White Paper

SMART ANTENNA

FOR

WIMAX BASE STATIONS

By
David Shani
VP of International Marketing & Sales
MTI Wireless Edge Ltd.

Table of contents

11 Hamelacha St. Afek Industrial Park. Rosh Ha'ayin 48091,Israel.
Tel : 972-3-9008900. Fax : 972-3-9008901
http://www.mtiwe.com/

Introduction

The concept of using multiple antenna elements and innovative signal processing to serve wireless communications systems more intelligently has existed for many years. In fact, varying degrees of relatively costly smart antenna systems have already been applied in defense systems. Until recent years, cost barriers have prevented their use in commercial systems. The advent 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 antenna systems practical for deployment in wireless telecommunications systems.

Today, when spectrally efficient solutions are increasingly a business imperative, these systems are providing greater coverage area, higher rejection of interference, and substantial capacity improvements.

Smart antenna solutions are required as the number of users, interference, and propagation complexity grow.

The benefit of maintaining a more focused and efficient use of the system's power and spectrum allocation can be significant in a WiMAX network deployment.

Smart Antenna Systems

A smart antenna system combines an antenna array with digital signal-processing capability to transmit and receive in a predefined or adaptive, spatially sensitive manner. This enables such a system to change the directionality of its radiation patterns in response to the particular signal environment. This results in dramatically increased performance characteristics of a wireless system.

There are two major categories of smart antenna systems relative to their basic functionality:

- Switched Beam—a finite number of fixed, predefined patterns or combining strategies (sectors)
- Adaptive Array—an infinite number of patterns (scenario-based) that are adjusted in real time

Both systems attempt to increase gain according to the location of the user; however, only the adaptive system provides optimal gain while simultaneously identifying, tracking, and minimizing interfering signals.

Switched beam antenna technology is a simple, less flexible, less expensive solution than an adaptive system but one that is also more susceptible to interference.

Adaptive antenna technology represents the most advanced smart antenna approach to date. By applying a variety of new signal-processing algorithms, the adaptive system is able to effectively locate and track end-users signals resulting in dynamically minimized interference and maximized signal reception.

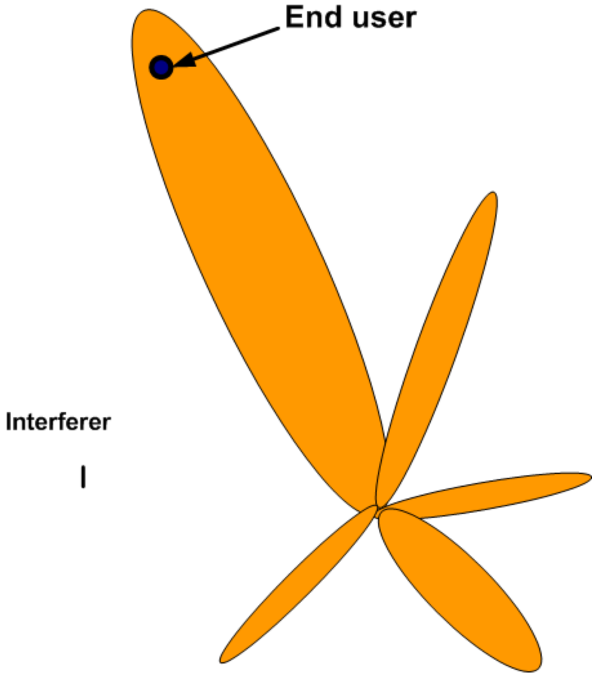

Figure 1 - Improving C/I by emphasizing the gain in the direction of the user and suppressing the gain in the direction of the interference

Adaptive Array Systems

Adaptive array systems, while they share many hardware characteristics with sector arrays are smart due to their adaptive intelligence capability.
To process information that is directionally sensitive requires an array of antenna elements (typically, for a WIMAX 120˚ sector unit 4 to 8 elements), the inputs/outputs from which are combined in a different phase and amplitude to control signal transmission adaptively.
Ideally the system is made up of two parts:

1. The Antenna array with calibration unit
2. The antenna signal processing unit and software included in the radio.

If we consider a typical smart antenna array of a 120˚ segment with one, 2, 4 or 8 antenna elements the dramatic increase in gain and narrowing the azimuth beamwidth with the increase in antenna elements is clearly illustrated in Fig-2.

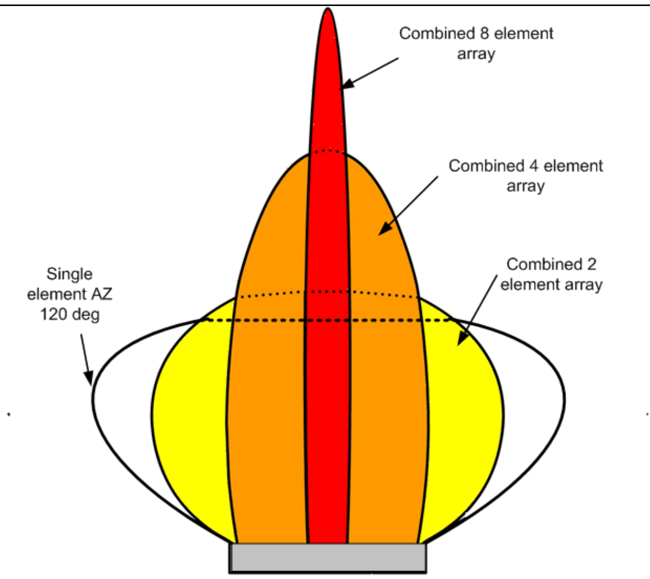

Figure 2 - Single, 2, 4 and 8 Element Performance Illustration

Antenna Elements	2 Element		4 Element		8 Element	
	Gain	AZ	Gain	AZ	Gain	AZ
One Element	15dBi	120°	15dBi	120°	15dBi	120°
2 Element	18dBi	60°	18dBi	60°	18dBi	60°
4 Element	- -	- -	21dBi	30°	21dBi	30°
8 Element	- -	- -	- -	- -	24dBi	15°

Features & Benefits

The dual purpose of a smart antenna system is to augment 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 antenna elements are combined to optimize available power required to establish given level of coverage.	**Better range/coverage**—Focusing the energy sent/received to increases range and coverage.
Interference rejection—Antenna pattern can be suppressed toward co- channel interference sources, improving the signal-to-interference ratio of the received signals.	**Increased capacity**—Precise control of signal nulls quality and mitigation of interference combine to frequency reuse, increase distance (or cluster size), improving capacity.
Spatial diversity—Composite information from the array is used to minimize fading and other undesirable effects of multi-path propagation.	**Multi-path rejection**—can reduce the effective delay spread of the channel, allowing higher bit rates to be supported without the use of an equalizer

Power efficiency—combines the inputs to multiple elements to optimize available processing gain in the downlink (toward the user)	**Reduced expense**—Lower amplifier costs, power consumption, and higher reliability will result at the CPE end.

Smart Array Tradeoff

The number of beams, gain, and beam width is a tradeoff of the price and size.
The higher the number of antenna elements [columns] making up the smart base station antenna array, the higher the available gain, the larger the size and higher the price.

Lower gain results in reduced size and price.

MTI's Smart Base Station Antenna for WIMAX

MTI is offering smart base station antennas for a variety of different frequencies. As an example, the MT-404052/NV antenna is a typical MTI smart base station antenna with 8 active radiating antenna elements (transmit/receive) and one calibration network. The radiation column is a 3.4-3.6GHz unit with 120° azimuth beam width. The radiating columns are phase and amplitude matched. A narrow high gain beam can be achieved by summing the columns. The antenna beam shape and direction can be changed by smart sum of the columns. The sum of the radiating columns is done by the transceiver. The calibration port is used to measure the phase and amplitude of each radiating column.

MTI is working on additional Smart BTS Antennas for WiMAX such as MT – 404053/NV, a four column 3.4 – 3.6 GHz, 15 dBi 4x120° antenna.

MTI Smart Base Station Design Concept

MTI's unique design concept is illustrated in Figure 3 below. An 8 element antenna is in fact made up of 12 columns. Each column is a linear vertical array of dipoles printed on a PCB. The central eight columns are active elements and the other 4 columns are passive, two on each side.

The printed columns are mounted orthogonally to the ground plane.

Each feed of an active column is located in the middle of the column to achieve maximum gain. The columns are located half wavelength from each other.

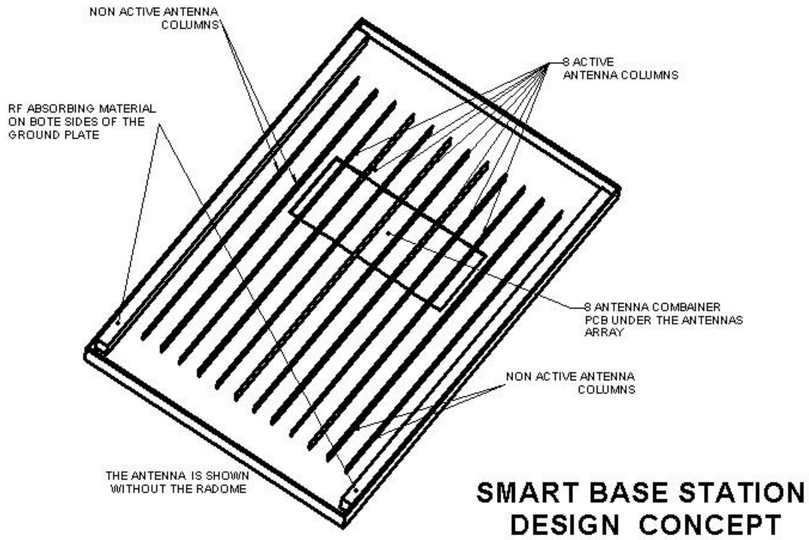

Figure 3 - Single, 2, 4 and 8 Element Performance Illustration

The two passive columns, located on each side of the active element columns, are not fed; they are used to shape the beams of the active radiating columns. The central active columns are influenced by both sets of passive columns which are used to simulate and influence the edged active columns. An unequal influenced column can cause squinting of the column beam.

A microwave absorber material is added on both sides of the antenna. The material is designed to reduce the back lobe radiation level.

The calibration network is done by a PCB located behind the ground plane under the active columns. This structure provides minimum assembly tolerances for minimum errors in phase and amplitude. A coupler printed on the antenna column is connected to the network. The network is connected to an N-TYPE connector.

The chassis of the antenna is a metallic box with a plastic cover in front of the antennas, to protect it from environmental conditions (heat, dust, rain and wind).

The antenna height is the column height, 700 mm, and additional ground plate to form the elevation pattern. The antenna width is a sum of 12 columns a half wavelength apart and absorbing material thickness. This creates an antenna width of 620 mm

Summary & Conclusions

MTI Wireless Edge provides a large selection of smart antennas for WiMAX next generation BTS improving the system performance and network coverage. This allows to choose the most cost-effective CPE and to improve the Return On Investment [ROI] of the WiMAX network.

About MTI Wireless Edge Ltd

MTI Wireless Edge is the world leader in the development, production and marketing of high quality, low cost, flat panel antennas for Fixed Wireless and RFID applications. MTI has more than 30 years experience in supplying antennas for both military and commercial applications from 100 KHz to 40 GHz. MTI flat panel antenna range for FBWA includes both base station and subscriber antennas for various broad and narrow band fixed wireless applications in Point-to-Point (PTP) and Point-to-Multipoint (PMP) schemes such in both licensed and unlicensed bands. MTI Military products include a wide range of broadband, tactical and specialized communications antennas, antenna systems and DF arrays installed on numerous airborne, ground and naval, including submarine, platforms worldwide. MTI's ISO 9001 and ISO 14001 certified development and production plant, based in Israel, produces small, low profile antennas with superior performance, and gain. In house test facilities include antenna test ranges, varying in length from 8 meters to 300 meters. We Are Taking Wireless Technology To The Edge. Visit us at www.mtiwe.com

Contact:

MTI Wireless Edge Ltd

David Shani

VP Int'l Sales & Marketing

MTI Wireless Edge Ltd

Tel: +972 3 9008900
E-mail: david_s@mti-group.co.il