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Wireless LANS

Tentative minutes of the IEEE 802.11 TGb (2.4 GHz) meeting held at Lynnwood, WA, January 19-23, 1998

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Minutes for the Task group b meeting

Jam 19, 1998 PM
Meeting opened by John Fakatselis-Chair.. Carl Andren-Secy

AGENDA FOR JANUARY 98 MEETING

- **APPROVAL OF MINUTES**
  - **APPROVED 23-0-4**
- **BACKGROUND**
- **WLANA REPORT**
- **DISCUSSION ON SCHEDULE AND CLOSURE PROCESS**
- **TECHNICAL PRESENTATIONS**
  - **GENERAL ISSUES**
    - **98/32 MAC REQ. FOR HIGH SPEED (R. BROCKMANN, NWN)**
    - **98/33 HIGH SPEED PLCP (R. BROCKMANN, NWN)**
    - **98/23 FCC FOR DS (CHAYAT, BREEZECOM)**

- 98/37 MULTIPATH ISSUES ARCH. (M. WEBSTER , HARRIS)

- NEW PROPOSALS
  - 98/1 CFO -SS (ISHIKAWA, KDD)
  - 98/20 MODS. TO MBOK (BRODSKY , RAYTHEON)
  - 98/24 2.4 GHZ PROPOSAL (HEEGARD, ALANTRO COM.)
- PREVIOUSLY DISCUSSED PROPOSALS
  - 98/11 BCPM (JAN BOER, LUCENT)
  - 98/10 DRAFT TEXT (JAN BOER, LUCENT)
  - 98/16 2.4 GHZ PROPOSAL (J. CAFARELLA, MICRILOR)
  - 98/18 PERFORMANCE (J. CAFARELLA, MICRILOR)
  - 98/25 2.4 GHZ PROPOSAL (C. ANDREN, HARRIS)
  - 98/26 GBT9 MULTIPATH (DRAPER, GBT)
  - 98/27 GBT9 IMPLEMENTATION (DRAPER, GBT)
  - 98/29 GBT9 THROUGHPUT (DRAPER, GBT)

- SCHEDULE AND CLOSURE PROCESS (CONTINUE)
- AGENDA FOR MARCH MEETING

Rough Graphic Outline

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	Full 802.11 TGa *Rainier*	!main- TGa !te- !nance *Baker! 301*	!main- TGa !te- !nance *Baker! 301*	Excursion to Boeing	TGb *Baker*
PM	TGb *Rainier*	!main- TGb !te- !nance ! *Baker! 301*	Full 802.11 TGb *Baker*	TGb *201 + 301*	TGa Full 802.11 *Baker*
Evening	~~TGb or Combined TGa and TGb~~	TGb *Baker*	TGb *Baker*	TGa *201 + 301*	

Legend: ..... = flexible adjournment/Start

Approval of minutes … Passed (23-0-4)

Background by: John Fakatselis (chair)

WLANA report by: Jeff Abromowitz- 3COM

WLANA(Wireless LAN Alliance) is a PR org that promotes Wireless market growth. Who are the High Speed 802.11 customers? Who are the likely customers for each market segment? High speed is primarily targeted at corporate market as opposed to small office or SOHO.

Discussion of the schedule and closure process

How does the committee get to closure? Is the March meeting the one? Jon Borne suggests that we make a trade matrix and fill in the blanks. A suggestion was made to a small group of people to go off and make proposals for evaluation. Volunteers: Duane, Al Petrick, Tan Hue, John F.

Technical Presentations

General Issues

98/32 MAC requirements for the high speed PHY (NWN, Brockman). Issues derived from the MAC are to minimize the loss of bandwidth due to collisions and cell planning. Inter cell time division use physical and virtual carrier sense. Code division suffers from the near-far problem. MAC will reduce to ALOHA in this case. Frequency division provides good isolation between cells. The optimum number of channels.
Questions: Dean: Near Far with CDMA gives 12 dB versus 40 dB with FDMA. Backwards compatibility with FH? Duane: Does channelization conflict with anything else that exists in the ISM band. Bob O'Hara. What isolation is available with CDMA? Chan: CDMA with short codes is too weak to do discrimination between nearly. Jeff Fisher: Adjacent businesses use TDMA Darrol: AP coordination is not in the standard, so frequency planning is needed. Dean: The assumption of a clean spectrum is flawed.

98/33 High Speed PLCP (NWN, Brockman)

The option for the HS header is flawed in that the rate field and length field do not uniquely specify the length of the packet in microseconds. Proposed solution uses service field MSB for the extra resolution. Jon: Current stations will drop the packet if the service field is non zero. Dean: Is there a mandate to not change the existing PHY? John F. : The PAR did not specify that the PHY not be changed.

98/37 Multipath Issues (Harris, Webster)

Linear Channel distortion drives receiver complexity. A 100 ns delay spread has significant energy to 600 ns. If the symbol length is much longer than the channel delay spread as in OFDM, you can mitigate the multipath. Broad bandwidth using a RAKE process needs good correlation properties that detract from the data carrying capability of the waveform. You can get 60 ns of delay spread capability with just a few feedback taps. With more taps and FF taps, we can approach 140 ns.

Lucent: Is the impact of the filter important to the performance?
Mark: The distortion due to the channel dominates the performance.
Ad.: Does channel impulse response estimation type effect the performance.
Mark: No, almost any estimator can be used.
John C. : RAKE should not be talked about in the same sense as equalization. Channel filtering can amplify noise, but the FB taps do not.

Vic announced that : The new method of getting data is electronic copy with 20 paper copies.

98/23 FCC issues for DS (Breezecom, Chayat)

FCC conference call results in the desire to redefine the processing gain. The newer waveforms have coding gain that is inseparable from the processing gain. The primary emphasis of the spec is to protect our customers from interference and to protect others from interference from our customers. We should go to the FCC with the approach that we made our best efforts to keep to the spirit of the spec. We should have something in the standard that forces people to make robust receivers.
We should have a multipath simulators such as constructed with cables and attenuators such that all manufacturers can test for robustness.
We should go to the FCC to change the rules for FH as well. Wider FH channels is desirable.

John C. : The idea that the processing gain is defined on other that a symbol is wrong and not inconsistent.
Cees Links: Crest factor is also a reference ratio and Japan's MTT should also be considered.
Greg R.: SNRout vs. SNRin is not the only criterion. BW ratios should be used.
Ken Clemens: What the FCC ruling means that they can't go to court to stop you from transmitting
John C.: The FCC ruling says that the PG is exclusive from the baseband coding gain.
Naftali: The FCC should be supplied feedback.
Mark: NB Gaussian interferer is worse than WB Gaussian noise.
Keith: Suggests that Naftali write a letter to the FCC.
Dean: What is the approach that the letter should address?
Naftali: Our first proposal to the FCC was turned down. We can try the position that this is OK.
Dean: The one thing that does not have any objection to is the definition of Es/N0 as SNR.
John F. : What the FCC wants is that we specify a new test to define PG.
John C.: What we need to go to them with is both a definition and a test.
Straw Poll: Most people (15/6) think that the CW is insufficient.
Mark: We need a definition and then we can architect a test.

Announcement

by Vic Hayes on the public announcement of the PAR

Jan 20, 1998 PM

New Proposals

98/1 CFO-SS (Hiroyasu Ishikawa, KDD)

Carrier Frequency Offset SS for high speed 10MBps using the current MAC protocol. Japan has only one channel in the ISM band. The spectral mask is slightly relaxed from the IEEE.
The technique uses 5 carriers with Barker code spreading. The receiver used SAW matched filter detection. It does not need an equalizer. It takes 5 channels of 2 MBps terminals. Separations of 1 MHz

are used where the frequency spectrum of the correlation peak has a null. This further spreads the channel power by 5 MHz, so 22 MHz becomes 27 MHz. @ MHz would make the system more multipath robust. Needs the symbols synchronized and the carriers orthogonal. Carrier is analog summation of the 5 channels. Receiver has 5 channels of demodulation with 5 SAWs. Receiver achieves good eye opening at the desired sampling time. Five power amplifiers are needed for the output. Naftali: combiner gives 7 dB loss. Darrol: how is the PN put into the RX? It is in the SAW. Conventional diversity is OK with this technique. Tracking is by time window like conventional 802.11 receiver. For acquisition, the center channel is used and the side channels have non interfering patterns. Suggest 3 & 5 channels with 2 MHz spacing and 17 MHz channel filter BW. They used a two path model to evaluate the performance. Naftali model results next time. 1.0e-5 BER at about 13 dB Eb/N0 (1 dB IL). Needs 20 dB for PER=10% with 6 dB C/D. BER improves as delay goes to 1 symbol.
Allows 3 sub bands in the ISM band. Interference performance unknown. No change in MAC SW. They expect to be completed with test models in Feb. Will demo at NAD'98 in Vegas in April. KDD follows IEEE patent policy. Backwards compatible.

Dean: What is the SAW structure?
Hiroyasu: Full matched filter for Barker code correlation.
Chris: Is the TX power the same for all rates?
Hiroyasu: Maybe. Going from 3 to 5 channels changes the power.
Cees: What is the sampling?
Hiroyasu: For acquisition, it is 44 MHz, but for data demod it is 1 MSps.
Dean: Do you use a 2.4 GHz filter to shape the spectrum.
Hiroyasu: No. Shaping is performed in the transmitter before the upconversion.
Naftali: This is another example of overlaid waveforms. What is it's advantages?
Hiroyasu: It is backwards compatible with the 1 and 2 MBps systems.
Darrol: Do you have a way to get away from 5 Los.
Hiroyasu: We use only 1 oscillator and frequency synthesize (PLL) the others.
Carl A.: What keeps the multiple parallel channels from interfering with each other?
Hiroyasu: The offset in frequency offsets the time response, putting the correlation peak out of the expectation window, preventing the multiple channels from interfering with each other.

98/24 Modulation and Coding in WLANs, Chris Heegard, Alantro

Comments on the current proposals and how they use modulation. Suggests using new metrics i.e. Shannon rather than Eb for energy per unit. Overlapped PPM uses 5 level modulation and that seems to be undesirable relative to the 2 level QPSK. Harris' scheme is one of the original Hamming code with a minimum distance of 4.
Cees: Lucent approach is based on FCC rules and was designed to operate against multipath and this comparison is biased towards sensitivity. They also take issue with the complexity estimates
Chris: PPM introduces memory, so the equalizer is needed even without multipath. You need a lot more SNR to get the error rates.
John C.: We wanted to keep the channel symbol longer to defeat the multipath.
Chris: getting the new systems to work at the same SNR as the low rate systems.
Dean: It is not true that you use longer symbols since you upped the spread rate. The proposals looked at the constraints and implementations that could be sold on the market. Look at Hiperlan and see what we need is an approach that meets these requirements.
Chris: The standard will be a compromise. This is something we should be in the standard.
Darrol: Our simulations show that FEC does not improve the performance enough.
Jon: You should take into account the environment more. Like multipath.
Greg: Would your system be a DS system with 10 dB processing gain?
Chris: A DS system would not have the high rate since SS processing gain depends on having a thin signal spread over a large signal space.

98/20 Proposed Modifications to MBOK, Wesley Brodsky, Raytheon

MBOK needs a 5 dB backoff of the power amplifier backoff. They propose offsetting the I and Q channels by one half chip to be able to use 0 dB backoff and less spectral regrowth. Second, the propose using QMBOK at half spread rate for lower data rate for more channels in the band. This would allow 7 channels for hex cell planning. Third, they suggest 11 chip per symbols. This would eliminate the FCC question. The result would be 8 and 4 MBps rates. The spectrum is minimized at 9 to 10 MHz filter BW. Spectrum is worse with the BMBOK waveform and not conducive to OQPSK techniques.
Darrol: Are there any IP issues with this suggestion.
Wes: No, it is textbook. OQPSK is close to MSK.
Greg: If you take the baseline of 8 chips per symbol, the offset causes 16 phase rotations per symbol.? Did this double the Processing gain in so far as the FCC is concerned?
Naftali: There is a duality between OQPSK and MPSK
Don: are you considering compatibility with the low rate systems.?
Wes: No not as a primary consideration.

Previously discussed proposals

Clemens: Siemens, decided not to proceed with their proposal due to not having enough time.
Dean: Symbol has decided not to pursue their proposal since the compatibility with FH has been addressed in several of the other proposals.
Naftali: Breezecom has decided not to continue with its proposal due to limited time to spend on it.

98/26 Performance in Multipath, Golden Bridge Technologies, Darrol Draper

Using 1 to 11 Barker codes gives a variety of data rates. The lower rates handle multipath better. The header is not a contributor to the PER.

98/27 Implementation, Golden Bridge Technologies, Darrol Draper

Basically the receiver structure is RAKE. The correlator is used multiple times, one for each multiple channel. Can lock on with 16 bits of preamble or 32 for diversity.

98/29 Throughput Efficiency, Golden Bridge Technologies, Darrol Draper

The data rate needs to be negotiated, so the existing preamble is desirable. The number of codes and the gap time can be optimized for throughput. Lower rate codes are more optimal for the shorter packets under these conditions. Short headers make the throughput better.
What environments need the high throughputs? An algorithm is needed to decide on the data rate to use. It will most likely be done in the AP.

Cees: You refereed to telephone line modems. There the conditions are more stable.
Wes: The comparison between the telephone modem and the radio is good. In the radio channel, the interference is likely to be variable. The radio channel offers a good bit of variation. Therefore there is a potential to gain a benefit.

Stuart: room 301 has a printer, and Bob O'Hara has the key in room 244

Close for today
tonight there will be an Ad-hoc committee to decide on decision methodology.

Jan 21, 1998 PM

Previously Discussed Proposals Cont'd

98/16 Microlor's Submission, John Caferella

This proposal is similar to the 5 GHz proposal. There are two bandwidths, full band and half band. The CRC is computed on 4 bit symbols. Suggest synchronous scrambling. Can get up to 9 MBps in Japan. 4X4 coding also used for a spin up mode. Uses a little bit of FEC for a 8.7 MBps mode for better MULTIPATH performance. Single error correcting uses straight through processing. As a practical matter, the DPSK errors are fewer than the MOK errors. So we compute parity on the DPSK part. Uses 40 MHz separation of channels for the full band case.

Mark: how do you decide to use the FEC mode.
John: The MAC does it in retransmissions by specifying the data rate.
Ad: FEC gives gain in noise, but not for specular MULTIPATH or CCI. So it is questionable if it helps.
John: We don't specify FEC for co-channel rejection. The scrambler also helps for this.
Ad.: The gain doesn't apply to specular MULTIPATH
John: That is why we let the MAC pick when to employ it.
Wes: If you operate into a fully saturated PA, what is the backoff?
John: With fully saturated, the sidelobes come up to 40 dB from 50 dB. It is not true that carving up the spectrum into narrow bandwidth is better.

98/18 Performance of the , John Caferella

The RF is the Prism chip set with a lower power PA. The modem is 25K gates with 10K gates for control. (without the enhanced CCA features). The preamble and header take about 30us.
8 search code channels, 48 cyclic code channels. CW PG performance is 14 dB. 12 dB PG against 25% AWGN. Patent still in progress. Senses old systems with enhanced CCA.
Will add alternates to the MULTIPATH model. The sidelobes of the response, the largest is -6 dB and most are -8 dB. They suggest 25% BW NB jammer.

Greg: Does the 25% BW give any real difference from WB noise and is it representative of any real jamming source..
John: You need something that represents a large number of NB signals that tends to Gaussian.
Mark: this argument shows that more is needed than just Naftali's model.
John: this shows better PG measure than CW.
Mark: would it be hard to specify your performance in a NB environment?
John: no, but I don't have the time to do it now.
Greg: why did you include other jammers in the standard?
John F.: the selection performance specifies this
Carl: why not use 5 CW jammers
John: The 25% was far enough in the tails to avoid the anomalies and your suggestion is too complicated. How many jammers and how spaced?.
Jeff: we tried this and verified John's anomalies.
??? : Does the 4X4 case defeat the FCC's test.
John: no, the Es/N0 goes up by the 6 dB, so the test shows the same.
Wes: Does the waveform itself have a patent?
John: no, the waveform is not patented, only the details of the implementation.
Mark: you prefer a specular MULTIPATH model over a diffuse.
John: I refer to Rappaport's paper where he showed that for 3 different receiver separations as a function of threshold. At the extreme, there is diffuse multipath and noise and at the other, there a few discrete paths that dominate.
Mark: does this make the test we are using useless?

John: no
Ad: which paper do you use?
John: I'll look it up
Dean: when you have MULTIPATH fading, you have to adjust for the fading, what should be the approach.
John: The Naftali model is simple, so it can easily be used.
Dean: take the exponential distr., referencing Eb/N0 for the fade. What have you picked?
John: I wouldn't do a noise free simulation.
Naftali: It is inappropriate to have a standard where two different chipping rates are allowed.
John: those are not meant to be dynamic. What you do with FDMA in the current standard is just that. They make for channels that do not interoperate.

98/37 Harris' 2.4 GHz submission, Carl Andren

Harris 2.4 GHz proposal

???:Is the equalizer data presented based on simulations.
Carl: Yes, difficult to setup a measurement.
Wes: Do we drop the BPSK mode if we go to OQPSK?
Carl: Uncertain.
Ad Kamerman: Co-Channel interference simulation.
Carl: No it is measured data. Transmit in packet mode the interference is continuous.
Ad Kamerman: FCC spreading requirements. With the offset does that qualify?
Carl: Still being debated.
John C.: Does change the processing gain change. Changing the code doesn't change. This is not a real improvement, but addresses FCC issues.
Jeff Fisher: 11 chip per symbol? How to transition?
Carl: We Developed clock scheme for that.
Jeff Fisher: are there 8 orthogonal codes at 11 bits?
Carl: There are codes good enough. The Lucent PPM scheme uses trans-orthogonal codes with acceptable performance.
????: Can you use a limiting receiver with equalizer?
Carl: We don't believe we would get good performance, but will try it.
Roberts: Diversity?
Carl: Change preamble for high speed mode.
Darrol: 4 to 1 improvement due to diversity at the most.
Carl: The results are based on measurements.
Darrol: What is the gate count?
Carl: 27,000 gates for the entire baseband processor, 35 K gates for the equalizer.
NCR: What is the S/No in the CW Jamming test?
Carl: We use Eb/No + ? dB. Shown in textbooks. 16.5 dB at 11 MBps.
Jeff F. What was the bandwidth used for the broadband noise?
Carl: We set it to the null to null bandwidth.
Roberts: Filters restrict the noise bandwidth.
Jeff F. Recommends 50 % noise bandwidth. To account for filters.
Ad Kameran: ??
Roberts; State the bandwidth?
Carl: We set to null to null bandwidth. The 90% power bandwidth of the waveform is 12 to 13 MHz.

98/10 Lucent's Draft standard Submission, Jan Boer

Same as previous submissions. They get 5 or 8 MBps. Squeezing by 2 chips give 10 MBps. Very little in the standard needs to be changed. The 10 MBps mode is 9.7777 MBps and they use two rates in the rate field to let the MAC know how long the packet is exactly. By placing the 5 level waveform relative to the 1 and 2 MBps case, the backoff will not be changed.

98/11 Performance of BCPM, Jan Boer

They use a channel matched filter, mode sifter, and tentative symbol estimator. They can use only the CMF for a low complexity receiver. Long preamble is not needed, about 25 us is needed to calculating the channel matched filter. Can do 20 us slot time and do diversity in this time. No change in SIFS time. Theoretical free space range of 1000M. Three dB lower TX power allows about the same power consumption as standard version. Patent may be infringed, see Lucent contact. 24 us for training.

Wes: How much backoff; is it 2.5 dB lower than low rate system?
Jan: Yes, to maintain the spectrum, the backoff needs to be 2.5 dB lower.
Ron: I agree with the cell planning statement, how are you planning to measure that?
Jan: We will discuss that tonight.
Ad: The cell planning may have to take into account the near far problem.
Darrol: What do you mean by infringement?
Jan: contact the lawyers.
Don: does the 8 MBps have FCC problems?
Jan: the 8 MBps has been shown to the FCC, and they gave written approval.
Mark: how many taps are in the matched filter
Jan: 12 taps.
Don: do you feel the need to need to use a QPSK preamble to estimate the channel?
Jan: no, we feel the BPSK preamble is adequate.
Ad: we want to stay interoperable.

Meeting adjourned at 6:15
Everyone invited back at 7:30 for a discussion on selection criterion.

Jan 22, 1998 PM

Demo by Richard Paine on Wearable computer from Boeing

Tutorial by Bob Heile GTE on Wireless wearables.
Uses: Mobile worker, collaborative maintenance, medical sensing. 19.2 to 100 kBps rates plus the usual requirements. 0.5 in^3. Overlap of multiple networks in same area. Network up to 16 devices. Is .11 the right answer? $40 price point.
Darrol: what would make anyone thing that this is a realistic thing?
Bob: It takes a while to get this technology up to this point, but if we can identify a lower data rate than you are addressing, it may become practical.
ftp://ftp.flexpc.com/wearables/???

Notification by Vic. 5 have problem with going outside the US for the May meeting, 6 have problems going into the US. If you have any options, see Vic.

John: Need brief write-up for the web page. Agenda discussion.

98/54 John Fakatselis, Schedule and selection process

Schedule is broken into bi-monthly milestones. March; beginning of the down selection process. May; final modulation selection. July; sept; draft complete. Nov; WG ballot. Jan'99; WG ballot resolution,. March; motion to submit sponsor ballot. May; sponsor ballot resolution. July; sponsor ballot resolution. Sept; standards board approval.

Selection process is structured to happen in the March and May meetings so that one candidate is selected. Document 97/157r1 is the is the formal basis for comparison. Elimination of proposals with incomplete data or not meeting the requirements will be by secret ballot. Establish a comprehensive comparison benchmark matrix. The matrix will be available 2 weeks before the March meeting. The presenter will show their data in the matrix with opportunity to explain the variances. Questioning of the presenters will be performed by the matrix creators. All proposers have closing arguments. Finally, exclusions based on 75% votes (secret ballot) to eliminate. The time between March and May is for the proposers to improve their proposals or combine them prior to final selection.

May final submittals and presentations. Update comparison matrix and presentation of the matrix to the task group. Proposers can make clarification points and closing arguments. Final run off by secret ballot. Adapt the group recommendation with 75% approval vote. Present to 802.11. Address comments and readdress.

Mark: on the multiple rounds, will the voter have more than one vote. Two votes may be better if there are three on the table.

Ad.: Two votes creates difficulties.

John: I recommend one vote for simplicity.

Motion to accept document 98/54 by: Ken/Stewart. 14/0/3 Passes

William Roberts, Carl H. and Naftali volunteered to be the matrix generators.

Agenda for March meeting

Technical submissions

Selection process

97/157r1 John F. Selection criterion discussion.

No comments from the audience therefor the document will stand as is.

98/55 John Fakatselis,. Empirical data taken with Harris' approach

An additional paper was allowed by the group for presentation(98/55). This is a general purpose paper to verify arguments made that multipath performance need to be carefully considered by the group since the empirical data verifies the concern. A short preamble will also improve significantly throughput when short packets are used.

It Showed data taken in the Harris lab. Shows data from 5 test sites in building 62, second floor. With 11 MBps and table rotation,

Ad.: 20% PER is impractical for 64 byte packets

John: That shows that something is required to combat this problem.

Ad.: is this data taken with a full network?

John: no, this is with an almost continuous packet transmission system with no protocol.

John C. where the antennas on the PCMCIA card?

John: no, they were 8 " apart, remote from the PC card.

Announcements:

Jon: there are still places on the tour tomorrow.

John F.: I was very pleased with the way things went this session.

Adjourn.