IEEE 802.11
Wireless Access Method and Physical Layer Specifications

title: **Tentative Minutes of the PHY Group meeting held July 12-16, 1993, Denver, CO**

date: **August 23, 1993**

Note: Two different persons took notes during the PHY meetings. The first section, which covers Tuesday, was provided by Richard Ely, and is included herein exactly as provided. Immediately following Richard's minutes are those taken by Wayne Moyers (handwritten). Please note that there is a substantial overlap between Richard Ely's and Wayne Moyers' Tuesday minutes...

Tuesday, July 13, 1993 (minutes by Richard Ely)

8:30am
Review of Larry Van Der Jagt's Paper
? what it the delay spread that this committee has settled on for 100 m lengths
lvj We have decided not to say.
McK We've decided not to design for worst case.
Bob Aachatzz that was measurements they made in a room that Larry talked about. Now they are measuring a warehouse. 10' wide 6' high shelves. The receiver was placed in a corner and the transmitter was moved up and down the aisles. They wanted to encourage people to use the 5 GHz band so they made measurements there too. They couldn't get good measurements with omini's.
Chad How much power
Bob 23? dBm. For $215 we're going to be releasing this data too, sometime at the end of this summer. NTIA working between HP and themselves HP11759D porting and Accolade and soon a Sparc station. Dr. Spalding report "The Natural and Manmade Noise Environement..."will be published in IEEE Communications and he hopes they can make that available soon.
? You are measuring 200 ns?
BobWe can go out to 625 ns,
? 100 m you would get 4 times rms delay spread
bob For obstructed 50% 70ns line of sight 25ns
lvj Not a significant increase in delay spread with distance.
Bob We don't like talking rms delay spread because of they different ways people are implementing.
Mck How much is the HP11759D?
lvj He thinks its about $45K
Bob HP simulator seems good for FH but not so good for DS because of the bandwidth. It can control 12 paths but one box controls 6.
? Does antenna divrsity reduce delay spread.
Bob McKown can answer that
McK Yes.

#93/101 Chandos Rypinski, Data Capacity of Radio Paths
The inteference range is often ten times the service distance. This affects the reuse of the bands. How do you get 100% area coverage with different channels. The reuse factor depends on antenna diversity, power control, protocol, etc. Corner illumination provides a better reuse factor. His best approach only reaches 1/4 of the RES10 goal. Symbol should'nt be less than the length of the delay spread.
Chad Last RES 01 meeting felt they couldn't meet goal of denstity per hectare.
Chan Feels he pushed it as far as you could go. 20Mbps channel rate is enough for radio.
Chad 20Mbps is not easy.
? Agrees without freq reuse you can't have much capacity. What reuse factor should we use
Chad The paper doesn't say what reuse to use.
? Previous paper said FH has more capacity than DS
Chad 2 approaches to multipath: slow symbol down and to resolve multipath spreading by spreading spectrum. Rules for a short reach system is diferent than previous long reach thinking of cellular work.

#93/ Francois Le Maut FHP Selection Criteria
In Europe they are using unofficially 100 channels but it may be reduced to 83. In the US it is 75. They have 22 patterns
Stru The same pattern being reused, they probably don't overlap at any point in time.
Fran but at some point they will totally interfere
Stru Then you could shift to another point in the pattern?
Fran Yes.
Rifaat Is this a worst case interference.
Fran 2 channels away it is completely clear is his assumption.
KC Based on you pattern it is optimum.
Fran Yes based on their criteria.
lvj If we were to adopt this approach, you would adopt one of these 22 patterns.
Fran We went with prime numbers.
what would happen to 29
Fran then we would go to 66.
? If you had gone to 83 instead of 79.
Fran If you don't use a prime number then you get 2 hits and sometimes 1. With prime number, it is deterministic. This isn't obvious. this is an anylitacal number derived from analysis. this has been given in IEEE papers.
Wayne Aren't you being generous with FCC rule making? Has anyone passed this by FCC?
Fran I'm not saying first one is psuedo random.
lvj If they don't accept these patterns then they aren't acting wisely.
Nathan Has dealt with FCC on similar matter and they didn't object as long as your occupied spectrum looks random. It's in their interest.
Wayne: 22 versus 66
Harrere Any sample under 30 does not produce significant statistics. You can't talk about means and standard deviations accurately.
Haim What phase noise are you assuming
Fran Assuming two access points next to each other.
---
lvj If we get the reference, we'll put it up this week.
#93/104 Ed Geiger RF Data Transport Protocol
Want a protocol that allows some level of immunity to interference. 16 hopping groups, every 2 seconds MAC changes hopping group Use Reed Solomon code for FEC. They send 5 fragments sequentially and if they receive 3 the same they can correct. This is independent of whether you have centralized or distributed control. They break MAC PDU into 3 segments. LAN_ID is negotiated by the MAC. All members of the same LAN group are time synchronized. You can change LANs if you wish and get another LAN_ID.

Any 3 of the 5 need to be received correctlly in order to reconstruct the packet.
What is the total overhead
Ed 40%
It is very difficult to state a number.
Ed Maximum payload is 255 for PDU. We're interested in moving Local Talk which is 700 bytes. 14 byte B_PDU Fragment with 2 bytes added. They are considering increasing the size.
Mike So total overhead will go to 50% maximum.
What BER are you desing for
Ed 10-5 typical.
Chan This addresses clustered errors.
Ed We are applying the Reed Solomon by the column so each column of the 5 PDUs are compared colomon by column and as long as 3 of them are ok, they can correct.
What is symbol size of Reed Solomon code.
Ed It is an exclusive OR calculation, you can do bits, bytes etc. He can bring more information about Reed Solomon next time. You look at the first 3 channels anyone transmits on to see if you are clear to send. They have 2 antennas in their implementation for diversity. They have long preambles to give the receivers to discover the transmission. It's about 500 us to send out preamble, they send on 3 different frequencies, Their hop time is 80 us of which clock recovery is 57 us Only 5us lapse between when they see channel is clear till they transmit.
Mike With a Novell network, it will create large delays. Aroun 70% of networks are running Novell.
Ed What is an unacceptable delay?
Mike Making a test with bridge at Ethernet speeds and Novell, they reduced thruput by 50% but with FTP/IP it worked well.
Struh This is a bridge so you don't care what is on the other side. You bridge at level 3.
Ed Timeout on this discussion.
Manson What kind of conditions is this designed to work on
Ed when interference from other similar LANs other LANs, microwave oven.
Manson This is expensive
Ed Why is it expensive?
Manson You have 50% overhead.
Apple? In clear channel conditions, this is overburdened but when you get into interference, this will be effective. It will guarantee delivery.
Ed This has some overhead. They considered simpler configurations. They felt 3 out of 5 was the best for the envirnment they wanted to go into.
? They are looking 3 years down the road. They've tried to pick the worst possible channel. Ask what are you will to pay for lost packets. They will have some simulation data at September meeting.
Hanson Have you estimated circuit complexity.
Ed Except for Reed Solomon, this is less than 8000 gates.
? What is shortest packet?
? Maximum dwell is 450us.
Ed when they do carrier sense, they are looking for preamble sense, not power level or noise. It doesn't look at retransmission, that is up to the MAC. They have designed it to work correctly at BER=10-2. BCH code is 8 bits. He thinks you can correst 2 bit errors.
Modulation schemes have been mostly 2 level FSK
How do you ensure a good distribution of hop groups? They identify all of the LANs and the user decides what LAN they want to use. 16 hopping groups, each with a different pattern, there is no communication between different LANs.
Walvis How does it translate into C/I?
They don't have the data.
It's 3 dB to 5 dB depending on the environment.
Adjorn at 11:55am.

****

Reconvene 1:18pm
Issue 24.10: What is Modulation Method for FH PHY
#93/ Jim MdDonald Discussion of Modulatin Parameters for the 2.4GHz Frequency Hop Physical Layer
Discussion of 4 level and 2 level. 2 level is 0.39 GMSK, 4-level is square root raised cosine premodulation filter.
Chad How do you define Eb/No?
Jim Eb/No for 10-5 BER. 4-level can go to higher speeds in the future. They also have advantages in splatter. VCO noise is important contributor to splatter in alternate channel.
Chad -140 dBc/Hz is going to be pretty hard to reach. You are being very conservative.
Jim VCO noise is going to dominate alternate-channel noise. Conclusion: 4-level's improved modulation splatter doesn't have a lot of value because of VCO noise.
Mike What do you mean comlex circuit needed
Jim Definitely over 10000.
Pulse No. Definitely under 8000 gates for 4-level.
Nathan How many preamble symbols needed?
Jim Twice as many
Hefer It looks like a 5-level system when you look at 2-level eye diagram.
Pulse I don't agree with any of your statements on economic differences of 2 and 4-level. Their isn't much difference between the two.
Jim those who are experienced in building systems will appreciate the difference.
Walvis Takes longer preamble to get sync for 4-level.
Pulse it's all related to lock up of phase lock loop.
Walvis I disagree.
? The compairson of levels...You can use the same preabmle to recover 500kbps 2-level as 1 Mbps 4-level
Wayne
Nathan If you use same number of symbols, it's a wash.
Mike I'd like you to put two eye diagrams on the projector.
? what about performance in a real channel?
chad One of the advantages of 2-level can be done analog and it consumes considerably less power.
Jim We think that is extremely important.
Pulse You won't be consuming a lot of power in digital implementation at the speeds we would be running.
Nathan There are ways to eliminate the errors due to inaccuracy of sampling time.
Mike I can't agree that it meets the data rate requirement.
nathan How does aggressive approach fit with what we previously agreed.
lvj At last meeting we talked about the aggressive approach but we had voted with the aggressive approach.
Pulse
Jim FCC has said you must use bandwidths less than 1 MHz. We think we should be dealing with looser crystals than 10 parts per million.
Chad I don't think trying to take every worst case is fair.
Jim 2-level allows for fast acquisition.
Chad How fast do you need the receiver to acquire a signal.
Jim National presented paper on diversity saying you need antenna diversity. You need to factor in all the factors.

#93/76 JerrySocci GFSK As a Modulation Scheme for a Frequency Hopped Phy
Struh In principal do you agree with Jim's proposal.
Jerry Yes.

Break 2:25pm

#93/97 Dr. Kamilo Feher, FQPSK: A modulation-power efficient RF amplification proposal for increased spectral efficiency and capacity GMSK and PI/4-QPSK compatble PHY standard. 10dB better can mean difference between 10-9 and 10-1. FQPSK. You can transmit 1.5Mb/s versus 1Mbps.
Walvis: Rayleigh fading will be serious in some channels and not in others. Should we do BER over several transmissions?
Feher Will cover that later. RF Power efficiency at 250 mW RF power, 10% efficient with linear, 50% with FQPSK means difference between battery power of 2-3 W and 0.5W. He's a strong believer in 2 level eye diagrams. Gaussian is most optimistic, Rayleigh is most pessimistic. 200ns delay spread is not uncommon.
lvj At any specific instance of a channel, you don't see 200ns.
Feher Cellular thought Doppler would kill them and delay spread was trivial. They were wrong. In incoherent case it is much worse. Adaptive equilizers are not well known for incoherent.
lvj When you have a channel with delay spreads, you don't have 200ns delay spreads.
Feher He offers a compromise GMSK to FQPSK because they are 99% the same. Adaptive equilizer's eat up a lot of time.
Walvis FQPSK information was available? Why did DECT committee choose GMSK?
Feher FQPSK didn't have any big promoters.
McKown Give personal estimate of additonal hardware costs in PCMCIA application.
Feher It is less cost.
McKown What is the additional royalty cost.
Feher It will be based on established industry practices, similar to Motorola or Qualcomm. He signed to agree to IEEE rules.
? You said it was cheaper than Motorola, could you justify lower power consumption
Feher Even at same bit rate... you need a good IF filter for incoherent.
Chad That only applies after AGC...You are saying
Feher This system was tested many times and papers published, the bandpass filter is much simpler.
Pulse What about phase response of SAW filter?
Feher you can tolerate 2 times more delay. The coherent is much more robust.
Nathan 1Mbps vs 1.5Mbps,
Feher Yes, CPSK can provide 1.2 Mbps
Nthan In regard to capture,
Feher About 2 degrees phase difference....much less ISI but it has a much broader eye. So you have much more tolerance to delay spread.
Nathan Difference in cost.
Feher He has real crappy AM to PM converter in his figure.
Nathan Rapid Doppler
Feher At 48 kbps while driving, then he couldn't recommend coherent, but at 1 Mbps Doppler isn't a probelm. With high data rates, Doppler flips aren't a problem at 300kbps and up.
lvj GMSK going with coherent you are trying to get 1 channel. You were trying to recover 2 data channels. Is there cross coupling of the channels.
Feher Coherent GMSK doesn't need to recover IQ. Cross coupling due to nonlinear modulation. Differential path delay, Nathan's proposal is at least 2 times more robust than Motorola's proposal.
? Apple is using noncoherent system, how do you make coherent switch freqs fast.
McD Diversity is a key to performance. You quoted diversity from selection which we think of as 2 basic receivers and you pick the one that gets thru. Antenna selection diversity is easier choice but that takes synchronization time away from coherent systems.
Feher Your eye diagram drifts up and down. If you want to design a dc drift compensation it takes a few bits.
? That applies for one antenna.
Feher Parallel symbol and carrier recovery, there are some patents on this.

Walvis How do we go on?
lvj We could go on trying to examine everything in great detail but we need to get on with it.
Walvis Let's agree on a basic data rate.
lvj This is only the first standard we will do for wireless LAN.
Mike: If we decide a data rate, it will be the rate for the next 6 years.
Cripp: What we are agreeing on is a basic rate, you can add more later.
lvj We're deciding on what it takes to close the issure.

93/### Peter Chadwick, Inteference Immunity
Measured some radios. First measured adjacent channel measurements.

---

lvj
Chad Move that we adopt GFSK with BT=.5 and a minimum deviation of 160KHz.
Second Burchall Cooper
Pulse Can I make a friendly ammendment.
Cripps I object to the ammendment
Mike I would add an ammendment to this motion. At least 1 Mbps data rate.
Cripps We are already constrained by the PAR.
lvj Can we say with a data rate of 1 MBps.
Cripps Yes I accept that.
lvj This is the first standard we are ever going to write. We need to nail things down.
Mike I want to make one more motion
lvj No you can't do that
Mike We should learn to have a framework to decide between 3 flavors of modulation. We should have it split in 3 with all motions on the table.
lvj myopion is there is a motion on the floor and we have to finish this first.
Mike I move to adopt a change.
Feher I move to adopt in addition
lvj Before someone makes an ammendment, lets find out what we are allowed to do.
McK The guy who moved on has certain rights. You can't amend it unless he agress
Feher He is making a second friendly ammendment.
lvj Let's have discussion on this while we're waiting for Vic.
Wayne We'd like to have alternatives on the floor.
Mike Getting Vic here..
Nathan I think the goal was to select a modulation. We should have them on the table.
lvj The way is to vote this down first.
Chan Let's talk to the question. We have to dispose of this motion. I propose to vote on this motion, those who feel there should be multiple choices should vote no.
Feher Larry in your letter you said there will be a detailed discusion before deciding.
lvj There is a motion on the table, if someone wants to make an unfreindly ammendment. If there is a second, we vote on it, then go back to the original motion. (VIC came into the room to make this ruling)
Mike He moves to make a friendly ammendment to
Feher To adopt in addition FQPSK
Mike More than 1.2 Mbps. Let me explain why. My opinion is we need at least 1.2 Mbps for multimedia. DVI from Intel,which is supported by Microsoft, needs 1.2 Mbps. If we do not provide at least 1.2, lots of applications won't work. So the penetration of this standard will be jeaporidized.
?Geiger There is no way you can put 1.2 over a 1.2 Mbps network. This is'nt a legitimate argument.
Feher I would like to make a friendly ammendment "such as FQPSK."
Mike I accept the friendly ammendment.

McKown There is something I don't understand. I thought we were specifying a single mode. Then you can negotiate a different modulation scheme. It is inapropriate to mention these other methods. We don't want anything else now.
Chan I'd like to suggest other wording. "We should adopt as a reference baseling and only consider other modulations as appropriate:
Feher I don't accept
Mike This changes the meaning
Chan I yiedl
Nathan You take GMSK as baseline, FPQSK and 4-level CPSK ares compatible.
Feher I would take this as a friendly ammendment. You could use GMSK and FQPSK.
Mck We're giving yu a common air interface which you can negotiate for a different transmission.
Feher Let's take a vote. The ammendments are finished.
? When we start talking about compatibility among these coherent detections, are we excluding noncoherent.
Nathan Adopt in addition to GMSK an modulation method doing more than 1.2Mbps such as FQPSK and 4CPFSK or others backwards compatible with GMSK.
Wayne We previosly decided criterion by which we would base our decision. Robustness, 1 Mbps, modulation index be clearly scalable upward as industry supported it. I think we have lost this last point. I would hate to see us vote any decision that wouldn't let us meet on a common channel and loose 10dB of C/I. What is the merit of the choice? We are going to walk across a bunch of patents. We ought to calm down and be very considerate of the alternatives. I don't want to throw away 10dB and don't want to muddy the decision.
McK More than one can't meet in the air.
Feher If we are really technical committee or political.
Wayne We've got to stay within the PAR. It says 1 mbps
Chan No it say we have to stay within 1 to 10
Wayne So we are OK with 1.2. We want to satisfy our customers.
Feher Ae we here to discuss technical parameters.
lvj No one is invited to these meetings. You come because you want to
Ed There is no way you can run a 1.2mbps application on a 1.2mbps medium.
Mike So you need more than 1.2Mbps
Ed You need at least 1.5 to do a 1.2Mbps application.
Buass: Move to call the question.

---

lvj Everyone in favor of calling the question?
26 Y, 8 N, 10 A.

Mike I want to clarify what we are voting on. If we are choosing GMSK then something else should be included.

---

lvj All in favor of accepting this ammendment
12 Y; 26 N; 7 A

---

lvj Now back to the original motion. Will start where we left off. I'm not going to propose another ammendment, but we could adopt for further study other modulation rates that could provide higher datat rates. If that sounds good, then someone could make it.
Bob My question was answered
Mike Pass
Chan I hope this motion doesn't pass. What happens if we come to market and something better comes up.
Ed Can we get a big increase with the regulatory requirements
lvj 1.5 is about as much as we'll be able to get
Ed You can shift gears when the data starts.

lvj Whether we start at a lower speed and then shift to a higher or vice versa is all we are trying to decide.
Chad We are trying to establish a base point at which we can all communicate. There is nothing that says you can't use 2 different systems.
Feher If it would say GMSK insteadof GFSK, there would be nothing wrong with it.
Chad This doesn't stop anyone from using other methods.
Wayne You cannot do what Peter wants if you start with GMSK.
Feher You are locking yourself into schemes that won't allow others.
Chad He only looses 10dB if he is using GMSK.
Feher Once you change it you are finished.
lvj How many nodes are installed
Chad Ad hoc networks are going to be looking for maximum range.
Feher Motorola fought against changing..
Chad That is irrelevant. What we are talking about is a base standard.
McD This 10db number needs to be changed. If you would do a DSP for binary FSK the number would be a lot less.
Nathan. Feher is pointing out a problem. If we come out with a bad standard, it is going to hurt everyone. Second Waynes point of the criteria we established in previous meetings.
lvj That was a list of things people should put in their proposals, it wasn't part of the criteria.
Nathan We all discussed about points we have to bring in our criteria. I haven't seen these things presented in these papers. We need these for our discussion.
lvj Socci had adjacent channel interference.
Nathan We've only seen a few of these things.
Bob Chad preemptied me.
Mck chan expressed a concern we will displace a superior method. Maybe we should quit striving for superiority and go for expediency. To say that we need to study it more is deadly to this standard.
Wayne The extensibility of our baseline choice, would Feher comment whether GMSK would allow higher data rates to be scaled, how feasible is this as a point to scale from?
Cripps. If you have all digital implementation, you should be able to do GFSK and then jump to another.
Wayne Is this an optimal point.
Cripps The objective is to come up with an acceptable solution.
Wayne Limits of acceptablity, and implementable. Nathan is next and I'll hold floor until we find out where we can go from here.
lvj There is a point of order.
Bob Is this proper procedure
lvj We are doing it now.
Feher Modulation index 160 kHz excludes you from coherent demodulation. John McKown liked his FQPSK in his book 12 years ago and proposed it to his management.
McK But that wasn't 802.11
McD You are accusing me of some underhanded proposal.
lvj He wanted to know if this could be scaled. Feher said this couldn't be used, but you ...
Bob We're hung up on modulation index. this discussion is off the wall.
Wayne Larry said that a modulator that can decode coherently and drop back to noncoherent with some hit. Jim McD, is that coreect.
Jim Yes
McK It's not true that a modulation type is best for every application. This is indoor, PCMCIA.
Pulse I's clear we aren't going anywhere and would like to suspend argument until the morning
Everyone: No
Nathan On basis this modulation is expandible. It isn't clear how it could be done.
Wayne If I could be convinced that thiis is scalable, then I could be satisfied with this.
Walvis There was statement this couldn't be detected incoherently. I believe this could be detected coherently.

Feher DECT Europe 1.25 Mbps. DECT is a cheap system.
Walvis this can be done.
Mike Larry you should be more impartial, please with friendship accept my advice to be more impartial. We have at least 12 people here with interests in GMSK. Motorola has 4, National has 3 or 4, Plessey 3 or 4. A much more fairer approach would be to have one vote per company.
Bob As original architect of their radio...
lvj as addressing fact that he is unfair. I have que, I never exercise chairman's option to only let one person talk, This is a straw environment now. On Thursday we will have the voting members vote. If there is block voting in the plenary, Vic will stop it.
Feher. I move that one company one vote.
lvj Straw pole. Who wants 1 vote 1 company.
11 Y; N were greater
Feher I'm ammending the motion to modify modulation index to h=.5
Buass Before this motion was made, I'd like chair to make straw pole of motion before this motion. On the original motion before Feher's ammendment,
(Motion was: Move that we adopt GFSK with BT=.5 and a minimum deviation of 160KHz with a data rate of 1Mbps.)
26 Y 8 N ? A
That isn't 75%.
Take straw pole with the ammendment.
Feher Add BT=0.39.
McD If we do GMSK you have to reduce to .25 and this would defeat basic concept of 1Mbps with simple hardware. We do want to preserve that we want simple equipment.
Bob Feher It's your motion what would you want. I want BT=.39. Motorola previously proposed 0.39.
Socci For an h=.5 you need to drop BT to .25
Buass That is a comment.
Feher Move h=.5. Give me the flexibility of DECT.
lvj You know this doesn't meet FCC spec.
McK Motorola has been here partly because this committee has asked for support. They make measurements and present data. This isn't Motorola against the world.
Buass From here on out, you have 30 seconds, Now who would like to speak
Ed Motoroal can't be held responsible for old data. They have made other measurements.
lvj What is happening here so that Feher's coherent demodulator could be implemented easier without some of the tricks. Unfortunately we have to deal with FCC.
Chad It effectively says that this throws GMSK out. You start closingdown the eye to the point it is not practical.
Buass Straw vote. Origingal vote the way it would be
No body would support it
Buass I release the floor
KC Chen We want to make something good happen. I would suggest to make another ammendment. This is only good for 1Mbps. This committee will try to something better in the future. If someone is puting out a better modulation, then we can consider it. A new scheme can be adopted in the future.
Feher What do you have against my proposal.
lvj There are a lot of engineers who are ready to put out products, and they have come to the conclusion that this is a good starting point. That isn't politics.
KC To make something happen while keeping technical merit open is our job.
Mike If this would be acceptable to ammend
lvj Modulation rates for higher data rates will be considered.
KC We should make modification.
McD We could say within our standard we could provide a means for arbitration to go to a different datat rate. We would like to have a future option.
lvj This is something that needs to be at a higher level.

KC We should set up a deadline for consideration.
lvj The deadline for new proposals was set at last meeting. Now we are hearing a new proposal
Feher Larry's ammendment, further data rates are for further study, it leaves the door open
lvj Is that a friendly ammendment.
McD Yes He clall the question.
lvj 18 Y, 0 N, 0 A
All in favor of modifying ammendment?
0 Y 1 A, Everyone else N
Feher Friendly ammendment: Modulation techniques for higher data rates are for further study by 802.11 PHY committee.
McD Accepted. Add to ammendment: A Means for negotiating a switch to higher data rate from GFSK is also for further study.
Chad So you could have non reversing compatibles.
lvj So we could add to motion "All 802.11 FH PHY shall be capable of operating using GFSK with BT=.5 and a minimum deviation of 160 KHz with a data rate of 1Mbps.
Cripps He accepts the changes.
Mike I have a modification. Larry you made a change out of order.
lvj Peter accepted.
Chad I make friendly ammendment that we accept this.
Cripps I accept.
Feher Us cellular phone has voice and digital capability. an AMPS type of receiver can't talk to digital.
McK This says we'll have one mode and can add others in the future.
McD Calls the question
lvj
All in favor of calling the question.
Y- 46, N-0, A-4
All in favor of this motion as it now stands.
39 Y, 5 N, 5 A
lvj Motion passes with 75% majority. Will take this forward on Thursday. Voting members vote
Y 16, 4-N, 2-A

Ed You only are supposed to obstain if you don't know how to vote Yes or No so abstentions don't count.
Adjourn 6:30pm.

The remainder of these minutes are transcribe d from Wayne Moyers' hand-written notes.

Tuesday AM

CHANNEL SESSION

#1 Paper 802.11-93/98, "NTIA Data Extraction Tools" : Lourens Van Der Jagt, Knowledge Implementations, Inc.

Reported computer tools they developed to read and analyze NTIA data. Both are for sale at nominal cost. Generates delay spread, impulse response, both RMS and finite out to 612 ns. Examples were shown and discussed.

#2 Paper 802.11-93/41R, "Indoor Wideband Propagation Data" : Robert J. Achatz, Peter B. Papazian, Michael Roadifer, National Telecommunications and Information Administration, Institute for Telecommunication Sciences.

Warehouse--rack stacks case. Took data at 1500 MHz in this report. Will encourage 5-8 GHz band use so will report data on this spectra: Omni to omni, and horn: 3 degree beamwidth, & log periodic 60 degree RX... And omnidirectional vertically polarized antenna...at 23 dBm into antenna.

Sees delay out past 250 µs. Will port all data to Accolade software and HP/EESOF tools. Used HP simulator model 11759D granted to them. Reported on Dr. Spalding's noise models which will be published in IEEE Communications and NTIA.

Gets 50% median at 70 ns in obstructed line-of-sight measurements at all ranges (in line-of-sight 25 ns case).

RADIO DESIGN SESSION

Paper #3 802.11-93/101 "Data Capacity of Radio Spectrum", Chandos Rypinski, LACE Inc.

Commented on great value of NTIA data now coming. Noted: Capacity is separate from utilization. Discussed factors of concern in channel and design.

Reuse patterns as good represented as squares as time-honored hexagons, typical in cellular telephony modeling. Suggests factor of 36 even, rather than 25 in WLAN environments. Fade margin is necessary but not sufficient alone. Important conclusions were drawn and reported fully in the submission.

Notes from Q&A:

- ETSI RES10 faces a 4:1 challenge excess. Agreed to by Chan Rypinski and Peter Chadwick.
- Modulation schemes should take into account reuse factors.

Paper #4 802.11-93/60 "Frequency Hopping Pattern Selection", François Le Maut, IBM

Notes impact of 15.247 in interference "hits" due to "poor" FHP's/families in same cloud. Suggests "neighbor" agreement on patterns and affects location of access points. Criteria of

selection critical to reuse, modulation index (adjacent channel usability, e.g. patterns of deterministic prime number noted, 22 vs. 66 if all usable), time co-ordination issues among microcells adjacent, etc.

Paper #5 802.11-93/104 "An RF Data Transport Protocol. The RF Adaption Sublayer and RF Physical Layer Specifications for Slow Hopping Spread Spectrum Radio LAN", Ed Geiger, Apple Computer Inc.

Note: Paper was not available at time of presentation.

Note: Is a "convergence layer" issue for PHY. Q&A's are included as presented. Introduced an "Adaptation Layer" above the RF PHY layer for FHSS device. Uses 16 hopping group of 5 channels each. Changes group every 2 seconds. Uses RS coding in an error control field to rebuild lost segments of sequential TX sessions. This for a "work around" of typical interference sources. All works in both dedicated and ad-hoc LANs. Several LANs can be active in same hop group via separate LAN ID numbers (changeable at MAC layer) which are ignored by "non-members" and a time code is transmitted to enable group hop sequencing. User PDU is an 802.3 packet rule, e.g. MAC_TIM synchronization is used decentralized as a MAC layer function. Overhead is at least 40% as FEC is on "burst" (PDU) basis instead of packet , due to formatting data field into 1/3 frame splits. Note: 255 bits is PDU size maximum, consistent with "LocalTalk" packets. Also, RS coding operates over vertical segments into 14 byte fields and 8-bit CRC for each attached check field. May go to 29 bytes and 16-bit CRC ("DEC") stated. Can correct 2-bit errors. Can go up to larger 802.3 frames was stated. Thus, total overhead can grow to 50% under ideal conditions. MAC is probably not perfect OSI model. Notes BER design point 1×10^{-5} end-to-end, channel (can correct from and assumed) 1×10^{-2} without correction using typical recognition of clustered errors that are corrected by burst loss and salvage even if 14-byte segment lost. Can re-build if 3 of 5 segments gotten good as RS is applied "cross-axis" to BCH code in each segment. Does "pay us now" rather than retry "pay me later" to excuse overhead "hit" of >40%. Columns are one bit or morewide as chosen.

To all above is appended preamble of 2 fields, e.g. sync and frame. These are of 2 unique lengths. Sync is used for clock and data recovery start-up as well as LAN subnet recognition.

Scan is continuous of 3 frequency channels of 5 in group and described by state diagram. This is a "fast" FHSS concept system.

Diversity = uses 2 antennae in design. Selects immediately after hop settle before attempt to recover clock. Hop time is 80 µsec + 16 µsec to do diversity, plus 57 clock times to do recovery Thus, total of 155 µsec for one scan, times 3 scans ≈ 500 µsec. Total to send out the preamble to guarantee get into synch.

Note: Does clock recovery on every scan cycle of first 3 segments until "receive" sequence . Is a 5 µsec lapse between RX and TX initiate.

Adaption layer builds a map of need to re-construct fragments (14 bytes each) via RS code usage.

Q&A:

It was stated that "Novell nets may not be compatible due to delay build-up in this protocol and mapping before bits output of MAC."

Another: "May need to think of bridge to re-time."

"What of 40+% overhead vs. 12% retry statistics?"
Ed: "Runs fine directly on top of a microwave oven." (and thus effective) "Is costly in clear channel conditions (only, sic)."

Ed: "Did simulate of 2 of 3 channels and 5 of 7 and chose this (3 of 5) in recognition of expected worst possible channel environment of future." (vs. retry) "Results of this simulations promised later."
"This system is up and running now."
"Is resident in ≤ 8K gate ASIC, without RS coder."
Can coexist with CS systems as will look at these emitters as noise. But, will transmit unless their bits are recognized on the ether.
MAC identifies all users in cloud and can decide (by ID number) which, if any, wants to join of 16 hop groups and channel clusters available.

Lunch break...

Tuesday PM

Paper #6 802.11-93/102 "Discussion of Modulation Parameters For The 2.4 GHz Frequency Hop Physical Layer", Jim McDonald, Motorola Inc.

An objective comparison, omitting cost challenges, was made between 2 and 4 levels. Much discussion resulted re validity of conclusions drawn and lack of equal basis/normalization of many comparisons which in presenter's opinion favored the 2-level at expense of 1/2 the data rate (even eye opening "very close" to same for both 2 & 4 level. Many in room pointed out favorable basis of 4-level. Peter Chadwick (and Jim McDonald agreed) that 2-level easier to do analog and thus usually at lower power level vs. digital assumed for "simple" demod in 4 level. No clear consensus seemed to develop as most comparisons were debated in theory and practice of implementation. Jim ended with an 802.11 issue (24.10) selection of 0.5 GMSK combined with spec. of deviation limit of 160 kHz minimum (175 kHz nominal).

Paper #7 802.11-93/76 "GFSK As a Modulation Scheme For A Frequency Hopped PHY", Jerry Socci, National Semiconductor

He looked at Gaussian pulse shape vs. BT product and modulation index, and using 20 dB B/W being 1 MHz wide.

Used Comdisco simulations in paper. Found that 0.25 BT product met the FCC at h of 0.5 in the mask. (0.36 needed to meet BT of 0.5)

Jerry got 180 kHz deviation vs. 175 kHz deviation in Jim's (McDonald) so in general and with proposal is in agreement with previous paper.

No discussion ensued.

Paper #8 802.11-93/97 (title??) Professor Kamilo Feher

Offered that FQPSK is his patent and will follow IEEE rules to use.

Some key points:

FQPSK exhibits 6-8 dB more power efficiency than non-constant envelope, etc. i.e. send 1.5 Mbps instead of 1 Mbps.

It is a 2-level scheme and simpler hardware than even non-coherent GMSK and is coherent in FQPSK.

Binary without jitter in each of I & Q channels, i.e. is a "2-state" system in FQPSK. Gaussian filter must be at least 8th order in GMSK or won't work right.

FQPSK is simpler to implement as GMSK. It can be implemented with non Ø equalized 4th order Butterworth receive filter. Xmit seq's special filter (under patent).

FQPSK can get to 3 bits/Hz in growth. (here it's 1.5 bits/Hz) i.e. it "scales."

Gaussian channel needs:

37 dB C/I GMSK for 10^{-3} BER vs. 27 dB for FQPSK

He dismissed DQPSK as no longer in running. He strongly advocates coherent constellation. (helps typical 200 ns delay spread which wipes out GMSK) Proposed selection of FQPSK. Invites PHY group to view real hardware demo at UC Davis.

Many Q&A were exchanged over 1/2 hour.

4:15pm... Paper added by Peter Chadwick (of GEC Plessey) from Apple Computer's data taken from real measurements by Time Blaney (of Apple Computer). Tim used a Fireberd bit error rate analyzer. Used 2-level CPFSK for A.C.I. Showed that 2nd I.F. went into gain compression. Effect of co-channel vs. modulation/no modulation signal C/I curves. BER ranged from 10e-3 to 10e-7 at -30 and -80 dBm. 2.40 GHz link demo with hardware from GEC Plessey Semiconductor. S/N# radios 007-009 at Apple of Plessey's 2000 series type. Gave only data "a bit crude."

Copies of paper are available.

Larry Van Der Jagt: Notes regarding I&Q demodulation... Cross coupling in channel defects.

Doug Morais (California Microwave): (differential path coupling in I&Q channel demodulations...especially in non-coherent demodulation)

Jim McDonald: Notes importance of diversity (antenna selection--spatial) in achievement of performance and timing of its selection/acquisition/sync time required. Notes phase change as antennae are switched.

4:35pm - Break

Motion by Peter Cripps, 2nd by Burchall Cooper

To effect: "All FH PHYs adopt GFSK with BT of 0.5 and a minimum deviation of 160 kHz with a data rate (raw) of 1 Mbps."

Discussion:

Much discussion ensued on premature cutoff of degbate and calling the question.

Mike moved an amendment , 2nd by Kamilo Feher:

"Adopt in addition to GMSK a modulation method such as FQPSK or others, resulting in more than 1.2 Mbps data rate (raw).

Chan Rypinski: Got floor and feels that better wording should be considered, but proposer and 2nd didn't accept rewording.

Nathan Silberman: Asserted that 4-level QPSK and 4-level CPQPSK are compatible with GMSK, and should be considered.

Kamilo Feher endorsed this proposal and indicates coherent detection of receiver is his recommendation (gains 2 dB or more).

Nathan's changes were accepted as friendly amendment and the amendment:

"and 4CPFSK or others backward compatible with GMSK"

was added to the amendment.

Seven speakers were to follow Wayne Moyes' points but Bob Buaas moved to call the question on the amendment. Vote: 26 YEA, 8 NAY, 10 ABSTAIN

Vote on the amendment as original: 12 YEA, 26 NAY, 7 ABSTAIN Amendment fails

Returned to original discussion of (original) motion.

Chan Rypinski spoke in favor of rejection of the motion indicating entry to market with this data rate/technology and alternatives far superior would defeat 802 standard than could last for years.

Peter Chadwick says want bottom level to enable start of communication link.

Kamilo Feher points out GMSK would enable this, but GFSK doesn't accomplish Peter Chadwick's purpose above.

Nathan Silberman emphasizes need for a good standard that will be used and meets the basic criteria of selection and endorsed Wayne Moyers' points stated a few minutes ago. A wise decision requires scalability.

Bob Zavrel endorsed Chadwick (???)

Wayne Moyers asked re: scalability of GFSK as point to demark from in air meeting interoperability.

Kamilo Feher: excludes coherent...
moves that we block vote by company (1 vote per company) --Larry allowed the "out of order"

Straw poll: 11 YEA, 30 NAY

Kamilo Feher: Offered an amendment, 2nd by Wayne Moyers:

"GMSK modify from GFSK, h to 0.5 index (and BT of 0.39 for GFSK)

This now on table...

Bob Buaas asks for a straw vote on base motion. Larry agrees this is out of order, but did [it anyway]:

Strawpoll, not including amendment: 26 YEA, 12 NAY, 8 ABSTAIN

Strawpoll, with amendment: 0 YEA, --- NAY, --- ABSTAIN [wasn't recorded in minutes]

K.C. Chen: What we need is a good solution. This motion limits us to a flat 1 Mbps. Dual rate capability. This is bad. Wants a scheme that is robust and scales.

Kamilo Feher asks what negative present on FQPSK (as a starting point)? Larry Van Der Jagt says GFSK is considered consensus and OK at 0.25 BT now that FCC has commented to 0.39 splatter mask. (but this closes the eye in!)

Bob Buaas called the question on amendment.
Vote: 0 YEA, "ALL" NAY, 2 ABSTAIN

Larry suggests (Kamilo Feher supports) that a friendly amendment be added to the "to [the] effect":

"Modulation techniques for higher data rates are to be further studied by 802.11 PHY committee." ... and that a means for arbitration (a negotiation to switch) to much higher rate is also to be further studied.

Vote: UNANIMOUS YEA, 0 NAY, ??? ABSTAIN - CALLING THE QUESTION PASSES

Jim McDonald and Bob Buaas 2nd calls the question on original motion as amended above:

46 YEA, 0 NAY, 4 ABSTAIN

Motion, as amended, is now ready for vote:

39 YEA, 5 NAY, 5 ABSTAIN

Motion passes, by more than 75%

Motion will go to closing 802.11 plenary as close of issue 24.10

re-vote straw vote:

16 YEA, 4 NAY, 2 ABSTAIN

So? still passes if abs.

[Editor's note: Though not noted in handwritten minutes, it appears that at this point in time, discussion shifted to a review of the DSSS template document. Also, the secretariat changed briefly (i.e. Wayne Moyers had to step out for a while). Three pages of handwritten minutes were inserted...author unknown. I am unsure of the exact chronology of these three pages...assume they go here.]

Peter Chadwick requested the withdrawal of the allegations of partiality made by Mike Rothenberg during the Tuesday afternoon debate. Mike did not accept this opportunity: Chadwick affirmed his confidence in the chairman.

Jan Boer reported that he had made changes in the performance template (802.11-93/83).

Noted:

Item 1:	European frequency range is 2400-2483.5 MHz
Item 6&25:	References to ETSI RES02-09 become "prETS300-328"

Discussion on item 14 followed: This centered on minor adjustment of system parameters.

There was a query on a 2 Mbps minimum rate: a lower rate was considered desirable in some circumstances, and this was to be defined later.

Further discussion followed on item 21 with no eventual change.

Items 21, 23, 26, 27 may need revision. These are placeholders, and are TBD.

Item 24: Spurs at > +/- ?2 MHz: -55dB

Item 29: 8dB considered tight, and a system issue. Further discussion may be expected.

Item 30: In discussion, Mr. Zuckerman queried the 18dB man-made noise level. Mr. Chadwick commented that the ITT Reference Data Book showed 10dB: Wayne Moyers commented that microwave ovens exceeded this figure. Mr. Achatz said that a paper was to be expected at the next meeting. Larry Van Der Jagt said that impulse noise effects would need testing. Peter Chadwick commented that some information may exist in IEC docs from CISPR and he would investigate.

Item 32: Under discussion: to be +/- [???] ppm. Other temperature ranges need consideration.

Item 37: Add after "testing": "stable with all phases of VSWR".

Action: Peter Chadwick to provide temperature bands for ETSI. Kerry to provide temperature bands for Japan. Info to Nathan Silberman.

Agreed: To settle outstanding items offline. Papers of general interest to be presented to PHY group. First meeting 14 July at 2030 hours.

Coexistence of DS to FH is required.

Agreed: Some discussion is needed at the next meeting and papers are requested for then.

Wednesday AM

Peter Chadwick first notes 8:00 - 9: break

Discussion re update of draft spec FHSS PHY (802.11-93/83r1)

Need for a co-existence etiquette is needed among FH <-> DS systems was discussed and need emphasized by Telxon and others.

Schedules were discussed for the first draft specification for both FH and DS with target of completion at end of November meetings. Ad ad-hoc meeting of the DS interests is set for 8:30pm (after the social) today.

Paper: 802.11-93/111 (title?) Juan Grau, Proxim

Uses switched from BFK at 400 Ksymbols/sec (400 kHz P-P deviation) then switched to 4CFSK at 1.6 Mbps 20dB BW h modulation index 0.5 (P-P). BT of 0.5 at 900-925 kbps used as the pre-modulation filter.

Larry asked about the validity of these combined factors. Juan uses mode of 800 kbps for all protocol packet transfer then payload at 1.6 Mbps with fallback by 1/2 to 800, 400, 200 kbps levels if needed after use of a 30 to 50 Msec CLK/jitter/data transitions timer and eye opening quality to establish valid data detect for rate fallback.

Note: Uses a 30 Msps ADC (5ma a lower clk [frequencies???]) that costs $2.50 (designed for camcorders).

Points were made and covered in the paper that suggest impacts upon the draft PHY Specification reviewed this AM. Juan emphasized need to only specify parameters absolutely required for basic interoperability.

Much discussion ensued re RX/TX and negotiation switching time specs and cost constraints for reasonable implementation, especially in heterodyne systems.

Noise floor BER is better than 10e-8.

Morning break....

Prepare for joint meeting...

Discussion of MAC/PHY linkage and potential for "keeping" concept of only <u>one</u> MAC with multiple convergence layers specified by the PHY group. Points were made on both sides.

Straw vote: Should we keep <u>one</u> MAC? 11 YEA, 18 NAY, 9 ABSTAIN

Discussion then turned to methodology of standardization... USA, here, Europe, ad-hoc industry groups, etc.

Functions need to be clearly defined that exist at the final MAC/PHY interface and which functions are handled within the "convergence" layer unique to each PHY. This needs understandings joined at meetings in PM and with MAC group. Ed Geiger pointed out information often is best obtained within the PHY layer (e.g. CRC tracking) but action to implement result is MAC function. Note his paper blends these realism.

Thus issues defined by Larry [Van Der Jagt] and group consensus for entering joint session are:

1) One or more MACs?
2) Sense of need for more joint meeting time next meeting?
3) How do we "force" combined MAC/PHY submissions? Consensus is that Apple's was good and first.
   Note: L. Zuckerman of ICS indicates this as a "strong possibility" in November 1993.
4) Value of meeting/sub-groups assembled to define "Profiles of Product Types" as means to approach standardization, as ETSI seems to do in Europe.
   - much merit of this was voiced
   - How set [are] boundaries of "type?"
   - Does this make the problem inherently simpler?

Thursday PHY meeting

Need to cover this AM (before joint meeting at 11AM):

Workplan suggested by Larry as item (1) below.

(1) Define now and in next [???] what will be passed in the air to enable PHY function, e.g. "the common air interface". What unique words, what will be done "in an encapsulated preamble and postamble" that the PHY will take off and use.

(2) Tom T. brought in results of last night's DSSS sub-group meeting, e.g. a list of "issues" to be put forward for official resolution by PHY group.

(3) Many said in effect the maximum limits of degradation in limits set of the air media must be defined for a minimum stated quality of service so as to set up a conformance testing the PHY group must write to enable claim of 802.11 compliance of interopability.

Discussion ensued on various topics. "How" we can pass a minimum set of information to a defined modulation, air-link-sync-demod capability to enable bit-stream extraction and pass to some MAC for session handling.

(4) We must also define a layer management interface "on this side" as well as the data stream interface to the MAC.

(5) Nathan Silberman, Ed Geiger, Wayne Moyers and others in various ways said: Timing and sequence of signals must be defined, such that some (variable) form of a state machine option can be envisioned to enable a real implementation; but such detail, once established that it can be done, is <u>not</u> a part of any 802.11 specification.

(6) Chan Rypinski discussed needs to define output documents, e.g. the transmitted signal must be defined in great and full detail. The receiver must also be specified for what it will do, and not do, to the captured bit stream. Result must enable harmonious link establishment. Details remain for PMM group to resolve.

(7) Discussion to standards content, "musts" and "shalls" vs. advisory/normalative comment inclusion.

(8) Again, redeclared in response to question from Ed Geiger, that clock recovery is a PHY function and associated timing and such parameters must be specified.

(9) Larry [Van Der Jagt] declared that the PHY group will deliver a full list of agreements as a Draft Standard for PHY to the plenary vote. Tom T. wants to open the list provided as issues from the DS sub-group. They would like to act upon clusters of items in the template as individual votes.

(10) Dick W. suggested splitting the -83r1 document ("Nathan's") again into 2 separate lists so that the templates for FH and DS can be separately handled. Most agreed.

Motion: It was moved by Paul Struhsaker that a single open cluster of items with parameter values be opened by the DS sub-group (ad hoc) for action and voted upon from a template defined by 93-83 document.

Second: Stuart

Vote: 23 YEA, 0 NAY, 5 ABSTAIN -- MOTION PASSES

Same as above for FH PHY:

Vote: 23 YEA, 0 NAY, 3 ABSTAIN

Motion: by Jan Boer, all proposals for the DSSS PHY must be offered by or at the September 1993 meeting of the PHY working group in Atlanta, after which new proposals will only be considered if a 50% approval is obtained. (Submissions [however] are allowed).

Second: Stuart

Vote: 21 YEA, 0 NAY, 10 ABSTAIN -- MOTION PASSES

Submissions expected at Atlanta meeting:

1: Apple will submit a PMD description for a (slow hopping) FHSS.

2: Apple also to supply a scrambler polynomial definition.

3: Apple will define details of their preamble in a submission.

4: Jerry [Socci??] will supply a PHY header/preamble definition.

5: François [Le Maut??] will supply a PHY header/preamble definition.

6: John McKown has an important reference to a preamble paper that he has put on the reflector and can be made available in Atlanta.

7: Chan Rypinski will have submission of omitted Parameter Line Items for our template inclusion.

8: Higher Data Rate Ad Hoc Group report, especially as impacts header for preamble decisions to be taken at the Atlanta meeting.

9: Representation of 802.11-92/96 by Tom Finney re service primitives and MAC/PHY interface.

Draft Work Plan for Atlanta [Meeting]

Monday AM:	Plenary of 802.11
Monday PM:	Submissions - joint -preambles and PHY headers -MAC/PHY interface (represent by Larry of Finney paper plus ????) (from Dayton, Ohio meeting)
Tuesday AM:	work on above decisions
Tuesday PM:	Split DS/FH meetings includint PMD spec (Apple) in FH session
Wednesday AM:	continue Tuesday PM and late AM
Wednesday PM:	meeting of joint/PHY
Thursday AM:	miscellaneous clean-up and plan for next meeting

-- Meeting adjourned at 10:30 AM.