IEEE P802.11 LAN Physical Medium

Title: **Wireless Physical Medium Technology**

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Background

There has been concern at the last few meetings that it may not be possible to design a low-power, small-size, high-performance radio PHY layer for the IEEE 802.11 wireless LAN standard product that meets the requirements of the PAR. This contribution will explore current technology related to wireless communications and offer some thoughts about a possible radio PHY that will satisfy the requirements using direct sequence CDMA spread spectrum communication technique.

Rockwell International / DCD has considerable experience developing and manufacturing, in quantity, components to interface to the physical layer of electrical, optical and RF conducting media. The expressed opinions are consistent with that experience.

1. Introduction

In general, small, low-power, low-cost components are the result of either a simple implementation or of an extensive effort, usually over several years, to reduce the complexity by optimization for a specific application. This contribution is based on the belief that it is currently possible, with a relatively simple implementation, to design and manufacture a set of components using current VLSI, DSP, RF, MMIC, and direct-sequence CDMA techniques that will provide for low-cost and power-efficient wireless LAN products. A corollary to this belief is that, over time, the requisite components will undergo further integration and thus become even more cost and power effective.

2. Digital Communication

To meet the objectives of the PAR, the near-term preferred methodology in the U.S. may be to use direct-sequence spread spectrum transmission in the 2.4 GHz ISM band. This paper is heavily based on the assumption that at least portions of the standard LAN will be operating in this frequency band and meeting the current FCC Part 15 spread-spectrum transmission requirements.

There are currently on-going trials of CDMA techniques in several frequencies, including the U.S. cellular frequencies (800-900 MHz range) and in the point-to-point microwave band (1.7-2.2 GHz band), as well as commercially available wireless PBX's utilizing the ISM bands. These trials and newly designed equipment are leading the development of techniques to control the transmitted power level of remote units to solve the near-far problem; of methodologies for soft hand-off between cells with each cell using the same frequency but with differing pseudo-random codes; of minimizing the interference to and from other users in the same band; etc. The wireless telephony trials are attempting to solve CDMA transmission issues in an environment much harsher than that expected in most wireless LAN environments. In one case, a 1 dB received power control within a dynamic range of approximately 80 dB is required. Pseudo-random codes in the billions of bits in length may be required to differentiate thousands of customers and hundreds of simultaneous users in a cell. The majority of these technological issues have a currently envisioned solution that lends itself well to integrated semiconductor components. (See References 1 and 2)

Therefore, the system for 802.11 can use many of these techniques currently being developed for adaptive power control, pseudo-random code generation, multipath equalization, etc., but in a manner considerably less complex than that required for wireless mobile telephony -i.e.within a cell covering many square miles and with users traveling 70 mph. A 31 bit Gold code (See IEEE802.11 / 91-G11) may be perfectly adequate since the code orthogonality is only needed to provide frequency reuse between adjacent cells and not to multiplex multiple users simultaneously within the cell. Furthermore, the issue of multipath interference most probably can be overcome without using diversity (antenna or finger receivers) by adopting a wideband CDMA method with at least 30 MHz bandwidth.

If a portion of the spectrum is allocated to wireless LAN's where spread-spectrum transmission is not mandated, wideband spread spectrum may still be the preferred transmission methodology. Assuming spectrum allocation with sufficient bandwidth, the methodology envisioned should be frequency independent. In a TDMA environment, for example, severe delay spreads may have to be handled by a complex equalizer. In addition, efficiency demands may require high speed DSP's for scheduling. Further if a broadband CDMA technique is not chosen, we (the Committee) may not be able to totally agree on a channel model that best represents a broad range of indoor environments.

3. Modulation and Coding

In choosing the type of modulation, it will be necessary to overcome the channel phase distortion and standing wave patterns that were outlined in the work by Michael Masleid. The chosen modulation technique should allow both coherent and non-coherent reception. An additional integral issue is the clock frequency drift tolerance specification since a proper choice of the modulation technique will minimize the complexity of frequency offset compensation in the receiver. Baseband shaping does not have to be overly complex to meet the FCC Part 15 requirements. Forward Error Correction most probably should not be used since, in most local environments, it increases the complexity of the product without sufficiently increasing the data transmission reliability . Flow control can include error detection with a resultant adaptive packet sizing for higher throughput in environments with a high bit-error-rate transmission path. (See Reference 3)

4. Radio frequency technology

Below 3 GHz, RF components are relatively inexpensive due to their widespread usage in cellular, satellite and commercial radar frequencies. Many BiCMOS and GaAs components are currently available including high-efficiency linear amplifiers and other low-power RF discrete components. Integration of RF components into GaAs MMIC's are now appearing in commercial products. (See Reference 4)

5. Baseband technology

Baseband processing can be done with VLSI and coded processors including digital signal processing. The power consumption of these components is directly related to the complexity of the processing requirements (both baseband and protocol) and the operating speed of the system. The combination of advancement in process technology allowing increasingly higher operating speeds along with a greater number of transistors per chip and the coming generation of silicon-based semiconductors capable of operating at 3.3 V will support the envisioned wireless LAN compute, integration, and power requirements.

6. Battery technology

Current battery technology used in hand-held cellular telsets allows an hour's talk time with an RF transmit power of 600 mW. The total power consumption during a conversation is usually somewhat more than double the transmit power. The "stand-by" time for a portable unit can reach close to a whole day. It is believed that a LAN design can be achieved so that a unit transmitting 100 mW can have a total power consumption in the 300 mW range and consume just several mW in the stand-by mode. This level of power consumption, in a computer powered by a battery pack similar to that currently used in laptop computers or portable cellular phones, should be acceptable for a first generation wireless local area communications product.

References

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