

802.11b

Wireless DSSS LAN

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VOCAL Technologies, Ltd. modem software libraries include a complete range of ETSI / ITU / IEEE compliant modulations, optimized for execution on ANSI C and leading DSP architectures (ADI, AMD-Alchemy, ARM, DSP Group, LSI Logic ZSP, MIPS and TI). This software is modular and can be executed as a single task under a variety of operating systems or it can execute standalone with its own kernel.

IEEE 802.11. This standard specifies a 2.4 GHz operating frequency with data rates of 1 and 2 Mbps using either direct sequence (DSSS) or frequency hopping spread spectrum (FHSS). IEEE 802.11b data is encoded using DSSS (Direct Sequence Spread Spectrum) technology. DSSS works by taking a data stream of zeros and ones and modulating it with a second pattern, the chipping sequence.

In 802.11, that sequence is known as the Barker code, which is an 11-bit sequence (10110111000) that has certain mathematical properties making it ideal for modulating radio waves. The basic data stream is XOR'd with the Barker code to generate a series of data objects called chips. Each bit is "encoded" by the 11 bit Barker code, and each group of 11 chips encodes one bit of data.

The CCK (Complementary Code Keying) achieves 11 Mbps. Rather than using the Barker code, CCK uses a series of codes called Complementary Sequences. Because there are 64 unique code words that can be used to encode the signal, up to 6 bits can be represented by any one particular code word (instead of the 1 bit represented by a Barker symbol)

The wireless radio generates a 2.4 GHz carrier wave (2.4 to 2.483 GHz) and modulates that wave using a variety of techniques. For 1 Mbps transmission, BPSK (Binary Phase Shift Keying) is used (one phase shift for each bit). To accomplish 2 Mbps transmission, QPSK (Quadrature Phase Shift Keying) is used. QPSK uses four rotations (0, 90, 180 and 270 degrees) to encode 2 bits of information in the same space as BPSK encodes 1. The trade-off is increase power or decrease range to maintain signal quality. Because the FCC regulates output power of portable radios to 1 watt EIRP (equivalent isotropic radiated power), range is the only remaining factor that can change. On 802.11 devices, as the transceiver moves away from the radio, the radio adapts and uses a less complex (and slower) encoding mechanism to send data.

802.11b Terminology:

- The MAC layer communicates with the PLCP via specific primitives through a PHY service access point. When the MAC layer instructs, the PLCP prepares MPDUs for transmission. The PLCP also delivers incoming frames from the wireless medium to the MAC layer. The PLCP sublayer minimizes the dependence of the MAC layer on the PMD sublayer by mapping MPDUs into a frame format suitable for transmission by the PMD.
- Under the direction of the PLCP, the PMD provides actual transmission and reception of PHY entities between two stations through the wireless medium. To provide this service, the PMD interfaces directly with the air medium and provides modulation and demodulation of the frame transmissions. The PLCP and PMD communicate using service primitives to govern the transmission and reception functions.

802.11b Features:

- The CCK code word is modulated with the QPSK technology used in 2 Mbps wireless DSSS radios. This allows for an additional 2 bits of information to be encoded in each symbol. Eight chips are sent for each 6 bits, but each symbol encodes 8 bits because of the QPSK modulation. The spectrum math for 1 Mbps transmission works out as 11 Mchips per second times 2 MHz equals 22 MHz of spectrum. Likewise, at 2 Mbps, 2 bits per symbol are modulated with QPSK, 11 Mchips per second, and thus have 22 MHz of spectrum. To send 11 Mbps 22MHz of frequency spectrum is needed.
- It is much more difficult to discern which of the 64 code words is coming across the airwaves, because of the complex encoding. Furthermore, the radio receiver design is significantly more difficult. In fact, while a 1 Mbps or 2 Mbps radio has one correlator (the device responsible for lining up the various signals bouncing around and turning them into a bit stream), the 11 Mbps radio must have 64 such devices.
- Figure 1 shows the digital modulation of data with PRN sequence.
- Figure 2 shows the Modified Walsh Transform uses for the reception of DSSS signal.

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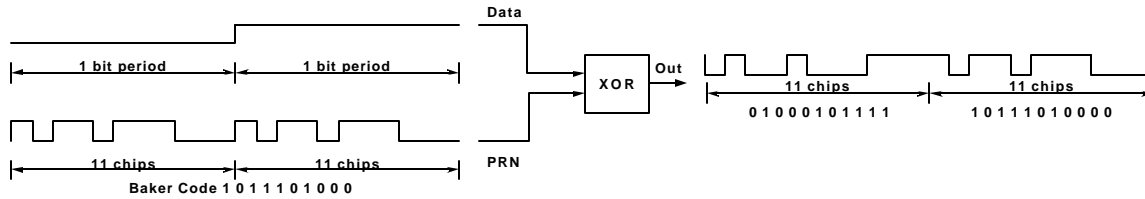


Figure 1. Digital Modulation of Data with PRN sequence

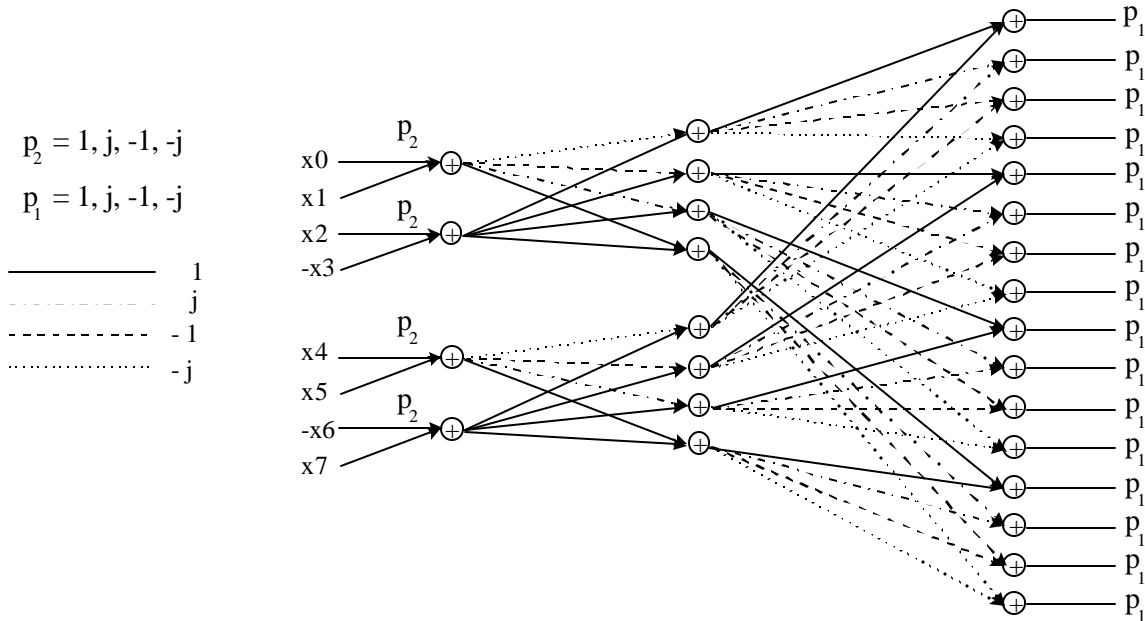


Figure 2. Modified Fast Walsh Transform.

802.11b Implementations:

- The wireless physical layer is split into two parts, called the PLCP (Physical Layer Convergence Protocol) and the PMD (Physical Medium Dependent) sublayer. The PMD takes care of the wireless encoding explained above. The PLCP presents a common interface for higher-level drivers to write to and provides carrier sense and CCA (Clear Channel Assessment), which is the signal that the MAC (Media Access Control) layer needs so it can determine whether the medium is currently in use.
- The PLCP consists of a 144 bits preamble that is used for synchronization to determine radio gain and to establish CCA. The preamble comprises 128 bits of synchronization, followed by a 16 bits field consisting of the pattern 1111001110100000. This sequence is used to mark the start of every frame and is called the SFD (Start Frame Delimiter).
- The next 48 bits are collectively known as the PLCP header. The header contains four fields: signal, service, length and HEC (header error check). The signal field indicates how fast the payload will be transmitted (1, 2, 5.5 or 11 Mbps). The service field is reserved for future use. The length field indicates the length of the ensuing payload, and the HEC is a 16 bits CRC of the 48 bits header.
- In a wireless environment, the PLCP is always transmitted at 1 Mbps. Thus, 24 bytes of each packet are sent at 1 Mbps. The PLCP introduces 24 bytes of overhead into each wireless Ethernet packet before we even start talking about where the packet is going. Ethernet introduces only 8 bytes of data. Because the 192 bits header payload is transmitted at 1 Mbps, 802.11b is at best only 85 percent efficient at the physical layer.

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