

SIGNAL TO INTERFERENCE-NOISE RATIO BASED FIXED STEP SIZE POWER CONTROL ALGORITHM FOR WCDMA SYSTEM

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ABSTRACT

Third-Generation based Wide Band Code Division Multiple Access (W-CDMA) systems have been designed for variable data rate services accessible to large number of users. But Co-channel, multichannel interference and noise is a major factor in constraining the performance of WCDMA systems. Power control is an essential function to remove these limiting factors and to enhance the network performance. In this paper power has been controlled by taking fixed step size instead of taking a range of power control step sizes. The power control step of 1.75 dB has been used to control the increment or decrement of the transmitted power based upon the received transmit power control command (i.e. TPC) at the mobile station from the base station. This has been done by taking applications of high data rate as per the requirement of network. The simulation result show that transmitted power (i.e. updated transmitted power) has been increased when the calculated SIR is less than target SIR and vice versa. It has also been shown that level of calculated user signal to interference ratio has been decreased as the data rate increases. The selection of target signal to interference value may increase the system capacity by completing the process faster.

Keywords: WCDMA Networks; Sirtarget, Sircalculated, Required Output Power

I. INTRODUCTION

The third generation based WCDMA is the radio access method that provides low data rate voice to high data rate multi-media services. WCDMA utilizes direct sequence spread spectrum (DSSS) technique that spreads the baseband data by directly multiplying the baseband data pulses with a pseudo-noise sequence. The PN code can be generated by using Barker codes, Walsh codes, Gold codes etc. [1]. The advantages of DSSS like soft capacity, improved handoff mechanism, good signal quality and user security make it the best choice over other multiple access schemes and also increases the WCDMA demand in mobile communication market [2]. But multiple accesses, co-channel interference and various kinds of fading puts a limit on system performance and the capacity of network [3]. Various kinds of techniques have been adopted in literature to improve the WCDMA system performance [4-8].

Power Control (PC) is the best alternative to enhance the performance of WCDMA system. Power control is needed in both uplink and downlink direction in FDD as well as TDD systems for reducing the co-channel interference. The detail of power control mechanism can be given in soft hand-over mode, ordinary and compressed mode in order to improve the system performance [9]. Various power control algorithms have been used to increase system performance. A new game algorithm for power control in cognitive radio in which, considered power not only fulfill the system SINR requirements but also includes the effect of threshold power. Adaptive power control algorithm for third generation based network that has dynamic range of transmitted power step size [10-12]. Network capacity for high data rate applications is increased by considering smaller value of target SIR.

The cellular CDMA networks control algorithms utilizes the concept of signal to noise ratio in calculating the required output power for transmission at various data rate application. This is due to fact that each slot of WCDMA frame contains 15 time slot with 10 ms duration of the frame. The downlink transmitted power has a fixed value during a given time slot. Slots are updated according to the SIR comparison in WCDMA network. Downlink power control uses the method of closed loop used to counter the uplink near far effect. The main mechanism behind this is that it uses the calculated SIR in the same path.

In this paper we studied the proposed power control algorithm of WCDMA for high data rate applications by calculating the user SIR based upon the received power of a user at the base station. TPC command is generated in the form of 0 and 1 by the base station .Where 0 and 1 is define the decrease or increase the transmitted power. Updated power value is transmitted by the mobile station based upon the received transmit power control command (TPC) from the base station. Process is terminated at the base station if for updated transmitted power, calculated SIR is nearly equal to the target SIR. The power control step of 1.75 dB has been used to control the updated transmitted power. This step will either increase or decreases the updated transmitted power value. For sending the request for decreasing updated transmitted power, transmitted power is divided with power control step of 1.75 dB and for increasing updated transmitted power calculated SIR is multiplied by 1.75 dB. All these work has been done for high data rate applications. So by this way updated transmitted power is controlled by base station.

The organization of the remaining paper is as follows: In section II we have studied about the power control in WCDMA system. In section III, basic system model is described used at the base station. In section IV, proposed power control algorithm is presented. The detailed experimental results and discussions are given in section V. Finally, we conclude the paper in section VI.

II. POWER CONTROL IN WCDMA SYSTEM

Power control can reduce the interference in both global and CDMA mobile system. Power control is classified into centralized and distributed power control. Centralized power control having the central controller. The function of the controller is it collects all link gain information of the system. Then, power is controlled by finding the optimal solution using all the link gain simultaneously. Disadvantage of this power control is it is

practically unrealizable as the complexity of the equipment and bandwidth is wasted due to the extreme signaling between base stations. In distributed power control each base station measures the link gain and SIR to control the power in that local link. Compared to centralized power control it is practically realizable as it does not have complex signaling and its implementation is also easy.

Distributed power control divided into two parts. One is open loop power control and other is closed loop power control. In open loop power control technique, user entity (UE) has the ability to set its output power to a specific value that can be suitable for receiver. Output power is adjusted by evaluating the channel interference. In this, received power level of the signal from the BS in the downlink is measured by the UE. If the user entity receives less power from base station then it is obvious that there is large distance between UE and base station and UE is required to increase the power. Such that adjusted power level is inversely proportional to the signal level from the BS in the downlink. The open loop power control tolerance is ± 9 dB at normal conditions and ± 12 dB at extreme conditions.

Closed loop power control is based on SIR measurements at the cell receiver i.e. at the base station and output is sent from the B.S to the UE. Closed loop contains inner and outer loop power control. UE uses the command to adjust the transmitting power for the BS; this is done by the inner loop having control frequency of 1500Hz. This method gives much better results than the open loop technique. One of the disadvantages of this power control technique is that for any changes in the channel condition its response is slow. In uplink, When BS receives the UE signal; it compares the signal strength with the pre-defined threshold value at the BS. Threshold (target SIR) value is adjusted constant by the outer loop power control. If the UE transmission power exceeds the threshold value, the BS sends a Transmission Power Command (TPC) to the UE to decrease its signal power. If received signal is lower than the threshold target then BS sends a command to UE to increase its transmission power.

The basic mechanism of algorithm used to set the updated transmitted power in closed loop power control technique is given as

- if calculated SIR is greater than target SIR then base station will request to UE to decrease the transmitted power;
- if calculated SIR is less than target SIR then base station will request to UE to increase the transmitted power.

III. BASIC SYSTEM MODEL

Power control can be modeled with the help of user SIR and target SIR on the uplink WCDMA system. The uplink case is explained and the SNR of J^{th} user is given by [13]

$$SNR = \left(\frac{w}{v \cdot r} \right) \left(\frac{P_j}{(PNF + i)} \right)$$

Where w is the chip rate, v is the voice activity factor, r is the data rate, P_j is the received power from user J , PNF is the background noise floor including thermal noise within communication system and i is the co-channel

interference of user J and is defined as the interference power coming from other links operating at the same frequency band within the communication system affects the power control in WCDMA. Power control mechanism take place at the base station and the signal transmitted by the UE which is received at the base station is used for the SIR calculation. The uplink capacity of single cell would be maximized by minimizing the required power [14].

IV. PROPOSED POWER CONTROL ALGORITHM

The proposed power control algorithm is based on received power level at the base station. Here the target SIR, co-channel interference and noise level is set constant for the calculation of user SIR at the base station for the uplink power control. Base station send the transmit power control command(i.e. TPC) to the user entity in order to increased or decreases the transmitted power such that the calculated SIR of the received power at the base station become nearly equal to the given target SIR. The step size of 1.75 dB is used to define whether the updated transmitted power is increase or decrease for controlling the power.

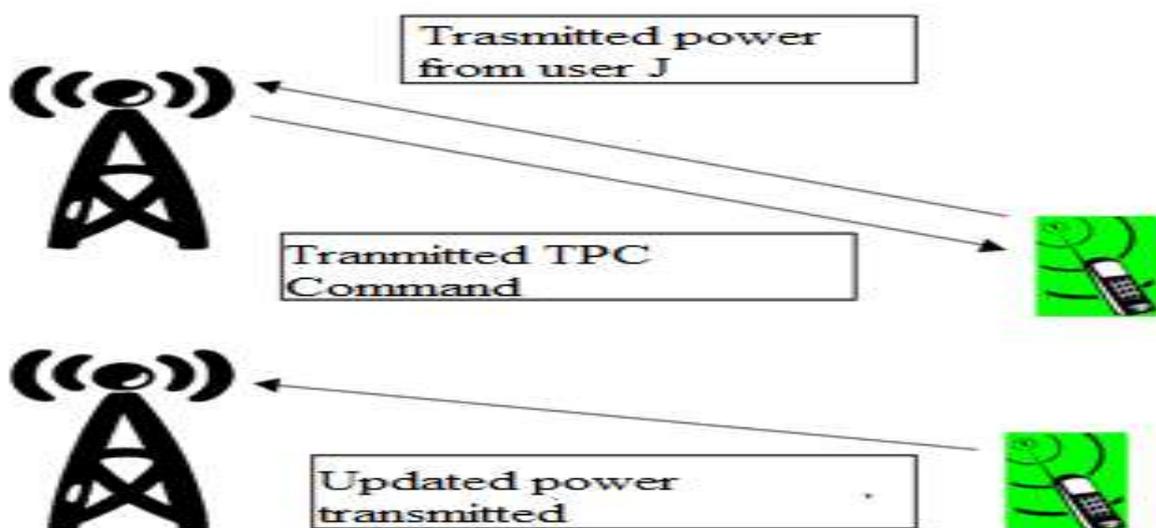


Figure 1. Uplink Updated Transmitted Power

In figure 1, describe the basic steps of proposed power control algorithm. User entity transmitting the power to the base station that is calculated as user SIR by the base station and it is compared with the constant target SIR of the base station. Base station sends the request to the user entity to increase or decrease the transmitted power (i.e. updated transmitted power) for the better communication .In figure 2,3 and 4 procedure of above mentioned at 144kbps and 384kbps data rate is define in the form of flow chart. Process is terminated in case of 144 kbps if new calculated SIR of the user after received updated power is in between 30 to 32 dB otherwise it is continue . For 384kbps, process is terminated if new calculated SIR of the user after receiving updated power is in between 25 to 27 dB otherwise it is continue.

In proposed power control algorithm at the base station, the transmitted power for the base station is set for the uplink direction as follow:

- If the calculated SIR is greater than target SIR, request is send (i.e. TPC=0) to decrease the transmitting power.
- If the calculated SIR less than target SIR, request is send (i.e. TPC=1) to increase the transmitting power.

In figure 4, flow chart of mobile user is explained as: TPC command is received at the mobile station. If received command is 0 or 1 then user is required to decrease or increase the transmitted power.

In proposed power control algorithm at the mobile station, the transmitted power for the base station is set for the uplink direction as follow:

- If mobile user received TPC=0, divide the received power of the user J by 1.75 dB.
- If mobile user received TPC=1, multiply the received power of user J by 1.75 dB.

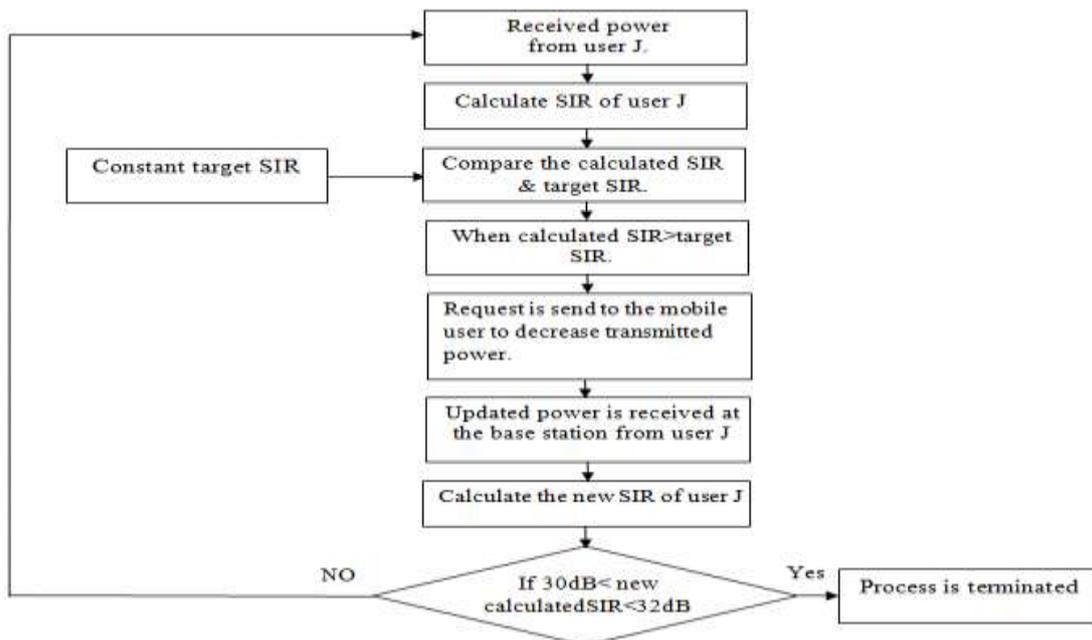


Figure 2. Flow Chart of Updated Transmitted Power when calculated SIR is greater than target SIR at the base station.

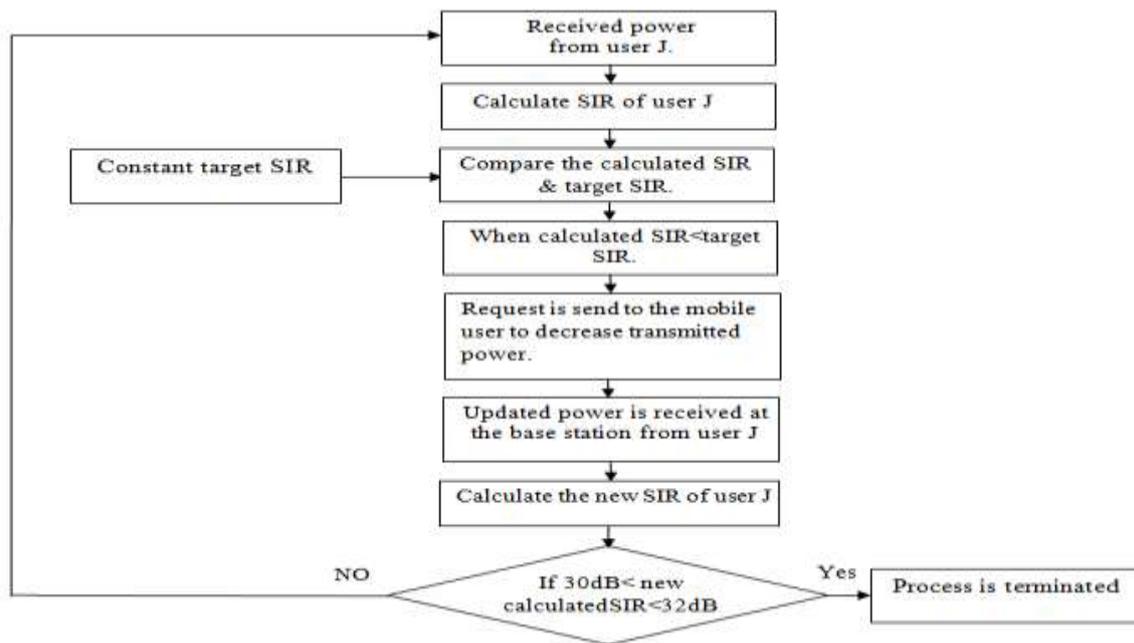


Figure 3. Flow Chart of Updated Transmitted Power when calculated SIR is less than target SIR at the base station.

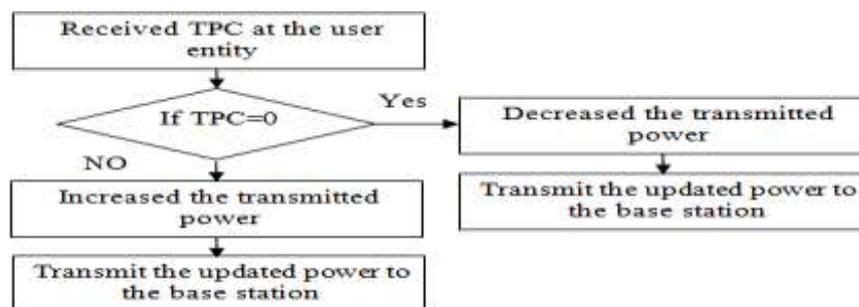


Figure 4. Flow Chart of Updated Transmitted Power at the mobile station.

V. SIMULATION AND RESULTS

In this section, computer simulations have been conducted to validate the proposed method by observing the graphs in between transmitted power of users and updated transmitted power of the users for better communication and to increase system capacity. Here only one WCDMA cell with 1 BS (1×1) is considered.

The simulation on multi-user (i.e. 7) is performed where one user is controlled at a time and others acts as interference. The number of mobile users (UE's) in the simulated zone is 7 for 144kbps, 256kbps and 384kbps data rate application. Here, various parameters such as chip rate (w) is taken as 3.84Mcps, voice activity factor (v) is 1 has been taken for analysis. The co-channel interference is usually taken 0.6. In proposed algorithm a constant target SIR at the base station is considered which is taken as 31 dB for 144kbps and 26 dB for 384kbps for all links. Updated power calculated the new user SIR whose results shows either to terminate or continue the

process.

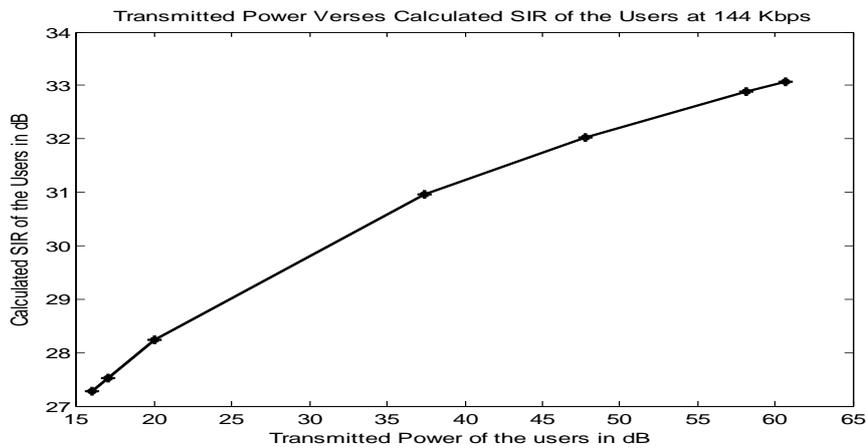


Figure 5. Transmitted Power Verses Calculated SIR of the Users at Data rate 144 kbps.

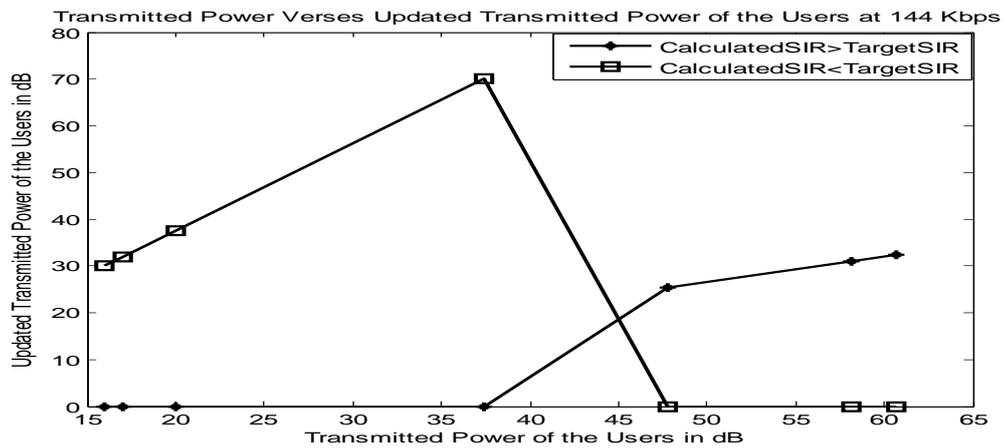


Figure 6. Transmitted Power Verses Updated Transmitted Power of the Users at Data rate 144kbps.

User no. (J)	Transmitted Power from the J th user (P _J) (dB)	Calculated SIR of User J (dB)	Updated Transmitted Power (dB)	New calculated SIR	Result(30dB<t arget SIR<32dB)
1.	16.02	27.28	30.04	30.00	Process is completed
2.	16.99	27.53	31.86	30.26	Process is completed
3.	20.00	28.24	37.50	30.96	Process is completed
4.	37.40	30.96	70.14	33.68	Process is continue
5.	47.78	32.02	25.48	29.29	Process is continue
6.	58.20	32.88	31.03	30.14	Process is completed
7.	60.71	33.06	32.37	30.33	Process is completed

Table1-Updated Transmitted Power Values w.r.t User no. for 31dB target SIR.

In figure 5, graph has been plotted in between transmitted power verses calculated SIR of the users working at data rate 144 kbps. Graph shows with increasing the transmitted power of the users there will be increase in the value of calculated SIR of the user at the base station. In figure 6, it is observed that the updated transmitted power increases if calculated SIR of the user is less than the target SIR of the base station and vice-versa as define in table1. This is due to fact that as obvious that as the calculated SIR of user at the base station is less than target, and then the user is required to increase its power and vice-versa.

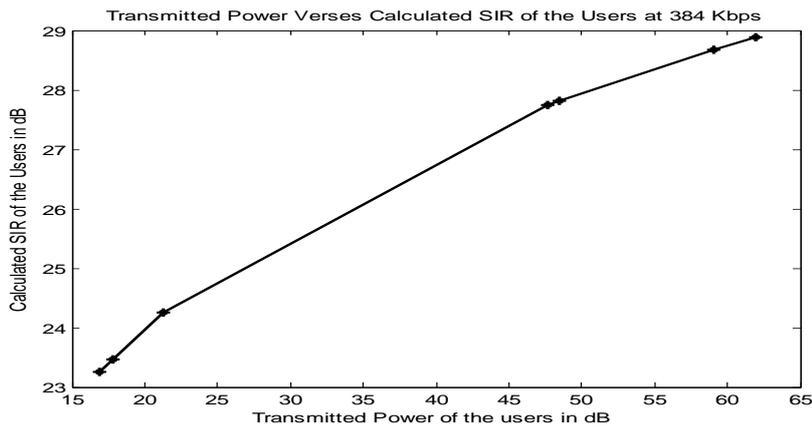


Figure 6. Transmitted Power Verses Calculated SIR of the User at Data rate 384kbps.

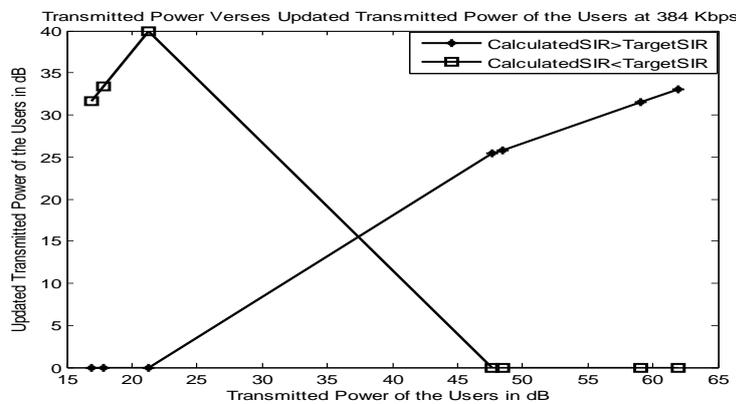


Figure 7. Transmitted Power Verses Calculated SIR of the User at Data rate 384kbps.

User no. (J)	Transmitted Power from the J th user (P _J) (dB)	Calculated SIR of User J (dB)	Updated Transmitted Power (dB)	New calculated SIR	Result(25dB< target SIR<27dB)
1.	16.90	23.25	31.69	25.97	Process is completed
2.	17.78	23.47	33.34	26.19	Process is completed
3.	21.30	24.25	39.95	26.98	Process is completed
4.	47.68	27.75	25.42	25.02	Process is completed
5.	48.71	27.82	25.82	25.08	Process is completed

6.	59.03	28.68	31.48	25.94	Process is completed
7.	61.97	28.89	33.04	26.16	Process is completed

Table2- Updated Transmitted Power Values w.r.t User no. for 26 dB target SIR.

In figure 6, graph has been plotted in between transmitted power verses calculated SIR of the users working at data rate 384 kbps. Graph shows with increasing the transmitted power of the users there will be increase in the value of calculated SIR of the user at the base station. In figure 7, it is observed that the updated transmitted power is increases if calculated SIR of the user is less than the target SIR of the base station and vice-versa as define in table2. This is due to fact that as obvious that as increasing the data rate, calculated SIR of the users decrease and then it is significantly required to increased the amount of transmitted power of the user and vice-versa under the condition of smaller target SIR at high data rate to accommodate large number of users. This is due to fact that as obvious that network capacity is increased if target SIR is lowest for high data rate applications.

VI.CONCLUSION

We studied the power control in 3G WCDMA based on received power from the mobile users. We notice that the proposed power control algorithm is easily implemented at fixed power control step. We show some result of the proposed power control algorithm at high data rate. The important parameters of proposed power control algorithm is target SIR. The fastest termination of the proposed power control algorithm may give a capacity increase and prevent from wastage from resources.

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- [14] A.G.Flattie, "Capacity improvement for WCDMA network," in 6th Joint IFIP Wireless Mobile Networking Conf., Dubai, UAE, pp. 1-7, April 23-25, 2013

EXAMPLE FOLLOWS

BOOKS

- [1] T.S.Rappaport. Wireless Communications: Principles and Practice, Prentice Hall, New Jersey, 2004.

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