Research Issues in Wireless Communications and Networking

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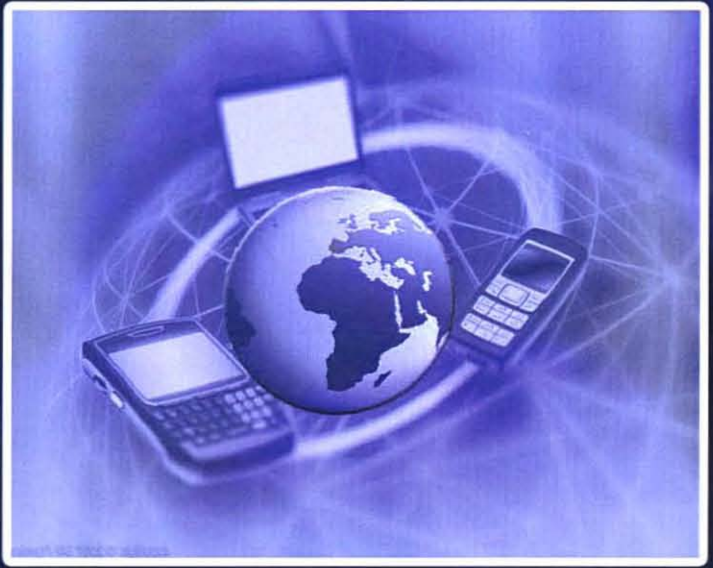

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CHAPTER 24

Performance Evaluation of Free-Space-Optic (FSO) Links

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24.1 INTRODUCTION

Once the knowledge about the basic performance parameters is gained it is possible to evaluate the performance of FSO links. Such is done firstly by evaluating all possible losses present in the channel, such as geometric, atmospheric and optical losses [1, 2]. Geometric losses are greatly dependent on the divergence angle and distance while atmospheric losses are created due to the signal's weakening due to atmospheric influence, or due to external performance factors mentioned earlier [3, 4]. Optical losses on the other hand are due to the physical configuration of each FSO terminal, and in some cases are negligible, as will be explained later in text. Knowing the losses or attenuation within the channel it is then possible to evaluate received power level and link margin, the main figures needed in order to evaluate the performance of FSO links [4, 5, 6].

24.2 LINK MARGIN

Observing power at the receiver and calculating the link margin, one can determine factors that affect quality of the link. Link Margin (LM) [7, 8], usually expressed in decibels, is a ratio of the received power and receiver sensitivity (*s*), or amount of power received above minimum detectable power equation (24.1).

$$LM = 10 \log \frac{P_R}{s} \tag{24.1}$$

For example, if a receiver sensitivity is $s = 10\ nW$, and the power received is $P_R = 100\ nW$, the link margin would be 10 dB:

$$LM = 10 \log \frac{P_R}{s} = 10 \log \frac{100}{10} = 10\ dB \tag{24.2}$$

For signal to be recovered at the receiver's side, its power must be higher than receiver sensibility or receiver threshold. Receiver threshold is usually given by manufacturer and it ranges from -20 to -40 dBm [9, 10].

Power at the receiver (Bloom, 2002) can be expressed as:

$$P_R = P_T * O * \frac{A_{RX}^2}{(A_{TX} + \theta L)^2} * e^{-\sigma L} \tag{24.3}$$

Where: P_R and P_T are power at the receiver and transmitter respectively (*mW*), *O* are optical losses, A_{RX} is receiver aperture area (*m*), A_{TX} is transmitter aperture area (*m*), θ divergence angle (*mrad*), σ atmospheric attenuation coefficient (km^{-1}) and *L* distance between transmitter and receiver (*m*).

As shown in the equation (24.3), power at the receiver is directly proportional to the transmit power and receiver aperture area, but inversely proportional to the link range and