Smart Antennas Anticipated for Cellular Mobile Communication

N. Sasikiran[1], M. Sudhakar Reddy[2], SP. Naredra Reddy[3]

[1, 2, 3]Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya, Kanchipuram, Tamil Nadu, India

Abstract: ***The adoption of smart / adaptive antenna methods in future wireless systems is predictable to have a significant of influence on the effective use of the range, the minimization of the cost of creating new wireless networks, the optimization of capability quality and realization of transparent operation across multi technology wireless networks. SAs can place nulls in the direction of interferers via adaptive updating of weights linked to each antenna element. SAs thus cancel out most of the cochannel meddling resulting in better quality of reception and lower dropped calls. This paper explains the architecture, growth and how the smart adaptive antenna differs from the basic arrangement of antenna. The paper additional explains about the radiation pattern of the antenna and why it is highly preferred in its relative field. The abilities of smart adaptive antenna are easily employable to Cognitive Radio and OFDMA system.***

Keywords: Smart / Adaptive Antenna, Wireless networks, Radiation pattern, Cognitive Radio, OFDMA system.

1. Introduction

In exclusive view of explosive growth in the number of digital cellular subscribers, service providers are becoming increasingly anxious with the limited capacities of their existing networks. This concern has led to the deployment of smart antenna systems throughout major metropolitan cellular arcades. These smart antenna systems have typically active multibeam technologies, which have been shown, through widespread analysis, simulation, and experimentation, to provide the considerable performance improvements in FDMA, TDMA and CDMA networks. Multibeam architectures for FDMA and TDMA systems provide the straight-forward ability of the smart antenna to be implemented as a non-invasive add-on or appliqué to an current cell site, without major modifications or special interfaces This paper mainly concentrates on use of smart antennas in mobile communications that enhances the capabilities of the mobile and cellular system such as earlier bit rate, multi use interference, space division multiplexing (SDMA), adaptive SDMA, growth in range, multipath justification, reduction of errors due to multipath disappearing, best aptness of multi-carrier modulations such as OFDMA. The best application of SAs is its suitability for demand based frequency allocation in hierarchical system approach (flexible antenna pattern are achieved electronically and no physical movement of receiving antennas is necessary). The advantage ofSAs application in the cellular systems are decreased inter symbol interference, decreased co-channel interference and the adjacent channel with interference, improved bit error rate (due to decreased amount of multipath and ISI),increase in receiver compassion, reduction in power consumption & RF pollution. Smart antennas are most appropriate for use of cognitive radio (software radio technology provides flexibility) and the greatest advantage of smart antenna is a very high safety. The main impairments to high-performance wireless communications are interference from other users (co channel interference), the inter-symbol interference (ISI) and signal declining caused by multipath Co-channel meddling limits the system capacity, distinct as the number of users which can be repaired by the system.

2. SMART Antennas

A. Smart

The concept of using multiple antennas and advanced signal processing to serve cells more intelligently has existed for numerous years. In detail, varying degrees of relatively costly smart antenna systems have already been applied in defense systems. Till current years, cost fences have prevented their use in commercial systems. The arrival of powerful low-cost digital signal processors (DSPs), general-purpose processors (and ASICs), as well as innovative software-based signal-processing techniques (algorithms) have made intelligent antennas practical for cellular communications systems.

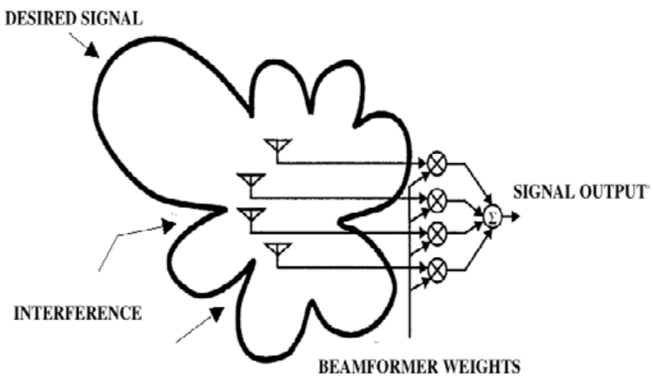

Figure 1: Smart Antenna

3. The Goals of a Smart Antenna System

The dual purpose of a smart antenna system is to expand the signal quality of the radio-based system through more focused transmission of radio signals while enhancing capacity through increased frequency reuse.

Feature Benefit

- Signal Gain—Inputs from multiple antennas are combined to optimize available power required to establish given level of coverage.

- Interference Rejection—Antenna pattern can be generated toward cochannel meddling sources, improving the signal-to-interference ratio of the received signals.
- Spatial Diversity—Composite information from the array is used to minimize fading and other undesirable effects of multipath propagation.
- SDMA- SDMA continually adapts to the radio environment through intelligent / smart antenna.
- Power Efficiency—chains the inputs to multiple elements to optimize available processing gain in the downlink (toward the user)
- Better Range / Coverage—Focusing the energy sent out into the cell increases base station range and attention. Lower power supplies also enable a greater battery life and smaller/lighter handset size.
- Increased Capacity—Precise control of signal nulls quality and mitigation of interference combine to frequency reuse reduce distance (or group size), refining capacity. Certain adaptive technologies (such as space division multiple access) support the reuse of frequencies within the same cell.
- Multipath Rejection—can reduce the effective delay spread of the channel, permitting higher bit rates to be supported without the use of an equalizer, improved bit error rate (due to decreased amount of multipath and ISI). Providing each user with uplink and downlink signals of the highest possible quality and can adapt the frequency allocation to where the most users are located.
- Reduced Expense—Lower amplifier costs, power feeding, and higher dependability will result. Lower power consumption reduces not only interferences but also reduces RF pollution (ease health hazard).It will also result in the full reduction of scares energy resource (diesel consumption) and save foreign currency.

4. Smart Antenna Systems

A. Smart Antenna Systems Work

Traditional switched beam and adaptive array systems enable a base station to customize the beams they generate for each distant user effectively by means of internal response control. Generally speaking, each method forms a main lobe toward individual users and attempts to reject interference or noise from outside of the main lobe.

B. Switched Beam Systems

In terms of radiation patterns, switched beam is an allowance of the current microcellular or cellular sectorization method of intense a typical cell. The substituted beam approach further divides macro-sectors into several micro sectors as a means of improving range and size. Each micro-sector contains a prearranged fixed beam pattern with the greatest sensitivity located in the center of the beam and less sensitivity elsewhere. The design of such systems includes high-gain, narrow azimuthally beam width antenna elements .Smart antenna systems communicate with the directionally by forming specific antenna beam designs. When a smart antenna leads its main lobe with enhanced gain in the way of the user, it naturally forms side lobes and nulls or areas of medium and minimal gain respectively in directions away from the main lobe.

C. Adaptive Antenna Approach

The adaptive antenna systems approach communication between a user and base station in a dissimilar way, in result adding a measurement of space. By altering to an RF environment as it changes (or the spatial origin of signals), adaptive antenna technology can vigorously change the signal patterns to near infinity to optimize the performance of the wireless system.

5. Comparative Benefits / Tradeoffs of Switched Beam and Adaptive Array Systems

A. Integration

Switched beam systems are conventionally designed to retrofit widely organized cellular systems. It has been commonly applied as an add-on or appliqué technology that intelligently addresses the needs of established networks.

B. Range / Coverage

Switched beam systems can rise base station range from 20 to 200 percent over straight sectored cells, depending on environmental conditions and the hardware/software used. The additional reporting can save an operator substantial infrastructure costs and means lower prices for clients. Also, the active swapping from beam to beam conserves capacity because the system does not send all signals in all directions. In assessment, adaptive array systems can cover a wider, more unchanging area with the same power levels as a switched beam system.

C. Interference Suppression

Switched beam antennas overwhelm interference arriving from directions away from the active beam's focus. Because beam designs are secure, however, actual meddling rejection is often the gain of the selected communication beam pattern in the interferer's direction. Also, they are normally used only for greeting because of the system's unclear perception of the location of the received signal (the consequences of transmitting in the wrong beam being obvious). Also, because their beams are prearranged, sensitivity can irregularly vary as the user moves through the sector. Adaptive array technology presently offers more complete interference refusal. Also, because it conveys a countless, moderately than finite, number of combinations, its finer focus creates less interference to adjacent users than a switched-beam approach.

D. Spatial Division Multiple Access (SDMA)

Among the classiest utilizations of smart antenna technology is SDMA, which employs advanced processing methods to, in result, locate and track fixed or mobile terminals, adaptively direction-finding transmission signals toward users and away from interferers. This adaptive of array technology accomplishes superior levels of interference destruction, making possible more effectual reuse of frequencies than the standard fixed hexagonal reuse patterns. In spirit, the arrangement can adjust the frequency allocations to where the most users are located.

E. Spatial Structure Methods

The spatial structure is used to approximation the direction of arrivals (DOAs) of the signals imposing on the sensor array. The measured directions of arrivals are then used to determine the weights in the pattern starting network. This is called beam forming. Spatial structure methods only deed spatial structure and training signals and the time-based structure of the signals is unnoticed.

F. Adaptive Antennas

Adaptive antennas (AAs) are an array of antennas, which is able to modify its antenna pattern dynamically to adjust to noise, interference and multipath. AAs are used to improve received signals and may also be used to form beams for transmission. AAs, unlike conventional antennas, restrict the broadcast energy to a narrow beam. It improves the way that signals are distributed through space on a real time basis by directing the signal to the desired user and "steering" it away from other users occupying the same channel in the same cell and adjacent or distant cell.

6. Conclusion

In conclusion to this paper “Smart Antenna” systems are the antennas with intellect and the radiation pattern can be diverse without being mechanically changed. With suitable adaptive algorithms such as Recursive Least Square Algorithm (RLS) the beam forming can be found. As the system uses a DSP processor the signals can be processed digitally and the performance with a high data rate transmission and good decrease of mutual signal interference. The narrow beams get free of interference, allowing many users to be connected with most users are located. With the adaptive beam forming, spectral effectiveness of the cell could be multiplied at least ten times. Smart antennas efficiently reduce the power consumption which in turn avoids RF pollution, minimize health hazard and save rare resource (diesel & foreign exchange). Certainly it has been claimed that performance requirement of a future cellular communication system cannot be made without the use of smart antennas.

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