SMART ANTENNA SYSTEM AND METHOD

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates generally to the field of wireless communications systems and, more specifically, to a smart antenna system and method.

BACKGROUND OF THE INVENTION

[0002] The rising use of mobile communications systems has led to an increasing demand for enhancing efficiency and performance characteristics, such as increasing network capacity, data rate, signal quality, network coverage, and power efficiency. When a wireless signal is transmitted to a receiver, such as an antenna, the receiver often receives interference along with the signal, making it difficult for the receiver to determine the original signal. This interference may include interference caused by the multipath phenomenon and/or co-channel interference caused by other signals or random noise in the same frequency as the original signal. Smart antenna (SA) systems are designed to reduce these types of interferences, and thus enhance the performance characteristics discussed above.

[0003] A smart antenna system is generally located near a base station transceiver and combines an array of antenna elements with digital signal processing capabilities to receive and transmit signals in a spatially sensitive manner. In other words, a smart antenna can adapt the direction of transmissions in response to the signals it receives. Thus, a smart antenna system may be said to track, or follow, mobile communication devices (such as mobile phones or personal digital assistants) as they change their location or active status (such as idle, ready, or standby). For example, when a mobile user is located in a particular location within a sector, the smart antenna system may select a best beam that provides the best coverage for that location and transmit signals to and receive signals from the mobile through that best beam. As the user moves to new locations, the smart antenna system may adapt by switching to the beam or beams that provide the best coverage for those locations.

SUMMARY OF THE INVENTION

[0004] In accordance with the present invention, a method and apparatus for beam selection in a smart antenna apparatus are provided that substantially eliminate or reduce the disadvantages and problems associated with previously developed methods and apparatuses.

[0005] In one embodiment of the present invention, a smart antenna apparatus including a receiving system, one or more beam analysis modules, a control channel monitoring module, a processing system, and a receiving beam switch is provided. The receiving system is operable to receive a plurality of uplink beams, each including traffic signals transmitted by a mobile station. The beam analysis modules are operable to analyze the uplink beams to determine one or more characteristics of each uplink beam. The control channel monitoring module is operable to monitor control channel signals being communicated from a base station transceiver. The control channel signals may include synchronization signals. The processing system is operable to synchronize the smart antenna apparatus with the base station transceiver using the synchronization signals received by the control channel monitoring module. The processing system is further operable to determine a selected beam from the plurality of uplink beams based at least in part on the one or more characteristics determined by the beam analysis modules. The receiving beam switch is operable to switch to the selected beam to allow the selected beam to be communicated to the base station transceiver.

[0006] In another embodiment, a smart antenna method is provided. The method includes receiving a plurality of uplink beams, each including traffic signals transmitted by a mobile station. The method further includes analyzing each of the uplink beams to determine one or more characteristics of each uplink beam. The method further includes monitoring control channel signals communicated from a base station transceiver. The control channel signals may include synchronization signals. The method further includes synchronizing the smart antenna apparatus with the base station transceiver using the synchronization signals. The method further includes determining a selected beam from the plurality of uplink beams based at least in part on the determined characteristics of each uplink beam. The method further includes allowing the selected beam to be communicated to the base station transceiver.

[0007] Various embodiments of the present invention may benefit from numerous technical advantages. It should be noted that one or more embodiments may benefit from all, some, or none of the advantages discussed below.

[0008] One technical advantage includes a smart antenna apparatus that may be coupled to a new or existing base station transceiver as an add-on or applique without having to modify, alter, or reconfigure the base station transceiver or any other component of the base station system, such as base station controllers. Thus, the cost and labor of modifying or altering base station system and/or dealing or negotiating with the manufacturer of the components of base station system, such as base station transceivers and base station controllers, is reduced or eliminated. Moreover, the smart antenna apparatus may be compatible with base station transceivers produced by a variety of manufacturers. For example, the smart antenna apparatus may be compatible with all base station transceivers using standard base station transceiver interfaces. Thus, the installation costs of the smart antenna apparatus are reduced as compared with traditional smart antenna systems. Moreover, the operating costs of the smart antenna apparatus are reduced as compared with traditional smart antenna systems.

[0009] In addition, the presence and operation of the smart antenna apparatus may be transparent to the base station system, including the base station transceiver. In other words, the smart antenna apparatus causes little or no delay in the reception and transmission of radio signals to and from the base station transceiver. Thus, the smart antenna apparatus may operate without affecting the timing of the cellular network or any mobile stations.

[0010] In addition, the beam selection systems and methods provided by smart antenna apparatus provide a number of advantages. For example, smart antenna apparatus may reduce the interference, such as multi-path and co-channel interference, associated with uplink signals received by a new or existing base station transceiver. In addition, the smart antenna apparatus may reduce the interference associated with downlink signals received by mobile stations. Thus, the smart antenna apparatus may increase the effective