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Comparative Study of Various Power Control algorithms in WCDMA

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Abstract — **Power control is an essential radio resource management method in CDMA cellular communication systems, where co-channel and adjacent-channel interferences are the primary capacity limiting factors. Power control intends to control the transmission power levels in such a way that required quality of service for the users is guaranteed with lowest possible transmission powers. This paper presents a comparative study between the power control algorithms.**

Keywords —**WCDMA, Power Control, FSPC, ASPC, MASPC.**

I. INTRODUCTION

The WCDMA air interface is organized in frames of 10 ms duration. A frame contains 15 time slots and each slot includes one PC command (up or down), which gives a PC update rate of 1500 b/s. The transmitted power has a fixed value during a given time slot. Power control in WCDMA is a closed-loop PC that is a combination of outer and inner closed loop control. The inner (also called fast) closed loop PC adjusts the transmitted power in order to keep the received Signal-to-Interference Ratio (SIR) equal to a given target. This SIR target is fixed according to the received BLER (Block Error Rate) or BER (Bit Error Rate). The setting of the SIR target is done by the outer loop PC, which is part of the Radio Resource Control Layer (layer 3), in order to match the required BLER. Outer loop PC update frequency is 10-100 Hz. The BLER target is a function of the service that is carried. Ensuring that the lowest possible SIR target is used results in greater network capacity. This target SIR is estimated on the basis of received BER and estimated BER for the system and this is an input to the inner loop power control. The inner closedloop PC measures the received quality, defined as the received Signal-to-Interference Ratio (SIR) and sends commands to the transmitter (i.e., the mobile in the case of uplink) for the transmitted power update. For updating the mobile station's power different algorithms may be used. Main purpose of the inner loop power control is to get the individual SIR of the MS's towards the targeted SIR value that have been determined by the outer loop power control[1].

II. CONTROL ALGORITHMS

Based on propagation conditions, the mobile may receive a power control command that specifies at what power level the mobile should transmit. However, the losses on uplink and downlink are not symmetric because Rayleigh fading is frequency-selective. To mitigate this, a closed-loop power control is needed to vary the transmitted power by the mobile based on measurements made at the base station, so that it can receive an equal E_b/I_0 from all mobiles. However, because of the existence of a multipath fading environment, it is useful to add another power control mechanism to adjust the desired E_b/I_0 level according to the mobile's error rate measured at the bases station; this is known as the outer loop power control [2].

There are many power control schemes n WCDMA i.e. Distance based power control, Distributed Balancing, Multi-Step SIR-based Power Control, Fixed step power control etc. Here we presenting and comparing three of them:

FIXED STEP POWER CONTROL ALGORITHM: FSPC algorithm uses a fixed step size to converge towards no outage. If a mobile is found in outage in iteration then power is adjusted (increased) by factor δ (Step Size), and if a mobile is found in non-outage in iteration then power is adjusted (decreased) by factor δ.

ADAPTIVE STEP POWER CONTROL ALGORITHM: ASPC is a variation of the MSPC (Modified Step Power Control) algorithm that uses an adaptive step size to achieve faster convergence towards no outage. This algorithm uses the information from the previous iteration in order to adapt the step size accordingly.

It uses two parameters to calculate the step size, one is μ (increment factor) and another is ν(decrement factor). If a mobile is found in outage then it looks that what the previous state (outage or non outage) was of the mobile, if it was in outage then the power is adjusted(increased) by factor μδ, (δ-Step Size), and if it was in non-outage then power is adjusted by factor δ. In other case when a mobile is found in non-outage then it looks that what the previous state (outage or non outage) was of the mobile, if it was in non-outage then the power is adjusted(decreased) by factor νδ and if it was in outage then power is adjusted by factor δ [2].

MODIFIED ADAPTIVE STEP POWER CONTROL ALGORITHM:
MASPC is an algorithm that work much similar to ASPC but with a bit variation. This algorithm also uses the information from the previous iteration in order to adapt the step size accordingly like ASPC. If a mobile is found in outage then it looks that what the previous state (outage or non outage) was of the mobile, if it was in outage then the power is adjusted (increased) by factor μδ, (δ-Step Size), if it was in non-outage then power is adjusted by factor δ, and if the initial power allocation caused by this mobile in outage then power is adjusted by factor μδ. In other case when a mobile is found in non-outage then it looks that what the previous state (outage or non outage) was of the mobile, if it was in non-outage then the power is adjusted (decreased) by factor νδ, if it was in outage then power is adjusted by factor δ and if the initial power allocation caused by this mobile in non-outage then power is adjusted by factor δ [2].

III. SIMULATION

The numerical hypothesis of the simulated system model for the mobile network is now given, all algorithms is evaluated in simulation. Simulation of all algorithm stated above is done with MATLAB (R2009a) on PC (Intel core i-3 processor, 2GB RAM, Windows-7) for scenario given below:

1. Radius of WCDMA Cell : 10 km
2. Number of Mobiles : 50
3. Distance of each mobile : Random

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4. Gain for each link : Random
5. Target SIR : -25 db

IV. RESULT

Result of simulation is shown in figure-1 below, the figure show the difference between the convergence speed to nooutage of FSPC, ASPC and MASPC.

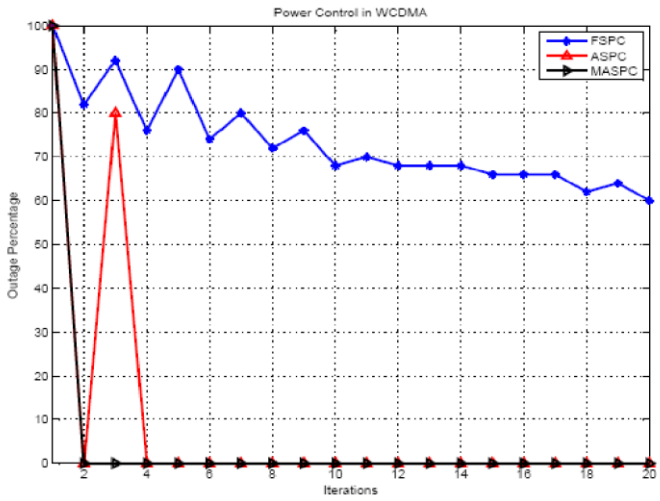

Figure-1 Convergence Speed of Power Control Algorithms

IV. CONCLUSION

Comparing the algorithms FSPC, ASPC, MASPC algorithm, we could realize that each has some better aspects regards to the other. To visualize this factor graphically, here we have presented the figure obtained by simulation above. Hence it can be claimed that MASPC gives far better stability to the communication system than that of ASPC at the expense of increased complexity.

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