# Research Issues in Wireless
## Communications and Networking

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## CHAPTER 4

# A COMPREHENSIVE STUDY OF CLOSED-LOOP POWER CONTROL SCHEMES IN CDMA COMMUNICATION SYSTEM

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### 4.1 INTRODUCTION

Wireless cellular communication systems have experienced a rapid growth during the last two decades. The first-generation (1G) systems were analog and provided wireless speech service. The major improvement in the transition to second-generation (2G) systems was the digital transmission technology, which enabled the use of error correction coding and increased service quality and capacity [1]. The 2G systems have evolved further to provide also packet-switched data service in addition to the conventional circuit-switched services like the familiar speech service.

In CDMA systems the users transmit their signals simultaneously in the same frequency band. Each user is given a dedicated spreading code, which is used to identify the users in the receivers by correlating the received signal with a replica of the desired user's code. Power control (PC) aims to control the transmission powers in such a way that the co-channel interference is minimized. In this study the power control techniques investigated and analyzed.

Transmission power control (TPC) is vital for capacity and performance in cellular communication systems, where high interference is always present due to frequency reuse. The basic intent is to control the transmission powers in such a way that the interference power from each transmitter to other co-channel users is minimized [2].

### 4.2 THE POWER CONTROL MODEL EMPLOYED IN THIS STUDY

The algorithms chosen in this study are targeted to improve the TPC performance in the presence of the practical limitations. The assumption behind the preferred algorithms is that the implementation of TPC is done using the combination of open loop, closed loop and outer loop PC.

The closed loop PC algorithm employed in UMTS and IS-95 systems is a fixed-step power control (FSPC) algorithm. This type of algorithm has been presented in [9]. It is given by

$$p_i(t+1) = p_i(t) + \delta \, sign(\gamma_i'(t) - \gamma_i(t)) \tag{4.1}$$

where all the variables are in decibels, pi(t), $\gamma_i'(t)$ and $\gamma_i(t)$ are the transmission power, SIR target and measured SIR, respectively, of user i at time t. $\delta$ is the fixed step size.

$$sign(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ -1 & \text{if } x < 0 \end{cases} \tag{4.2}$$

$$\gamma(t) = p(t-n) - g(t) - I(t) \tag{4.3}$$

The power control system model is illustrated in Figure 4.1 for uplink. The n-sample delay block models the power control loop delay. Note that the integrator in the mobile unit inherently includes a delay of one sample. Hence the total loop delay is k = n + 1. At time t the base station measures the uplink SIR.