802.11® Wireless Networks

The Definitive Guide

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802.11® Wireless Networks: The Definitive Guide
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Printed in the United States of America.

Published by O'Reilly & Associates, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

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Editor: Mike Loukides

Production Editor: Matt Hutchinson

Cover Designer: Ellie Volckhausen

Printing History:

April 2002: First Edition.

ISBN: 0-596-00183-5

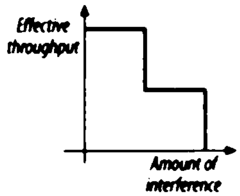

Figure 10-17. Throughput response to interference in DSSS systems

separated by an adequate amount. Generally speaking, interference between two direct-sequence devices is a problem long before a primary band user notices anything.

Differential Phase Shift Keying (DPSK)

Differential phase shift keying (DPSK) is the basis for all 802.11 direct-sequence systems. As the name implies, phase shift keying (PSK) encodes data in phase changes of the transmitted signal. The absolute phase of a waveform is not relevant in PSK; only changes in the phase encode data. Like frequency shift keying, PSK resists interference because most interference causes changes in amplitude. Figure 10-18 shows two identical sine waves shifted by a small amount along the time axis. The offset between the same point on two waves is the phase difference.

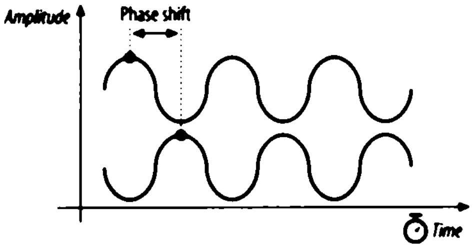

Figure 10-18. Phase difference between two sine waves

Differential binary phase shift keying (DBPSK)

The simplest form of PSK uses two carrier waves, shifted by a half cycle relative to each other. One wave, the reference wave, is used to encode a 0; the half-cycle shifted wave is used to encode a 1. Table 10-6 summarizes the phase shifts, and Figure 10-19 illustrates the encoding as a phase difference from a preceding sine wave.

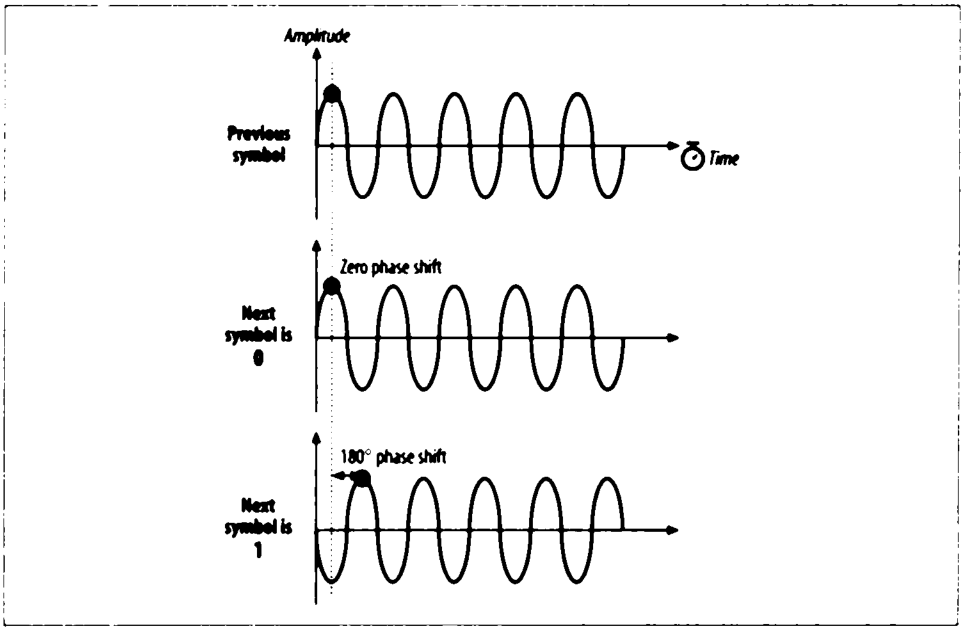

Figure 10-19. DBPSK encoding

Table 10-6. DBPSK phase shifts

Symbol	Phase shift
0	0
1	180° (π radians)

To stick with the same example, encoding the letter M (1001101 in binary) is a matter of dividing up the time into seven symbol times then transmitting the wave with appropriate phase shift at each symbol boundary. Figure 10-20 illustrates the encoding. Time is divided into a series of symbol periods, each of which is several times the period of the carrier wave. When the symbol is a 0, there is no change from the phase of the previous symbol, and when the symbol is a 1, there is a change of half a cycle. These changes result in "pinches" of the carrier when 1 is transmitted and a smooth transition across the symbol time boundary for 0.

Differential quadrature phase shift keying (DQPSK)

Like 2GFSK, DBPSK is limited to one bit per symbol. More advanced receivers and transmitters can encode multiple bits per symbol using a technique called differential quadrature phase shift yeying (DQPSK). Rather than a fundamental wave and a half-cycle shifted wave, DQPSK uses a fundamental wave and three additional waves, each shifted by a quarter cycle, as shown in Figure 10-21. Table 10-7 summarizes the phase shifts.

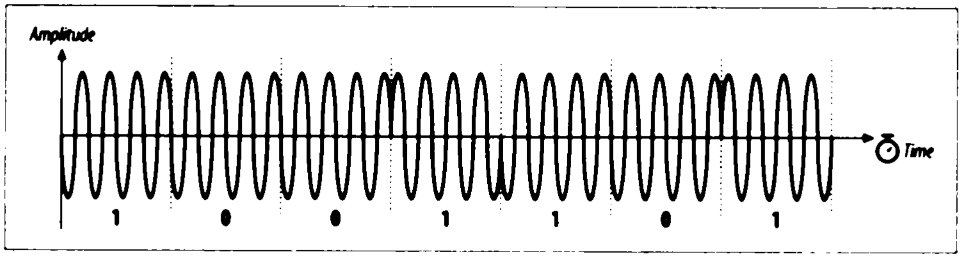

Figure 10-20. The letter M encoded in DBPSK

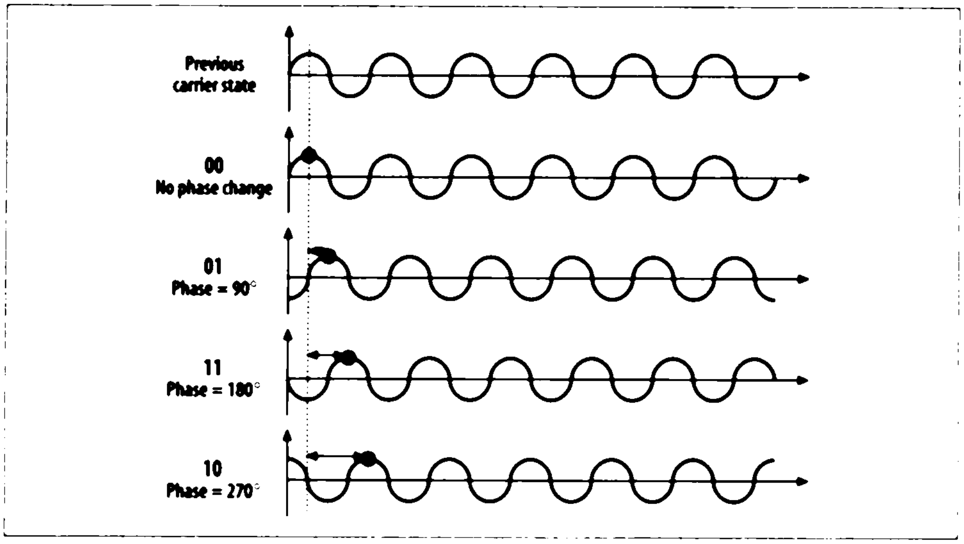

Figure 10-21. DQPSK encoding

Table 10-7. DQPSK phase shifts

Symbol	Phase shift
00	0
01	90° (π/2 radians)
11	180° (π radians)
10	270° (3π/2 or −π/2 radians)

Now encode M in DQPSK (Figure 10-22). In the UTF-8 character set, M is represented by the binary string 01001101 or, as the sequence of four two-bit symbols, 01-00-11-01. In the first symbol period, there is a phase shift of 90 degrees; for clarity, the figure shows the phase shift from a pure sine wave. The second symbol results in no phase shift, so the wave continues without a change. The third symbol causes a phase shift of 180 degrees, as shown by the sharp change from the highest amplitude to the lowest amplitude. The final symbol causes a phase shift of 90 degrees.

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