Evaluating the Enhancing Capacity of Multiple Carrier Code Division Multiple Access (Mc-Cdma) System Using * Power Controls

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Abstract- In Communication system, the system capacity and performance are adversely affected and degraded by interference. Hence, power control plays a prominent role in an interference-limited system, which increases the efficiency by mitigating the adjacent and co-Channel interference in the system.

In this paper, primarily power control is said to be used in maintaining the acceptable Carrier to Interference Ratio (CIR) by meeting some Quality of service (QoS) requirements Objective function that is defined as maximum channel capacity in a power constraint scenario. The signals in a radio channel undergo different propagation effects like reflection, refraction, scattering and shadowing. Hence, the distribution of users across subcarrier groups as well as their transmission powers within a given cell has a significant effect on how users and power are accordingly distributed elsewhere in the network to maximize the capacity of the system thereby enhancing its performance by the multiple carrier code division multiple access (MC-CDMA).

Constraints on the available radio spectrum, owing to a continuous evolution and innovations in the field of Telecommunications affect adversely the development of Mobile Communications. The introduction of high data rate multimedia mobile services in the Mobile Communication Systems such as MMS, video calls, TV on phone, Internet etc, require a huge amount of bandwidth. There is an ever-growing demand on the limited radio resources with the burgeoning number of mobile phone users. Consequently, an efficient use of radio resources has become an imperative global challenge. Among different Radio Resource Management (RRM) techniques, power control, also known as TPC (Transmit Power Control), is one of the important Power Control 'interference suppression' techniques. The system capacity and performance are adversely affected and degraded by interference. Hence, power control plays a prominent role in an interference-limited system, which increases the efficiency by mitigating the adjacent and co-channel interference in the system.

There are several power control techniques using the link quality measurements in both forward and reverse channels to adjust the power levels. There are also centralized and distributed power control algorithms. But the limited scope of this thesis is to consider the effectiveness of using power control in enhancing the capacity of multiple carrier code division multiple access (MC-CDMA) systems.

I. Introduction

Power control in cellular communications is a challenging task since the system is complex and mobiles randomly move all the time. Thus the channel is time varying and the various channel parameters affect the system performance considerably.

Power control is proved to be a potential technique for resource allocation, which balances the power levels of all the transmitters and receivers in the system. It also shows promising results in the capacity enhancements irrespective of the multiple access techniques.

In addition to this, power control also has an important role in reducing the battery power consumption, which is an essential factor for the next generation mobile phones.

In this context, we try to evaluate the performance enhancing capacity of MC-CDMA using power control to gain a better understanding of these different power control approaches to enhance MC-CDMA in the field of cellular mobile communications.

II. PROBLEM STATEMENT

The basic power control problem can be termed as the 'Near-Far effect'. In a general power control environment where all the mobiles in a system transmit with equal power levels, the power of the mobile closest to the base station dominates that of the mobile relatively further from the base station. This phenomenon is called 'Near-Far effect' and fig. 1 depicts the same explicitly.

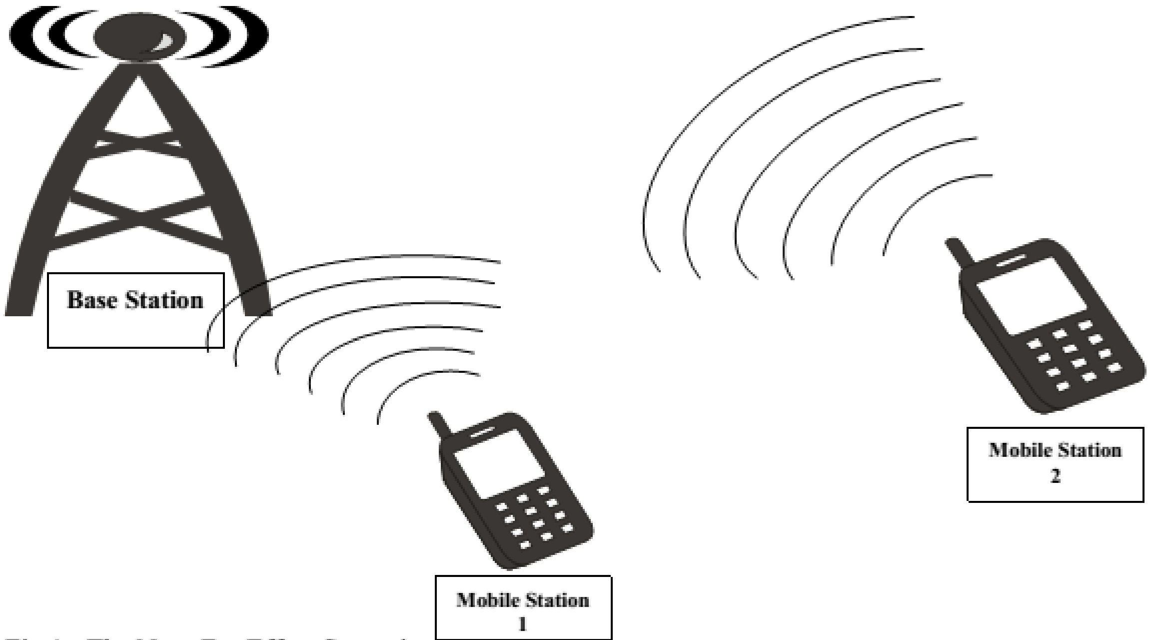

Fig 1 ; The Near-Far Effect Scenerio.

To accommodate greater number of users, the available radio spectrum is divided among the users with some multiple access techniques and the same spectrum can be reused with different criteria. But, if the power levels of a user are not controlled, it may result in some interference to both co-channel and adjacent channel users.

Apart from this, in the event of a random movement of the mobile user, the mobile tries to be connected to the nearest base station all the time, maintaining certain minimum signal. So, every time the mobile moves from place to place, its received power levels at the base station also vary. If the user is at the edge of the cell, the mobile tries to increase its power. This results in using up of the battery of the mobile quickly. Hence, power control has become extremely important not only for suppressing the interference and increasing the capacity of the system but also for enhancing the battery life.

III. METHODOLOGY

3.1 BACKGROUND REVIEW

The basic problem in mobile communications is the efficient use of the radio spectrum. In overcoming, this problem, the mobile communications have evolved significantly from 1st generation (1G) to 3rd generation (3G) and now are heading towards the 4th generation (4G). The early cellular telephony system was based on the Frequency Division Multiple Access (FDMA), where the entire spectrum is divided among users and there are separate channels for uplink and downlink communications.

The First Generation cellular systems in the early 1980s basically catered to the requirements of voice communications only.

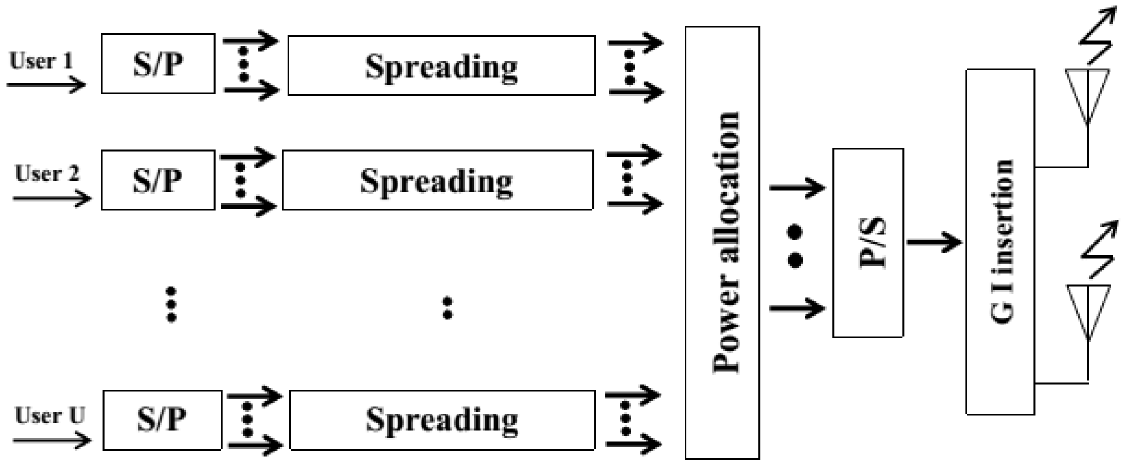

Fig 2; **the introduction of data**

Multicarrier CDMA (MC-CDMA) technology is the one of the major key solution for the development in future wireless communication systems. The further improvement of data transmission with the limited bandwidth is achieved by multiple-input multiple-output (MIMO) structure. The MC-CDMA system is subject to limiting factors such as multiple-access Interference (MAI) and inters carrier interference (ICI) and these interferences diminish attainable throughput performance. The transmission strategy to avoid the interference noise is by its power allocation to each user.

The capacity enhancement in Multi Carrier Code Division Multiple Access (MC-CDMA) technique with multiple antennas at both the transmitter and the receiver is achieved by restricting interference noise through power control method at transmitter. Due to time varying nature of the channel, channel fading is not identical to all sub carriers. So, the allocation of sub carriers to the users according to the instantaneous Channel State Information (CSI) also improves the capacity of the MCCDMA system. In this paper, the maximization of capacity in MCCDMA-MIMO system is achieved through dynamic allocation of sub carriers to each user and power allocation to constrain total power at transmitter. Power is distributed among all users with the help of SINR that is received by the transmitter instead of getting full Channel State Interference. The sub carrier group assignment is implemented by selecting best sub carriers with maximum Signal to Interference and Noise Ratio (SINR) value and user's rate requirements. The performances of capacity improvements and outage probability reduction in MCCDMA-MIMO are analyzed with various diversity sizes (SISO, 2×2, 4×4).

Multicarrier code-division multiple access (MC-CDMA) is used to suppress multipath and to overcome the multipath channel estimation problem in single-carrier SIC systems. In addition, an optimal power control algorithm for MC-CDMA, allows analytical bit-error rate expressions to be found for an uncoded system. Multiple access techniques must be wisely managed. This perspective is pivotal since the variations in propagation channel are very fast and the system is highly complex due to random and unpredictable movement of mobile users continuously. This complexity in the cellular system periodically contributes to different interference levels, high or low, resulting in the degradation of the system capacity. Transmitter power control is an efficient technique to mitigate the effect of interference under fading conditions, combat the Near-Far problem and conserve the battery life. In this paper, Objective function is defined as maximum channel capacity in a power constraint scenario. The signals in a radio channel undergo different propagation effects like reflection, refraction, scattering and shadowing. A smooth surface reflects the signals. But, when the signals encounter sharp edges of buildings, they are refracted, while a rough surface scatters them. When these signals are obstructed by big buildings, they pass through them causing the shadowing effect. All these effects cause the channel to be lognormal, Rayleigh and Rician distributed.

The fading of signals is categorized as fast or multi-path fading and slow or shadow fading. The fast fading of signals is due to the rapid change of the signal amplitude and phase due to the multi-path arrival of the signal. Similarly, the slow fading of the signals is due to the shadowing effects caused by the buildings, mountains, hoardings etc. These fading channels are modeled by a log normally distributed random variable. In fact these fading problems can be used in a constructive way to boost the signal strength. For instance, multi-path fading is best utilized using Multi Input Multi Output (MIMO) antennas.

I.V. POWER CONTROL

The primary purpose of power control is to maintain the acceptable Carrier to Interference Ratio (CIR) by meeting some Quality of service (QoS) requirements. So, it is obvious that all the transmitters should transmit with different power levels since every

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transmitter (Mobile station in our case) is at a different distance and the signals experience different fades. **Open Loop Power Control**; is generally used in combating the Near-Far and shadowing problems. As the name itself indicates, this power control does not have feedback mechanism as the mobile itself dynamically adjusts its transmitting power. The mobile tries to estimate the signal strength on the forward pilot channel (Base to Mobile) and decides its transmitting power. If the mobile senses a large power then, the mobiles assumes that the base station is near and reduces its power level and vice versa.

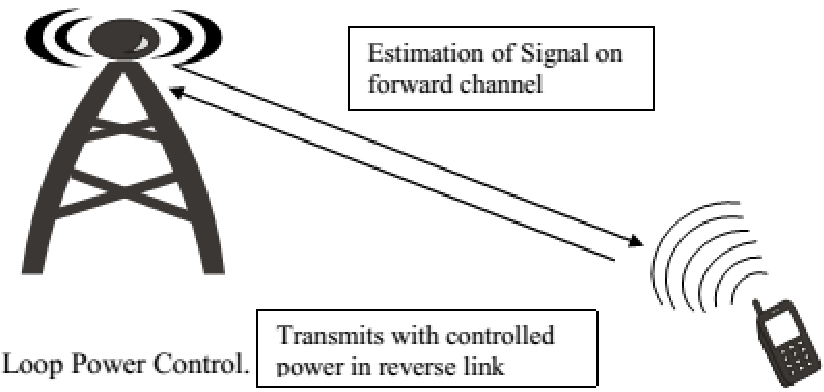

Fig 3; Open Loop Power Control.

Closed Loop Power Control; is used in combating the fast fading effects, generally caused by multi-path fading. This mechanism is also termed as 'fast power control' as it deals with the fast fading. Since the forward and reverse links are considered to be highly uncorrelated, the feedback mechanism is employed in this power control. The base station estimates the signal from the mobile in the reverse channel (Mobile to Base) and compares that signal-estimate with a predetermined signal level and sends the appropriate power control command to the mobile station as illustrated in fig.4.

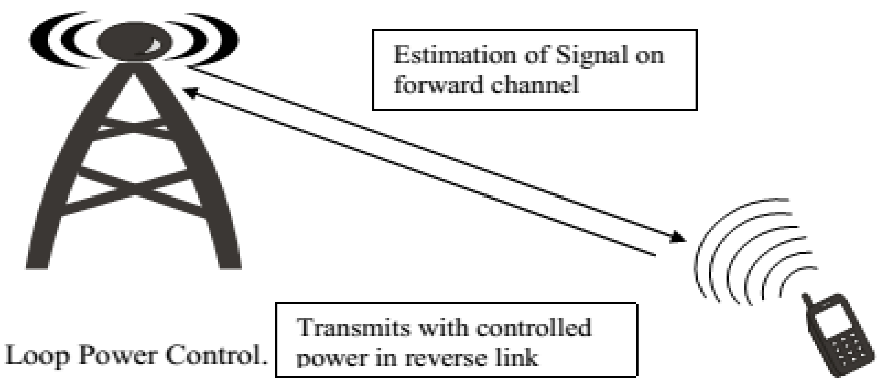

Fig.4 closed loop power control.

Outer Loop Power Control is used to maintain different CIR levels depending on the QoS requirement. The signal from the mobile in the reverse link is measured and its frame error rate (FER), is calculated. This FER is compared with the predetermined FER depending on the QoS. If the measured FER is not equal to the Estimates the signal on the reverse channel Compares with target and Sends power control command Mobile adjusts the TP and transmits back. Centralized Power Control is a mechanism with a central controller having the information of all the link gains of the system. These link gains are utilized to find the optimal solution to control the power in all the links simultaneously. This type of power control is practically unrealizable, since the equipment is complex and there is extreme signaling between base stations.

De-Centralized or Distributed power control is based on the local link gain measurements. Each base station measures its local parameters like link gain and CIR to control the power in that link. This type of power control is practically realizable since it does not involve complex signaling and is easier to implement.

Some of the advantages of power control can be briefly summarized as:

- Suppression of Near-Far problem
- Reduction of adjacent and co channel interference.
- Improvement of QoS
- Enhancement of system capacity

- Enhancement of battery life.

V. CONCLUSION

The distribution of users across subcarrier groups as well as their transmission powers within a given cell has a significant effect on how users and power are accordingly distributed elsewhere in the network to maximize the capacity of the system. Hence the concept of power control in MC-MCDA its performance by different basic distributed power control are seen to be basic interference problem solving techniques in today's wireless communications, the advantages of Multiple carrier - Code division multiple access techniques is in its use of smaller bandwidth.

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