codes. One or multiple pilot correlation filters in field unit **14** is used to detect the pilot symbols.

[0100] Each field unit **14** monitoring the pilot channel **44** typically includes a power detector circuit to measure a power level of the received reference signal **710**. For example, the power detector is used to measure the strongest pilot path of the received reference signal **710**. This measurement is used to estimate a forward path loss between base station **20** and field unit **14**.

[0101] The total received signal power level of the reference signal **710** can be computed based on the sum of the magnitude squared of the I and Q channel. Power measurements are optionally filtered for providing a better estimate of a received power level under fading conditions.

[0102] As shown in **FIG. 7**, messages are transmitted on paging channel **41** from base station **20** to field units **14**. One

such message is message A that includes information indicating a power level at which reference signal **710** is transmitted from base station **20**. This value can be expressed in dBm that already takes into account the gain of the base station antenna. Thus, message A can include effective radiated power level information at which base station **20** transmits reference signal **710**. In harmony with the principles of the present invention, additional messages such as antenna gain information, offset information, correction information and general information can be transmitted to a field unit **14**.

[**0103**] Field unit **14** decodes message A to determine a power level at which reference signal **710** is transmitted. The forward path loss between base station **20** and field unit **14** is then determined by comparing the received power level of the reference signal **710** at field unit **14** with the effective radiated power level as indicated by message A.

[**0104**] The calculated forward path loss can then be used to estimate a reverse path loss between field unit **14** and base station **20**. For example, the reverse path loss is estimated to be about the same as the forward path loss, although it is probably at least slightly different. This estimated path loss is used to determine an initial setpoint at which messages can be transmitted from field unit **14** to base station **20**.

[**0105**] Consider a case where base station **20** transmits a reference signal **710** at an effective radiated power level of 55 dBm. As discussed, this information is sent to field units **14** via message A generally broadcasted on the paging channel **41**. If the received power level of the reference signal **710** is 22 dBm, the forward path loss is calculated as 55−22 dBm, or forward path loss=33 dBm. Based on this path loss, a field unit **14** can estimate a reasonable power output level for a subsequent attempt to transmit a message to base station **20**.

[**0106**] Additional messages can be sent on paging channel **41** from base station **20** to field units **14**. For example, message B is also generally transmitted to field units over paging channel **41**. Message B preferably includes encoded information indicating a desired power level at which base station **20** will receive subsequent messages from a field unit **14**. This information can also be a specific message directed transmitted to a particular field unit **14**. Thus, a field unit **14** can use the information to estimate at what level a message should be transmitted so that a message is received at the desired power level. In a case where message B indicates a desired power level of 12 dBm and the forward path loss is approximately 33 dB as discussed, field unit **14** can attempt to transmit a message at 33+12 dBm, or 45 dBm, to base station **20**.

[**0107**] Notably, the reverse path loss may be much more than 33 dBm as estimated. In such a situation, base station would not necessarily detect a message transmitted by field unit **14**. As previously discussed, however, the power output setpoint of 45 dBm can be a starting point at which messages such as access request messages **750** are transmitted over access channel **51**. If a collision is not detected at base station **20** and no ACK message **240** is received over paging channel **41**, the power output of field unit **14** can be increased by 1 dBm to 46 dBm for a subsequent attempt to transmit a message. This procedure of adjusting the power output level of a field unit **14** can be repeated until a message is detected at base station **20**.

[**0108**] Messages transmitted to base station **20** can also be monitored to determine a power level at which a message is received from a field unit **14**. To achieve this end, a message such as message C can include pilot information such as a pilot symbol or sequence of pilot symbols. Pilot correlation filters are then used to identify the strongest diversity path and side paths as shown in **FIG. 8**. One or multiple paths are then used to determine a power level at which the message is received at base station **20** on access channel **51**. To ensure that a message C is properly received, the message is analyzed for errors using error detection information such as CRC check bits. These and other aspects of invention were previously discussed in this specification.

[**0109**] After message C is properly received at base station **20**, a power adjustment message is generated at base station **20** to indicate how the field unit **14** should be adjusted so that subsequent messages to base station **20** are received at a desired power level. For example, if base station **20** determines that a message is received at 23 dBm, base station **20** can send a message over paging channel **41** indicating that the field unit should reduce its power output level for subsequent message transmissions so that a message from a field unit is received at a lower power level such as 12 dBm.

[**0110**] **FIG. 8** is a graph illustrating a received diversity string for a pilot symbol according to the principles of the present invention. A received message such as reference signal **710**, message A, message B or message C can include a marker such as one or multiple pilot symbols that are monitored at a receiver to determine a power level of a received message.

[**0111**] Both base station **20** and field units **14** include pilot correlation filters for identifying a marker such as one or multiple pilot symbols in a transmitted message. This marker aids in analyzing both timing alignment and a received power level of a message. Incidentally, the diversity string illustrates the receipt of a marker in a message as a result of multipath fading. That is, a signal from a transmitter is received at a target at different times due to varying times it takes for the signal to reach the target over different paths between a transmitter and receiver.

[**0112**] Preferably, the strongest received diversity path will be designated as the time alignment string at base station **20** field unit **14** for analyzing the timing of a received message. Likewise, the single strongest path is preferably chosen to calculate a power level at which a message is received. However, additional paths are optionally used to determine a received power level of a message.

[**0113**] Timing alignment and a received power level of a message is determined using the correlation profile of the strongest pilot in a particular string, which is analyzed as mentioned using correlation filters. The output of the correlation filters typically consist of 256 samples, which represent 64 lags at 4 samples per lag. The 256 sample output-window represents the total correlation time span of a receiver device. This can vary depending on the application. Preferably, the time alignment point is sample number **80** which allows 20 lags for precursor and 44 lags for post cursor channel information.

[**0114**] Generally, the computation of the time alignment error is based on a determination of where the centroid or

peak lies in a given sample string. For example, each field unit **14** transmitting in a time slot includes a marker, i.e., the peak signal, located at a predetermined position within a time slot. The strongest pilot path for the channel and 2 samples on either side of the main path, i.e., 1 and ¼ chips, is statistically analyzed to determine the centroid or peak of a marker within a time slot. Location of the centroid, L, of the samples in **FIG. 6** is calculated based on the following equation:

$$L = \frac{\sum [t \times Q(t)]}{\sum Q(t)}$$

[**0115**] where t=sample time and Q(t) is the magnitude of a sample at a given time.

[**0116**] For example, L is calculated based on the results as shown in **FIG. 6**:

$$L = \frac{(.25*76) + (.5*77) + (1.0*78) + (.8*79) + (.6*80)}{.25 + .5 + 1.0 + .8 + .6}$$

[**0117**] L=78.317

[**0118**] Again, the timing alignment error is determined by comparing the timing of the computed centroid to the desired time set point of **80**, which is chosen as the reference point for timing alignment within a time slot. Since the centroid in the example above is estimated to be 78.317, timing is early relative to the set point of **80**. An appropriate message can be sent to field unit **14** indicating how its timing should be finely tuned so that messages from field unit **14** are received at the appropriate time at base station **20**.

[**0119**] In a similar manner, the diversity string of **FIG. 8** can be analyzed to determine a power level at which a message is received. Thus, an appropriate message can be sent to field unit **14** indicating how its power output level should be adjusted so that a message is received at a desired power level.

[**0120**] As mentioned, this technique can be used to detect a received power level of reference signal **710** at base station **20**.

[**0121**] More details regarding timing alignment and power control between a base station **20** and each of multiple field units **14** can be found in co-pending U.S. Application No. (2479.1067-001) entitled "Minimal Maintenance Link to Support Synchronization" filed on Feb. 7, 2001, and co-pending U.S. application Ser. No. 09/775,305 entitled "Maintenance Link Using Active/Standby Request Channels" filed on Feb. 1, 2001, the entire teachings of both of which are incorporated herein by reference.

[**0122**] **FIG. 9** is a flow chart illustrating a method for setting a power level output of a field unit based on an estimated path loss according to the principles of the present invention.

[**0123**] Step **900** indicates an entry point into the flow chart. Following in step **910**, field unit **14** monitors pilot channel **44** for reference signals **710**. As previously discussed, the field unit determines a power level at which reference signals **710** are received using a power detector circuit and pilot correlation filters.

[**0124**] In step **920**, paging channel **41** is monitored by a field unit **14** for messages transmitted from base station **20**. As previously discussed, message A is received on paging channel **41** and decoded to determine an effective radiated power level at which reference signals **710** are being transmitted from base station **20**.

[**0125**] Based on the detected power level of reference signal **710** as received at field unit **14** and corresponding effective radiated power level at which the reference signal **710** is transmitted from base station **20**, a path loss is estimated between the base station and field unit **14** in step **930**. Preferably, the path loss is estimated by computing the difference between the power level at which reference signal **710** is transmitted from base station **20** and a power level at which reference signal **710** is received at field unit **14**.

[**0126**] Message B is subsequently received at field unit **14** in step **940**. This message preferably includes information indicating a desired power level at which messages are to be received at base station **20**.

[**0127**] Based on the desired power level at which messages are to be received at base station **20** and the estimated path loss in step **930**, field unit **14** determines a power output setting for field unit **14** so that a message is received at the desired power level at base station **20** in step **950**. More specifically, it is presumed that an actual path loss from the field unit **14** to base station is approximately the same as the calculated path loss between the base station and field unit **14** based on measurements of reference signal **710**. Thus, an appropriate power output level of field unit **14** can be determined by adding the estimated path loss to the desired power level setting to determine a power output setting for field unit **14**. Consequently, this power output setting of a field unit **14** should be a reasonable starting point for attempting to transmit an initial message to base station **20**.

[**0128**] Also in step **950**, field unit **14** transmits message C such as an access request message to base station **20** over access channel **51**. Upon receipt, base station **20** measures a received power level of message C at base station **20**. This received power level is then compared to the desired power level so that feedback can be provided to field unit **14** indicating how to adjust its power output level so that subsequent messages are received at the desired power level.

[**0129**] Following in step **960**, field unit **14** monitors paging channel **41** for an ACK message indicating that base station **20** properly received message C. If an ACK is not received in step **970**, the power output level of a field unit **14** is increased in step **975** and the message is subsequently re-transmitted in step **960**. This loop of increasing power generally repeats until base station **20** acknowledges receipt of the message.

[**0130**] When an ACK is received in step **970**, process flow continues at step **980** in which additional messages are received from base station **20** indicating whether the message transmitted in step **950** was received at the desired power level. As discussed, information can be transmitted to a field unit **14** indicating how to adjust its power output level so that subsequent messages are received at the desired power level at base station **20**. Consequently, the output

power level of the field unit **14** is adjusted accordingly for subsequent message transmissions.

[**0131**] While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

What is claimed is:

1. A method for supporting wireless communications, the method comprising the steps of:

transmitting a first message from a first transceiver, the first message including effective radiated power level information at which the first transceiver transmits a reference signal; and

measuring a received power level of the reference signal received at a second transceiver;

decoding the first message at the second transceiver to determine the effective radiated power level information; and

estimating a path loss between the first and second transceivers by comparing the received power level and the effective radiated power level information.

2. A method in claim 1 further comprising the step of:

transmitting a second message from the first transceiver to the second transceiver indicating a desired power level at which subsequent messages shall be received at the first transceiver.

3. A method in claim 2 further comprising the step of:

transmitting a reply message from the second transceiver to the first transceiver at a power level so that the first transceiver receives the reply message at the desired power level.

4. A method as in claim 2 further comprising the step of:

determining a power output setting at the second transceiver based on an estimated path loss so that a message is received at the first transceiver at the desired power level.

5. A method as in claim 1, wherein the first message is transmitted over a paging channel of a CDMA (Code Division Multiple Access) communication system.

6. A method as in claim 3, wherein the reply message is transmitted over an access channel of a CDMA communication system.

7. A method as in claim 1, wherein the second transceiver transmits an access request message to the first transceiver in a time slot of an allocated reverse channel.

8. A method as in claim 7, wherein the access request message from the second transceiver to the first transceiver includes encoded information for measuring timing alignment of the second transceiver.

9. A method as in claim 1, wherein the second transceiver sends a reply message to the first transceiver, the reply message including a reference marker that is monitored for timing alignment.

10. A method as in claim 1, wherein the first transceiver transmits the first message over a dedicated channel to multiple transceivers.

11. A method as in claim 1 further comprising the step of:

measuring a power level at which a reply message transmitted from the second transceiver is received at the first transceiver.

12. A method in claim 11 further comprising the steps of:

comparing a power level at which the reply message is received at the first transceiver with a desired power level at which messages should be received; and

transmitting a power adjustment message to the second transceiver for subsequent message transmissions.

13. A method as in claim 1, wherein the reference signal includes pilot symbols.

14. A method as in claim 1, wherein the reference signal is transmitted over a pilot channel.

15. A method as in claim 1, wherein a path loss is calculated based on the difference between an effective radiated power level of the reference signal and power level of one or multiple received reference signals.

* * * * *