Tentative Minutes of the IEEE P802.11 Working Group

Interim Meeting
Gaithersburg, MD
January 7-10, 1991

Monday, January 7, 1991

The meeting was called to order at 8:39 AM, Vic Hayes, chairman IEEE P802.11[1)], being in the chair. Twenty-four (24) people were present, the total attendance for the Monday morning meeting was thirty-four (34).

1. Opening

1.1 Introduction : All people in the room were invited to mention their names and affiliation.

1.2 Voting rights: There are 50 members of 802.11 with voting rights. Voting rights are obtained in 802.11 by attending two plenary meetings out of 4 consecutive plenary meetings, rights are granted at the third meeting. One interim meeting may replace one of the required plenary meetings. This means that if you do not now have voting rights and attend the next plenary meeting in February, and have attended this January meeting, you will have voting rights at the May meeting. Attendance at a meeting requires your presence in the meeting room for at least 75% of the time as determined from the circulated attendance list. (Attendance at interim meetings is not required at this time. This may have to change. The aggressive schedule of at least one interim meeting per plenary meeting can result in retaining as voting members people who miss more than 3 out of 4 meetings.)

1.3 The attendance list was distributed. The chairman drew attention to the obligation to register for the meetings.

1.4 Logistics. Meetings start at 8:30 each day. Breaks are normally at 10:30 a.m. and 3:00 p.m. Lunch break is flexible, normally started at 12:30 and lasting for 1 hour. There are several good restaurants in the shopping center across Russell, and the Japanese/Korean Ichiban across the street. Dinner can be ordered from the hotel barkeeper. Breakfast served free by the hotel. Document distribution is done using pigeon holes - you will find your copies and messages in the referenced location in the expanding file folders.

[1)]The officers of the Working group are:

Mr. VICTOR **HAYES** Phone: +31 3402 76528
Chairman IEEE P802.11 Fax: +31 3402 39125
NCR Systems Engineering B.V Telex: 47390
Architecture and Systems Management
Zadelstede 1-10
3431 JZ Nieuwegein, NL
E-Mail: Vic.Hayes@Utrecht.ncr.com

Mr. JAMES. **NEELEY** Phone: 919 543 3259
Vice Chairman IEEE P802.11 Fax: 919 543 0159
IBM
LAN Systems Design
POB 12195
Research Triangle Park NC 27709, USA
E-Mail: neeley@ralvmk.iinus1.ibm.com

Mr. MICHAEL **MASLEID** Phone: 219 399 2454
Secretary/Editor p802.11 Fax: 219 399 5714
Inland Steel Co. MS2-465
Process Autom Dept
3210 Watling St.
East Chicago IN 46312, USA

1.5 Meeting fee. The meeting room is free; the coffee, donuts, projectors and VCR are not. The host, Jonathon Cheah, will collect a fixed fee ($50.00) from all those attending. Any over charge will be used to defray costs of copying. Be advised that the meeting fee for the Plenary meeting has been increased to $150.00. It was claimed that the largest single costs at the Plenary is copying. (A check of the Executive Committee records indicates that this is not true.)

1.6 Other announcements. Richard Allen regrets that he cannot attend. He is willing to take a lead for infrared products, and is willing to head up a group. Can we write a letter? (See action items at the end.) Rick Albrow is at an ETSI meeting. Russell (from the FCC?) is not able to attend and sends his regrets. Special thanks to our host, Jonathon Cheah, for the excellent meeting facilities and directions .

2. Approval of the minutes of the previous meeting

2.1 Approval of the minutes of the La Jolla meeting, Document IEEE P802.11/90-22.

The statement on page 3, attributed to Chandos - "Given the genealogy of DECT (optimized for voice transmission), it appears that P802.11 is the principle forum for data over radio." - triggered a great deal of discussion. The statement is an accurate report of an opinion expressed at the meeting - it may not be a fact, or the official opinion of the committee.

P802.11 does not wish to exclude DECT from consideration outside of Europe. It is also understood that regardless of capacity, DECT is the only forum for voice or data over radio in Europe. That is a political issue, not a technical one.

The technical issue is data rate. To paraphrase Chandos `As a personal opinion, DECT is OK at the bottom, at 2 Mbit/s perhaps - but if it is not able to approach 10 Mbit/s it will not have the generality needed to serve the anticipated market. The original statement - if not the truth - is at the edge of truth.'

DECT can achieve high data rates by having a station capture several carriers on several frequency channels at the same time. There is some discussion within the European community between those supporting voice and those supporting data services as to how much bandwidth a data service will be allowed to capture.

Dr. Pahlavan points out that the reference on page 12 to the WIN Lab meeting is wrong. There is a meeting of the International Symposium on Personal, Indoor and Mobile Radio Communications at King's College - University of London, 23rd-24th September 1991.

The minutes were approved by consensus except as noted above. The Chair thanks Mr. Masleid for doing a xxxx of a job.

2.2 Matters arising from the minutes. Some members (Dave Bagby) received the documents too late. This is due to peculiarities of the mail service. Please note when you receive this mailing so that we can determine were the use of alternative methods is required.

ETSI will use DECT as the main forum for low to medium data rate radio LAN's. DECT is a publicly owned network, but it can be privately owned. (In the United States, the publicly owned RLAN's may be developed by T1P1 in some forum different for P802.) The data rate that can be obtained with DECT using carriers on several frequencies meets the functional requirements of P802. It would be a mistake not to continue considering DECT under the umbrella of P802.11. We need a report on how to use DECT for higher data rates.

The meeting broke until 10:50. 10 inches of snow is expected by days end.

3. Reports

3.1 Report from the executive committee. The Chairman reported the following subjects of interest to 802.11:

The meeting fee at the next three Plenary meetings is increased to $150.00 per meetings.

The Functional Requirements, IEEE Project 802, Local and Metropolitan Area Networks Standard Committee, Draft 6.5, Document IEEE P802.11/91-12 (temporary document G3) is under 30 day letter ballot. Vic Hayes can send comments - contact him in this meeting.

IEEE has developed new rules for standards activities. We are running in the old fashion under project 802. The Executive Committee is studying the change to Subcommittee status for 802, reporting to the Technical Committee on Computers and Communications, TCCC. There may be some changes in the approval process, with official ballots from IEEE members only. A poll indicates that 17 of those present are members of the IEEE.

3.2 Report from the liaison organizations.

The secretary reported on his discussion with the ANSI ASC X3T9 executive committee. (Mr Masleid is his company's principal voting member at X3T9 and X3T9.5.) ASC X3T9 has no objection to P802.11's extension of scope to 100 Mbit/s, however, any components of the P802.11 standard that are essentially the same as FDDI (the Fiber Distributed Data Interface and its variations in ASC X3T9.5) must be identical to FDDI - minor variations to the X3T9.5 standards living in the 802.11 standards can not be tolerated. No action was taken pending an official request from P802. (Dr. Rigsby is the official P802 liaison to ASC X3T9.)

Vic Hayes reports that the European Committee is willing to support the ETSI liaison.

Simon Black reports briefly on two areas in ETSI. RES-6, the standards for digital trunked mobile radio for voice and data, is moving on packet data. Within RES-3 (DECT), RES-3S, the services and facilities requirement document is a firm draft as of December. RES-3N network and system in single bearer unprotected mode is progressed. RES-3R PHY and MAC and RES-3N network and system for simple voice are a firm draft. The packet data specifications are about 90% complete - there are gaps.

A DECT consultant's market report and cost projections is complete. Simon will find out how to get copies of the consultant's report.

RES-6 had an ad-hoc first meeting in late November on private mobile radio systems (PMI) and wide area packet data services.

4. Registration of contributions

Contributions were reviewed and assigned positions in the agenda.

The DECT Report may be available:

The effect of Market & Technological Factors on the Implementation of a Digital European Cordless Telecommunications System January 1990

CEC DG XIII

37 Rue Joseph 2
1040 Brussels
Belgium

Ph +32 2 236 2936
Fax +32 2 236 2723

There were no contributions on spectrum requirements.

8. Markets to be addressed.

8.1A Introduction of Contribution by Mil Ovan, *Wireless In-Building Network Market Considerations*, **January 7, 1991; Document P802.11/91-08, temporary documents G12 and addendum G12.1.**

Mil Ovan presented an analysis of market research conducted by Motorola. This represents the results of 4 years of interviews with the MIS, telecom, or departmental managers of about one thousand companies employing from 200 to 1000 personnel on site.

Mil believes that the architecture should be optimized for the intended market - a general purpose network will always fail in competition with a network specifically focused to the needs of a particular market.

A large wired network replacement market is foreseen if the wireless network provides more flexibility, no less speed, and compatibility with existing applications. It must be reliable, secure, and cost effective, and must not require special login procedures.

According to Mil, the wireless network must provide both voice and data service. It is a mistake to look at voice and data as the same, or to look at voice and data as uniform within themselves.

Mil does not see a need for on premise portability for the telephone. The managers interviewed had no desire to permit removal of data or voice equipment from the premise, so no need is foreseen for roaming between extended basic service areas.

Mil presented an analysis of Enabling Technologies where CT2, DECT, TELEPOINT, Digital Cellular, PCN, ... are seen as perhaps complementary technologies covering a broad spectrum of markets.

Discussion:

The discussion assumes use of an 18 GHz band that is divided among 5 license holders in any 35 mile region. Licensing can be used to control frequency reuse and as a recourse in case of interference. A manufacturer, if so inclined, can reduce the licensing burden on the user to just identification.

Dr. Ray Simpson argues that licensing does not have to be used to guarantee recourse in the case of interference. Simon Black asks - wouldn't type approval achieve the same protection?

Dave Bagby points out that the roaming portable personal computers used by many of us at the meeting do not fit in the market as described by Mil. (We move frequently from one geographic area to another in our work.)

Mil believes there is no solution that covers all markets.

Puzzle: How can a market survey of existing applications provide useful information about what the market will be for a product that does things that are impossible for the existing applications? - but doesn't have the data rate for existing applications?

Jim Neeley says that wireless will become more useful as applications are written that use the local machine for fixed data and the network only for variable data.

8.1B Introduction of Contribution **by Ronald L. Mahany,** *Wireless LAN Users and Applications*. **January 7, 1991; Document P802.11/91-09, temporary document G13.**

This paper presented by Ronald Mahany describes life outside of the office environment. Wireless data collection systems exist now. The market exceeded $100 million in 1990. Some of the devices work at up to 9.6 kbit/s under FCC part 90 rules, others at up to 230 kbit/s under FCC part 15 spread spectrum rules. Most of the devices are used in retail and industry, most are used in inventory tracking. These are the true portable and mobile applications as apposed to applications that replace normally fixed wired networks. The market may not be large - but it is growing. (I:) It is important that these applications be able to coexist with what seems to be developing here. (A thrust by Mil to design a wireless network optimized to replace wired networks.)

8.2 Discussion of Market Contributions.

The Chairman invited Mil to make changes to the PAR (which was not the intent), and to make additions to the Ibis issues list.

Mil points out that page 4 of the PAR document still seems too general. (I:) You need to draw a line in the sand for what you are going to do and what you are not going to do.

The Chairman advises that it is not wise to be restrictive in the PAR.

(I:) Should a principle distinction be between speeds of service (data rate)?

Chandos questions: Does the wireless network replace or complement the wired system? I do not intend to replace the wired system - perhaps no more than 10% on the wired systems. Does the capital gain come from sale of equipment or from franchise of the service? The franchises are already competently and strongly represented (to the FCC and in the marketplace) but there are other legitimate economic interests. The range of devices (that would be serviced as Mil's market) range from 2500 hand sets to Sun (™ Sun Microsystems) workstations. I refuse to let the 20 dollar item dominate - the carbon button mike hand set has to go anyway. The notion that business operations are happy with the push button and light 25 wire pair system is not reasonable. Do not be burdened by the past. Are we going to undertake integrated voice data LAN? It is a non trivial undertaking! It is conditioned by what can be obtained from the public network - but that is changing. I don't want to use the task definitions (that we might define) to limit what can be considered.

Mil wonders if this is a public versus private or versus franchised question? Chandos would define it as the people who pay for the system are those who use it. Mil questions pay for service or pay for use? Chandos says that that becomes obscure when there is the question of cooperatives.

(I:) Do we support the $20 phone?

(I:) Do we support the ISDN U interface?

(I:) Do we standardize data rates of 2.5 5 10 20 Mbit/s scaleable?

Orest asks (I:) Is the network meant to replace or complement the wired network? The mobile equipment is not wireable. The mobile market can afford to pay more. (The mobile crane or robot or vehicle is inherently expensive. There is no competition from inexpensive wired connects.) (I:) It would be nice to make a matrix of markets, rates, type (mobile, roving, fixed), . . .

Dave Bagby questions: Is the PAR what it is - or is it open for discussion? It is more important to identify the principle issues than to discuss the PAR for another week.

I: Does the wireless network replace or compliment the wired system?

I: What of those who must use wireless? How can the inherently wireless (mobile, data collection, AGV) coexist with the wired LAN replacement (desktop computer, desk phone) wireless?

I: Should the network be private or franchised?

I: What is the definition of the voice service mentioned in the PAR?

I: What importance do we give each class of supported equipment from the 2500 hand set up through the Sun workstation?

I: How reliable does the network need to be - as good as telephones, or at the level needed for industrial control systems?

I: What about security?

I: Should the PAR be more inclusive about supported environments? What if new ones are required.

I: Should the standard provide an alternative reach/rate tradeoff by means of scaleable physical media signaling speeds?

Dan Lewis wonders (I:) can we define the market that we wish to address? There are distinct needs - that is the point of both of these papers. There are at least 5 markets that seem distinct, retail, campus, industrial, . . . These can be defined by density of phones, cost sensitivity, coverage area, . . . Dan Lewis ***moves*** that we set up a list of what these market segments to be addressed shall be. Second by Robert Buaas. (The attempt to formalize the motion overreached. Secr.)

Motion: **Identify a list of market segments and formulate ad-hoc focus groups to study the needs of each segments.**

Discussion:

Chandos: I am sympathetic to insuring that certain applications are in the scope, but it is an extremely time consuming process. As a better way to serve the same end, each proponent can describe the market he wishes to serve, some will have a larger application space than others. The protocol may in fact be the same for industrial and retail and campus, the difference may be in redundancy and circuit complexity. Let people come forward with what they propose. Let us evaluate proposals on the scope of their applicability.

Robert complains that Chandos' approach is bottom up, but it can be accommodated in the context of the open motion by submitting each architecture to all of the subcommittees. Change "ad hoc focus groups" to "expert groups" Dan seconds. (15/2/1)

Dave Bagby: We need to have an idea of the commercial applications, but there are not enough representatives here to support the expert groups.

Jonathon Cheah is against the motion. (I:) We want to get to a global coverage. (Find a way for the standard to support all markets.) The minority (be it campus, industrial, or so forth) must find a way to fit themselves to the architectural - or modify the architecture.

Position: The major market segments (retail - shopping mall, warehouse distribution, manufacturing, office, and campus - outdoor) are different in key parameters. For instance, retail is characterized by a high density of concurrent operation under independent jurisdictions.

Jim Neeley - and the office has one jurisdiction? Jim will shred any attempt to make definitions of this sort. The Manhattan office - the glass towers - is the same as the shopping mall.

Mil supports the motion, marketing is important. The standard must say what it will do. A line must be drawn in the sand.

Don Johnson - we need to have defined markets, but some may be served by the same architecture.

(I:) Markets can be defined by cost, coverage, (rate,) throughput and voice requirements.

Dave agrees that there are several market segments that must be supported, but is against the motion. There are market segments that are not represented.

Michael Masleid speaks against the motion. The standard should be segregated by architectural, not markets.

Larry Van Der Jagt says that we need to figure out topographies, LAN's (stations) per square meter.

Ken Biba speaks against the motion, it is to early to vulcanize the discussion. The dominant wired LAN's are different - but meet identical needs - that is not good. That they don't interoperate is bad. The difference between (LAN's and markets) is more in perception than in reality.

(I:) A scaleable architectural should be chosen, then market advocates can interact? (If properly done, the market segments can interoperate?)

Jim Neeley, speaking as Big Blue. We went back and looked at what we did. We computerized accounting. Then the office. Then MIS. Now on to CIM (Computer Integrated Manufacturing). Each of these created significant new applications and users of the mainframe. The wireless LAN addresses those with no access to the main frame - and no applications on the mainframe to tie to. First we must make the hardware based on existing application - so it must replace or compliment the wired LAN. Then the inventors will make the

new applications that drive the industry one more magnitude higher. (The radio LAN) must look like the existing LAN's, but must also be independent.

The transportation (distribution) industry has requirements we recognize. IBM stands firmly on both sides of the issue. (Wireless supplants or compliments wired.)

Robert - we must be market driven to get to a Standard - but we may have a handle on this already - we can assess the market needs. We lack architecture proposals. The markets must provide a needs requirement.

Even if the motion fails special interest groups can continue. Dave Bagby calls question. (19/0/1)

The ***motion*** "Identify a list of market segments and formulate expert groups . . ." ***fails*** (2/14/1).

(I:) Integrity of service. Can the next door amateur radio operator take out the LAN?

(I:) How do we provide the greatest level of system integrity for system users?

This completes agenda item 8. The meeting adjourned at 4:48 PM for dinner and to provide time to read submissions.

Monday, January 7, 1991, Evening meeting

9. Review of work performed in the IEEE P802.4L Task Group 7:30 PM.

There was a presentation Monday evening, a review of the work of P802.4L (the antecedent of P802.11) developing a through air physical layer for the token passing bus MAC. A lot of the information from that work is in our archives.

Larry Van Der Jagt presented the test methodology and some of the results of the tests that he, Gunther Martin, and Michael Masleid conducted at Orest Storoshchuk's GM plant in Oshawa. Larry used a DPSK transmitter and quadrature receiver in the 900 MHz band to capture impulse and phase information using a LeCroy digital oscilloscope. Sample rate was 5 ns, chip time 40 ns, sample depth 40,000 per channel.

Michael Masleid presented a 20 minute video of the impulse response of the GM Oshawa plant in the phase plane versus time three space. The video was made using the solid modeling hardware of a Silicon Graphics 4D25 T workstation and RGB Videolink 1400AX scan converter. After seeing the video Dr. Pahlavan commented that the assumption in much of the literature, that phase versus time is random, seems to be invalid.

Bruce Tuch presented a history of the peculiar difficulties of trying to adapt the radio channel to the assumptions made about the physical layer in token bus or ethernet media access controllers. He then presented the path attenuation measurements made in a European office environment, and some of the tradeoffs that can be used to improve the environment, such as use of spectrum, space, and antenna diversity.

Dr. Jonathon Cheah presented a summary of what was learned from Hughes' measurements of interference from microwave ovens.

Tuesday, January 8, 1991, Morning meeting

The meeting was called to order at 8:38 AM, Vic Hayes, chairman IEEE P802.11, being in the chair. Thirty-two (32) people were present in the Tuesday morning meeting, thirty-six (36) wre present in the Tuesday afternoon meeting.

10. Architecture

10.1A Introduction of Contribution **by Dave Bagby,** *One Approach to Wireless Network Architecture.* **January 4, 1991; Document P802.11/91-2.**

Mr. Bagby takes what he refers to as a simplistic approach to the network requirements. The radio itself - or the use of carrier pigeons for that matter - is only part of the issue. (Emphasis first on characteristics of the channel, the least well understood of the parameters in this standard, is referred to as a bottom up approach.) Start at the top and work down. Lets examine network architecture first.

The first constraints are those established in the PAR. A key issues - the Standard must support several physical layers. I assume this means only one MAC and PHY per unit of time at a given station. (There may be more than one PHY per MAC at the same time with DECT.)

(I:) Should more than one PHY be supported at the same time?

I (Bagby) want a computer data network. Personally I think there are lots of ways to do voice, few for computers, so I don't think the complexity of doing both is worth the effort.

These are the system design requirements:

The system must be robust in design.
The system design should be driven by market requirements.
The system design should support niche markets, but must insure that there is a large volume market.
Ease of installation is important.
Ease of use is important.
Low hardware costs are important. There must be a way to build a low cost adapter.
Low operating cost is important.
Very low power consumption is important. (To support the portable computer application.) There should be no "I'm still alive" requirement.

These are the working definitions for functional parts of the architecture:

Station. A station is any computer which contains an implementation of an 802.11 MAC and PHY. If the computer contains several MACs, it may or may not be treated as several stations. It may be that if there is a single management layer for multiple MACs then the computer is a single station? There is no assumption about the presence of a human associated with the computer.

Basic Service Area (BSA). A Basic Service Area is that area in which each station can directly communicate with any other station.

Access Point (AP). An access point is a fixed radiation point provided by a distribution system. (The AP is the interface between signals in air (water, vacuum) and signals within the distribution system.)

Extended Service area (ESA). An Extended Service Area is the sum of the coverage areas provided by a distribution systems' access points

Distribution System (DS). A Distribution System is defined to be that system which links a set of access points together in such a way that stations within different access point coverage areas can communicate.

Distribution System Media (DSM). The Distribution System Media is the media used by a distribution system to interconnect access points.

(I:) Does the definition of BSA require direct peer to peer communication, or does it require at least a single access point?

P: The BSA might support peer to peer communication by using an elected (from the peer pool) redistribution point, or a separately supplied redistribution point. Use of an elected redistribution point provides greater range within the BSA than could be achieved by depending on direct peer to peer communication. Ken Biba points out that the group of stations can create an infra structure to support the BSA.

Dave Bagby continues with a discussion of BSA geometry. The direct peer to peer requirement causes the diameter of the BSA to be equal to the radius of coverage of an individual station in the limit. (One fourth the area.) The BSAs can be tied together by DSM.

Think about three contiguous and one isolated basic service areas connected into and extended service area.

The distribution system ought to segment traffic if possible.

The distribution system must be able to handle the same message arriving into the distribution system at more than one point and more than one time.

The distribution system ought only send to who must receive. Local traffic must remain local.

The access point must have a routing algorithm. That may appear to be a layer violation, but it really is a local issue.

(I:) If the interface between the CPU and DSM is well defined, then the DSM to wire interface is not important and need not be defined.

(I:) Management is adequately dealt with by having an addressable entity.

(I:) Should we standardize the distribution system media?

Dave, in rebuttal of Mil's presentation, points out that if the customer doesn't have a wired LAN, he won't pay for the wireless LAN because he does not yet know the real cost of the wired LAN. If the customer does have a wired LAN, he won't pay for the wireless LAN because he already has the wired LAN.

Discussion:

(I:) Do we need to standardize the distribution system?

Mil, in rebuttal of Dave's rebuttal, points out that the argument assumes no additions to the network.

(I:) Mil Ovan also points out that we should avoid the use of loaded words, like **RADIATION**.

(I:) Ray questions - do we need to define behavior of the distribution system?

(I:) Is conformance testing mandatory? Hidden interfaces make conformance testing a real problem.

Larry, speaking with regard to the ISO layering violation points out that if it is our wire (DSM) - we can do what we want with it. Some things, like routing, that happen at high levels in the Standard also happen at low levels. An LLC-service that has hidden routing and retry below it is really OK.

Jonathon Cheah points out that real time voice can be done even in such a system as Dave presents. Dave Bagby replies that it is not worth doing, since voice makes data a secondary use - human needs always seem to dominate. Jonathon points out that voice doesn't cost so much. Dave asks: How much?

Dr. Anthony Shober asks (I:) if only one network will be running in a given area? Dave replies that we must allow interpenetrating separate networks, so we can't use all of the spectrum. Two portable computers carried into an area (with an existing service) should be able to network without interaction with the existing service.

Dave Bagby points out that if you start from the premiss that computers are easy to move, then you move it around allot - once you realize that you can move it! But - portable computers are storage limited - so you network into the data base.

Mil: (I:) You talk of the laptops in this room talking to each other. Don't you also want to be able to link through the ESA of this hotel to your home base?

Ray points out that 2/3 of laptop computers are not now networked, there is a big market.

Ray asks: What is non real time voice? Dave replies that non real time voice has variable latency. Voice is sent as packets. All of the packets must be assembled. The timing requirements on this process are removed for non real time voice. (As such, it is good for one way communication.) Dr. Raphael Rom points out that real time voice tends to be used for two way communications.

10.1B Introduction of Contribution **by Bruce Tuch,** *Wireless Signal Distribution Architectural Considerations.* **December 14, 1990; Document P802.11/91-01.**

Mr. Tuch begins with a review of basic assumptions. The network will be built up using a dynamic addressing bridge so that traffic, as much as possible, will be broadcast only to the station addressed. This allows reuse, the network should, as much as possible, handle simultaneous traffic - increasing throughput.

What is the system throughput? How much information gets through? Much of what is sent is overhead and protocol. You **MUST** look at the total system - the whole beast must be considered.

Dr. Anthony Shober comments that this must be defined in terms of a test set - it is a Pandora's box.

Bruce continues: You can not ignore it (the need to define complex system performance without getting lost in hyperbole). The engineers must do this. Marketing should be a separate issue from the standard's development. As engineers, we know we are pure of heart, we have integrity, we will do what is right.

I assume the use of the three ISM bands because that is all that is available now. The 1.7 to 2.3 GHZ band would be preferred to the ISM bands. Voice is nice - we should have the hooks for voice, but it should not have priority and we will drop it if it is too costly.

(I:) Service must be continuous. It is adaptive and transparent - it is not handoff in the sense of analog cellular. Access points can be virtually redundant. If one access point goes away, another can take over.

(I:) We must have security. P802.10 deals with security. We can show that we are more secure than a cabled LAN (assuming that we use methods from P802.10) since it is possible to eavesdrop on 802.3 with a loop antenna.

(I:) Ways to minimize power consumption should be included in the standard.

(I:) Optical paths should not be presupposed in the basic service area - (I:) There should be no requirement placed on the user about antenna orientation. (Regarding very directional antennas.)

These are the working definitions for functional parts of the architecture:

Access Point. A fixed transceiver whose electromagnetic reach defines a limited coverage area.

Basic Service Area. The area in which a particular access point can service most effectively.

Extended Service Area. The area in which all connected basic service areas can service user equipment.

Dynamic Addressing Bridge. The system which forwards messages via an access point, using only one hop, from user equipment from one or the same basic service area to another within the extended service area. Since user equipment is mobile and the channel is time variant, all address tables are changing accordingly.

Dynamic Addressing Bridge Relay. The system which forward messages via Access Points, using one or more hops as a function of the "least cost path", from user equipment in one or the same basic service area to another within the extended service area.

(I:) Is it necessary for the distribution system to know when a station comes and goes?

(The tessellation of the service area - decomposition into a three dimensional mosaic of coverage areas - is complex.) It must be understood that it is a three dimensional twisted service area. You will be xxxxed if you try to apply an open plane two dimensional four color map theorem.

The signal attenuation with distance is assumed (based on measurement) to be 6 dB per octave for the first 10 meters then 12 dB per octave after that. Once outside the building - out a window or door - attenuation is free path again, 6 dB per octave. See references papers for through floor loss. (Per octave is per doubling of distance - 1 meter, 2 meters, 4 meters, 8 meters.)

The modulation structure requires 12 dB of signal level above interference.

Chunks may have to be at least the size needed to get to the MAC destination address. (A chunk is a physical layer packet in ping pong architectures. MAC data packets are broken into chunks for transmission by the physical layer to reduce latency and store and forward buffer requirements.)

(I:) Sharing must be in the protocol - a method must be provided to allow uncoordinated LAN's to coexist.

LAN's that use separate frequencies can be asynchronous. Such a LAN doesn't need knowledge of what is going on around it.

Bruce argues that the super star architecture (Chandos' presentation) is simple, but is not desirable because it presents a single point of failure. The backbone bus protocol using distributed intelligence is more complex. The complexity is warranted by the advantages.

(I:) (The state transition matrix of the MAC can be such that a station can become an access point if need be.)

(I:) Bridging in the distribution system is desirable.

(I:) Saturated access points (placement of the maximum number of access points in a service area) reduces the dynamic range requirement on receivers.

(I:) Should the distribution system by synchronous? There is a high cost for asynchronous operation. (Acquisition of phase, gain, . . . , and start delimiter.)

(I:) The distribution system backbone could be wireless using another frequency or it could use electro-optics, but it can also be on the same frequency as the access point. The MAC could be required to support same channel communication to other access point entities across the extended service area.

(I:) (Bruce) Transmission of the same message to all (will he nil he) should be wiped of the face of the earth.

(I:) If you require optical path transmission why talk about radio - use infrared.

(I:) Many of the discussions link complexity to cost. This is no longer a valid thought. Complexity is no longer costly. (The complexity that can be supported on a single chip is much greater now it was a decade ago.) Only the R and D effort increases. R and D cost is not an issue. (The R and D cost is carried by those developing the standard.)

(I:) Given that complexity does not increase cost!?, does increased complexity decreases reliability?

The following is true: Increased component count decreases reliability. In many cases failure rate is directly related to the number of interconnections. (Bagby) There is a trade off between analog (radio, not voice) and digital complexity. Analog complexity and cost increases linearly. Digital complexity and cost increases in gross quantum steps. (The cost of an LSI chip, the cost of a gate array, the cost of custom chip, the cost of a wafer full.) There are levels of complexity that are simply untestable.

(I:) We will need to use an acknowledged protocol (ACK/NACK) in the MAC. This provides a fast physical layer retry. ACK/NACK may be better than using more power or a (very) long FEC.

(I:) What is the required geographic size of the basic service area?

Tuesday, January 8, 1991, Afternoon meeting

The meeting broke at 12:07 PM for lunch, resuming at 2:02 PM. For those whose rooms do not provide data jacks, the hotel management recommends unscrewing the wall plate. The hotel is converting from the top floor down.

10.1C Introduction of Contribution **by Dr. Jonathon Y.C. Cheah,** *A Proposed IEEE 802.11 Radio LAN Architecture.* **Document P802.11/91-07, temporary document G11.**

Dr. Cheah expresses a need for an architecture that can be built at low cost, and that can be built better for more money. (This is not a tautology. A gold plated wheelbarrow is not much improved, but a Corvette is better than a go-cart.)

Jonathon's architecture is described not at the top level, but one level more detailed than Dave Bagby's or Bruce Tuch's. Some of the LAN's problems can be solved at several levels, so it is necessary to look at the whole system sometimes.

This architecture is Slotted Aloha Demand Assigned Multiple Access (S/Aloha/DAMA) with Autonomous Head-ends and Stack-able expansion. The architecture has the following features:

> It can support harsh and benign environments.
> It has good coverage flexibility
> It can interface transparently to MAN and WAN's.
> It can support multiple phys.
> It can support real time voice.
> It can support a true wireless backbone.
> It is robust.
> It does not have single point of failure.
> It supports large volume markets.
> It supports el-cheapo to niche markets.
> Ease of use.
> Low power consumption.
> Circuit simplicity.
> Multiple data rates within the ESA (with restrictions).
> Peer to peer communication supported.
> Low start up cost.
> Support of mobile, roaming, and fixed stations.

A mobile station requires communication while in motion. A roaming station can move, but requires communication only when holding still. A fixed station never moves.

It is assumed that small basic service areas are good for many reasons. Assume that the system begins operation in a Garden of Eden.

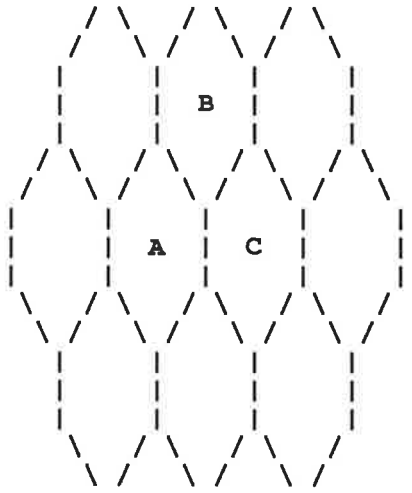
The head end appears and begins its clock. The head end first listens for any of a pre determined set of Gold codes for a second or two. The head end begins transmitting with a code that it doesn't hear in service. The head end then spends most of its time transmitting, listening only at Aloha, LACK, and SYNC slot times. Aloha and LACK times are locked to Aloha and LACK time of any other head ends that are heard. SYNC is moved at random relative to Aloha and LACK. SYNC is used to frequency lock the local transmit VCXO to any other head ends that are heard. (A frequency locked transmitter is similar to a phase locked transmitter, but the phase relationship is casual for the first and causal for the latter.) The high transmit duty cycle is used to improve the ability of several head ends to synchronize. (- by increasing the probability that transmission will be heard during SYNC time.) (I assume that the transmitters are frequency locked to improve the ability of a moving station to arbitrate and acquire alternate head ends assuming some form of pseudo coherent modulation. - Secr.)

Assume now that the head end(s) are running, and a station, Node 1, wishes to send to another station, Node 2. Node 1 signals its intention to a head end (using that head end's code) at Aloha. The head end, having received the request. broadcasts at Poll time that Node 1 is calling Node 2. If Node 2 is local, it identifies

itself at LACK (Local Acknowledge time). If Node 2 is local the head end calculates bandwidth requirements and sends slot time number assignments to Node 1 and Node 2 at the next Poll time.

Node 1 sends in its slot time numbers. The head end ping pongs. Node 2 receives in its slot time numbers. The protocol shall allow Node 1 and Node 2 to swap direction of traffic without relinquishing their bandwidth assignment. (But note that the head end can change their bandwidth assignment on the fly.)

Adjacent cells (head ends) have different spreading codes:



To move from one cell to the next cell, the moving station first contacts the next cell using the next cell's code at Aloha time. When a moving station leaves a cell that was supporting local traffic to the moving station then throughput can double, since one cell can devote all of its time to receive and the next cell can devote all of its time to transmit (or vice-versa).

To explain in more detail: Node 1 in BSA A is talking to Node 2 in BSA B, Node 1 is slowly moving through BSA A (let's say toward BSA B). The BSA A Poll broadcasts the expected time of BSA A Sync (a time when nothing in BSA A is transmitting), at which time Node 1 listens for the best code heard. (Presume that Node 1 eventually hears BSA B codes at good levels.) If the best code reaches a preset signal level, Node 1 will try to switch as follows:

Node 1 signals BSA A (during LACK) with a request for a housekeeping slot - to freeze dynamic bandwidth allocation for one cycle so that Node 1 can safely ignore BSA A Poll. If granted, Node 1 signals (using BSA B code) to BSA B during Aloha requesting bandwidth allocation in BSA B. If the request succeeds (indicated by BSA B Poll) then Node 1 exits A and enters B. If the request fails pick a random number and wait as many cycles before trying again.

Discussion:

After a break the meeting resumed at 3:40 with a discussion of Jonathon's architecture.

What happens if the basic service areas are noncontiguous and a mobile station leaves one area of coverage, travels through an uncovered area, and then enters another covered area? Reply: It has the same effect on communications as turning off the station.

What happens (with synchronization) if all of the head ends power up at the same time? Reply: The aggregate will anneal into domains (think magnets, or crystals). The larger domains should swallow up the smaller domains until only one is left. It is possible to get an oscillatory configuration. A pierced disk (torus) is susceptible to this.

Must the codes be preset? Reply: The head end can use any code that it does not hear in service. If the head end hears all codes in service then it should sleep because its service isn't really needed.

What are the boundary conditions on the 31-bit 12-vector Gold code correlation profiles attached to IEEE P802.11/91-G1? These are the a even periodic (bounded by more of the same) auto and cross correlations.

A high reliability mobile station can be built that incorporates a second channel node and MAC/PHY that establishes communication to an adjacent cell.

Dave Bagby points out that real time voice is not guaranteed by this system. Jonathon replies that it can be done. Voice tolerates up to 34 milliseconds delay for echoes. A voice channel can capture a slot to obtain guaranteed bandwidth.

(I:) Novel Netware is very sensitive to delay. (Application software is becoming dependent on the low latency time obtainable on immature (very lightly loaded) 802.3 networks. Must we attempt to obtain the same "crisp" response?)

This architecture is insensitive to single point of failure. If a head end fails stations within its coverage area will migrate to the codes of adjacent coverage areas.

It is possible to communicate between incompatible PHY layers by going over the distribution system backbone to an access point that has the appropriate PHY. The distribution system will know which to use since it obtains identification with the Aloha and Poll of the appropriate PHY.

Michael Masleid comments that this will require a congestion flag similar to the ring architecture. (So that a fast PHY talking to a slow PHY doesn't monopolize the buffer capacity of the distribution system.) It was argued that the real problem occurs in the middle of the internet. (- which misses the point. The problem is nicely handled using dynamic bandwidth allocation.)

10.1D Introduction of Contribution **by Dale Buchholz,** ***"Straw-Man" Protocol Model.*** **Document P802.11/91-06, temporary document G9.**

Dale presents a model similar to IEEE P802.9 and ASC X3T9.5 (FDDI). The model includes a Hybrid MUX and two MACs, one MAC supports (data packet) LLC, the other Isochronous MAC supports D B and C Isochronous LLC. This expands the domain from P802.4L, which could only address physical signalling and physical medium dependents in the PHY layer.

The model targets support for the desktop market. Voice is included. It is not hard to foresee a time when workstations become speaker phones. If the Wireless LAN does not support voice it will be a no sale. If I have to run a wire for voice, I might as well run a data line too. The EIA building wiring standard does this already - we have to compete with that.

Mil has talked about the 2500 handset. That is a proprietary arrangement (with the phone service provider). As a standards group we ought look at something like ISDN.

Discussion:

It is argued that EIA is not an issue. Jim Neeley advises us that there is something called strategic wiring, a practice wherein every 20, or 15, or 10 years a building is gutted and refreshed. For instance, a major office building in New York city will do it in the next three years.

There is a real cost to move change and add - just to move from office to office and change a phone numbers. We should include an isochronous service.

P802.9 does this using a 125 microsecond frame on a cable - sent a byte at a time. That is not convenient to radio, but there are things that can be done. We need to collect the ISDN bytes and turn them into packets.

The MAC and Isochronous MAC are shown separate in the model. It is a goal to make the MACs common.

Dave Bagby asks who will do the isochronous LLC box? Reply: Assume (it is enough to know for now) that the packet presented through isochronous LLC must be serviced in a particular time.

Dave Bagby wonders that the work is done but not supported by all? Reply: The desktop is going toward integrated networking. A standard that allows integrated LAN's is important.

Dave Bagby comments that the market place will make the decision.

The Isochronous LLC has a D B and C channel. D is an asynchronous channel used for maintenance. (D uses out of band signalling referenced to a voice channel. In our context this implies support using the data packet MAC methodology. (out of band signalling in the radio channel causes abysmal problems)). The B

and C channels are isochronous - periodic, - continuous. The B channel is 64 kbit/s with 125 microsecond frames. The C channel is an aggregate of several 64 kbit/s channels. As an instance, slow scan TV uses 384 kbit/s C channel.

The B and C channels, modified by the Isochronous MAC, are combined with any packets from the asynchronous MAC by the Hybrid MUX for injection into the physical signaling layer.

(I:) Is isochronous data required independent of real time voice? - Say to support real time process data or telemetry in an industrial application.

(I:) What is the cost (- per station, - politically, - in development time,) of having voice in this standard?

(I:) What is the cost of not having voice in this standard?

Survival goes to he who provides the most service.

The PCN service will arrive at the same time as we finish this standard. If we do not offer competitive service we will no doubt lose our spectrum to them.

Chandos comments that PCN is a very serious competitor. They (the PCN service providers) want to make money on franchises. We (the users and computer manufacturers) want to make our companies (or our companies products) work more efficiently.

Jonathon wants to drop the discussion on voice and instead give parameters that enable voice. His architecture supports fixed time packet transfer so that if you want voice you can add it latter.

Simon Black (representing DECT) points out that it is funny to watch us wrestle with doing voice - and DECT wrestle with doing data.

Dave asks if many data users will want voice? Reply: Many data users will want isochronous type service. This is not primarily a stationary environment, not with people moving through it. The desktop does tend to sit still. Incidentally, Motorola points out that the switching 18 GHz horns are intelligent antennas - not complicated antennas.

Wednesday, January 9, 1991, Morning meeting.

The meeting was called to order at 8:30 AM, Vic Hayes, chairman IEEE P802.11, being in the chair. Thirty-one (31) people were present in the Wednesday morning meeting, thirty (30) were present in the Wednesday afternoon meeting.

10.1E Introduction of Contribution **by Simon Black,** *DECT - A Standard for Cordless Data Networks.* **January 4, 1991. Document P802.11/91-10, temporary document G14.**

In Europe DECT has considerable support - for those who anticipate product offerings in Europe, it would be wise to reckon with it. DECT is a voice oriented standard that is working hard to incorporate data, as apposed to 802.11 which seems to be data oriented standard that is working hard to incorporate voice.

The DECT standard target dates are intended to support product offerings by 1992. DECT application areas include private cordless PBX and data, though data is not necessarily only LAN, data could also be for an X.25 terminal.

Key technical features are use of the 1880-1900 MHz band in accord with the Memorandum of Understanding. (There is much more important detail in the document. Please refer to it. Secr.) DECT uses 11 carriers spaced at 1.728 MHz. The basic data rate is 1152 kbit/s. DECT uses dynamic channel selection and provides seamless handover between synchronize base stations. Data is protected with a CRC. Voice is not protected.

Channel selection is done by the portable station. The portable listens to the base station's beacon signals. Handover is done with the portable station acquiring service with the next base station before abandoning the first. The base station beacons in one of the communication slots.

The portable can scan for time slots in all 11 frequencies. The hand held normally uses one slot in one frequency. You can request multiple slots on the same frequency. It is probably possible to use slots on multiple frequencies as well. The slots are time division multiplexed. There is a large guard band, 25 microseconds in a 10 millisecond frame. Two contiguous frames must still observe the guard band.

Discussion:

Does the DECT distribution preserve packet ordering? Reply: DECT data packet ordering seems to be preserved in the fixed wiring part. Packet numbering is used.

What about the 80 dB dynamic range that would be required if two radio fixed parts (on different frequencies) has one transmitting while the other is receiving? Reply: There are guides on fixed station spacing.

Who manages frequency assignment of the radio fixed part? Reply: DECT is self organizing, it is to be self managing. It is stated that the fixed radio parts will select the best frequency for their use from the set of frequencies that are allowed.

DECT is logically connectionless. It supports broadcast data from base to portable. Of course there is a call set up requirement. Connection set up time is fast - less then 50 milliseconds. Authentication is required for set up, which takes time. Authentication is used to restrict access of any sort to the network. Encryption can be used to protect data. Once a station is authenticated a fast switching (registered) mode can be maintained.

A portable station can set up a connection to a server (host computer) by using the DECT fixed wiring interworking connection. Throughput up to 768 kbit/s can be maintained using one carrier with 23 forward slots and 1 reverse slot. The control of how many carriers are sucked up by data service seems to be unenforced. 11 carriers are guaranteed (by the Memorandum of Understanding). If there is enough demand for DECT, then 50 MHz more will be allocated.

Is there embedded FEC (Forward Error Correction)? Reply: It is being considered.

DECT as a European Clan Standard? DECT has a frequency allocation, with an extension available for growth. DECT has somewhere to go. DECT knows about P802.11 - but also knows that it will never get into Europe in the DECT band - and wonders why P802.11 would want to be in the ISM band in the United States?

DECT is optimized more for voice than for data. Type approval procedures are used for DECT equipment. DECT protocol uses negotiation for bearers, call set up, and quality of service. Bearers can be given or taken away.

GSM in Europe provides wide area coverage (Similar to cellular phone in the USA). DECT provides more focused coverage, in some cases no more than a single building. (Europe is well ahead of the USA on this one.)

Rick Albrow is on RES3N, Simon Black is on RES3F. They evolved on DECT and so can represent them to P802.11.

10.1F Introduction of Contribution **by Chandos A. Rypinski,** *Radio LAN System Power Budgets and Levels.* **December 27, 1990. Document P802.11/91-04, temporary document G5.**

"This is a diverse group. Some of what is well known to some in the group is not known by others. I will discuss some of these things.

About power calculation: No one ever got fired for too much signal strength, only for too little. In the early days land mobile was approaching 100 watts. As a reference - I consider transmitter power of 1 mW a useful assumption. DECT is using 250 mW. I use a 10 MHz bandwidth, they probably use a 2 MHz bandwidth. The difference may be due to a tendency for radio designers to overdesign by heroic proportions. I will explain my choices and the assumptions and calculations that lead to them.

The first step is to define the receiver and the required signal to noise for the required BER. - That differs little for different modulation and different people but the 50% threshold point selection (the start of the water fall?) is sometimes argued. A 21 dB signal to noise ratio (with no margin) is my design goal. Noise power is a function of bandwidth.

A chart - The UHF Band Free Space Diagram shows power, distance, and frequency. Power variation - decreasing with distance and decreasing with frequency - is mostly due to sphere surface area increase with distance and capture area reduction of the antenna with wavelength. At high frequency we tend to use focused beams and point to point links. (Omni directional antenna, sized to fractional wavelengths, are the problem here. The capture area of a dish is the size of the dish.) The (loss) formula is (4*pi*d/lamda)**2.

From the chart, 1 mW is enough for 10 meters for free space propagation. The free space model is often accurate per measured data out to 10 meters. After that it becomes necessary to use the cluttered loss model. Variance in cluttered loss is so great that it can't be solved with power. Use of indirect propagation takes a lot of power - 30 dB fade margins are not atypical. The number of design imponderables make the problem such that it can't be designed by remote control, each case requires an expert. The way to avoid having site surveys and analysis - the way to do it is to go for optical path propagation. (Even though this may imply 10 meter radius BSAs).

Discussion:

What is the advantage of this over infra red? Reply: There are OSHA problems with (laser diode) radiation.

What is included in the 21 dB signal to noise requirement? Reply: 21 dB signal to noise assumes Boltzman noise plus 10 dB noise figure.

Michael Masleid claims that higher power is also not how to deal with impulse noise.

Chandos is apposed to anything above 10 mW due to hardware and implementation costs.

It was mentioned that experience with 1.8 GHz indoor military spread spectrum indicates that these numbers are accurate.

10.1G Introduction of Contribution **by Chandos A. Rypinski,** *Radio System Multipath Propagation Analysis Leading to Possibilities for Mitigation.* **December 27, 1990. Document P802.11/91-03, temporary document G4.**

Because of multipath the first arriving signal (line of sight) is not necessarily the strongest, and in some cases it may be too strong (due to multipath forming a waveguide). Tests done a long time ago - pulse radar bus locating using 0.2 microsecond pulses at 3 GHz in Chicago - gave the same figures we are seeing now.

We must first agree about how nature works. Then we can agree on what we will do about it!

Side firing antenna always has a floor reflection that is significant - even if the floor is a dielectric. A down firing antenna will give a much better demarcation to the service area.

The floor bounce has only a small path difference from the line of sight path. To make a deep fade it must not be very much longer than the optical path.

For a ten meter path (base antenna height 2.5 meters, mobile height 1.5 meters) the optical path can cancel. A 50 MHz bandwidth is not enough to get out of the null. However, movement in height of the mobile antenna outside 1.3 to 1.7 meters is more than enough to span the null. For sensitivity to path length refer to the paper.

A zero horizontal gain down firing antenna with depression angle to be determined may be the best choice for the standard.

Comments:

(I:) Is the antenna part of the PHY layer standard?

There may be a problem of cancelation due to ceiling and floor bounce.

Wednesday, January 9, 1991, Afternoon meeting

10.2 Architecture Discussion.

An ad-hoc group had met Tuesday night through Wednesday morning to list design criteria. Michael presented the output on screen. (The committee is not ready for this! the material will be distributed later)

(The following discussions were interleaved. I have reordered them to provide some coherence. Secr.)

Vocabulary:

Dave Bagby: I propose that we formulate an issue, evaluate that issue, then vote if it is to be part of the design criteria. To do that, something that is needed is a common vocabulary.

We must avoid a conflicting vocabulary with regard to the existing IEEE vocabularies. Several terms (terms with different names and the same meaning, terms with the same name and different meanings,) have been used in this meeting. Can we create a subset of terms for our use?

Parameter Matrix:

Larry Van Der Jagt: We can approach the problem by making a matrix of target parameters that is filled in and cross indexed to market or area serviced.

We need to collect that application list - that was the purpose of the attempt to form market advocate groups. We still need a model for the users. (We have a channel model, we need a user model.)

Dr. Raymond Simpson: We don't want to know the application specifically. We need the coupling of the parameter groups. You get the insights from the market, but do the work with the numbers.

Dave Bagby: I do believe there are many tradeoffs in radio that I don't know. The radio is indeed a key component, but it is not the only important thing. Though we all have separate interests, they are all intermeshed.

Bruce Tuch: It may be useful to have a blue print document that everyone can take back and fill in.

Dr. Cheah: I am uncomfortable with numbers picked from air. So we take guesses? We must separate wishes from realities or else we have a horse defined by committee.

Dave Bagby: Hard numbers are needed for (low level) design. Concepts and needs are required for high level design.

We need rationality between what can be done and what is needed.

Electronic communication:

Everyone should attempt to provide some method (e-mail, BBS) for electronic communication

The Wrench:

We are developing a standard. Not deciding to manufacture to a specific market. The standard is a general purpose tool. (Jim got out his Swiss army knife.) Defining the purposes that a wrench will be put to is more difficult than defining the wrench. Dave Bagby points out that the standard is a very general purpose tool, you will be surprised at the usage that tool is put too.

Heisenburg:

Dale Buchholz: Mil is not here now, but there was a four year study. Dave has a market projection. Mil has a well defined market that he is trying to serve. For new market you may have to guess, I caution against too tight a requirement for hard data. Bruce Tuch: New markets are (not) made by marketing people.

Ken Biba: There is a Heisenburg effect, what we do here will effect what the market becomes. (The act of asking the question affects the answer - but it goes far beyond that.) In my marketing the answer depends on how the question is presented. If you ask "If wireless is equivalent to a wired network will you buy it?" the answer is yes. Of course it is yes.

We could collect some of the market research data on how contemporary cabled LAN's are used. The can be done segregated by base network and operating system. The results will show what is really being used. (Free of Heisenburg uncertainty.) A fair number are now collecting data with sniffers.

10.2A Discussion of Contribution **by Dave Bagby,** *One Approach to Wireless Network Architecture.* **January 4, 1991; Document P802.11/91-2.**

Power consumption:

It has been argued that any protocol that requires periodic transmission wastes power. It may take more power to operate the receiver than to operate the transmitter.

Dave: There are two issues tied together. I perceive that transmission is more costly. That is not the only issue. Periodic transmission - the act of having to detect if a station is on or off is unnecessary. It is not an error when the station is off-line when the station is not needed. Any failure (or awkwardness in the protocol) is just due to the poll (and a poor choice of protocol) in this case.

Masleid: Even the industrial application may need low power - imagine depressed angle radiators on storage yard lights using a full wireless distribution system powered by solar panels. (Incidentally, the antenna on my vehicles are not 1.5 meters above ground. Their tires are 1.5 meters in diameter. Secr.)

DECT has power problems also. Portable phones have the same problem with power that the laptop computer has. The phones use an active idle with 160 millisecond up time to listen to the base station. The access method provides a reasonable battery life time.

Ray points out that improvements on current technology might reduce receive power consumption, but transmit power will always be constrained by the power emitted.

Ken Biba points out that both the transmitter and receiver can be scheduled off.

Basic Service Area:

(I:) What is a basic service area? There is no agreement that the basic service area and the range available for direction connection are closely related.

(I:) What size must a basic service area cover to be useful?

Dr. Raymond Simpson: One of the major things in this paper is an assertion that if the (distribution) media is well separated from the descriptions of sub elements of the Access Point, than the media can be done separately from this standard. (If a distribution system is required by this architecture, must the standard define its use?)

Chair: Architecture is the definition of MAC services as seen from the LLC, and a description of what (the MAC) does at this boundary triggered by events at the MAC LLC boundary and others. Architecture is also the description of how the network internals go about doing this.

Jim Neeley: I like thinking of distribution as separate. But people don't want to have to put in more wire.

(I:) Should the distribution system be a visible (exposed) interface?

Bruce Tuch: A proprietary interface is not a good thing.

10.2B Discussion of Contribution **by Bruce Tuch,** *Wireless Signal Distribution Architectural Considerations.* **December 14, 1990; Document P802.11/91-01.**

(I:) (Can the architecture provide the crisp, quick response time (low latency) of a lightly loaded 802.3 10BASE5 network?)

An assigned slot time is not enough like ethernet when there is contention for bandwidth assigning slots so that low latency can (not) be obtained.

Dale Buchholz: Request grant can give lower latency than token ring (ethernet?) contention for bandwidth - or slot assignment will seem to take the same time.

Chandos Rypinski: Time slotted architecture is not mandated by isochronous channel support. Pure packet asynchronous transmission is more efficient than time slotted.

Designing for dynamically allocated isochronous traffic combined with low latency asynchronous traffic is a challenge.

Larry Van Der Jagt. Bruce has combined elements of asynchronous and synchronous. The slots are not of (MAC) packet length, they are broken into smaller chunks. This is similar to the Cambridge Ring, but this break up prevents quick response on complete (MAC) packets.

Ken Biba: Breaking a packet into chunks is tricky.

(I:) Can we capture a model of the coverage area?

Masleid argues that indoor coverage areas may resemble fractals, not hexagonal cells, and offers to provide a distribution system with multipath model as a work item if there is still interest in PHY.

(I:) This paper addresses distribution in detail. Is this an issue?

(I:) Should the distribution system that connects the BSAs together be part of this standard? (Some issues come up over and over again. Secr.)

If the functionality of the distribution system can be done by an existing LAN then it should be done with an existing LAN, if not we must describe the distribution system.

Simon: Is this below 802.1? The distribution may ...? There is confusion on this issue due to lack of vocabulary for components within the distribution system!

Jim Neeley points out that IBM has internal definitions that are tied to external LAN standards as much possible.

The components used to build the distribution system may have the same or similar functionality to components used in the stations. If we use the same names for the functions or components we will get in trouble.

Jim Neeley. When we assign bridging to the backbone we desire to appear to provide seamless source routing. We must deal with access control, and how to deny access.

10.2C Discussion of Contribution **by Dr. Jonathon Y.C. Cheah,** *A Proposed IEEE 802.11 Radio LAN Architecture.* **Document P802.11/91-07, temporary document G11.**

Ray points out that the head ends transmit all of the time (with few exceptions - Aloha, LACK and Sync) when they are not receiving. This is transmission of energy with no claimed receptor. We should only transmit when we need to reduce interference.

Reply: This is done so that head ends can be used as building blocks. The long transmit times are needed to allow the (head ends and) nodes to keep frequency lock. Synchronization requires constant information. The Sync holes needs to hear activity. If the head ends are on (transmitting) for a long time response is snappier, it takes cost out of the nodes (stations).

(I:) Should periodicity of the H field be reduced in the low 100 Hz range?

One design goal is to reduce periodicity of the H field in the low 100 Hz range. This can be done by randomizing transmit slot times. It may also be done by burst waveshaping - control of the build up and decay of the carrier so that no low frequency components exist at all.

(I:) There is much work on physiological effects - do we have a liaison with someone doing the physiological work?

(I:) How will the FCC view the power emitted from the S/Aloha/DAMA network? Reply: The basic service area is amenable to power reduction. (Actual interference from this network may be less than from non scaleable networks).

Ray questions can we do this with infra red? Overlapped coverage areas (required in this protocol!) could be achieved with wavelength multiplexing or code division multiplexing?

1st reply: It is wise to anticipate the changes needed for the PHY so that infra red can be supported - with the intention that only the PHY need be changed latter, not the protocol. (It is clear to some of us that the 802.3 protocol is based on the nature of RG6 baseband coax, that 802.4 protocol is based on broadband, and

adapting these to new media is difficult to nearly impossible. We will fall into the same trap - but can we at least do it with our eyes open? Secr.)

2nd reply: Infra red has been extensively tested. Multipath exists. Building a secure system is very complicated. Building a robust system is very complicated. Providing availability and integrity is very complicated. This occurs with multiple diodes. Even with specially shaped radiation patterns (even tracking diodes) to try to keep single ray reception, infra red is hopeless due to our own signal's inter symbol interference. (Remember that significant energy is reflected by any object larger than a fraction of a wavelength - and infra red wavelengths are microscopic. A laser source obviously won't work due to speckle. Chandos' paper indicates that optical path two ray fades are insensitive to bandwidth, so use of non coherent emitters may not help much. Secr.)

3rd reply: One scheme uses a relocateable beam bounced off of 4 ceiling tiles - which in turn are targeted by many work stations in a careful aiming scheme.

What about sunlight and infra red? Reply: Sunlight is not much of a problem. (The optical bandwidth that needs to be passed by a dichroic filter to accept a modulated coherent emitter is really small. Secr.)

Source routing is a protocol between stations on bridged LANs. On normal LAN's all messages are seen by everyone. A transparent bridge makes this so between two nets.

10.2D Discussion of Contribution **by Dale Buchholz,** *"Straw-Man" Protocol Model.* **Document P802.11/91-06, temporary document G9.**

Dale: "To recap motives - show need for high capacity. I have been thinking that spread spectrum does not give me high capacity, so I showed an alternative that might give high capacity. The purpose of the model presented is to support scaleablility at the PMD level.

Chandos Rypinski comments: There is much in Motorola's presentation that I heartily agree with. This is unusual since I usually disagree with Shaumburg (Arlington Heights). My view is different about the protocol stack:

The station has an RA (radio attachment) and layer 1 2 and 3-6. It has a data and U (isochronous) interface.

The wiring closet has a (remotely wired) RA and layer 1 and 2 tied to a bus. The bus is controlled with AH (access ??). This (concentrator) exits through another layer 2 and 1 to an equipment room (as one among 64 lines).

The equipment room brings in 64 lines through a layer 1 2 and 3 stack to a common buss controlled by an AM, (access manager), which is required for trucing. Connection into and out of the equipment room is symmetrical.

RA is the radio, it is one part of the Physical Medium Dependent layer in Dale's model. (The mapping of the distribution system to Dale's model is poor at the Physical Signaling layer - another manifestation of a vocabulary trap. There is no model for the distribution system, nor names for its components. Secr.) There is an MDI, a medium dependent interface between RA and level 1. This interface, and the 2, 3-6 interface are defined by the 802.11 standard.

Direct peer to peer within an organized BSA is allowed. The reason for the access point is that some traffic is not local. The access point is the most likely hub - it at least reduces number of required hops.

The common buss in the wiring closet can assumed to support 16 pairs (16 RA access points). The wiring closet knows about service and station address - but isochronous service is not the driving force. We ought to define the air interface (antenna and site conditioning) and the RA (to MDI) interface. We ought keep the wiring closet and equipment room out of the scope. (This ends Chandos" comment.)

Dave Bagby, commenting on Dale's presentation: The isochronous service can be done without the isochronous layer MUX (multiplexer). Reply: The H MUX arises, and seems needed, because the isochronous MAC needs periodic service, while the asynchronous MAC can queue data.

Jim Neeley, commenting on Dale's paper and Dave's comment: We have looked at similar architectures. We can do layers 115. Dale's intent is correct. Let's look at what is required of the H MUX, and use the H MUX to assist us at this time as a place holder.

(I:) Support, **NOW**, for isochronous data is preferred because asynchronous data can be done if isochronous can, but not necessarily the other way around!

(I:) The politically correct term is more intelligence not more complexity.

(I:) ISM spread spectrum does not limit data rate. (Bandwidth is adequate, rate is intersymbol interference limited.)

Jim Neeley points out that it is easy to do data or voice over a token ring - but you can't do voice if data is allowed on the same ring.

Voice rides on an isochronous data stream . Don't just concentrate on voice. The isochronous stream is a class of transmission that you can't ignore.

We are wireless. The media is open - not shielded. Any standard we produce can not run together with another similar service in the same band. If the hooks are not there for voice we are doomed. The more we can get everyone together the better the chance that we can get and keep spectrum.

We are loosely confusing isochronous, voice and cordless telephone. Cordless telephone requires all the signalling for the public switched network.

(I:) How do we make the connection from voice on the wireless network to voice on the public switched network. We may choose to limit ourselves, use an electronic box (- not a transparent interface, the box generates the switched network signalling). This is a way to include voice but avoid inclusion of the signalling.

Thursday, January 10, 1991, Morning meeting

The meeting was called to order at 8:45 AM, Vic Hayes, chairman IEEE P802.11, being in the chair. Twenty-eight (28) people were present in the Thursday morning meeting, eighteen (18) were present in the Thurssday afternoon meeting.

Alpha graphics does not yet have the documents mentioned in doc: IEEE P802.11/90-25, but will have them by the end of January. The second transfer of 802.4L information will be 8-11 PM Tuesday at the March plenary. P802.11 is receiving good press coverage. There is an invitation to chair a session of EFOC LAN. Does any one want to present a paper? The sponsoring organization is not known.

10.2E Discussion of Contribution **by Simon Black,** *DECT - A Standard for Cordless Data Networks*. **January 4, 1991. Document P802.11/91-10, temporary document G14.**

Bruce Tuch points out that getting spectrum will be a problem in the United States.

Simon Black: "DECT is a written standard with some features that we may not want to reinvent. It may be a competitor. DECT has done competent marketing. DECT is not infallible, it is important that this group understand and not make the same mistakes.

DECT is approaching firm draft. Is there a way for a non member to get a draft? Reply: No.

Ray: DECT is not particular different from what Jonathon has proposed. If the rates available are ok, and if DECT is adopted for a public revenue service, it seems unlikely that a privately held data service will be allowed to gloom 30% of its capacity here and there, especially for free. Reply: Within the DECT community there is much debate between the data and voice advocates about revenue.

(I:) Can DECT provide the data rate mandated by the P802 functional? Reply: Is the rate a marketing tool?

Dale Buchholz: The way computers are really used spreads them across several hundred segmented networks. There is a wealth of users all working at the same time. A wireless LAN (like DECT) that is little different (provides segmenting) will have good response time and high throughput. That is important.

Whatever we do, it should make use of what others have come to understand already. We do need to compare throughput.

Hype and snake oil:

Capacity and response time will be adequate if, when the LAN is between the computer and the hard disc, there is no impairment. (Can we compete with SCSI??) 20,000 Erlangs per square kilometer is the highest density considered needed. The other number is watts per square kilometer. The cable LAN's have more bits per square kilometer than the DECT system. There is another capacity - the aggregate capacity - the smaller the cell the larger that aggregate capacity is. Can we define a new (data) unit comparable to Erlang?

(I:) What performance levels are we to define? How are they measured? How much performance do we need?

People do optimize there systems. It would be nice if they didn't have to optimize for latency and delay. People would like 100 Mbit/s - but not in their wallet. What people finally want is sometimes equal to how much money they have in their wallet.

Segmenting is not clean in radio. It is hard to segment if stations are next to each other. Masleid argues that segmentation often flows naturally from the way people are arranged in space and workgroups. Reply: The interworking connection in DECT helps with this.

10.2G Discussion of Contribution **by Chandos A. Rypinski,** *Radio System Multipath Propagation Analysis Leading to Possibilities for Mitigation.* **December 27, 1990. Document P802.11/91-03, temporary document G4.**

Dr. Raymond Simpson: "This is a really valuable contribution. There seems to be an aim of keeping range horizons in hand. Long range is a disaster - but there is a fixed cost (for the radio access) part that doesn't go down even if you are selling pet rocks. There must be an optimum and it probably isn't at the long ranges and it isn't at the very short ranges either.

Bruce Tuch: "An interesting contribution. It does restrict to very close range. This is not always obtainable in all sites. If we are restricted to very close range and must use the infrastructure already present (EIA wiring), it makes it hard to apply where that infrastructure is not available.

For the expansive factory, there is always the option of a very expensive box (in the equipment room) to keep track of what is happening everywhere - an artificial intelligence. A smaller application will use a smaller and less expensive box.

The right size (range) is that which includes the number of stations that is covered by one segment of a bridged LAN. That is seen typically as 10 to 30 stations.

(I:) Is it a design goal to provide a reach rate trade off?

(I:) Is it within the scope of the standard to have to describe the antenna?

Propagation is dependent on the antenna. It is clear that we must examine what antennas do to (or for) the network.

Dave Bagby cautions against having guidance sections in the standard - it makes for a non standard. If you say something in a standard, make it required.

10.2F (temporal order) Discussion of Contribution **by Chandos A. Rypinski,** *Radio LAN System Power Budgets and Levels.* **December 27, 1990. Document P802.11/91-04, temporary document G5.**

Don Johnson: Can we get by with a milliwatt? This aught to be 100 milliwatts.

Anonymous: I came with a prejudice that many tens to one hundred milliwatts is the right amount of power. Maybe that is wrong. As I read it, there is no fade margin there for 1 milliwatt. For worst case more power is needed - not one watt because of batteries - less, but open for debate. Reply: There is a 10 dB margin at 1 milliwatt, everyone hides margin somewhere. The traditional margin is 30 dB.

Dave Bagby: I think Chandos started with 1 milliwatt and worked to find how to get to that conclusion. Are people comfortable with that? It is not the right thing to do. We need to characterize the channel, that is what is needed.

Bruce Tuch: The paper is right but absorption is not taken into account. The number needs to be 100 or more greater for my office. If we are in the ISM spectrum space, the external ISM is not under our control, so we may need to out shout our interferers.

Jonathon Cheah: The others have said what I wanted to say. I want to add that you can never fix a good number for man made noise. It comes down to cost. You can have a manual or dynamically adjustable power, power control is very important.

Ray likes the idea of automatic power control.

(I:) Should the standard have power control up to 1 Watt or major fraction there of?

Anonymous: I am disturbed by Chandos' number, I feel it should be a number of milliwatts, for what it's worth we did what Dave accused Chandos of - starting with power and working back to a design. It came out the same. As to out shouting - there are lots of examples of what happens when the other guys are uncoordinated, and the other guys can also increase power: They have bigger hammers.

Chandos: Dave correctly picked the purpose of the paper. Yes, anyone can pick the parameters and the procedure - but that was not meant to force the group to a value. It is an example. You can't say what fading margin is allowed until you can take into account what margin is available.

Announcements: Excess meeting fees will first be used to pay out of pocket copying expense, any remaining will be passed forward to the next meeting. The meeting broke at 10:07 AM, and resumed at 10:31 AM.

11. Interferers

11.1 Contribution **by Chandos A. Rypinski,** *Evaluation of Interference Between Radio LAN and USA Point-to-Point Microwave at 1.85-1.99 GHz.* **December 27, 1990. Document P802.11/91-05, temporary document G6.**

Evaluation of interference between 1.85 and 1.99 GHz and point to point microwave. If we use LAN's in this band in big cities does the 2 GHz microwave point to point have to move out? It is claimed by them that it will cost $500 million to move up to higher frequencies. Perhaps that is an exaggeration, but it will be hard to find a way economically to get them to give up their frequency.

Refer to the paper for a description of exiting users. In Los Angeles it includes the sheriffs office and other point to point links that take great effort to show harm. To learn more, the FCC will allow access to files, you could find latitude, longitude, power and gain. You could do a field strength survey. Since there is so much power their presence is obvious. You might find a frequency coordinator, an employee of the FCC with an anointed quasi official status.

(I am able to represent only a small part of the presentation and discussion. There is much important detail in the document. Please refer to it. Secr.)

With regard to Figure 1, The Spatial Signal Distribution: The 79 dB contour is a dot. The 87 dB contour is an envelope 300 meters wide, 10 kilometers long - perhaps a square mile of LAN. The antenna is directional to values 40 dB down from this, that is to say 155 dB down from boresight.

If you design a radio LAN for minimum interference, it is designed differently than if other assumptions are used. Don't turn on transmitters unless they are in use.

(I:) Is it wise to use collision detect in light of interference?

Microwave point to point links want as much margin as they can get, 40 dB margins are common place, though not necessary, approved or blessed. Point to point can be lost due to fades, aircraft, and the sun. Sun in the boresight of the antenna is a problem, the temperature at 12 GHz is 20,000 degrees Kelvin. The sun's spatial angle is very small, a narrow angle antenna is effected, a non directional (or low gain) antenna is not effected. Six to nine meter reflectors get killed five of six minutes twice per year.

(I:) is minimum interference a design issue.

Building walls help somewhat with interference to point to point links. An indoor radio LAN may have 20 dB loss through the walls, 6 dB through window, more if the windows are metalized.

3.2 (Temporal order) Report from T1P1 **by Dr. Rick Dayem, Apple Computer, Inc.**

T1 is an ANSI accredited standard committee. P1 deals with the personal communication network. Everyone will have one or more personal telecommunication numbers (PTN), so the net can find the person, wherever he is, and route call to him - and charge him for it. Rick explains that the jacket he is wearing is there to hold the Microteck(?) phone. The phone belongs to the jacket.

ANSI represents the United States to ISO, but United States representation is through the State Department.

Who are the players in T1P1, what is the tone? Telecommunication manufacturers, common carrier RBOCS (regional phone companies) and a number of data interests, say IBM and Apple. P1 was formed in hopes of catching up with progress made by other countries in this field.

Masleid points out that the scope document of T1P1 indicates that they are 802.11's oversight committee, their scope is a superset of ours. However:

T1 deals with the use of the public networks. P802 deals with private departmental use - though the two are connected. The distinction is not voice versus data. T1P1 clearly is working on a voice **and** data networks. Perhaps P802 is the PBX?

(I:) Chandos says that we should connect to the public network through a bridge. If we put a little of the public network into each station we are in trouble.

Given the aggressive pace and need for our viewpoint we need a liaison.

Dr. Rick Dayem is formally chosen as our representative to T1P1 by consensus.

Agenda items 12-16 were canceled

17. Tentative Meeting schedule

Date	Month	Year	Place	type of meeting	Location
11-15	March	1991	Hilton Head Island, SC	Plenary	Westin Resort
6-9	May	1991	Worcester, MA	Intermediate	Marriott
8-12	July	1991	Kauai, HI	Plenary	Hyatt Regency Hotel
TBD	September	1991	San Francisco Bay Area	Intermediate	TBD
11-15	November	1991	Fort Lauderdale, FL	Plenary	Embassy Suites
TBD	January	1992	TBD	Intermediate	TBD
9-13	March	1992	Irvine, CA	Plenary	Irvine Marriott Hotel
TBD	May	1992	TBD	Intermediate	
6-10	July	1992	Minnesota	Plenary	TBD
TBD	September	1992	TBD	Intermediate	
9-13	November	1992	La Jolla, CA	Plenary	Hyatt Regency Hotel

The following invitations for future Intermediate meetings have been received:

New-York (NY) Area		AT&T
Chicago (IL) Area	(for a May or September meeting)	Motorola
Raleigh (NC)		IBM
The Netherlands		NCR

17.1 Confirmation of March 1991 meeting.

Next meeting is March 11-15th. Remember that the next 802.4L info transfer is 8-11 PM Tuesday evening at Hilton Head Island, SC. Westin Resort Hotel (803) 681-4000, FAX (803) 681 1087. Refer to temporary document G11.

17.2 Objectives for March 1991 (Hilton Head) meeting

The following objectives were agreed:

To establish the Architecture for a Wireless MAC
To consider the need for a petition for frequency spectrum
To consider formal request for expansion of the bit-rate
To review liaison with other groups on Wireless

17.3 Last Mailing date. We decided that 8 February would be the last day for the mailing. (Was deferred to 15 February by the chair to give members a week more time)

17.4 Any other intermediate meeting needed? We decided not to plan an other intermediate meeting.

17.5 Confirmation of May meeting. The May meeting was confirmed as stated above. Out of the three possible accommodations listed by Dr. Kaveh Pahlavan, we selected the Marriot.

18. Review of Document list

18.1 Approval of output documents. We did not need to approve an output document.

18.2 Destination of input documents. The decisions are given in Annex 2.

19. Any other business

Plans for contributions to next meetings:

Dave Bagby, Toshiba	Definitions
Dave Bagby, Toshiba	Strawman model for Portable PC applications
Dave Bagby, Toshiba	Issue-list opinions
Masleid, Inland Steel	Cantor dust and how it applies to our medium
Masleid, Inland Steel	Multi-ray path for a distribution system
Buaas	Issue on security and authentication
Buchholz/Ovan, Motorola	Characterization of the desk-top environment
Buchholz/Ovan, Motorola	Definition of Isochronous services
Buchholz/Ovan, Motorola	IEEE P802.9 historical information
Rypinski, LACE	Air interface protocol proposal
Rypinski, LACE	Architecture models
Tuch, NCR	Marketing information and capacity
Tuch, NCR	Expansion of current submission
Cheah, HNS	Protocol part 2
Cheah, HNS	Propagation link calculation
Ken Biba	Information on usage of current wired LANs
Wilkus/Shober, AT&T	Coding issues in Direct Sequence Spread Spectrum
Wilkus/Shober, AT&T	Personal Communication Systems and wireless loop

This is probably enough for three meetings. The authors will need to estimate how long their presentations will be, and how long the discussion . . . Something that might is to provide access to the pigeon holes on Sunday. E-mail or FAX Vic Hayes if you want to get the material early.

Work items:

Michael Masleid asks if P802.11 wishes to make a formal request to ASC X3T9 regarding use of data rates beyond P802 limitations? The chair suggests to wait for the plenary meeting as the issue is an Executive Committee action.

A bulletin board service may help. NCR will see if the NCR SCSI BBS phone number is still active.

We need a report on how to use DECT for higher data rate. ***We need the specification and someone to explain how to use it***.

Richard Allen is willing to take a lead for infrared products, and is willing to head up a group. Can we write a letter?

Generate a letter for the T1P1 liaison.

How about writing a petition to the FCC for spectrum allocation? It should be docketed. If you write and ask them something that they want to be asked then they do it. It can't be done without the imprint of the opinion of some of us here. . . Data is sufficiently important to get their attention. Single contributors are ok, but it is better if they are a principle or representative of an important organization

Simon Black: I am involved in making minor input into the UK and Europe on cordless data and have informed them of IEEE P802.11 existence.

Appendix 1
Attendance list

Mr. KENNETH C. ALLEN	NTIA	303 497 3412
Mr. DAVE BAGBY	Toshiba America Info Systems Inc	714 583 3846
Miss. HELEN E. BEVIS	British Telecom	+44 473 224 378
Mr. KEN BIBA	Ken Biba	415 665 1812
Mr. SIMON BLACK	Symbionics	+44 223 421025
Mr. CHARLES BRILL	AMP Inc	717 561 6198
Mr. ROBERT A. BUAAS	The Buaas Corporation	714 968 0070
Mr. DALE BUCHHOLZ	Motorola Inc.	708 632 5146
Dr. JONATHON CHEAH	HUGHES Network Systems	619 453 7007
Mr. RICK DAYEM	Apple Computer Inc	408 974 5780
Mr. VICTOR HAYES	NCR Systems Engineering B.V	+31 3402 76528
Mr. BOB HEILE	WINDATA Inc.	508 393 3330
Mr. LARRY van der JAGT	Knowledge Implementations Inc	914 986 3492
Mr. DONALD C. JOHNSON	NCR Corporation WHQ 5E	513 445 1452
Mr. DANIEL E. LEWIS	Telxon	216 867 3700
Mr. RONALD MAHANY	Norand Corporation	319 369 3552
Mr. MICHAEL MASLEID	Inland Steel Co. MS2-465	219 399 2454
Mr. JAMES MATHIS	Apple Computer Inc	408 974 8100
Mr. T. MITSUTOMI	Sharp	714 261 6224
Mr. MICHAEL C. MOORMAN	PA Consulting	609 426 4700
Mr. DOV MORAN	Tadiran-Miltope	516 756 7606
Dr. K.S. NATARAJAN	IBM T.J. Watson Research Center	914 784 7844
Mr. JAMES. NEELEY	IBM	919 543 3259
Mr. MIL OVAN	Motorola Inc.	708 632 3102
Dr. KAVEH PAHLAVAN	Worcester Polytechnic Institute	508 831 5634
Dr. RAPHAEL ROM	Sun Microsystems Inc.	415 960 1300
Mr. ROBERT H. ROSENBAUM	Integrated Strategies	508 263 7877
Mr. CHANDOS RYPINSKI	LACE Inc.	707 765 9627
Mr. RICHARD SCOTT	CAVU Corporation	919 846 9275
Dr. R.ANTHONY SHOBER	AT&T Bell Laboratories	908 949 7991
Mr. RICHARD SILLMAN	Sun Microsystems Inc	415 336 3670
Dr. RAYMOND SIMPSON	O'Neill Communications Inc	609 497 6819
Mr. MARVIN SOJKA	Norand corporation	319 369 3564
Mr. WALT SONNEVILLE	Sonneville Associates	301 869 4460
Mr. ROBERT STEENBERGE	Teledyne Inc	619 260 4412
Mr. WILLIAM STEVENS	Apple Computers Inc	408 974 6307
Mr. OREST L. STOROSHCHUK	General Motors of Canada	416 644 6994
Mr. BRUCE TUCH	NCR Systems Engineering B.V.	+31 3402 76527
Mr. J. GLENN WHITED	CYLINK	703 360 9848
Mr. STEVE WILKUS	AT&T Bell Laboratories	508 960 6033

Appendix 2
Temporary Document list

Ref No	Source	Title	Destination
G/1	Hayes	Temporary Document List	Annex
G/2	Hayes	Attendance list La Jolla	no distr
G/3	Hayes	Functional requirements 802	11/91-12
G/4	Rypinski	Radio System Multipath Propagation analysis leading to possibilities for mitigation	11/91-03 ALPHA
G/5	Rypinski	Radio LAN System Power Budgets and Levels	11/91-04 ALPHA
G/6	Rypinski	Evaluation of interference between Radio LAN and USA Point-to-Point Microwave at 1.85-1.99 GHz	11/91-05 ALPHA
G/7	Johnson	Second Notice of Inquiry GEN Docket No. 89-554, re Preparation for WARC 92, Freq. allocations in spectrum	no distr
G/8	Masleid	Handout for .4L work (partly)	no distr
G/9	Buchholz	"Straw-man" protocol Model	11/91-06
G/10	Rypinski	Reply Comments to GEN Docket 90-314	no distr
G/11	Cheah	A proposed IEEE 802.11 Radio LAN Architecture	11/91-07 ALPHA
G/11.1		Hand drawn foils	
G/12	Ovan	Wireless In-building Network Market Considerations	11/91-08 ALPHA
G/12.1		Additional Foils	
G/13	Mahany	User and application Overview for wireless data collection systems	11/91-09 ALPHA
G/14	Black	DECT - A standard for Cordless Data Networks	11/91-10 ALPHA
G/15	Hayes	IEEE P802 Document order form August 19990	no distr
G/16	Hayes/Neeley	Attendance list third meeting	Annex
G/17	Dayem	Report of T1P1	11/91-14 ALPHA

annex	will become an annex or appendix to the minutes of meeting
no distr	This document is not distributed
reference	This document will only be referenced in the archive document
11/..	Distribute to P802.11 members and observers
Ex Com	Distribute to P802.0 members
ALPHA	Include in the Alphagraphics document order system