Advancement in GSM and Wi-Fi technology Using Smart Antenna

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ABSTRACT:-

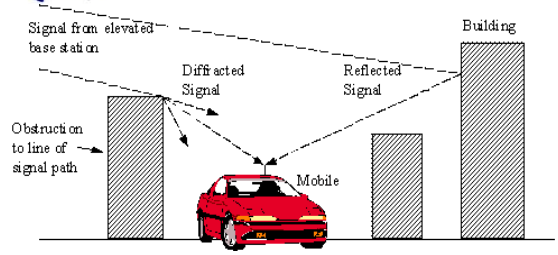
As we are using the Wi-Fi routers and GSM in our daily life as Wi-Fi consists of the isotropic or omni-directional antenna. Isotropic antenna which radiates power equally in all direction so it has a higher beam width and rays will get absorb and scattered ,waves becomes weak,it will tends to the loss of power. And in the GSM system,we are facing the problem like interference suppression, capacity enhancement, multiple path diversity, fading etc. With the use of smart antenna, which improve the flow of isotropic antenna in Wi-Fi router. We developed this new technology by using the "Space Division Multiple Access(SDMA)", "Global System for Mobile(GSM)" and "Time Advance". These three parameters control the flow of wave and they decide the need of wave in different directions, it radiates the wave according to the requirement.

Keywords:-

GSM; SDMA; Time Advance; Smart antenna; Adaptive Array System

1. INTRODUCTION:-

Wireless is an enormously growing industry in the world and it is expanding exponentially day by day. Many applications of wireless communication are coming in the market. So the frequency band is used up. And the market is demanding for the high data rate and more efficient and low power consumption technique. The main disadvantage of the wireless communication is Rayleigh Fading. When signal transmit through the transmitter, it undergoes the multipath propagation because of the reflection, refraction, scattering diffraction etc. Due to the multipath, signal is distorted and it undergoes the division of phase and amplitude component. When the signal is gathered at the receiver, it is distorted in time as well as in frequency domain. And it also degraded the performance of GSM system which is widely used in the world for mobile communication. The performance of GSM is degraded by the mainly four parameters. First is the multipath fading, as seen from the diagram that signal after transmission of antenna, it undergoes a generation of indirect signal which is generated by the reflection, refraction and diffraction of signal.



After reflection through the objects or building, waves undergoes the change in phase shift, these phase shift signals add up and absorb at the receiver.

The second is delay spread, which is difference between the time of arrival of the earliest multipath component (e.g. line of sight component) and the time of arrival of the latest multipath component.

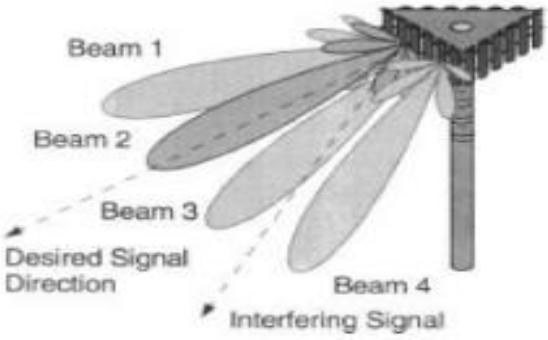
Third is the co-channel interference, to increase the capacity of channel we use the frequency reuse concept. In frequency reuse, we use the same frequency in different cell(coverage area). Due to which, we utilize the frequency spectrum efficiently. With the advantage of frequency reuse, there is one disadvantage also, which is the co-channel interference. It occurs due to the cross talk of frequency channels which are utilizing the same frequency.

The fourth is the limited radio frequency spectrum, day by day number of users of wireless communication increases. Bandwidth for wireless communication is now at the peak. So we should utilize the spectrum efficiently.

Although, we use many technique like sectoring and cell splitting to improve the wireless communication but still we do not get perfect solution there is cost also increases due to hand off and new base station for accepting the splitting and sectoring technique. To overcome these problems, concept of smart antenna is introduced.

2. SMART ANTENNA

A smart antenna is an intelligent antenna which has a Digital Signal Processor that makes the system smart. It is based on the concept of sectorization, smart antenna is the enhancement of the sectorization of cells. Smart antenna consists of multiple beams. This is achieved by the antenna array and beams arrangement. Geometry arrangement of smart antenna such that it can adjust the power according to the requirement and remove the unwanted signal.



It encode each path into bit stream and it makes a collection of different path into bit stream format. Similarly it encodes different path loss into bit stream. Then according to the requirement, it can adjust the values with the help of digital signal processor. With the adjustment values, it increases the radiation pattern in desired direction and decreases the pattern in undesired. These all combinations help the base station to transmit power and it also decreases the co-channel interference and consumes a low power.

3. SMART ANTENNA TECHNIQUE

3.1 SWITCHED BEAM SYSTEM

It has the ability to choose from predefined pattern and increase the receiving signal. This is extension of the cell sectoring in which cell is divided into the small areas. And mobile is moving from one place to other place. The smart antenna choose from the predefined beam and switch the beam towards the mobile. It increases the gain as per user location.

Although, this is not the optimal approach but it utilizes the bandwidth efficiently and increases the channel capacity. For M array elements resultant beam formation is given as

Array gain=$10\log_{10}$M db

M=4

Array gain=$10\log_{10}4$=6 db

If 120^0sectored antenna has a +14 db gain then using four element in beam former will be 14+6=20db using a fourth power. Increase in antenna allows base station to reduce the transmit power by a factor 4 so it increases the efficiency of system.

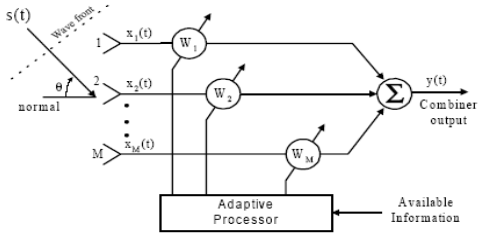
3.2 ADAPTIVE ARRAY SYSTEM

It is the array of multiple beam elements, with the received signal weighted and combine to form a resultant signal. It has an infinite number of patterns that are adjusted in real time. It has the property that they can direct the beam toward the signal of use and suppress the radiation pattern in the direction of interference. It can customize an appropriate radiation pattern for each individual user. It dynamically adjusts the antenna pattern to enhance reception while minimizing or fully rejecting interference.

For adaptive array system, the signal adaptive array processor is necessary. And with the adaptive processor, sensor array, pattern forming network are also very necessary.

3.2.1 Sensor array: The sensor array consists of N sensors designed to receive and transmit signal. The geometric arrangement of the array can be chosen arbitrary, depending on the requirement.

3.2.2 Pattern forming network: The output of each of the N sensor element is fed to the pattern forming network, where it is processed by the linear time-variant(LTV) filters. These filters determine the radiation pattern of the smart antenna. The output of these LTV filters are summed to form a new function y(t) and after that the complex weight of the LTV filters is determined by the adaptive processor.



3.2.3 Adaptive Processor: The adaptive processor determines the complex weights of the pattern forming network. It can filtering in both the space and frequency domain, reduces the system's sensitivity towards the noise.

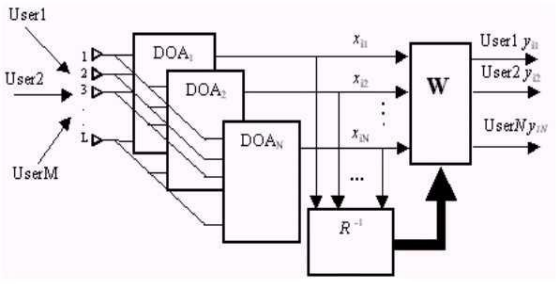
The adaptive antenna array processor is based on the Direction of Arrival (DOA) calculation. It consists of mainly four parts:

DOA Estimation: It estimates the direction of arrival of the signal using the Multiple Signal Classification (MUSIC), estimation of signal parameters via rotational invariance technique (ESPRIT) algorithms, it involves a spatial spectrum of the antenna array. From the received data, it extracts the uplink wave front and their DOA is calculated.

DOA classification: It identifies the wave-front which are coming from the user, it eliminates the require wave front with the help of spatial pre-filter, filter resolve the wave fronts and eliminates the data. And it rejects the wave front which belongs to the interference.

Tracking: The required wave fronts are tracked to increase the reliability of the system.

Signal Reconstruction: Now, a beam forming algorithm forms an antenna pattern with the help of the wave front which are coming from the user and it minimizes the interference wave front.



The development of adaptive array processor is to increase the received signal and decrease the interference. Thus it is providing the required singnal to noise ratio(S/N).

2. SPACE DIVISON MULTIPLE ACCESS(SDMA)

Due to increasing the application of wireless communication, there is shortage of the bandwidth for communication but this problem is minimized or remove by the Space divison Multiple Access technique. In SDMA, it enables to locate many users creating different beams for each user. Similar communication channel is allotted to different user for communication only with the different angle of separation.

With increasing the applications of wireless communication, demand of high data rate is also increasing. In GSM cellular network, station is only aware about the distance of mobile phone by the technique called “Timing Distance” but it is not aware about the direction of the mobile phone. In order to think about the future demand, bandwidth is a scare source so we should utilize it very efficiently. To use it efficiently, we should use the smart antenna technique and multiple access technique.

Now, the space domain does not limited with in the cell. Advance base station use a smart antenna with steering beam by the replacement of the isotropic antenna, thus, it is possible for base station to radiate the power in specific direction with the different uplink and downlink frequency. It gives immediate impact to the increase of the SIR (Signal to Interference Ratio) is the possibility for reduce frequency reuse distance. This will

lead to large capacity increase since more carriers can be allotted per cell. A mimetic algorithm is used to adjust the phase and amplitude weights based on the power of the array in desired direction.

The goal of smart antenna is to maximize the total output power of the desired signals and minimize the total output power of the interfering signal. During the process of mimetic iteration, the weighted vector kept for the next step iteration should make the output power of the desired signal to be increased and the output power of the interfering signal to be decreased monotonically. So, the mimetic algorithm is applied to find the weighting vector of the proposed smart antenna by using the two-way convergent method. Obviously, this technique can maximize the signal to interference ratio (SIR). The optimization of smart antennas can be achieved.

3. ADVANTAGES OF SMART ANTENNA

- The great interest in the smart antenna is the increase of capacity and range.
- Increase the useful received signal level and lower the interference level, so improvement in signal to noise ratio(S/N).
- They are able to focus their energy towards intended users instead of directing and wasting it in unnecessary directions.
- It adds up security to users, so information are less prone to detection.
- It helps in enhancing the gain of signal of required and rejecting the interfering signal.

4. CONCLUSION

In the whole paper, we see that how smart antenna solve the problem of omni directional antenna like bandwidth allocation, security, Signal to noise ratio(S/N), fading , multi path diversity, capacity enhancement, interference suppression. With the help of smart antenna, wireless communication becomes efficient and reliable communication.

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