

# ETC Antenna (Easy to Configure): A New Approach to Smart Management of Cellular Networks

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**Abstract**— The ETC antenna is presented as an intermediate approach between the current radio cellular systems and the future cellular system with the smart antennas. The goal is to get a flexible and asynchronous way to optimize the coverage following the schedule traffic changes and the requirements of the cell using the current mobile operator measurements and making the beam changes by a programmatic and remote technique.

**Index Terms**— Antenna design. Land mobile radio cellular systems. Land mobile radio diversity systems.

## I. INTRODUCTION

The current fixed antennas are one of the most important variables at the time of giving dimension to cellular radio systems, but this variable is determined at the beginning, and their later modifications are not very flexible. These antennas are designed for the worst case in order to guarantee a fixed power in the whole sector which must satisfy a quality parameter; however, that power level is not always necessary.

The first considered solution should be the smart antennas; these antennas let shape beams for each mobile terminal that establishes communication with the mobile station.

However, this solution has multiple inconveniences and requires a substantial technological chan-

ge in the base station equipments. The change depends on the systems being used (GSM, CDMA, WCDMA, etc), modulation type, access, multiplexing process (TDD, FDD, etc), the link to which the intelligence is applied (uplink or downlink), and other many factors, that would make the cell network to miss a faster implementation in order to adapt to newer technologies for a smart coverage.

## II. TYPICAL ARCHITECTURES OF THE SMART ANTENNAS

There are several architectures and techniques that could be classified in the concept of the smart antennas. [1-4]

Switching-Beam Array (SBA), although this represents an improvement compared to the traditional systems of coverage [5], it is not guaranteed to switch the beam in the wanted steer.

Phase array [6], It's possible to detect the Direction of Arrival of the signals and steer the beam to the wanted signals [7, 8].

Beam Tracking [2], in this architecture the beams now adapts or follows a trajectory to maximize a parameter of the signal.

The reference [4] presents a comparison that analyzes their advantages and disadvantages in the

framework of the code division multiple access (CDMA), without considering the temporary dispersion or the multipath.

Implementing smart antennas is sensibly more expensive and more complex than the current arrays antennas, since the intelligence is not plug-and-play, it's necessary to get deeper in different sub-systems of the base station, which is not always possible, since the sub-systems equipments usually depend on the manufacturers; therefore, it should upgrade more components of the Node B or Base Station, making two well differentiated parts of the traditional structure into a new one, or, on the other hand, to increase the equipment of the antenna for repeated functions that the Node B or Base Station have to do later.

In the worst case, each radiant element of the smart antenna array would need its own electronics and calibration [2], increasing the computational load and the probability of errors.

### III. GOALS

The variation in the traffic type, for particular events or for time slot, like work hours, is one of the factors that increase the load in the optimization tasks, affecting directly the performance of the cellular network; if local regulations for maximum power level are also considered (e.g. sensitive points like kinder gardens, gas stations and hospitals), the sector cell should be modified constantly.

### IV. THE ETC ANTENNA CONCEPT

Combining technologies or their philosophies is also a valid solution to save obstacles and to improve the performance of cellular networks.

This reason is the base for the concept of the smart management of the cell. Designing the base station antenna with a cylindrical array, or angular sectors of a cylinder, based on the smart antennas framework, enables the operator to adapt the beam and steer in elevation and azimuth in a remote way, following several statistical requirements of capacity, traffic, scheduled events and others. This increases the capacity and optimizes the quality of service (QoS) and the use of resources, saving energy and improving the environmental impact.

The antenna is provided with some kind of intelligence, so that it is managed as an active component of the system, giving a flexibility that does not exist yet, beyond fixed beams and the electrical downtilt and mechanical handle in azimuth.

This partial intelligence allows an intermediate solution between the current topology and the concept of "the smart antenna", providing the cell network with great versatility at low cost.

The ETC Antenna will be able to beamforming the sectors in several ways, optimizing the use of resources and energy. This provides a new dimension to the operators according to the sector requirement, together with the rationalization of the energy costs, and with the capacity to create minimum radiation fields in sensitive areas inside the sector or steer the maximum of radiation some grades in azimuth.

In short, a new element for the cell network concept, which minimizes the shock of technological change, and offers flexibility to the operator is presented.

### V. HOW

The market offers several types of antenna arrays that provide service to one sector. Allgon, Decibel Products, Fractus, Moyano, Ryma and Thales Antennas (this last with panels in a cylindrical structure) serve traditional sectors with azimuth beamwidth from 65° to 90°, and gain from 16.5 to 19 dBi.

These cylindrical arrays could also be cylindrical sectors for the cases where the three sectors cannot be placed in the same mast. The number of individual beams would be given by the electronics of the arrays, usually three, allowing complete overlapping of beams.

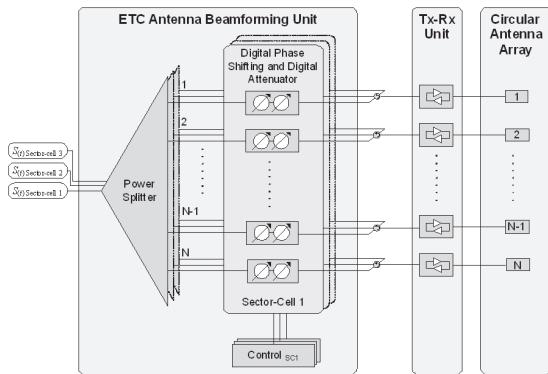
Fig. 1 and Fig. 2 show the block diagrams for a Passive ETC antenna.

The passive Phase Shifting and 6xN Attenuator represent an evolution of the network currently used by linear arrays. This new network is able to generate two beams of 30 degrees per sector.

The digital components of the ETC Antenna are easily found in the market, e.g. digital attenuators, digital phase shifters and switches manufactured with MMIC (Monolithic Microwave Integrated Circuits) technology. These will be controlled through high-speed buses connected to one or several FP-GAs (Field-programmable gate array), and cylindri-

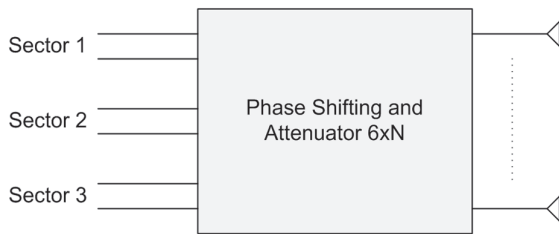
cal arrays of 29 and 36 inches high, and diameters from 10 to 17 inches, as shown in Figures 6 to 9. Figures 3 and 4 show the block diagrams for an ETC antenna. With one circular array is possible to have three or more sectors, to allow for any type of cellular configuration in a cylindrical array. Since the ETC antennas are independent elements of the cellular network, a specific diagram is required.

FIG. 1. ETC ANTENNA PASSIVE SYSTEM BLOCK DIAGRAM FOR 3 SECTOR-CELL AND 1 ETC ANTENNA



Fuente: Autor del proyecto

FIG. 2. PHASE SHIFTING AND ATTENUATOR 6XN



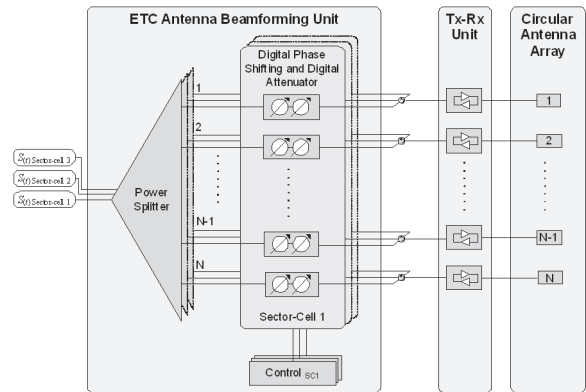
Fuente: Autor del proyecto

Considering the radiating elements in [9], a SSFIP antenna (Strip Slot Foam Inverted Patch) [10] is proposed. This antenna is to be placed in a metal cavity [11] of 2.7559in x 2.7559in x 0.9964in and another cavity of 3.5433in x 3.5433in x 1.146in. This is a printed antenna with low permittivity substrate thickness, providing a high bandwidth. In this type of antenna the patches are covered by a layer of plastic. This layer has to be located directly above the foam (Inverted Patch), and must be thin enough to avoid altering the properties of radiation from the antenna. This provides a surface to mount the patches, and protects the antenna against the environment.

The large bandwidth of these antennas, along with a clean radiation pattern, low cross polariza-

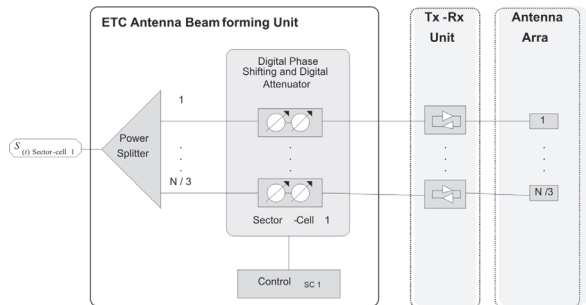
tion and low coupling between components make them an ideal candidate to design a simple array as an attractive feature for their use in mobile communications. Figure 5 shows the basic structure of an antenna SSAIP.

FIG. 3. ETC ANTENNA SYSTEM BLOCK DIAGRAM FOR 3 SECTOR-CELL AND 1 ETC ANTENNA



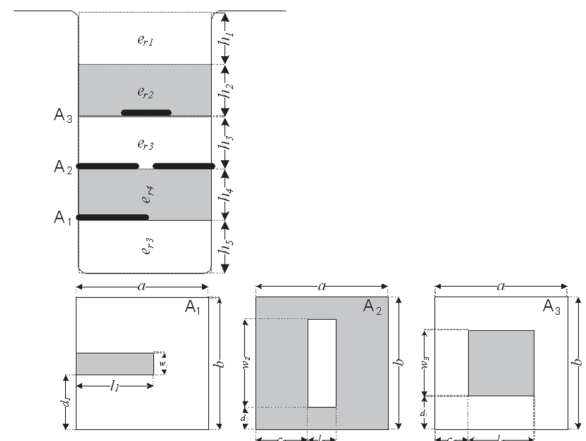
Fuente: Autor del proyecto

FIG. 4. ETC ANTENNA SYSTEM BLOCK DIAGRAM FOR 1 SECTOR-CELL AND 1 ETC ANTENNA



Fuente: Autor del proyecto

FIG. 5 ESTRUCTURA BÁSICA DE UNA ANTENA SSAIP



Fuente: Autor del proyecto

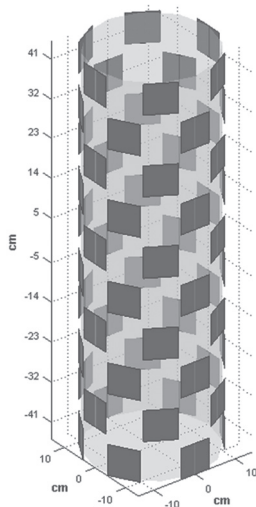
Option A

This geometry has 10 layers, and each layer has 12 elements, for a total of 120 radiating. Table I shows the description for this option.

TABLE I. GEOMETRY DIMENSION OPTION A

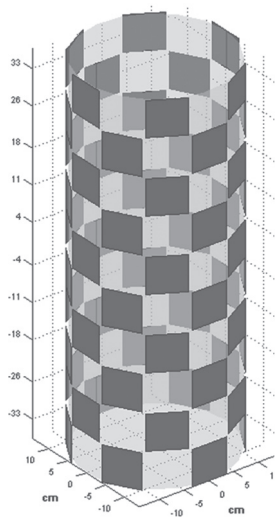
Description	$\lambda$
Azimuth spacing elements	0.50000
Array radio	0.95493

FIG. 6. CYLINDRICAL ARRAY FOR OPTION A WITH RADIATION ELEMENTS OF 2.7559IN X 2.7559IN X 0.9964IN



Fuente: Autor del proyecto

FIG. 7 CYLINDRICAL ARRAY FOR OPTION A WITH RADIATION ELEMENTS OF 3.5433IN X 3.5433IN X 1.146IN



Fuente: Autor del proyecto

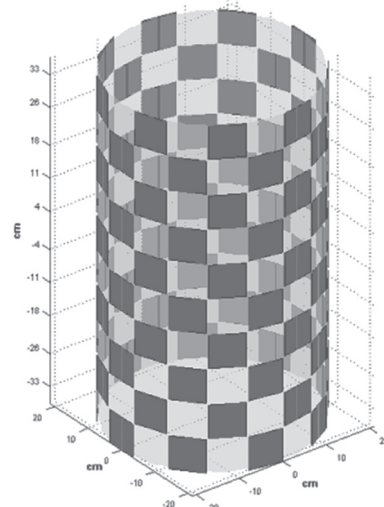
Option B

This geometry has 10 layers, and each layer has 18 elements, for a total of 180 radiating. Table II shows the description of this option.

TABLE II. GEOMETRY DIMENSION OPTION B

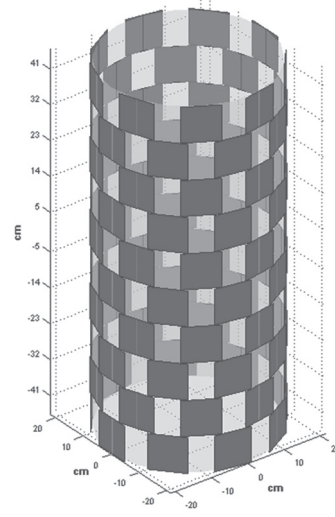
Description	$\lambda$
Azimuth spacing elements	0.50000
Array radio	0.85944

FIG. 8. CYLINDRICAL ARRAY FOR OPTION B WITH RADIATION ELEMENTS OF 2.7559IN X 2.7559IN X 0.9964IN



Fuente: Autor del proyecto

FIG. 9. CYLINDRICAL ARRAY FOR OPTION B WITH RADIATION ELEMENTS OF 3.5433IN X 3.5433IN X 1.146IN IN

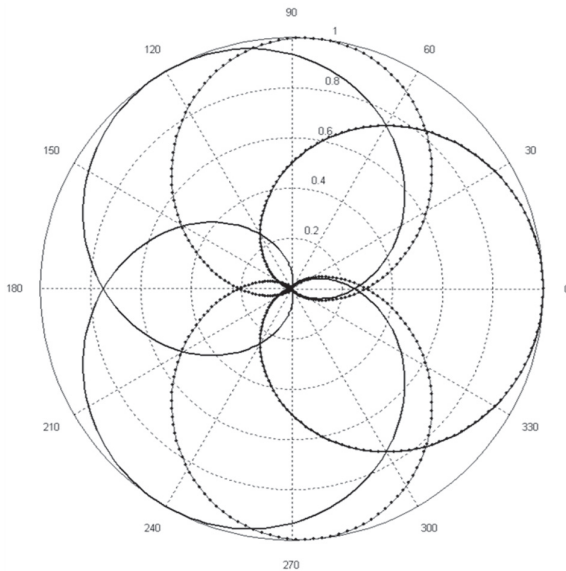


Fuente: Autor del proyecto

## VI. POTENTIAL APPLICATIONS

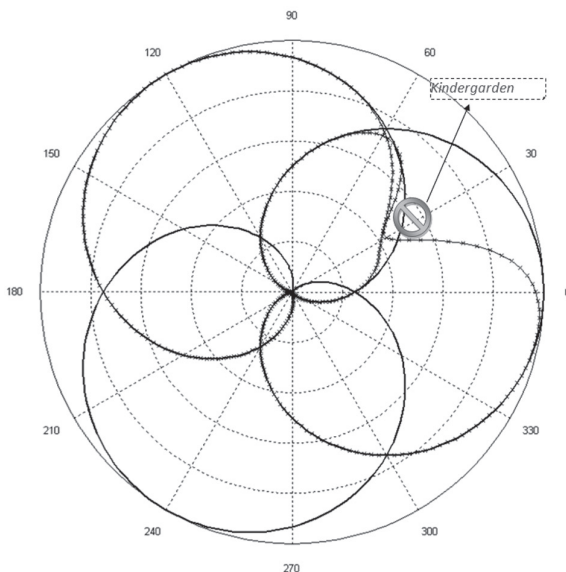
The ability of the ETC antenna to modify or shape the beam (Fig. 10 and Fig. 11), represents the possibility to increase or decrease the gain of the beam in each sector, influencing directly on the dimension of the cellular radio and selection of the cell traffic, allowing for a flexibility in optimization and initial search of locations.

FIG. 10. COVERAGE INCREASE IN A BUSINESS SECTOR, DURING WORK HOURS. DOTTED LINE REPRESENTS THE MODIFIED BEAM



Fuente: Autor del proyecto

FIG. 11. FIELD REDUCTION IN A SPECIFIC AREA. DOTTED LINE REPRESENTS THE MODIFIED BEAM



Fuente: Autor del proyecto

This flexibility allows that the antennas beams, which have been restrictive in the past, become tables where starting from certain requirements will be coupled better to the requirements of each one of the cells in a certain planning.

Another potential application of these antennas is for Wireless Network Sensors (WNS), where the power consumptions of the antennas reduce the sensor life.

## VII. CONCLUSIONS

One of the most restrictive aspects in the quality of the current cellular networks is the quality of the radio links. The radio links are getting, in fact, more and more saturated by a growing penetration of terminals and high-speed services; the different kinds of digital signal processing has helped overcome their limitations.

With the ETC antennas, it is possible to find an intermediate point of evolution between the un-spread smart antennas associated to difficult and complex installation, and the current antennas, that, in spite of being deeply integrated in the practice of those who develop the cellular networks, don't offer flexibility. This way, it is possible to provide a uniform coverage in areas that don't admit uniformity in many cases.

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