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# IEEE 802.4L Wireless Radio Lan Issues for March Meeting

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# 1. Introduction

This document provides a brief discussion of some of the issues that could be discussed at the 802.4L Task group meeting in March.

# 2. Ping-Pong

This section lists issues associated with the ping-pong technique suggested for the distribution system. We use the term burst to indicate a transmission on the channel either in the forward or reverse direction.

**Baseband Interface**

The time division scheme requires that the baseband interface operates with a discontinuous clock. This discontinuity occurs because each burst is a piece of the message stored in the 802.4 interface controller. We should validate that the VLSI controller, e.g. the Motorola MC68824 can operate with a discontinuous clock. Also, Draft L of the 802.4 standard mentions silence and idle as controls that pass across the interface. In a ping-pong system, we may be able to comply with the intent of these controls, but perhaps not with detailed timing requirements.

**Overhead**

We should set some ranges for the burst size. A large burst will be efficient in terms of overhead but inefficient if the data messages are short. This inefficiency can be compensated by increasing the symbol rate on the channel.

For the overhead, we envisage three requirements. A sync pattern (preamble) will be needed at the start of the burst to estimate symbol timing, set AGC levels, and make a diversity reception selection. If a convolutional code is used for error protection, an FEC flush will be needed to complete the burst decoding. A CRC check will be needed to help the distribution system select a valid message for rebroadcast. There is also a requirement for a network ID.

Say we are looking for 90% efficiency. If sync is 16 symbols, flush is 16 symbols, and CRC is 8 symbols, network ID is 16 symbols, then the burst would have to be about 560 symbols. This is 1120 bits or 140 bytes. That is, in our opinion, fairly large for a burst because many messages might be much smaller than that. Perhaps the token itself might be a smaller burst than that.

If this is an issue, we might want to reconsider having a rigid frame structure for the transmission of the data. This will also have implications on the distribution system.

# 3. Distribution System

This section discusses some of the RF considerations in implementing a factory radio distribution system. No particular conclusions are reached.

## 3.1. Impairments

Transmission will be impaired in two ways.

- The RF carriers from two transmitters may completely cancel each other out thus providing no energy to a receiver at a particular location. (A deep Rayleigh frequency selective fade)

- The delay spread may exceed one symbol thus creating intersymbol interference.

Both of these events will happen at some time in the factory environment regardless of any steps we decide to take short of reconstructing the factory. The issue is how we can design the distribution system to make outages caused by these effects tolerable. We would like to assure that these events will be transitory and that protocols will (almost) always allow the network to successfully transmit the required information.

### 3.2. RF Cancellation

To make the RF cancellation effects transitory, we need to assure that the system has enough uncertainty built into it that RF effects will naturally change with time. This means assuring that all of the oscillators are incoherent and at slightly different frequencies and certainly different phases. This will prevent any "dead spots" from existing for more than some brief periods of time. It also has the nice property of simplifying the equipment.

If we can collect some data on an oscillator short term frequency drift, a more detailed analysis can be done to estimate time constants for outages to see if the FEC will be effective in recovering bits lost due to fades. Perhaps some interleaving for the FEC would be appropriate since symbol errors during outages will be highly correlated.

### 3.3. Delay Spread

The nature of the receiver is to either integrate the multiple returns over part of a symbol time, or to select one of the returns and use it. In either case, delay spreads of longer than one symbol cause intersymbol interference. In the case of integrating over more than one chip time per symbol, increased delay spread will imply taking in more noise. This is undesirable but not necessarily fatal.

If we speak in non-relativistic terms, all of the distribution transmitters should transmit at the same time to minimize delay spread. (This seems so obvious, it is probably wrong.) Simultaneous transmission requires calibration of delays between transmitters. This is probably not too bad in a centralized system, but it may be a real problem in a bus system.

## 4. Equal Gain Combining

At the January meeting of the 802.4L task group, a philosophy for combining multipath returns was suggested. In a typical spread spectrum system, the energy from every chip in a symbol is combined and then sampled once per symbol. This presumes that the chip and symbol timings are known perfectly. This is sometimes called an integrate and dump.

In a line of sight environment, such a system is optimum. In a multipath environment it is possible to collect energy from each of the multipath returns. The idea is that the environment is sufficiently dynamic that prevents the receiver to lock to any single multipath return. An article in the June 1987 Journal on Selected Areas in Communications pp 815-823 describes this technique. It is attached for general reference. It dealt with a system in which the delay spread is a much smaller part of a symbol than the 802.4L case, but it is still interesting.

## 5. Channel Phase

If the channel phase is not stable over a symbol or two, differential phase modulation or any direct sequence spread spectrum modulation requiring a correlation receiver will have performance degradation related to the phase roll over the correlation period.

In a meeting with Ted Rappaport, he stated that he believed the channel phase to be stable over several symbols. Unfortunately, he did not take any measurements that could directly be used to confirm this. Rappaport understood the phase velocity arguments, but he didn't think they would be significant in a practical system.

## 6. Distribution System Architecture

Two architectures have been suggested for the distribution system. A bus architecture connects all of the distribution radios on a common wired LAN. A star architecture places each radio on a spoke of a wheel and a central processor in the hub to select valid messages.

In the bus architecture, each distribution radio would receive, decode and validate the parity of a burst. Each radio achieving a valid CRC check would send the entire correct message on the wired LAN. Once collisions were resolved, each radio would have a copy of the correct message ready for retransmission. The radio is, of course, more than just the radio, it is an entire receiver including baseband processing, FEC decoding and parity checking.

The centralized system would connect each radio to a central processor which would make all decisions. The radio may be simply the RF section, the demodulator, or the full unit. If it is the RF section, it will need some sort of Tx/Rx switch control.

The tradeoffs between the two systems are the usual distributed versus centralized tradeoffs. The bus system grows gracefully, requires more hardware, and is more failure resistant, the bus gives some other system such as monitor and control direct access to all of the radio units. The centralized system may need a redundant hub, it can easily distribute timing, the connections between the hub and the radio are high speed and collision-free, it is difficult to select an optimum size for the hub unit, monitor and control between the radio and the hub requires may require a separate interface from the primary information.

The issue of timing distribution is critical if the strict frame structure is maintained. If that is dropped, then the timing becomes less critical. Even so, it may still be important to synchronize transmitters for delay spread minimization.