Chapter IV

Space-Time Wireless Communications (a.k.a. Smart Antennas)

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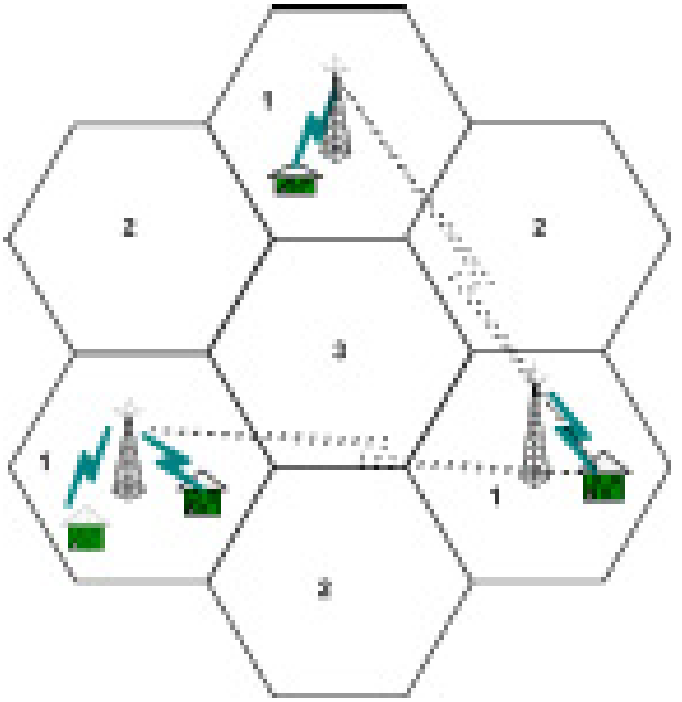
INTRODUCTION

The rapid progress in radio and electronics technology has triggered a communications revolution. Mobile wireless networks are being deployed throughout the world to meet increasing consumer demand. Wireless service revenues are currently growing at about 40% per year and these trends are likely to continue for several years.

A mobile wireless network (see Figure 1) has a cellular architecture. Each cell has a base station (BTS) that services multiple users. The BTS communicates with the users (forward link) and the users communicate to the BTS (reverse link). Typically, adjoining cells (cells 1, 2 and 3 in Figure 1) in a cluster are allotted distinct frequency blocks. These blocks are used once every n cells, where n is the cluster size or equivalently the frequency reuse factor. Radio links suffer from interference from cells that share the same frequency block. This interference is known as co-channel interference.

Successful deployment of wireless networks presents a number of challenges. These include limited availability of radio frequency spectrum, a complex, time-varying wireless environment, and user demand for higher data rates, better quality of service, fewer dropped calls, higher capacity and user coverage. A number of different radio technologies, using sophisticated

Figure 1. Mobile wireless network



transmit and receive processing schemes, have been used to meet such diverse requirements.

Space-time processing technology is a powerful and recent tool to improve system performance. In this technology, multiple antennas and space-time processing are employed at the transmitter (Tx) and/or at the receiver (Rx). A space-time modem operates simultaneously on all antennas, processing signal samples both in space and time. Smart antennas provide four main leverages, namely *array gain, diversity gain, interference reduction*, and *multiplexing*. These leverages can be used to improve coverage, link quality, data rate and system capacity in a cellular network (see Table 1).

Table 1. Space-time processing leverages in a cellular network

	Coverage	Link Quality	Capacity	Data Rate
Array Gain	X	X		
Int Reduction		X	X	
Diversity		X	X	
Multiplexing			X	X