[0039] Generally, a smart antenna system is provided as an add-on to an existing base station in a wireless communications system. The smart antenna system combines an antenna unit that may include a smart antenna array and optionally a backup sector antenna with a smart antenna apparatus having signal processing capabilities to receive and transmit signals in a spatially sensitive manner, or in other words, along one or more selected beams. The smart antenna apparatus is operable to execute one or more algorithms, based on a number of inputs, to select an uplink beam for uplink signals and a downlink beam for downlink signals. The uplink beam is used to communicate uplink signals received from a mobile station to a base station transceiver. The downlink beam is used to communicate downlink signals from the base station transceiver to the mobile station.

[0040] The smart antenna apparatus may include a fast decision beam selection module to make beam selections in substantially real time and a smart decision beam selection module to make beam selections based on more input and processing. The smart antenna apparatus may be operable to determine whether to use the results from the fast decision beam selection module or the smart decision beam selection module depending on the particular circumstances. In general, the smart antenna apparatus may use the fast decision beam selection module to make beam selections during the initiation of a call from a mobile station and then switch to the smart beam selection module after the call is established.

[0041] The smart antenna system may collect and use signaling information for making beam selection determinations generally as follows. The base station transceiver and the base station controller communicate signaling and traffic information with each other via an interface, such as an A-bis interface in a GSM or GPRS environment or an LUB interface in a 3G environment. The smart antenna apparatus includes a monitoring system coupled to the signaling interface and operable to receive signaling information being communicated between the base station transceiver and the base station controller without affecting, or disturbing, the communication of the signaling or traffic information between base station transceiver and the base station controller. The signaling information received by the monitoring system may then be decoded, filtered and/or otherwise processed to determine relevant signaling information for the smart antenna apparatus. The relevant signaling information may be used by a smart antenna processing system in selecting uplink and/or downlink beams.

[0042] In addition, the smart antenna apparatus may also be operable to synchronize itself with the base station transceiver in time and frequency using control channel signals being communicated from the base station transceiver to one or more mobile stations. The smart antenna apparatus may include a control channel monitoring module operable to convert control channel signals received from the base station transceiver in a downlink frequency to a frequency that may be received by a smart antenna receiver. A processing module may execute one or more synchronization algorithms using the control channel signals as input in order to synchronize the smart antenna apparatus with the base station system in time and frequency.

[0043] The smart antenna apparatus may be coupled to the existing base station as an applique with little or no modification needed to be made to any component of the base station, including the base station transceiver. In particular, the signaling information monitoring system is operable to passively monitor the signaling information being communicated between the base station controller and the base station transceiver without making any modifications to the base station controller or the base station transceiver. In addition, the control channel monitoring module is operable to passively monitor the control channel information being communicated from the base station transceiver to the mobile stations without making any modifications to the base station transceiver. Thus, the smart antenna apparatus may be easily and inexpensively coupled to a variety of existing base stations.

[0044] FIG. **1** illustrates an embodiment of a wireless communication system **10** that includes a base station system **12**, a smart antenna system **14**, and one or more mobile stations **15**. In one embodiment, wireless communication system **10** operates in a GSM (Global System for Mobile Communications) environment. However, wireless communication system **10** may operate according to other wireless standards including, for example, CDMA (Code Division Multiple Access) standards such as IS-95A and IS-95B, CDMA 2000, W-CDMA, TD SCDMA, TETRA, and TDMA (Time Division Multiple Access) standards such as IS-136 and IS-54, without departing from the scope of the present invention.

[0045] Base station system **12** may include one or more base station transceivers **24**, a base station controller **26**, and any other suitable components of a wireless communications base station. Smart antenna system **14** may include an antenna unit **18** and a smart antenna apparatus **16**. Smart antenna apparatus **16** may be coupled to base station system **12** as an add-on or an applique.

[0046] Base station transceiver **24** is generally operable to communicate radio signals to and from antenna unit **18** via one or more radio signal wires **40** and **42**. In this manner, base station transceiver **24** is operable to transmit radio signals to and receive radio signals from one or more mobile stations **15** via antenna unit **18**. Base station controller **26** is generally operable to control the operation of one or more base station transceivers **24**.

[0047] Base station controller **26** and base station transceiver **24** may be coupled by an interface **36**. Interface **36** may be operable to communicate signals, including traffic and control (or signaling) information, between base station controller **26** and base station transceiver **24**, as described in greater detail with reference to FIG. **9**.

[0048] In a GSM (Global System for Mobile Communications) environment, base station system **12** may be a Base Station System (BSS), base station transceiver **24** may be a Base Transceiver Station (BTS) and base station controller **26** may be a Base Station Controller (BSC). In a third-generation (3G) environment (such as W-CDMA or CDMA 2000, for example), base station system **12** may be a Radio Network Server ENS), base station transceiver **24** may be a Node B base station, and base station controller **26** may be a Radio Network Controller (RNC). Base station system **12**, base station transceiver **24**, and base station controller **26** may alternatively be any other suitable base station components in other wireless communication environments or under different communication standards.