IR-PHY Adhoc Group Meeting
Wednesday, March 11, 1993

The meeting was called to order by Tom Baumgartner 8:40 AM.

0. Introductions - everyone in the room was invited to state their names and affiliations.

1. Adoption of Agenda - by consensus

2. Adoption of Rules of Operation of the Group

It was agreed that the group should have a chairman and secretary. Tom Baumgartner was drafted as chairman, and Carolyn Heide was drafted as secretary (as long as duties don't conflict with secretarial duties of the 802.11 Working Group or the MAC subgroup. At those times, should they happen, Richard Ely will assume the secretarial role.)

Standing within 802.11 - it is agreed the group should meet as an adhoc group reporting results to the PHY subgroup. There is desire not to meet in conflict with the MAC and PHY subgroups.

Tom B. feels we better start drafting a specification in 1993, and writing things outside of meetings and bringing them back to these meetings is the best way to make progress. Carolyn thinks that submissions can be official 802.11 contributions even if they are only presented here (will check with the 802.11 chairman about this).

7. Presentation of Submissions

Informal Summary of IR Submission made to date, by Tom Baumgartner

91-15, Infrared Wireless Networks by Richard Allen, Wireless Research (doesn't have an official copy of this, just one with a hand written number on it)

Proposes that there are 3 types of IR--Point-to-point (600 feet at 10 Mbps), Directed (70 ft. at 10 Mbps), and Diffuse (30 ft. at 1 Mbps). Lists advantages and disadvantages of each. Gives some formulae for SNR. Discusses Directed IR at some length as introduced by Photonics in 1989. Some discussion of Diffuse IR. Lists CSMA, Token Ring, and Token Passing Bus as possible access methods. Discusses OOK of NRZ data and PPM as modulation methods. Lists Photonics, BICC, TI, and Spectrix as IR suppliers.

IEEE P802.11-91/33, Infrared wireless networks by Richard Allen, Wireless Research

Doesn't have a copy of this document; perhaps this is the above document with its official number, see above.

IEEE P802.11-91/51, Draft strawman infrared PHY Interface Specification by Richard Allen, Wireless Research (an unofficially numbered copy of this)

Proposes diffuse CSMA PPM specification for 100 Kbps to 10 Mbps. Optical wavelengths between 800 and 900 nm. Includes specific proposals for field of view and emitted power. Discussion of synchronization, packet format, optical rise and fall times, and other details. The best paper IR paper ever presented.

IEEE P802.11-91/123, PHY Experiences - Diffuse Infrared by David Waskevich, Spectrix

One page about financial trading system (1 Mbps Manchester encoded, diffuse 830 nm, reservation polling protocol).

IEEE P802.11-91/124, Diffuse Infrared, Conference room tests by Roger Samdahl, Photonics

Results of testing of diffuse IR in a conference room. Data rate of 230 Kbps over a 920 Kbps system with FEC. Tests confirmed operation in the presence of sunlight and bright overhead spot lamps.

IEEE P802.11/91-126, Papers on Infrared Wireless LANs by KC Chen, National Tsing Hwa Univ. (IEEE document list has incorrect title so this paper was almost overlooked)

Paper 1. Results of ongoing investigation of direct and diffuse 10 Mbps IR system. Considered Manchester OOK and PPM. Tested both normal diode and laser diode transmitters. Discusses Token passing, polling and CSMA protocols.
Paper 2. Mathematical treatment of BER, transmission rate, power, and system parameters for OOK modulation.

IEEE P802.11-92/10, Proposal for Physical Layer Specifications of a Diffuse Infrared Medium by David Waskevich, Spectrix

One page statement of PHY layer specs. No details to justify specs.

As an aside, Tom mentions that Spectrix has a patent on a Reservation-based/ Polling Protocol that can be made public if that's what is needed to move the group forward

IEEE P802.11-92/30, Physical Layer Initial Review and Compilation: Infrared Media Conformance Specification by Richard Lee, Spectrix

Review of presentations and other research on IR. Response to PHY Layer Template Document. Worth reading.

IEEE P802.11-92/34, Issues on Infrared Transmission by KC Chen, National Tsing Hwa Univ.

Says that, although coherent IR, channelization and Code Division Multiple Access are possible, intensity modulation is the cost effective way.

Richard Ely asks if the group members can we get copies of all these documents. Tom Siep starts a list circulating, everyone signing get copies.

4. General Purpose - identify and discuss issues related to the use of IR within the context of 802.11

Tom B. suggests speed, modulation method and protocol as IR specific items.

Richard Ely suggests conformance measurement is another. I.E. for diffuse how do measure the power output or receiver sensitivity. An integrating sphere?

Tom B. suggests the MAC/PHY interface - how a single MAC supports both IR and Spread Spectrum. Another is categorizing types of IR another issue - there seem to three types of coverage people talk about: desk-top; hall-way(directed); room(diffuse).

A brief look at each of these items:

Speed:

In response to a question from Roger Pandanda, Tom B. says the maximum speed submitted as tried so far is 10 Mb which may be the maximum possible due to the multipath problem.

Tom B. thinks that room diffuse coverage at 1 Mb may be a simple implementation specification to do first, and later add a more complicated system.

Tom Siep: by virtue of field experience with the simple one we will know how to proceed better.
Richard Ely: yes but we need to give input to MAC subgroup on higher speeds coming. IR has more potential for this and we should push it.
Tom B.: speed has been contentious at the PHY meetings, some feel that 1 Mb is not ambitious enough.
Richard: radio wants a provision for a fallback lower speed. We want to provide for going higher.
Leon Scaldaferri: in an ISM presentation they proposed a lower and a higher rate, so a lot of media are going to want to ask the MAC to accommodate more than one rate.

Modulation:

Tom B. suggests we may be able to agree on OOK at 1 Mb, Manchester encoded?

Rui Valadas: have been using OOK, but plan to upgrade to PPM.
Tom B.: suggesting OOK for the baseline 1 Mb and upgrade later.
Rui: PPM could save a lot of power.
Dick Walvis: PPM makes you more sensitive to multipath problems.
Tom B.: sounds like a technical discussion is required here. Does anyone know of any other methods that should be considered.
Rui: PSK has been used at very low data rates.

Protocol:

IBM has submitted a deterministic protocol, and Spectrix uses a similar one - Tom B. is in favor of deterministic protocols. Also feels that IR doesn't lend itself to direct peer-to-peer communication. Minimizing portable power use, while the base station has power to use, lends itself to an unbalanced channel.

Tom S.: can't have an adhoc network if you have to have a base station to communicate.
Carolyn Heide: why discuss protocol here (rather than in the MAC subgroup)?
Tom B.: can't decide on a specification here until we know the protocol.
Dick: shouldn't you decide what IR-PHY things are dependent on the protocol and take them to the MAC subgroup?
Tom S.: as long as we are at low data rates we have to be deterministic.
Tom B.: does anyone object to following the path of a deterministic protocol?
Rui: tends to favor carrier sense for many reasons. You don't have to have information on the number of stations in a cell. And it minimizes the power consumption - you only access the media when you have to send.
Richard: this is equally important to radio.
Adriano Moreira: FEC as an issue also.
Tom B.: packet size limiting could be used to help with error handling. Briefly describes Larry van der Jagt's Matematica modeling work - we may want to use that before the end of this.
Richard: bursty noise is also a consideration to the radio people. Maybe IR noise is more random and less bursty.
Tom B.: al this hinges on channel characterization.
Tom S.: power consumption is being implicitly considered as important. Maybe we need to be more explicit about that.

Tom B.: power and weight are very basic. A specification needs to consider this - we are not necessarily talking about cable replacement here, but about things that are moving in people's hands.

Measurement:

Does anything exist? Are there any recognized standard for specifying strength, intensity, amount of light being generated by the transmitter? Part of the specification will be a statement of "some intensity when measured by some method" - field of view, must be included here. Perhaps mWatts per square cm or something like that.

Adriano: also very important for health reasons to limit the radiance. there is no European standard for LEDs that applies, there is an American one, reference ANSI Z136.2 .
Tom B.: with an LED at near contact with the eye and lens focused at the retina, a hole can be burned in the retina. This is a function of power, time and wavelength. To fill a full sized room you don't meet those criteria though. Even a diffuse transmitter, if held right to the eye these things must be considered.
Tom S.: UL restrictions for laser are tight, but not for LEDs.
Tom B.: to drive the LEDs used by Spectrix at a level hard enough to cause damage, the LED would burn out before any damage was done.
Richard: IBM has a patent for sensing breaks in fiber optics for safety that might be relevant here.
Tom B.: the specification probably won't say don't use specific transmitters, but the power consumption may preclude their use.
Richard: there used to be different specifications for coherent and non-coherent safety measurements.
Dick: we specify one safe implementation, we don't have to state what's not allowed.
Tom B.: the PAR says we are supposed to take safety concerns into consideration. We need to not force people to design things that exceed safety specifications.

5. Classes of 802.11 IR Use

Categories of interest: (1) diffuse-room coverage; (2) docking station type, desk-top LAN (to get into the wired LAN or maybe to form small adhoc groups). Point to point directed, or diffuse at very low power; (3) directed, everyone points at the same spot with a reasonably narrow focus. Like a hallway, tight-beam with fair distance. Is (3) of interest as part of a LAN specification?

Adriano: for IR bit rates it is interesting.
Richard: mobility is of interest, so pointing to a spot on the ceiling is too limiting.
Rui: applications where a WLAN for fixed stations is desirable. They could use transmitters in the desktop aligned vertically.
Tom S.: the user pointing at something is unacceptable, but this directed is an area broader than your TV remote.
Tom B.: sounds like all 3 classes are of interest. May or may not require separate specifications, if directed is used to go a greater distance without the multipath problem.
Tom Tsoulogiannis: what about a high bit rate? Directed can give you higher than a diffuse system can give you.
Rui: availability of practically priced components for high speed is an issue.

6. Review of Requirements

PAR (IEEE P802.11-91/58) and Functional Requirements (IEEE P802.0-91/-). From these two documents Tom B. found requirements of particular interest: 1 Mb minimum; one MAC for all PHYs; at least 100 meters distance; frame error rate 8×10^{-8} per octet of packet length (the meaning of this is not clear).

Tom T.: thinks that the MAC is supposed to improve the channel error to this.
Wayne Moyer: this goes back to the channel model, which is completely undefined, so its somewhat fictitious. 93/20 is the working draft standard that everyone should make sure they have.

8. Discussion of Specifications and Conformance Testing Methods

Previously discussed, under agenda item 4.

9. IR MAC-PHY Interface Special Requirements and Considerations

What does everybody think they are?

Tom S.: the hidden node problem may be worse for IR than radio.
Tom B.: is it enough of a problem in radio that it will get consideration, even though it may be worse of IR.
Nat Silberman: it should be dealt with at the MAC layer. It creates more interferers due to out of range nodes.
Richard: radio considers automatic power control (above a certain power level). Do we need to be concerned with this?
Tom B.: thinks their reason is the good-neighbor theory - operating at as low power as you can get away with. Tends to think IR has more of an established transmission level.
Nat S.: two access points in the same room interfering with each other can be a reason for power control.
Tom B.: if the MAC includes power control, to support radio, we could take advantage of it.
Richard: for IR there aren't many things you need to set: Speed control; Maybe some receiver level power reporting. IR requirements are pretty minimal.
Tom B.: maybe we need to take the list of the things the radio people want to set and look at it from the IR point of view.
Nat S.: four transmit power levels have been decided on. How many bits of receiver power level has to return has not been determined yet. It would be useful to know receive power characterization. A 6 to 10 db tolerance would be reasonable. Maybe 8 levels identified.
Tom B.: dynamic range might be tighter in IR. That determines the granularity of the report. If there are different categories of use, the category of use might want to be reported to the MAC.
Leon: there were 2 hopping rates proposed, there could also be two somethings in IR. The number of bits that need to be set may be the consideration.
Tom B.: the size of the MAC might be the issue with how may things there are to set. What about channelization? KC Chen concluded in one of his papers that economically there is no way the channelize IR.
Frederic Bauchot: it would help with cell isolation to channelize. The specification could say that it could be supported if a way exists to do it. Helps to support one MAC for multiple PHYs.
Tom B.: certainly it will be there for radio and we should use it if we can. What about wavelength - 800 to 900 nm was specified by Dick Allan's submission. Such a wide specification (as opposed to something like 820 to 850) has ramifications on the tightness of the optical filter. Research on how important this tightness is would be a good contribution. It is probably in that range, due to the low cost emitters there, but how tight.
Richard: at lower data rates (top 1 mb) the higher power devices are at longer wavelengths. This is a means to separate the low speed from the high speed.
Tom B.: that distinction may become obsolete in the next year or so. That is an area for research- maybe we can get IR emitter companies to attend or at least make presentations.

Siemens, Stanley and Hewlett Packard are identified as manufacturers from which the group would like to hear. Tom S. says he will check on TI too.

10. Plans for Future Actions and Meetings

The chairman favors people interested bringing presentations (formal or informal) to meetings. The next meeting is Wilmington, Delaware on May 10-13. To make decisions research must be made.

Looking for a person to contact Stanley, HP and Siemens. No one volunteers, so Tom B. volunteers Spectrix's optical engineer Jeff Welch for that.

What about a submission of the pros and cons of deterministic vs non-deterministic MAC protocol for IR use? No one volunteers, Tom B. says he would like to make a submission in favor of deterministic protocol for IR use if he can find time to do so. It is important that any special requirements that IR has of the MAC be made so the MAC can consider them in the decision making process.

Richard Ely will look for IR test and measurement methods that may have already been established.

Research should be done into what the markets requirement document says about IR requirements.

Richard: eye safety and noise sources?
Tom B.: channel characterization is essential. Is there any existing information on characterization?
Rui: there are papers that consider the system as a whole which consider a simple channel model. Noise is considered to be isotropic, stationary. Interface characteristics of the noise are considered.
Richard: has seen the room lighting output - when the cycle goes through a zero crossing (light to none) there is a sharp spike into the MHz range. This occurs 120 times a second. At the edge of the florescent tube where there is no phosphor.
Rui: this is deterministic, more interference than noise. Around 100 Hz.
Tom B.: between 300 and 500 KHz there is significant noise from florescent lights. There is a new electronic ballast out that can stop IR systems from operating.
Tom S.: old ballasts can also cause problems because their characteristics change.

What are topics that anyone wants to study and talk about next time?

Tom S.: we have talked about transmitter diodes, what about the receiver photo detectors?
Tom B.: thinks that technology is pretty stable right now. There might be something coming we don't know about but commercially nothing is happening.
Adriano: someone proposed using APDs instead of diodes.
Tom B.: specification will not preclude use of other things probably.
Rui: traditional application for LEDs and photo diodes has been photo optics. The requirements are quite different, and most of the devices available reflect that application. That doesn't mean our high power and high speed are not possible. High active areas and less capacitance could be developed - that's why the manufacturers being here would be very helpful.
Tom B.: Jeff will have photo diodes added to his presentation for next time.

Where do we go from here - next meeting time? Small groups before the next 802.11 meeting?

Tom S.: needs to be at the 802.11 meeting times. people can't justify even more travel.
Tom B.: outside the normal hours makes it 6 to 9 PM time frame. Monday morning for the next plenary. For the interim, Monday evening. A straw man specification would be the most productive way to go, or to comment on the one from Dick Allan in 1991. Hopes to have that done himself, and hopes there are others who will do the same. A draft specification by the September meeting is a good goal.
Tom S.: why are people here, specific needs for IR or just general interest?

Straw Polls: How many people would attend on a Monday night if they had no time or money constraints (vote shows a lot). How many people are here for interest alone rather than wanting to influence the standard (about a third).

In the mailing the chairman will call for submissions on specific topics to be worked completely through next meeting.

Meeting adjourned: 11:30 AM