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Multimedia Networks based Dynamic WCDMA System Proposal for QoS

Anubhuti Khare, Manish Saxena, Shweta Tiwari

Abstract: **In WCDMA 3rd Generation (3G) systems although there is no need for frequency planning as the case with second generation (2G) systems, the limitation of both capacity and coverage by the interference level in the system rendered the planning task for 3G systems far more complex than 2G systems. As the 3G radio networks now more sensitive to radio environment and traffic conditions, the advantage of dropping frequency planning could be cumbersome due to difficulties linked to what is called Cell-Breathing Phenomenon (CBP). In this work we propose a Dynamic WCDMA system that adjusts the spreading factor adaptively to overcome this problem. The simulation design will have the output of mapping the network load in terms of the number of users to the E_b/N_0 required; this will give the network controller an idea about the number and type of users that may cause coverage to shrink i.e. start cell breathing. Therefore the network controller will be able to decide on the number and type of users admitted to the network at specific times.**

Index Terms*: D-WCDMA, *Coverage, cell breathing, Multimedia services

I. Introduction

Good system performance in terms of capacity, coverage and QoS measures are preserved through especially well designed Radio resource allocation schemes. In WCDMA these three system performance parameters are interrelated. In fact these parameters depend very much on the received bit energy-to-noise density ratio E_b/N_o given by:

$$\frac{E_b}{N_o} = \frac{S}{I} \cdot \frac{W}{R} \qquad (1)$$

Where *S* is the signal strength, *I* is the total interference at the receiver, W is the system bandwidth and R is the bit rate of the Mobile User (MU).
or higher in order to be considered within the coverage area of the cell's Base Station (BS). The ratio (*W/R*) is called processing gain or spreading factor (SF). In a WCDMA system a large spreading factor (processing gain) is achieved. The interference any user sees is averaged over a large ensemble of sources. Each user attempts to achieve an acceptable signal to interference-plus-noise ratio (SIR). The SIR can be improved by increasing transmitted power, or reducing interference. SNR is determined by the transmission powers of the users and the gains of the radio channels between the users and base stations. An increase in the transmission power of a user, or in the channel gain between a user and a base station, increases its E_b/N_o, but also increases the interference to other users, causing a decrease in their E_b/N_o s. On the other hand, an increase in the processing gain (decrease in the transmission rate) of a user also increases its E_b/N_o, but decreasing the transmission rate prolongs the time duration over which the user creates interference to other users. The aim of a power and rate control algorithms is to allow the maximum number of users to share the network, while meeting the minimum QoS requirements.

In this paper we continue the work started in [1] and [2] about the problem of cell breathing in WCDMA System. We propose a dynamic WCDMA system that can adjust the processing gain adaptively. We extend the study by considering two types of service real-time (RT) and non-real-time (NRT) Services. The users of RT services, such as voice and low-rate video, have no tolerance for delay but can withstand some amount of transmission errors, whereas the users of NRT services, such as data communication (paging, electronic mail, fax, file transfer, etc.), are sensitive to transmission errors but are tolerant to delay. We assume that NRT users have a variable bit rate during transmission of data, depending on the BER and cell load. This will allow the system to control the coverage area by adaptively varying the transmission bit rate. It is worth noting here that the proposed standard for third-generation mobile communication systems supports variable processing gain (variable-rate transmission) for packet data [3] and [4].
The rest of the paper is organised as follows, in section 2 we overview the WCDMA network as well as the cell breathing section 3. In section 4 we present the results and discussions. This paper is concluded in section 5.

II. CELL BREATHING

A. WCDMA System Overview

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* Correspondence Author (s)
Dr. Anubhuti Khare*, Reader, Department of Electronics and Communication, University Institute of Technology, Rajeev Gandhi Technical University, Bhopal (M.P.), India Email:- anubhutikhare@gmail.com , Mobile:+919425606502.
Manish Saxena, Head of Department of Electronics and Communication, Bansal Institute of Science and Technology Bhopal (M.P.), India Email:- manish.saxena2008@gmail.com , Mobile: +919826526247.
Shweta Tiwari, Student, M. Tech (Digital Communication), Bansal Institute of Science and Technology Bhopal (M.P.), India email- shweta.tiwari86@gmail.com Mobile 91-7828982256.

The WCDMA UL system, shown in Figure 1, illustrates the different transmission stages required. In this system transmission power varies among users, some users will have to transmit at higher power than other users due to higher fading or interference affecting the MS transmitted signal. This is controlled via the Radio Resource Management (RRM) at the BS.

Each cell contains numbers of users who transmit on the same channel and have exactly the same transmitter structure, but with different scrambling and spreading codes.

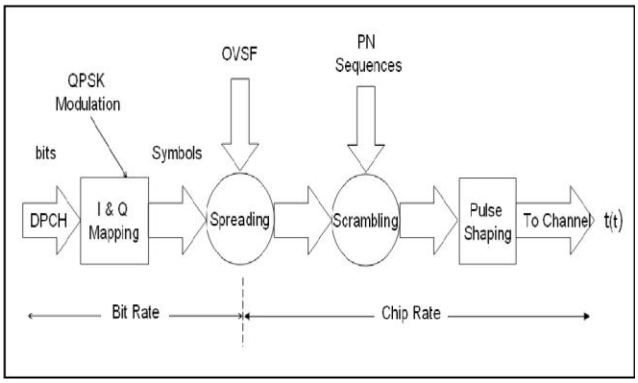

Figure 1. WCDMA Transmitter block diagram for UL

WCDMA systems use RAKE receivers as they take into account the multipath effects that propagating signals encounter. It utilises multiple correlators to detect the strongest multipath signals, which are time-shifted version of the original transmission.

Figure 2 below shows the stages through which the multipath composite received signals are processed. The received signal $r(t)$ is actually a combination of multipath signals which the reviver antenna has combined and passed through to the rake fingers.

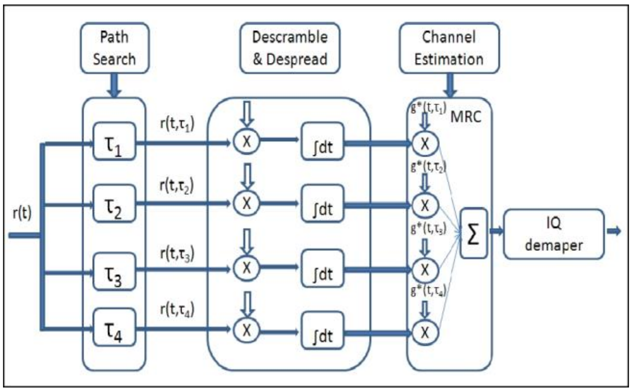

Figure 2. WCDMA RAKE Receiever

Unlike FDMA/TDMA systems in WCDMA, all users access the same frequency band simultaneously. Each communication channel is separated by modulating the data signal with a noise-like carrier, which is unique for the link, and spreading the modulated signal over a large frequency bandwidth. Since the signal appears like noise over the channel, the signals from all other users constitute a certain level of interference. This leads to a new definition of capacity; the *soft-capacity*. According to this concept it is permitted to accept more users to the cell at the price of a slight loss in quality in terms of mean Signal-to-Interference Ratio. Due to this soft-capacity nature of WCDMA networks, the coverage of a cell depends intensely on the desired QoS in terms of sustainable interference level, spatial mobile user distribution and the corresponding time-dependent user traffic intensity. Hence, it depends on the dynamics of the power control procedure used to adjust interference [5].

The fact that capacity in WCDMA networks is influenced by the number of users in the cell has let the cell coverage area be considered as elastic. This cell breathing effect leads to an iterative approach to compute the power allocated to each user and the level of interference. These computations depend directly on the user locations and on the services (data rate) used. Thus, 3G-radio network planning is performed through simulations of a user and service distributions. The total power, P_t, transmitted by the BS is given by the following equation:

$$P_t = \frac{N_r W \bar{L} \sum_{j=1}^{N} \nu_j \frac{(E_b/N_o)_j}{W/R_j}}{1-\eta_{DL}} \qquad (2)$$

Where $\bar{L}$ the average path loss between BS and MU, Nr is the noise at the receiver; η_{DL} is the load factor at the downlink. Load factor η is a measure of how much the cell is loaded. The higher the load factors the higher the load of a cell. In WCDMA the system is interference limited therefore the loading is a function of the received interference. Where P_n is the noise power at the receiver

$$I = P_n / 1 - \eta \qquad (3)$$

where P_n is the noise power at the receiver. From the link

budget equation (2), the path loss L could be obtained; consequently the cell range can be readily calculated for a known propagation model, for example the Okumura– Hata model. The propagation model describes the average signal propagation in that environment, and it converts the maximum allowed propagation loss in dB to the maximum cell range in kilometers [6].

B. Cell Breathing

Cell breathing happens when part of the cell loses coverage and becomes 'dead area' this can be explained from Uplink (UL) perspective as follows: when a new mobile user admitted to the network the interference observed by each user in the cell increases, and their SINR (ε) at the BS decreases and required to transmit with higher power to compensate for the increase in the interference level. Eventually as more users are admitted to the network, users at the edge of the cell are transmitting with their maximum power. As MU's move closer to the cell boundary they will run out of the necessary power to maintain the connection; then they will be dropped. In effect the cell coverage has shrunk. This means that during periods of low traffic, such as in the early morning,

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users can take advantage of a relatively large footprint for cell coverage. But as the traffic level rises during the day, MU's on the outer edges of a particular cell may effectively lose coverage and suddenly find that they are unable to make or receive calls as shown in Figure 3.

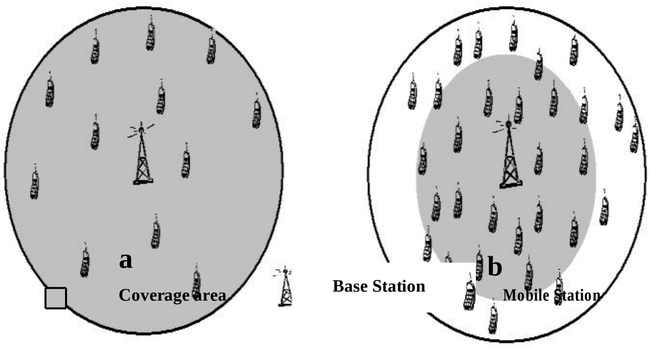

Figure 3. Cell breathing phenomenon (a) cell with light loading (b) coverage after cell breathing

From downlink perspective the CBP occurs as a result of the BS available power being insufficient to support more mobile users in that cell. Since users at the edge of the cell require higher power from the BS, these users will be dropped and the cell size is reduced. One way to solve this problem is by implementing more BSs which means an added cost that might not be affordable. Another approach is to use antenna tilt and varying transmitting power at the BS, and beamforming antennas or higher order antenna diversity reception [7] and [8]. Other approaches to alleviate the problem of cell breathing have dealt with the physical nature of antennas, improvements of the materials used, mechanical/electrical tilts for better reception and even combinations of sectorisation with macro and micro cells [2].

What we are proposing in this paper is a dynamic WCDMA (D-WCDMA) System which can adjust the coverage of the cell through adjusting the spreading factor. Rather than measuring coverage of the cell directly as a distance, the received BER of MS are used as a coverge function. As more MS's admitted to the network BER will deteriorate in some areas which indicate no coverage. Reducing the bit rate to accommodate higher priority users has been proposed in the scheme was called bandwidth reallocation. The bit rate (bandwidth) reduction was performed in level-by-level basis, and system performance was evaluated through simulation in terms of dropping probability and blocking probability. Similar scheme was proposed in the only difference with the one in [9] is that the reduction of bandwidth is performed now in a single step in order to admit new call at faster rate. The objectives in [10] were the same as in [9] and they do not include the effects on coverage planning of the network.

III. PROPOSED ALGORITHM

The proposed D-WCDMA system adjusts SF through a feedback loop in order to guarantee the QoS for current users. This eventually reduces the data rate. However, this will allow more users at a given QoS to be accommodated by the cellular network, also preventing call dropping in the coverage area.

Figure 4 shows a D-WCDMA system, which can be used to control the SF at the transmitter *TX*. The Receiver stage *RX* processes the received frames and checks the BER. If BER is not desirable, then the Receiver *RX* passes a message to the *TX* to adjust the SF i.e. when

BER is high, then SF is increased and vice versa. In other words, this feedback channel allows the system to adapt to new changes that are taken to reduce the BER or increase it depending on the wireless channel effects.

The algorithm design will have the output of mapping the network load in terms of the number of users to the E_b/N_0 required. This will give the network controller an idea about the number and type of users that may cause coverage to shrink i.e. start cell breathing. Therefore the network controller will be able to decide on the number and type of users admitted to the network at specific times.

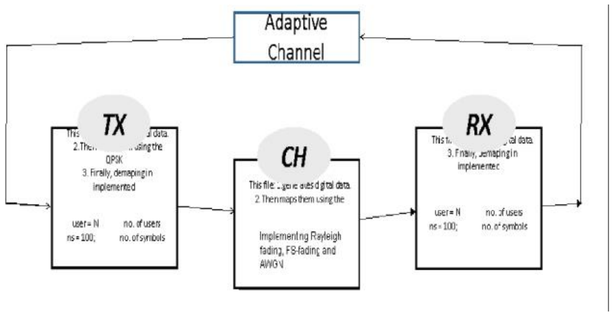

Figure 4. Proposed Algorithm

IV. RESULTS AND DISCUSSIONS

Figure 5 shows the simulation results obtained from the proposed system in Figure 4, Other simulation parameters are shown in Table 1. Three different BER results are used to specify different services in multimedia environment, i.e. data, voice and video channel. In order to maintain a fixed QoS, the proposed algorithm uses high SF when the signal power is small, i.e. small E_b/N_o. On the other hand, the system will have to reduce the SF as the signal power increases i.e. channel effects are insignifica.

In effect this D-WCDMA system reduces the impact of the Cell Breathing phenomena. In Cell Breathing, when a cell becomes heavily loaded with users, the BS noise floor appears to rise, which necessitates the increase in the power transmission. However, there is a limit to this transmission power that can be tolerated. Thus, some users are handed over to less heavily-loaded neighbouring cells.

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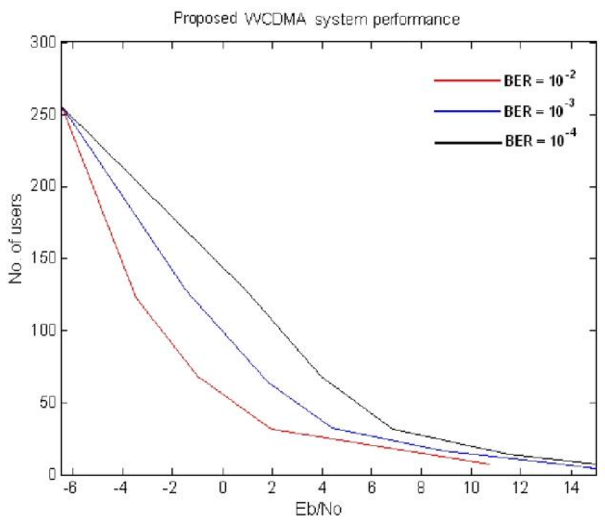

Figure 5. D-WCDMA system performance with controlled QoS

V. CONCLUSIONS

In this paper we have proposed an algorithm that mitigates the cell breathing phenomenon by controlling the spreading factor in the up-link channel for different services in the 3G network. The algorithm is based on the interaction between the capacity and coverage of cell in WCDMA system. This interaction has led to the emergence of the CBP in the first place. The derivation of the algorithm shows how many degree of freedom a network designer has to control the coverage area of a cell and to mitigate the adversity of the CBP.

The algorithm output adjusts the network load in terms of the number of users to the E_b/N_0 required. This is shown to give the network controller an idea about the number and type of users that may cause coverage to shrink i.e. start cell breathing. Therefore the network controller will be able to decide on the number and type of users admitted to the network at specific times.

[TABLE I: PARAMETERS USED IN SIMULATION]

Parameter	Value
Maximum transmission power (Voice)	21 dBm
Maximum transmission power (Data)	24 dBm
E_b/N_o *Voice*	7 dB
E_b/N_o *Data*	5dB
Activity factor *Voice*	0.6
Activity factor *Data*	1.0
Voice bit rate	12.2 kbps
Data bit rate	64 kbps, 32 kbps,12.2 kbps
Log-normal fading margin	4 dB
Other cell to own cell interference ratio	0

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REFERENCES

1. O. Alani and H. Ali, “Power control scheme to combat cell breathing phenomenon in 3G mobile systems”, Int. J. Mobile Network Design and *Innovation*, vol. 1, Nos. 3/4, pp.234-239,
2. 2006.
3. M. Al-Akaidi, H. Ali, and O. Alani,”Performance analysis of antenna sectorisation in cell breathing”, *MESM03, IEEE UKRI SPC*, Publisher EUROSIS, *January*, 2003.
4. F. Adachi, M. Sawahashi, and H. Suda, “Wideband DS-CDMA for next generation mobile communication systems,” *IEEE Commun. Mag.*, vol. 36, pp. 56–69, Sept. 1998.
5. E. Dahlman, B. Gudmundson, M. Nilsson, and J. Skold, “UMTS/IMT-2000 based on wideband CDMA,” *IEEE Communications Mag.*, vol. 36, pp. 70–81, Sept. 1998.
6. K. Tutschku, , K. Leibnitz, and T-G Phuoc, () ‘Teletraffic issues in mobile communication network planning’, Presented at the 11th ITC Specialised Seminar on Multimedia and Nomadic Communications, Japan., October, 1998.
7. S. Saunders, ‘Antennas and Propagation for Wireless Communication Systems’, John Wiley& Sons, 1999.
8. I. Siomina, P. Värbrand, and Di Yuan, “Automated optimization of service coverage and Base Station antenna configuration in UMTS networks,” *IEEE Communications Mag*., vol. 13, Dec., pp.
9. 16–25, 2006.
10. E. Amaldi,; A. Capone; F. Malucelli, “Optimizing UMTS radio coverage via base station configuration,” *Proc. The 13th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, vol. 1 pp. 315 – 319, 2002.
11. Y.C. Yee, K.N. Choong, Andy L.Y. Low, S.W. Tan and S.F. Chien “A conservative approach to adaptive call admission control for QoS provisioning in multimedia wireless networks”
12. *Elsevier Computer Communications*, Vol. 30, pp 249-260, 2007.
13. F. Prihandoko, M.H. Habaebi, B.M. Ali () “Adaptive call admission control for QoS provisioning in multimedia wireless networks”, *Elsevier Computer Communications,* Vol. 26, *pp 1560*