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A Survey on Emerging WiMAX Antenna Technologies and Slotted Microstrip Patch Antenna's for WiMAX Applications

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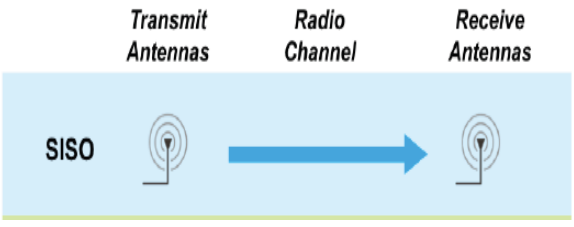
Abstract - *WiMax (Worldwide Interoperability for Microwave access) has been established by the IEEE 802.16 working group. WiMax theoretically can have coverage of up to 50 km radius. WiMax technology is replacement for wireless internet access. WiMax has three allocated frequency bands. The low band (2. 5-2.69 GHz), the middle band (3.2-3.8 GHz) and the upper band (5.2- 5.8 GHz). New WiMax antenna technologies like SISO,SIMO,MISO,MIMO,AAS are developed which promises increased data rates, greater bandwidth, security and more productive use of the wireless spectrum. The antenna is very essential element of communication as it is used for a transmitting and receiving electromagnetic waves. Today Communication devices such as mobile phones become very thin and smarter, support several applications and require higher bandwidth where the microstrip antennas are the better choice compare to conventional antennas. This paper presents a literature survey of slotted microstrip patch antenna's these are Double C-slot MSA and C-slot MSA for WiMAX applications. In this paper we also discussed the basics of microstrip antennas with their advantage and disadvantages.*

Key Words: MIMO, MISO, SIMO, SISO, AAS, MSA, Wi-Max.

1.INTRODUCTION :

New WiMax antenna technologies like SISO, SIMO, MISO, MIMO,AAS are developed which promises increased data rates, greater bandwidth, security and more productive use of the wireless spectrum.

1.1.SISO Mode:

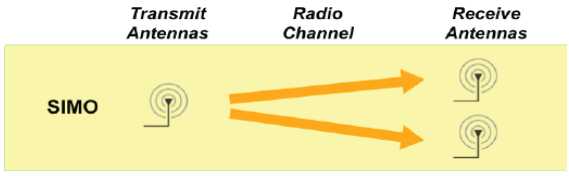


[Fig.- SISO systems]

SISO mode (single input/single output) is the more conventional mode of communication This is effectively a standard radio channel - this transmitter operates with one antenna as does the receiver. The advantage of a SISO system is its simplicity There is no diversity and no additional processing required.

1.2.SIMO Mode:

SIMO mode (single input/multiple output) is the conventional mode of communication, Single Input/Multi Output systems, which are used in traditional cellular uplinks.

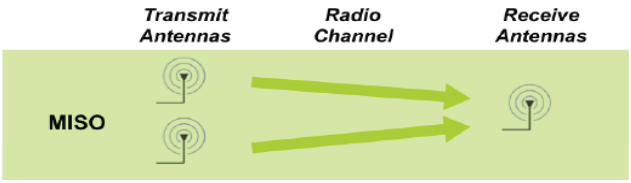


[Fig.- SISO systems]

SIMO has the advantage that it is relatively easy to implement although it does have some disadvantages in that the processing is required in the receiver. The use of SIMO may be quite acceptable in many applications, but where the receiver is located in a mobile device such as a cellphone handset, the levels of processing may be limited by size, cost and battery drain.

1.3.MISO Mode:

MISO mode (multiple input/single output) is the mode of communication, where there is multiple antenna's transmitting and one antenna receiving.



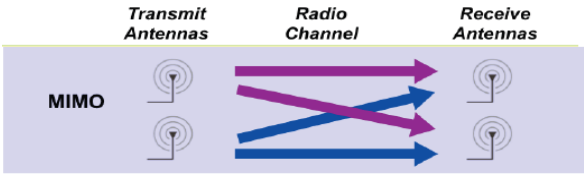
[Fig.- MISO systems]

The advantage of using MISO is that the multiple antennas and the redundancy coding / processing is moved from the receiver to the transmitter. In instances such as cellphone UEs, this can be a significant advantage in terms of space for the antennas and reducing the level of processing required in the receiver for the redundancy coding. This has a positive

impact on size, cost and battery life as the lower level of processing requires less battery consumption.

1.4.MIMO Mode:

MIMO mode (multiple input/multiple output) is the mode of communication, where there is multiple transmitters and multiple receivers.



[Fig.- MIMO systems]

The study on microstrip patch antennas has made a great progress in the recent years, compared with the conventional antennas. Microstrip patch antennas have more advantages and better prospects.

MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without additional bandwidth or transmit power. It achieves this by higher spectral efficiency more bits per second per hertz of bandwidth) and link reliability or diversity (reduced fading). Because of these properties, MIMO is an important part of modern wireless communication standards as IEEE 802.11n (Wi-Fi), 3GPP Long Term Evolution, WiMAX.

1.4.1 MIMO Features:

a. High data rate (several Mb/s) to a mix of users,

b. Different coverage and network load,

c. Optimal protection against multipath and Doppler spread,

d. Sub channelization as inter-cell interference mitigation,

e. Adaptive Modulation and Coding (AMC),

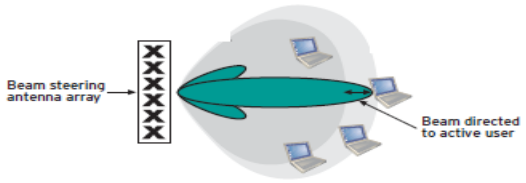
f. Dedicated bandwidth to each MS,

g. Choose modulation accordingly,

h. Increase of per-user throughput.

1.4.AAS Mode:

AAS mode (Adaptive Antenna system) is the mode of communication, where there is an array of close spaced antennas often enclosed in a single package. The AAS approach uses a technique known as beamforming and generates a single beam aimed at a particular user or device. This provides a stronger link to the user and hence improves reach and capacity.



[Fig.- AAS systems]

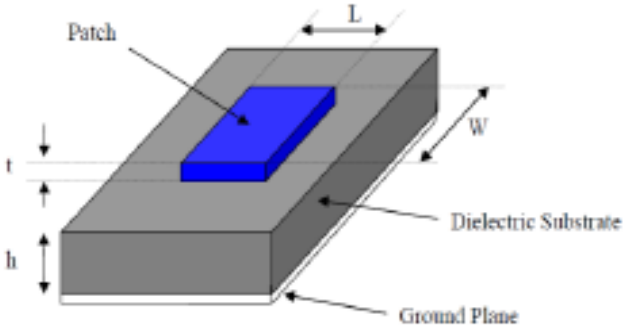
This approach is also intensive in signal processing and is based on accurately controlling the signals to each antenna, thus requiring an array of custom antennas tightly coupled to the signal processing and carefully calibrated. AAS is a proven technology that has been around for many years.

2. MICROSTRIP PATCH ANTENNAS:

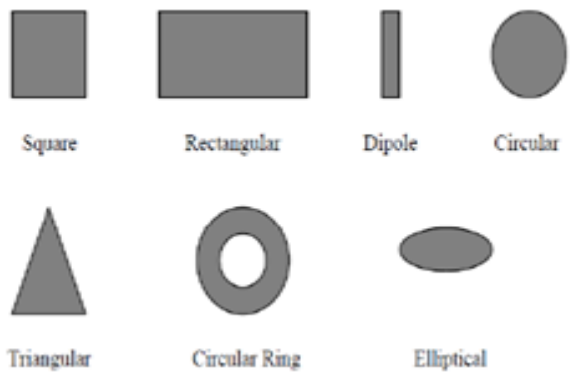
The next generation networks we require high data rate and size of devices are smaller. In this evolution two important standards are Wi-Fi (WLAN) and Wi-MAX. For success of all these wireless applications we need efficient and small antenna as wireless is getting more and more important in our life. This being the case, portable antenna technology has grown along with mobile and cellular technologies.

Microstrip antennas (MSA) have characteristics like low cost and low profile which proves Microstrip antennas (MSA) to be well suited for WLAN/Wi MAX application systems. A Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. The EM waves fringing off the top patch into the substrate and are radiated out into the air after reflecting off the ground plane. For better antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation.

The dielectric substrates used are Bakelite, FR4 Glass Epoxy, RO4003, Taconic TLC and RT Duroid. The height of the substrate is variable.



[Fig.-Structure of microstrip antenna]



[Fig.- Different Shapes of MSA Patches]

3. ANTENNA PARAMETERS

Performance of the antenna s measured by different parameter such as VSWR, Return Loss, Antenna Gain, Directivity, Antenna Efficiency and Bandwidth is analyzed.

(a) Gain: The gain of an antenna is defined as the ratio of the intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically.

(b) Radiation Pattern: The radiation pattern is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates.

(c) Antenna Efficiency: It is a ratio of total power radiated by an antenna to the input power of an antenna.

(d) Bandwidth: Is is range of frequencies over which antenna operates efficiently. Bandwidth is difference between upper cutoff frequency and lower cut off frequency

(e) VSWR: Voltage standing wave ratio is defined as VSWR=Vmax/Vmin.It should lie between 1 and 2.

(f) Return loss: Return loss is the reflection of signal power from the insertion of a device in a transmission line. Hence the RL is a parameter similar to the VSWR to indicate how well the matching between the transmitter and antenna has taken place. The RL is given as by

Return Loss=-20 log10 (Γ) dB.

For perfect matching between the transmitter and the antenna, Reflection coefficient = 0 and Return Loss = ∞ which means no power would be reflected back, whereas a Γ = 1 has a RL = 0 dB, which implies that all incident power is reflected. For practical applications, a VSWR of 2 is acceptable, since this corresponds to a RL of -9.54 dB.

4. FEEDING TECHNIQUES:

A feed is used to excite to radiating patch by direct or indirect contact. The feed of microstrip antenna can have many configurations like microstrip line, coaxial, aperture coupling and proximity coupling, but microstrip line and the coaxial feeds are relatively easier to fabricate. Coaxial probe feed is used because it is easy vary the input impedance of the coaxial cable in general is 50 ohm. There are several points on the patch which have 50 ohm impedance. We have to find out those points and match them with the input impedance. These points are find out through a mathematical model.

4.1.Comparison of Feeding Techniques

Characteristics	Micro Strip line feed	Coaxial feed	Aperture Coupled feed	Proximity coupled
Spurious Feed radiation	more	more	less	Mini-mum
Easy of Fabrication	Easy	Solderin g & Drillig needed	Align-ment Requi-red	Align-ment Requi-red
Impe-dance matching	Easy	Easy	Easy	Easy
Band-width	2-5 %	2-5 %	2-5 %	13%

Table-Comparison of Feeding Techniques

5. ADVANTAGE AND DISADVANTAGE

Microstrip patch antenna has several advantages over conventional microwave antenna with one similarity of frequency range from 100 MHz to 100 GHz same in both type. The various advantages and disadvantages are.

A. Advantages-

1. Low weight
2. Low profile
3. Require no cavity Backing
4. Linear & circular polarization
5. Capable of dual and triple frequency operation
6. Feed lines & matching network can be fabricated simultaneously

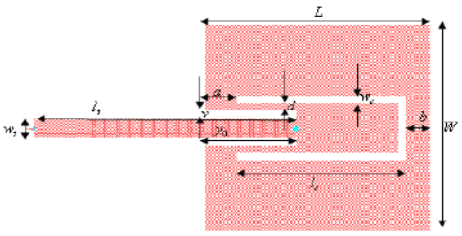
B. Disadvantages-

1. Low efficiency
2. Low gain
3. Large ohmic losses in feed structure.
4. Low power handling capacity
5. Excitation of surface wave
6. Polarization purity is difficult to achieve.
7. Complex feed structure required high performance arrays.

6. SLOTTED MICROSTRIP PATCH ANTENNAS:

The concept of microstrip antenna with conducting patch on a ground plane separated by dielectric substrate was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970, after that many researchers have described the radiation from the ground plane by a dielectric substrate for different configurations. The early work of Munson on micro strip antennas for use as a low profile flush mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems. Various mathematical analysis models were developed for this antenna and its applications were extended to many other fields. The micro strip antennas are the present day antenna designers choice.

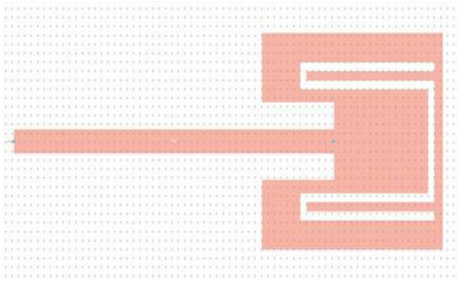
6.1. Design of C-Slot Microstrip Patch Antenna for WiMax Application, Boutheina Tlili [2]



[**Fig**.- C-Slot MSA]

In this paper a C slot microstrip patch antenna designed, a parametric study on the structure is made in order to obtain the best possible size and position of the slots. Extensive simulation results using Advanced design systems by Agilent. It is developed to operate in theWi-Max frequency range of 2.5-2.69 GHz. The antenna presents return loss is -19.1dB.
The dielectric material selected for the design is an FR4 with glass epoxy substrate of height h= 1.5 mm and r = 4.34. A 50 inset microstripline feed is attached to the microstrip.

6.2. Design of Double C-Slot Microstrip Patch Antenna for WiMax Application, Boutheina Tlili [1]



[**Fig**.- Double C-Slot MSA]

Double C-slot microstrip antenna designed and simulated for the WiMax frequency range of 2.5-2.69 GHz. Antenna presents a size reduction of 37% when compared to a conventional square microstrip patch antenna. The ntenna is fed by Inset feeding technique. The antenna is designed using FR4 as dielectric substrate.

The length L and width W of the patch are 28.3 mm and 24.3 mm, respectively.The length lc and width wc are 21 mm and 1 mm respectively. d = 1 mm, v = 1 mm, a = 4 mm and b = 1.3 mm. The best matching conditions occur when the double C-slot is placed away from the left edge of the patch.

The antenna shows a return loss of -31.613 dB at f = 2.646 GHz as shown in Figure . It has a VSWR = 1.059. The simulated gain is about 6.462 dBi.

6.3. Comparison of C-slot & Double C-slot

Antenna ⇨ / Parameters ⇩	C-slot	Double C Slot
Resonant Frequency (GHz	2.53	2.64
Return Loss (dB)	19.10	-31.61
Gain (dB)	5.67	6.46
Directivity (dB)	5.88	6.48
Efficiency (%)	96.5	99.5
Size Reduction (%)	37.14	37.14

Table-Comparison of C and Double C-slot antennas

7. CONCLUSION

A survey on Wi-Max antenna Technologies like SISO, SIMO, MISO, MIMO,AAS and slotted microstrip patch antenna's for Wi-Max, applications presented in this paper. After study of research papers it concluded that gain, return loss and VSWR can be improved by using slotted microstrip antennas than conventional patch antenna's . Some characteristics of feeding techniques and various antenna parameters are discussed and comparison of slotted patch antennas with number of antenna parameters discussed.

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