IEEE P802.11
802 LAN Access Method for Wireless Physical Medium

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A PROPOSAL FOR A PHY LAYER MANAGEMENT SYSTEM IN WIRELESS LANS

I. The Problem

The problem of managing a wireless LAN system is more complicated than that of a "closed" hard-wired LAN. Since a radio link is utilized, the transmitted information is literally "broadcast" over the airwaves and is, consequently, far more prone to eavesdropping and interference than the wired iteration. There is nothing that can be done to eliminate the eavesdropping danger. Encryption is the only method possible, but phy layer interface standards must use a common non-encrypted format.

In addition to the usual wired LAN the wireless LAN phy-layer control should have the following capabilities:

1. Manage a dynamic propagation medium. (signals will be of highly variable intensity, often exhibiting rapid fading)

2. The propagation medium will contain much lower signal/noise ratios than is generally experienced in wired LANs.

3. The frequency bands are likely to contain undesired signals (from other LANs, other applications, other services, and possibly hostile sources)

It will be the nature of these frequency allocations that other users can appear and disappear at random. Noise levels and other interference phenomenon will also appear and disappear at random. The <u>only</u> fail-safe mode of operation will involve the receive station to repeat every bit of transmission for confirmation. The nature of the radio link will render the probability of errorless transmission to considerably less than one.

II. The Solution

The first priority to solve the usual LAN problems plus the extra complexities of a wireless environment is to develop a standards for the following parameters:

1. Frequency allocations

2. Baseband modulation/demodulation schemes
3. Multiplexing formats, be they FDMA, TDMA, or CDMA or combinations of these
4. Radio operation management system
5. LAN system management

Although these five elements are somewhat interrelated, we can treat each as an individual problem. I wish to offer a solution to #4 as the proposed solution can be applied to any solutions rendered optimum for the other requirements. The exact manifestation of the proposed solution will, of course, be optimized by considering the other parameters and a host of other conditions. This solution is intended, at this juncture, to be more of a guideline rather than a detailed LAN management solution.

The problems of radio system management for wireless LANs are nearly identical to the problems faced by the amateur radio service for the past seventy years. (The five problems sited above can almost be stated about the characteristics of the amateur bands verbatim). Therefore, a radio system management solution already exists for wireless LANs. Furthermore, if such a proposed standard were explained in this context, nearly four *million* amaterus worldwide would instntly understand the system principles! Since *most* wireless LAN design programs will have a least one amateur on the staff, the problem of education and acceptance will be minimized.

A copy of "operating standards" from the *ARRL Handbook for the Radio Amateur* including a complete listing of Q signals is provided for the readers not having been exposed to them. Nearly every conceivable scenario in a wireless LAN environment is also possible in an amateur radio environment, and these problems have been worked out over seven decades by millions of trained operators! There are a few points that need clarification to visualize the excellent fit between the two systems. Of course, in a wireless LAN environment the protocol will be managed by software as opposed to human operators in the amateur service. However, the principles are quite similar.

1. In amateur radio, each station has a unique call sign. In the wireless LAN, this might simply be an "address".

2. Amateur operation distinguishes among three types of communications:
A. Broadcast (one station transmitting to many stations and not listening to any)
B. two-way communication (two stations communicating, a keyboard and printer might serve as an analogy here)
C. "Net" operation (three or more stations communicating among themselves)

There are many possible "subroutines" of amateur net operation. For example, if two stations find they need to communicate without the others listening, they can "QSY" to another channel while the net continues, returning to the net when their "traffic" (data transmission) is completed. In any event, a "net controller", a designated station (probably the CPU station or a CPU station in a LAN system) runs the net. If two-way communications is established, a net controller is not required, since standard operating proceedure can handle this. The special set of Q signals that apply to amateur net operation are also given with the "generic" Q signals.

3. If standards for baseband transmission, data rates, FEC schemes, and the like can be adopted, the standard operating practice can avoid, or at least manage multiple users on the same band at the same time. Also, standard operating procedure allows avoidance of noise and interference on channels. When signals become weak (QSB) or there is noise (QRN) or interference (QRM), one of the easiest ways to maintain a viable link is to "QRS" or send slower (lower bit rate while narrowing bandwidth).

4. To initiate communications, (after turning on the radio) standard proceedure is to "listen" first. If after listening for a few seconds and finding no signals present, our station says "QRL?" (are you busy?) If no one answers, we can "call" (address) the station we wish to "work" (communicate with). If we don't know his "call sign" (address), we can "CQ" (calling any station). If our desired station (or others) is hearing us he will call our station and give his call sign (address). In the event of many stations responding, a "pile-up", we then inform the multitude of stations calling that we want to hear only addresses beginning with 1, then 2, etc. In most cases, many stations on the same frequency will have already organized themselves into a "net", and the net controller will have responded to our initial "QRL?". Therefore, pile-ups will be rare. However, if the net controller can't hear us, but another station in the net can, he will inform us to "QRX" (please standby) or "QSY" (go to another channel or CDMA code etc.).

Once communication is established, relative signal strength information can be exchanged (perhaps a standard text to check bit error rate rather than a simple signal strength report). This signal quality report "RST" can then be used to set a preferred bit rate, "QRS or QRQ". Since the transmitting station has no way of knowing what the receiving station is experiencing, the only way to confirm reception is for the receiver to resend the data back to the transmitting station for comparison. Now actual data transmission can begin. The station called asks "QRU?" (do you have any data for me?). The calling station then says QRU." and sends a data package. When the receiving station sends identical data back to the transmitter, the transmitter can confirm receipt "QSL". Mission accoplished.

In the case of net operation, a relay network might have to be configured "QSP". Perhaps as many as three relays might be permitted. This would allow configuration of point-to-point systems capably of a mile or more of communications using parabolic fixed antennas. Limiting it to three would also impose a practical limit of a mile or so preventing attempted use of the system over long distances. Also, as stations are moved closer or farther apart, the RST reports can also permit adjustments of transmitter power to conserve battery lives and minimize interference to other stations "QRP and QRO". Once a "net" has been established and a net control station (NCS) established, the special Q signal protocol for nets can commence.

During the course communications, several dozen other "Q" signals permit a wide range of vital commands and responses.

III. Conclusion

The adoption of amateur radio standard operating practices into a wireless LAN phy layer controller would have the following benefits:

1. Little modification of the basic amateur system would be needed to render it usable at the wireless LAN phy-layer.
2. Can manage nearly any possible radio LAN operating situation.
3. It represents a near-optimum solution (field proven under the widest possible number of circumstances for over seventy years and billions of contacts)
4. Accepted as an international standard, fully understood by over four million amateurs world-wide (literally every country on earth).