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Smart Antenna Considerations for Wireless Communication Systems

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Outline

- Technology Trends
- Network Operators
- Base Station Manufacturers
- Opportunities and Applications
- The Key of Standardization

Conventional Antennas

- **Diversity Schemes**
  - Spatial - horizontal, vertical
  - Polarization - ±45°, 0°/90°
- **Packaging**
  - Lighter, lower profile antennas
  - Two diversity paths in one antenna (dual-polarization)
  - Multiple sectors in same package (three-sector package)
  - Integration with RF front end in future micro/pico cells
- **Performance**
  - High efficiency
  - Low IMD generation
- **Reliability**
  - Designs with less mechanical assembly, higher reliability
  - 10 year lifetimes
- **Cost**
  - Continuing reduction in antenna costs while improving quality, reliability, and performance

Switched-Beam Smart Antennas

- **Current Status of Systems on the Market**
  - **Dynamic operation for FDMA and TDMA**
  - **Static operation for CDMA (can be used for load balancing)**
  - **Receive-only or transmit/receive systems available**
- **Work in Progress / Future Systems**
  - **More robust algorithms for beam selection**
- **Available Products**
  - **Appliqués, but no complete system including base station and network backhaul**

Adaptive-Beam Smart Antennas

- **Current Status of Systems on the Market**
  - **Dynamic operation for FDMA and TDMA**
  - **Fully adaptive product for CDMA systems not available**
  - **Receive-only or transmit/receive systems available**
- **Work in Progress / Future Systems**
  - **Space-time processing algorithms**
  - **Multiple diversity schemes, angle of arrival determination and delay spread issues**
  - **Evaluation of transmission performance based on received-signal measurements for FDD systems**
  - **Techniques for better estimation of the downlink channel using feedback from the mobile**

Network Operators - What Do We Want?

- **Integrated Hardware Solution**
  - Smart radio access technology integrated with base station and network
  - No modifications to existing network infrastructure by operator
- **Desired Antenna Tower Configuration**
  - Fewer, smaller, lighter, less obtrusive antennas
  - Configurations allowing easier zoning approval
- **Complete Network Solution**
  - No need to re-engineer older existing networks
  - New smart access technology which is more spectrally efficient than current schemes
- **Integrated Cost**
  - Capital cost of base station with smart access technology lower than re-engineering older existing networks
  - Engineering, operations and maintenance costs unaffected

What Do Smart Antenna Vendors Offer Network Operators?

Hardware

- with existing base station and network equipment
- Requires custom interfaces with different base stations
- Base station manufacturer may void warranty of BTS
- Need to change current antenna configuration
- More antennas, larger antennas - more cables, heavier tower loading

- **Integration with Network**
  - Requires re-engineering by network operator to integrate product into existing network
  - Requires modifications to live, functioning network
- **Smart Antenna Costs**
  - Significantly higher cost per base station to increase capacity of existing cell site
  - Increased engineering, opera- and maintenance costs

What Do Network Operators Currently Buy?

- **Antennas Purchased by Network Operators**
  - **Conventional antennas for almost all of network**
  - **Very few after-market smart antenna products**
  - **Standardized antennas for entire network**
  - **Millions of dollars spent on conventional antennas during multi-market buildout**
- **Types of Conventional Antennas Purchased**
  - **Sectorized panel antennas**
  - **60° to 120° azimuthal beamwidths**
  - **16-23 dBi gain, high efficiency**
  - **Low IMD**
  - **High quality and reliability**
  - **Conformal profile, multiple antennas under single radome**
  - **Alternate diversity schemes - vertical, dual polarization, etc.**

Base Station Manufacturers - What Do They Build?

- **Complete Wireless Networks**
  - Radio base station products integrated with network backhaul
- **Types of Products**
  - Standardized products (e.g. IS-136, IS-95, IS-41)
  - Products for large-scale deployments both in the US and abroad
  - Niche products without a standard not productized
- **Benefits of Integrated Smart Radio Access Technologies**
  - Allows manufacturer to build a base station with better spectral efficiency for higher data rate services
  - Allows manufacturer to provide a network with greater capacity per base station than competitors
  - Allows manufacturer to be more competitive and win contracts for the next upgrade of wireless infrastructure

What Do Smart Antenna Vendors Offer Base Station Manufacturers?

- **Smart Radio Access Techniques**
  - Many smart radio access technologies already developed
  - Smart access schemes allow greater capacity and more robust wireless links
  - Smart access schemes allow better spectral efficiency, particularly important for higher data-rate services
- **Fast-Track Development**
  - Small companies typically have shorter development cycles and more focus on specific access techniques
- **Perfect Partnership**
  - Smart radio access companies can develop technology, partner with or license to base station manufacturer
  - Base station manufacturer can productize, manufacture, and distribute the end product

Who Will Base Station Manufacturers Look To For Smart Radio Access?

- **Type of System Desired**
  - Smart access systems for new third-generation and wireless local loop systems
  - Smart access technique that either has been standardized or is most likely to become standardized
  - Smart access scheme that can be designed into base station and network
- **Type of Smart Radio Access Company**
  - Company with widely accepted technology and approach for smart access systems, and the patents to protect their intellectual prop.
  - Company willing to work with base station manufacturer to standardize smart access tech.
- **BTS Manufacturer**
  - One who realizes value in what the smart access company has developed and will standardize

Third-Generation System Applications

- **Opportunity**
  - **One of the most immediate opportunities for wide-scale deployment of smart radio access technologies**
- **Benefits of Smart Access Technology**
  - **High spectral efficiency required for high data rates, or for larger number of users**
  - **Interference mitigation required for multirate radio access systems**

Wireless Local Loop Applications

- **Opportunity**
  - Second largest opportunity for wide-scale deployment of smart radio access technologies
  - Fixed wireless users can utilize smart access technologies on both ends of the link for added benefit, not just at the cell site
  - WLL base site or hub may tolerate larger infrastructure with more or larger antennas as long as it is cost effective
- **Benefits of Smart Access Technology**
  - Could provide high data rates (capacity) required for fixed wireless users at a price the market can tolerate
  - Can take advantage of fixed wireless access vs. mobile users
  - Alternative for providing high-data rate fixed services to the home

The Complete Solution

- **Not An Antenna Product**
  - Smart radio access technology integrated with base station
  - Entire network solution, including base station, controller and switch
- **Path to the Complete Solution**
  - Partnerships between smart radio access technologists and radio equipment / switch manufacturers

- **Contributions by Sides**
  - Smart radio access technologists bring the expertise in spectral utilization to the table
  - Base station manufacturers bring productization, volume manufacturing, and global distribution to the table
  - Antenna manufacturers will likely still provide antennas as a separate product

Standardization Is The Key

- **Cooperation Required**
  - **Private industry and standards bodies must standardize the smart access technologies that will be used**
  - **Standards-setting bodies will adopt accepted, standardized technologies if lobbied by the smart antenna technologists and equipment manufacturers**
  - **Association composed of both smart access technologists and base station manufacturers should be established to promote standardized smart access technologies for third-generation systems and WLL**
- **Reality**
  - **Smart antenna vendors know the technical issues and should provide smart access scheme that can be standardized**
  - **Base station manufacturers will come to company with standardized scheme, and will ultimately decide what smart radio access technology will be accepted due to their ability to sell operators complete wireless network solutions**