Tentative Minutes of the IEEE P802.11 Working Group

Plenary Meeting
Kaua`i, HI
July 8-11. 1991

Monday, July 8, 1991, Late Afternoon

The meeting was called to order at 3:15 PM, with Vic Hayes, chairman of IEEE 802.11[1], presiding. The other two officers of IEEE 802.11, Jim Neeley and Mike Masleid, were both unable to attend the meeting. Tom Phinney agreed to be secretary at 3:30 PM, when these minutes were started.

[Annotation: Boldface section headings reflect the agenda items published in 802.11/91-66 and -66R. Clarifications inserted by the secretary are contained in square brackets, followed by "— sec."]

1. Opening

1.1 Introduction: All people in the room were invited to mention their names and affiliation. 63 did.

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[1]The officers of the Working Group are:

Mr. VICTOR **HAYES**
Chairman IEEE P802.11
NCR Systems Engineering B.V.
Architecture and Systems Management
Zadelstede 1-10
3431 JZ Nieuwegein, NL
E-Mail: Vic.Hayes@Utrecht.ncr.com
Phone: +31 3401 76528
Fax: +31 3402 39125
Telex: 47390

Mr. JAMES **NEELEY**
Vice Chairman IEEE P802.11
IBM
LAN Systems Design
POB 12195
Research Triangle Park, NC 27709, USA
E-Mail: neeley@ralvmk.iinus1.ibm.com
Phone: +1 919 543 3259
Fax: +1 919 543 0159

Mr. MICHAEL **MASLEID**
Secretary/Editor IEEE P802.11
Inland Steel Co. MS 2-465
Process Automation Department
3210 Watling Street
East Chicago, IN 46312, USA
E-Mail: masleid@pa881a.inland.com
Phone: +1 219 399 2454
Fax: +1 219 399 5714

Dr. Jonathon **CHEAH**
Editor IEEE P802.11
HUGHES Network Systems

10790 Roselle Street
San Diego, CA 92121, USA
E-Mail: oscar!sv.dnet!jcheah@nosc.mil
Phone: +1 619 453 7007
Fax: +1 619 546 1953

Mr. CHANDOS **RYPINSKI**
Editor IEEE P802.11
LACE, Inc.
921 Transport Way
Petaluma, CA 94952, USA
Phone: +1 707 765 9627
Fax: +1 707 762 5328

1.2 Voting rights are obtained in P802.11 by attending two plenary meetings out of four consecutive plenary meetings; with voting rights granted at the start of the third meeting attended. One interim meeting may replace one of the required plenary meetings. Attendance at a meeting requires the claiming individual's attendance in the meeting room for at least 75% of the time, as determined from the circulated and signed attendance list.

The chairman requested the Working Group participants to retain their current seating positions for the entire plenary.

1.3 Attendance List, Registration: The attendance list is circulated during each morning and afternoon session, and must be signed during the session itself; signing for future or past sessions is not permitted.

All members and prospective members are required to register at the general Meeting Office, and pay the $150 (US) registration fee. Failure to register will cause immediate loss of accumulated voting rights, as well as incessant harassment from the committee chairman.

1.4 Logistics: Document distribution at the meeting is done using "pigeon holes" (a filing system). The "pigeon holes" may also be used for mail. Don Johnson and Dr. "Nat" Natarajan managed the distribution system.

During the week, the morning meetings start at 8:30 AM, break at 10 AM for 10 minutes, and break for lunch at 12 N. The afternoon meetings start at 1:30 PM, break at 3 PM for 10 minutes, and conclude by 5:30 PM.

2. Approval of the minutes of the previous meeting

The minutes of the Worcester, MA interim meeting (11/91-67) were not available, and would not arrive until Wednesday mid-morning, so consideration of the minutes was deferred until Thursday.

3. Reports

3.1 From the interim 802.11 meeting. The chairman recounted the evolution of the latest letter which was sent, via the IEEE 802.0 Executive Committee, to the FCC.

3.2 From the Executive Committee. The chairman summarized issues from the IEEE 802.0 Executive Committee meeting earlier today.

A document on Organizational Unique Identifiers is available for review. Comments are welcome before end of Wednesday.

The chairpersons were asked to update the TCCC letter ballot forecast. 802.11 needs to review its plan.

IEEE has made new rules for distribution of new publications of standards projects in the following way:

> 250 documents are available for free distribution; these will be distributed among the members with voting rights within the working group that produced the document, the voting members of the other working groups and the other registered participant of the meeting at which the document is being distributed.
>
> Those qualifying above but could not get a book due to shortage can file an order for a book with 50 % discount.

The subject of patent licensing was discussed intensively. The still relevant rule is that a, known,patent holder is required to file a letter stating that he would license the Patent at "Reasonable and non-discriminatory" terms & conditions before a standard could be approved.

The 802 Management needs were discussed. Expansion of the contents of 802.1F and promotion to standard level may be the result. A further action item is that throughout the 802 standards gauges and counter accuracies are to be standardized.

The following organizational items were announced: -No conditional approvals by RevCom will be accepted and no coordination between RevCom and NesCom may be assumed. This implies that the title of a new or revised standard must be exactly the same as the name of the PAR, if not a timely correction of the PAR must be undertaken.

Names of companies mentioned in a standard needs to be supported by a written approval of a legal officer of the company.

4. Registration of contributions

Eight contributions were added to the chairman's master list: 11/91-75 through 11/91-82, and the titles of the other contributions since the Worcester, MA meeting were reviewed.

.11/91-66	Tentative agenda for the sixth meeting (July 8-12, 1991)
.11/91-67	More comments on CSMA (Ad Kamerman, NCR)
.11/91-68	An Engineer's summary of an ISM band wireless LAN (Bruce Tuch, NCR)
.11/91-69	Comments and measurements on the Physical Layer (Bruce Tuch, NCR)
.11/91-70	Status of DECT Standard and capabilities of DECT (Rick Albrow, Symbionics Ltd)
.11/91-71	Status report of ETSI RES ad-hoc group on cordless Networking (Simon Black, Symbionics Ltd)
.11/91-72	Tentative minutes of the May 1991 meeting
.11/91-73	A simulator for evaluating MAC protocols (Dick Allen, Wireless Research & Stan Fickes, Photonics)
.11/91-74	Medium Access Control Protocol for radio LANs (Natarajan K.S., Huang C.C. and Bantz D.F., IBM Thomas J. Watson Research Center)
.11/91-75	Multi frequency radiowave propagation measurements in the portable radio environment (Devasirvatham, Banerjee, Krain, Rappaport)
.11/91-76	Independent contiguous Radio LANs (Chandos Rypinski, LACE)
.11/91-77	High and low PHY signaling rates with a common chipping rate (Chandos Rypinski, LACE)
.11/91-78	Strategies for channel assignment (Chandos Rypinski, LACE)
.11/91-79	Dynamic access-point reassignment, or there is no handoff problem (Chandos Rypinski, LACE)
.11/91-80	Access protocol for IVD wireless LAN - part II (Chandos Rypinski, LACE)
.11/91-81	Research on Wireless lan in Japan
.11/91-82	IEEE 802.11 design goals questionnaire (Chandos Rypinski, LACE & Larry Van Der Jagt KII)

5 Adoption of the agenda

The chairman reviewed the agenda, and attempted to allocate papers to the work categories. Bob Crowder requested that Test Beds and Regulatory Bodies be covered on Wednesday AM, when some members would be absent with liaison activities. [Wednesday AM at Plenary meetings is the preferred time for inter-802.x liaison activities — sec.] To accommodate this request, the Channel Characteristics agenda items were moved to Tuesday PM, and the MAC items to Wednesday PM.

The partitioning of new submissions (since the Worcester interim meeting) was:

6.1	Market issues:	1
7.1	Channel characteristics:	5
6.2	MAC alternatives:	6
8.x	Liaison and Regulatory Bodies:	3

The committee took a "10-minute" break, from 4:30 to 4:50 PM. During this interval a number of the papers were distributed.

6. Establishment of architecture

6.1 Market requirements

6.1.1 802.11/91-82 Chandos Rypinski presented 802.11/91-82, **IEEE 802.11 Design Goals Questionnaire**, which he and Larry van der Jagt have developed. Each committee member was requested to fill out one or more copies of the questionnaire as homework, and mail them to Larry van der Jagt. Larry's address is:

Larry van der Jagt
Knowledge Implementations, Inc.
32 Conklin Road
Warwick, NY 10990, USA
Phone: +1 914 986 3492
Fax: +1 914 986 6441

The ensuing discussion attempted to clarify whether data should be based on current systems or informed conjecture. It appeared that respondents could use either.

The group determined that packet sizes mentioned in the questionnaire were to be measured at the MAC-LLC interface (i.e., they are MSDU size measurements) and so their sizes should not reflect any lower-level artifacts of an assumed MAC protocol.

Chandos was asked to modify the questionnaire to include a number of suggested changes. Suggested changes were to be given to Chan by noon, Tuesday. Chan was asked to provide either an updated questionnaire, or a schedule for the updated questionnaire, on Thursday. [I believe this was overlooked on Thursday — sec.]

0.1+ More announcements. The chairman announced the Tuesday-evening tutorial by IBM on a protocol for Gbit/s LANs.

Dr. David Leeson, of California Microwave, announced that his company is setting up a bulletin board for IEEE 802.11. Its US (and Canadian?) access number is +1 800 24 802.11. This should be operational by early August. The default password is IEEE. Your user-name should be your last name or names (van der Jagt will be van der Jagt).

The need for a non-800 number for access from outside North America was pointed out. David said he would look into assigning a non-800 number as well. David's own phone number is +1 408 720 6215 and his fax number is +1 408 732 4244.

The committee thanked Dr. Leeson for this generous contribution, and applauded as well his choice of 800 phone number.

The meeting adjourned for the day at 5:30 PM, to reconvene Tuesday morning at 8:30 AM.

Tuesday, July 9, 1991, Morning

The chairman opened the meeting at 8:40 AM. A brief poll on the subject of fixed seat assignments for the week indicated that the people who had seats in the front of the room favored fixed assignments, while those in the back were opposed. The requested policy of fixed seat assignments was abandoned.

The "pigeon hole" document system, attendance list, voting rights and other procedures were re-summarized. Another round of introductions ensued; 68 people were in attendance.

7+. Establishment of architecture (cont.)

7.1 Channel Characteristics

7.1.1 802.11/91-75 was presented by Chandan Banerjee. A number of measurements were made at 850 MHz, 1.7 GHz, 4.0 GHz, and 5.8 GHz. The conclusions from the measured data were that delay spread was independent of frequency, and that path loss was best approximated as free-space path loss plus attenuation per unit distance, with the attenuation coefficient decreasing as the frequency increased.

The buildings measured had metalized walls, which appeared to be a substantial radiation barrier, containing emitted radiation and attenuating outside interference. This appeared to result in a smaller delay spread than had been measured in other buildings, where reflections from outside the building were detectable.

7.1.2 802.11/91-76 was presented by Chandos Rypinski. He presented two co-located LAN scenarios, which he characterized as Twin Towers (TT) and Shopping Mall (SM). The paper concludes that access points which use inwardly-directed quadrantal antennae [i.e., with a main-lobe beam width of about 90 degrees — sec.], and which are located at the perimeters of the selected areas, can be used to reduce the interference between co-located LANs. The argument assumes low duty cycle messaging for the interfering stations, and observes that only a small fraction of the stations are likely to be maximally interfering, because most stations will not have LOS paths to access points of co-located foreign LANs. The resultant probability of "collision" between co-located LANs seems low enough to be handled by ARQ techniques.

Chan pointed out that the physical isolation presented here complements CDMA or TDMA isolation techniques. [Since directional antennae lead to semi-isolated coverage areas, they provide a quasi SDMA (space division multiple access) system, which is obviously complementary to CDMA, TDMA and FDMA techniques — sec.]

Chan stated that his results applied to positive control systems, but not to CSMA systems. Discussion ensued. Major points made were:

1. In direct sequence spread spectrum systems, which detect signal rather than raw "carrier", the "carrier sense won't work" argument does not hold as strongly. However, re-use of a direct sequence chip-code set within the antenna's coverage region may cause false sensing of carrier.

2. Coordinating frequency hopping between adjacent cells may also reduce interference.

3. The directional antennae assume some degree of installation coordination between co-located LANs.

   Chan noted that rules or recommended practices (such as driving on the proper side of the road, or illuminating a parking lot according to rules) would be needed, but that his approach could tolerate a few renegades.

4. The requirement for rigorous placement rules was questioned, particularly given the succession of tenants in a shopping mall, and their continuing expansions and contractions of needs.

5. The question was raised of whether cells would inter-penetrate, as indicated by Mike Masleid's video and multipath considerations, leading to "fractal" micro-cells. Chan pointed out that putting the access-point antennae in the corners of served cells reduced the problems cited, but did not eliminate them. He also pointed out that Mike Masleid's evidence required wideband, rather than narrowband, signals to reduce the peak-to-mean power ratios caused by multi-path.

6. The question of autonomous systems without access-point infra-structure was raised. Chan stated that infra-structure was probably a necessity in such high-density systems, but that infra-structure was probably present anyway to support credit-card authorization. [Presumably part of this need comes from the requirement to secure the credit authorization process — sec.]

7. The requirement for an infra-structure timing channel to synchronize time slots among multiple users was questioned.

8. The difficulty in requiring humans to orient RF antennae when they have no built-in RF sensors was raised.

9. It was pointed out that the situation in a SM with co-located access points from independent LANs, on opposite sides of a thin wall, may be the worst real problem due to near/far considerations. Powering access points at higher levels than stations would aggravate this situation.

10. Synchronization is a tool, and can be obtained easily between access points, because they can usually overhear one another.

11. Spatial separation (SDMA) is not potentially regulatable, whereas FDMA, TDMA and CDMA separation techniques can be regulated. Therefore the standard should not rely on spatial separation techniques, because they are unenforceable.

12. Cordless telephones are an example of independent systems which coordinate channelization successfully — the "find-a-free-channel" model.

13. Real installations, and multi-path, lead to very irregular spatial boundaries.

The consensus seemed to be that spatial diversity is a tool, but cannot be relied on. In indoor environments, macro-cell-based cellular concepts are not directly applicable.

A coffee break, from 10:00 to 10:20, was announced. The meeting restarted at 10:30, with 71 people in attendance.

14. While the out-of-building macro-cell and in-building micro-cell environments are different, many of the same techniques are applicable. Directionality techniques will not be adequate for a standard, but can help. If they are included, then they probably will cause a slight increase in the complexity of the protocol.

15. Redundancy should be permitted, but not be a primary focus of the system.

7.1.3 802.11/91-69 was presented by Bruce Tuch. The 802.11 outage requirement of 10^{-3} of all areas was discussed. The S/N vs. BER (signal-to-noise versus bit-error-rate) curve is such that the outage probability dominates; a system with a BER of 10^{-3} has almost the same outage probability as a system with a BER of 10^{-8}.

Fading margin is the critical parameter affecting outage. Receiver diversity can be used to reduce the necessary fading margin for a 10^{-3} outage rate from 30 dB to 10 dB. This paper used a lumped fading margin (Rayleigh fading plus shadow loss) of 18 dB.

The power budget shown in the paper was evaluated against an American-style office building (Herman-Miller open offices) in the Netherlands. It was observed that the higher the manager in the organization's structure, the more attenuation that his office suffered, due to bigger offices and more-solid walls.

The measurements all showed Rayleigh distributions, whether antennae were above or below the partitions, and whether the distance was medium (13 m) or long (38 m). This was with non-directive dipole antennae. LOS at 13 m had no effect on this distribution, presumably due to floor, ceiling and other multi-path propagation. Different (Rician) distributions were observed only for short LOS paths. Bruce pointed out that for these short LOS paths, IR would be a better physical layer than RF. The measurements were all narrow-band, but other measurements showed the office to have flat fading with a 50 - 100 MHz fading bandwidth. The delay spread measured in this office was 20 ns.

Discussion ensued. Major points made were:

1. Polarization diversity helped beyond 10 m, though its effects are not included in the paper.

2. At 10 m LOS, RF is unnecessary and IR is adequate. With shadow fading, RF seems more important.

3. For a statically-located transmitter and receiver the coherence-time of the channel is on the order of seconds. This would not be the case for mobile devices, where the coherence time would be on the order of milli-seconds.

3.1 Financial Report for interim meeting The financial report for the Worcester meeting was presented. A balance of $402.87 will be applied to the September 1991 meeting, which Apple will host in Palo Alto, CA.

Robert Buaas ***moved to accept the financial statement***; Chandan Banerjee seconded. **Passed** 32-0-0.

7.1.4 802.11/91-77 was presented by Chandos Rypinski. He pointed out that to increase commonality of microwave ICs, it is possible to define both high-rate and low-rate systems that share RF components by using a single common chip rate (which equals the baud rate when chipping is not employed).

7.1.5 802.11/91-68 was presented by Bruce Tuch. He stated that his paper was derived from a number of presentations he has made, and relates the story of NCR's wireless LAN. (For details, see the slides — 11/91-68A.)

Some focal goals/requirements were:
— A LAN identity requires a data rate of 1 Mbit/s or greater.
— Function is data packet communications
— Zero infra-structure needed for initial installations.

For the MAC sublayer, CDMA seemed to have inappropriate characteristics:
— relatively high cost to handle near/far problems (requiring power control, among other measures).
— partitions system into individual code channels, rather than providing dynamic sharing of bandwidth

So a form of TDMA based on CSMA/CA was chosen. Its features are:
— a distributed protocol, similar to 802.3
— the RF channel's "capture effect" increases system capacity
— with "hidden" terminals, the channel can degrade to ALOHA
— the protocol is inefficient at high loads.

One overall conclusion was that Physical layer spreading and the MAC protocol are independent (nearly unrelated) choices.

A number of measurements, and measured environments (office buildings, retail stores) were presented.

The NCR product uses antenna polarization and antenna switching. Transmission occurs on the vertical antenna.

Reception can be on either the vertical or horizontal antenna. The horizontal antenna provides a substantial amount of shadow fading resistance due to multipath in the horizontal plane.

Receiver sensitivity was -72 dBm, which includes an 18 dB (above thermal) noise margin to account for man-made noise. The transmit level was +24 dBm. The antenna diversity provides a 2 dB gain in noise margin. A Barker-11 code was used to minimize side-lobes between correlation peaks.

The baseband spectrum is a filtered $\frac{\sin^2(x)}{x^2}$. The modulation has been made near constant-envelope to permit class-C amplification. However, MMICs make linear modulations feasible, and should be considered in the future.

In the office environment, echo diversity does not occur. However, with delay spreads > 60 ns, echo diversity does occur. Delay spread above 400 - 500 ns would cause inter-symbol interference. The NCR product uses echo diversity by selecting the largest echo; it does not combine the energy of echoes arriving in distinguishable chip intervals.

The curves of outage vs. distance vs. echo diversity index show a substantial outage reduction due to 2-way echo diversity. The expected outage is 10^{-3} at 60 m.

The protocol used is CSMA/CA, based on demodulator output. Each message carries a network ID in its header, and CA is used to avoid transmission when "overhearing" a second LAN on the same FDM channel. 50% channel utilization is common.

Nodes were randomly distributed in the test office area.

Momentary overloads are handled using a good backoff algorithm. Analysis of a 200-node system shows that throughput can still reach 50% with the chosen algorithm.

The Working Group broke for lunch at 12 N, scheduled to reconvene at 1:30 PM.

Tuesday, July 9, 1991, Afternoon

The chairman called the meeting to order at 1:35 PM. He announced that a meeting of the editing committee on the letter to various national RF administrations was planned for that evening.

7.1.5 802.11/91-68 (cont.) Discussion about the paper ensued. Major points made were:

1. The 11 Mchip/s rate was chosen because of cost and delay spread.

2. The jam-resistance of any direct-sequence spread spectrum system (DSSS) is inadequate to cope with other ISM signals which are permitted in the band. Even 30 dB processing gain would be inadequate to reject other permitted in-band users. Therefore the protocol provides the error recovery for major Physical-layer noise hits.

3. The NCR system uses a 7-bit PN scrambler together with the 11-chip Barker code, and has a processing gain of 10.6 dB.

4. The maximum MSDU (and thus MPDU) sizes are determined by the user. It was noted that one of the most popular LAN managers imposes a 576-octet MSDU limit.

5. Antenna phase diversity provides a 10 dB fading margin, which in an environment with an N=3+ attenuation exponent, gives a 2:1 improvement in range.

6. The technology at 900 MHz seems compatible with low-power usage requirements (e.g., notebook computers) because of simple receiver processing requirements.

7. The NCR bridges are PC-based, using an RF card and a second LAN attachment in a PC, and using standard PC bridging software.

6.2 MAC alternatives Presentations began at 2 PM.

6.2.1 802.11/91-73 was presented by Dick Allen.

He and a C programmer have developed a simulator for evaluating Wireless MACs. It is written in ANSI portable C, with all machine dependencies isolated to less than one well-commented page. It has been tested on a number of PC platforms. It has been tested with models for ALOHA, slotted ALOHA, and P-persistent CSMA, all of which have demonstrated statistics similar to those published for the respective protocols.

The simulator software consists of:
- a Test Data Base Generator
- models of various MAC protocols
- the Simulator
- a Statistics Collector/Analyzer

The simulator can model various hidden-node and point-to-point connectivity problems, and various node traffic patterns and packet-size distributions. The model supports two different packet sizes to approximate observed bimodal distributions.

This is an interim report; work started only a few weeks ago. Source code will be made available (free) to anyone who wants it, either by BBS access or disk.

A demonstration on the chairman's PC, projected onto a large screen, showed ALOHA at 50% offered load converge toward 19% throughput, the known asymptotic limit for the protocol.

Questions indicated a substantial amount of interest and a number of ideas for enhancement. Dick indicated that such enhancements, to be made by the questioners themselves, would be a welcome contribution.

6.2.2 802.11/91-74 was presented by Dr. "Nat" Natarajan. He discussed a frequency-hopping approach for an RF system, designed around a fixed distribution system.

The hybrid access method presented includes:

1) access-point to station traffic, sent in broadcast mode;

2) scheduled station to access-point traffic, sent in a contention-free interval; and

3) unscheduled station to access-point or station-to-station traffic, sent during a contention-permitted interval, consisting of:
   a) registrations of new or moving stations,
   b) requests for isochronous and non-isochronous bandwidth, and
   c) bursty single-packet messages.

Frequency hopping with a fixed, synchronized hopping period maximizes spectral reusability when LANs are collocated.

Questioning clarified the following:

1. Coexistence with autonomous LANs has not yet been addressed.

2. The maximum dwell time per hop is 400 ms under current FCC Part 15.247 regulations. However, 50 ms may be a more appropriate time interval.

3. Each access point has its own hopping sequences.

4. Handoff time was not yet reportable.

5. A prototype is under development.

6. It was noted that a solution encompassing both isochronous and non-isochronous data was encouraging, and that the committee looked forward to future reports of experimental results.

The working group took a 20-minute break, from 2:55 PM to 3:15 PM.

The meeting reconvened at 3:21 PM with 56 people.

6.2.3 802.11/91-78 was presented by Chandos Rypinski.

Chan began by apologizing for the large number of contributions which he had made. [Would that all members contributed as much — sec.]

The paper addressed the use of code division spread spectrum (CDSS) to separate overlapping access point coverage areas. A previous paper had addressed time-sequence separation for such areas.

Various code re-use patterns were examined. For simplicity, square 2-D partitions were considered, but similar considerations apply for irregular 2-D and 3-D partitions as well.

The more resistant a modulation technique is to interference, the more frequently a pattern can be re-used, resulting in a smaller re-use pattern.

Chan digressed to say that, in his opinion, 6 ms is the maximum tolerable fixed delay for real-time voice data which an RF LAN can introduce.

The paper presents a 1-setup-channel, 9-data-channel re-use model. Using 9 data "colors", and restricting channel occupancy to 50% [through CSMA/CA or similar techniques — sec.], it is possible to "color" a larger re-use map, such as a 5x5 (=25) "color" grid of access points.

Discussion ensued. One major point made was:

1. The presentation assumes coordination ("coloring") of access points performed by some means outside of the protocol, such as pre-configuration. A WLAN protocol also needs to cover the case where two co-located LANs have no extra-protocol cooperation. [This comment was made, in various forms, by a number of people — sec.]

More generally, it was suggested that after a more elaborate set of requirements (than those in the PAR) is established, then each presenter should include in his/her proposal an assessment of how well the proposal meets each of the requirements.

6.2.4 802.11/91-67 was presented by Bruce Tuch.

Bruce observed that the effective propagation delay of a WLAN system consists of:

— transmit carrier delay:	4 μs in the NCR system
— medium propagation delay:	1 μs / 300 m (free space)
— receiver carrier detect delay:	5 – 15 μs in the NCR system

Thus a 10 – 20 μs propagation delay was achieved in a cost-effective manner.

At 4 Mbit/s, for non-persistent CSMA this gives a coefficient **A** of 0.009 – 0.018 and a limit of 80% throughput, where **A** is the classical CSMA parameter, $\mathbf{A} = \frac{T_{\text{propagation delay}}}{T_{\text{packet transmit duration}}}$.

Adaptation in P-persistent CSMA or in CSMA/CA is based on a population estimate of the number of colliding stations.

Real loads are not Poisson distributed; most servers work on a request-response basis. An M/M/1 queue model seems more appropriate for modeling server-based networks. Using such a model, NCR found that the time vs. number of queued items distribution for a 200-node network with 2 Mbit/s capacity showed that two or fewer items were queued 80% of the time.

Two methods for enhancing delivery reliability were itemized:
— a MAC-level acknowledge [presumably with an alternating-bit protocol for duplicate rejection at the receivers — sec.], and
— use of a higher-layer protocol with some built-in error recovery, such as LLC2 or LLC3 or TP4.

The paper concluded with an observation and two open questions:

1. Enhanced CSMA systems can provide a high throughput performance by applying only relatively simple and inexpensive control provisions.

2. Are non-CSMA-like systems more efficient under real-life LAN circumstances?

3. How can a highly-reliable service be provided within the MAC layer itself?

6.2.5 802.11/91-80 was presented by Chandos Rypinski. This paper summarizes the evolution of 802.11/91-19 which has occurred since 21 February 1991. The material will be presented in detail at the next meeting; at this point the new document (11/91-80) is being distributed for information but without comment.

6.2.6 802.11/91-79 was presented by Chandos Rypinski. In it Chan argues that it is dangerous to use cellular terminology for problems and situations which are distinctively different from those encountered in cellular systems, because the meaning inferred by cellular-knowledgeable people will be incorrect and lead to confusion of all concerned.

"Hand-off" is a cellular connection-oriented problem. Passage of primary access-point-ship from one AP to another, between messages, is the non-analogous problem faced by a WLAN.

Discussion ensued. Major points made were:

1. Perhaps "hand-over" is a better term. It will apply to isochronous or similar connection-oriented (CO) services. Hand-over can occur at different levels — at the channel level, or above. Hand-over can be seemless — without loss — or lossy/duplicative.

This led to a discussion about requirements placed by IEEE 802 on all MACs. Topics considered were:
— source routing,
— bridge compatibility,
— the impact of the ISO/IEC 10039 MAC Service Definition

6.2.7 802.11/91-88, Consideration on Collision Detection (CD) Methods for WLAN, was presented by Hideaki Haruyama. He stated that three CD methods had been considered for the 802.3 coax-based RF broadband networks:

— best signal level detection,
— bit comparison and collision enhancement,
— random pulse.

In best signal level detection, stations would use power level control and frequency modulation. Collision would be detected by receivers as either a zero or double level. This requires a "listen while talk" capability.

In bit comparison and collision enhancement, each sender compares sent and received data bits [and generates a separate collision reinforcement signal when a collision is detected — sec.]. This requires a "listen while talk" capability.

In random pulse, each sender sends two pulses with a random interval. This extra preamble causes a "deterioration of throughput" but does not require "listen while talk".

For WLAN systems, random pulse requires approximately half the bandwidth of best signal, and somewhat less than half the bandwidth of bit comparison. Random pulse also permits direct transmission (no access point), which provides robustness for direct inter-station communication.

Design example:

collision window:	N pulses
number of transmitted pulses:	K
probability of missed collision:	$\frac{1}{{}_N C_K} = \frac{1}{C(N,K)} = \frac{K!\,(N-K)!}{N!}$

If N=33, K=16, then $C(N,K) > 10^9$. If pulse width = 300 ns and delay spread = 200 ns, then the collision window = 16.5 µs, which is less than 802.3's minimum packet length of 57.6 µs. Therefore this caused only a small throughput deterioration.

In conclusion, the random pulse method requires minimum bandwidth and no access point. When applied to a wireless LAN, the throughput deterioration is small.

Discussion ensued. Major points made were:

1. Hidden terminals from co-located LANs can still cause undetected (by the transmitter) collisions. However, there cannot be hidden terminals from the same LAN, by definition of a BSA.

2. The hidden terminal problem will dominate the message loss rate, and thus the equivalent BER required of the WLAN MAC.

3. Random pulse requires rapid switching between transmit and receive. This switching delay is affected by filter storage, AGC settling time, etc. One member noted that these problems had been solved for radar systems.

4. The problem of hidden nodes is encountered in all CSMA protocols, and in fact in all WLAN systems, and so should be treated separately.

The meeting adjourned for the day at 5:25 PM. The committee to work on the letter to the various national RF spectrum allocation administrations was scheduled to meet at 6 PM in the same room.

Wednesday, July 10, 1991, Morning

The chairman called the meeting to order at 8:50 AM. 56 people were in attendance, who introduced themselves. Dick Allen volunteered to take the minutes for the morning, since the interim editor would be absent [along with a number of other members, performing the customary Wednesday AM inter-802 liaison activities — sec.].

8+. External Liaison

8.1 Preparation of letters to Regulatory Bodies

8.1.1 802.11/91-62/D2, IEEE P802 Request for World-Wide Harmonized Radio Frequency Spectrum for Local Area Networks was introduced by Chandos Rypinski. This letter is intended to be suitable for use with European and other RF regulatory administrations. Draft 2 (D2) resulted from comments by the chairman of CCIR TG8/1, who recommended changes which would increase the chance of a productive response to these petitions. Thus D2 does not provoke direct competition between the telecommunications and computer industries, but attempts instead to create a plea for spectrum for personal communications.

A long discussion ensued about the history and purpose of, and need for, the letter; about the reasons for requesting 140 MHz of bandwidth; and about the status and permitted usages of the ISM bands in various countries.

The working group took a 30-minute break at 10 AM, and reconvened at 10:38 AM.

The title was changed from "Harmonized" to "Coordinated". A small number of other changes were made, including clarifying the ISM bands as 2.4 GHz and 5.8 GHz. A "Recommendation" section was added just before the conclusions on page 5.

Chandos Rypinski ***moved that the letter, as amended, be submitted to the IEEE 802.0 Executive Committee for their consideration, to be sent to various Regulatory Administrations worldwide***. Bruce Tuch seconded. Passed 17-0-0. The chairman declared the motion as Approved Unanimously.

The working group then considered which Administrations should be graced with the letter. The chairman asked for approval to select appropriate agencies in Europe, including the CEPT working group on radio LANs. There were no objections. To this list were added the RACE project team on radio LANs and the ETSI RES ad-hoc radio LAN group.

Since Chandos Rypinski has been appointed as the international rapporteur for 802.11 on CCIR TG8/1, and he is a U.S. delegate, he asked that a copy be sent to the head of the U.S. delegation (Frank Rusk (sp?) of the FCC). The chairman indicated that was inappropriate, but that as a US delegate to TG8/1 Chandos should forward the letter to all members of TG8/1.

Dr. John O'Sullivan agreed to provide an address for the appropriate Australian administration. Don Johnson has the appropriate Canadian address. The group also agreed to determine appropriate addressees in Japan and Latin America. Chandos Rypinski then volunteered to use the international mailing list for CCIR TG8/1 to send the letter out as an information letter to the TG8/1 members, which include about 30 countries. There were no objections.

Israel and Korea were added to the list when volunteers to find appropriate addresses spoke up.

Chandos Rypinski ***moved to authorize the chairman to identify addressees at his own discretion***. Dick Allen seconded. Carried 17-0-0.

8.2&3 Liaison Reports

8.2.1 ASC X3T9 No report.

8.2.2 ETSI liaison report was presented by Rick Albrow.

8.2.2.1 802.11/91-70. Rick reported on the current status of the DECT standard and on the data services provided above the MAC boundary. A tutorial on the DECT MAC and Physical layers must await a future meeting.

DECT CI approved TC RES (Radio Equipment and System). The next stage is a public enquiry. Comments will be distributed and resubmitted at working TC RES meetings. If approved, the result will go to the ETSI Technical Assembly for final approval and issue as a European standard by the end of 1991. First products are expected by the end of 1992 in Geneva. DECT has very wide support (in Europe).

Comments made clear that DECT has approached the need for a European Cordless Telephone, but now includes some data capabilities, whereas IEEE 802.11 has approached the need for wireless data, but with some isochronous capabilities.

Rick pointed out that the anticipated uses for DECT have grown:
1. Fixed telepoints, interacting with the PSTN
2. Mobile telepoints, using a GSM backbone
3. Cordless local loop for bypass in countries where permitted (e.g., U.K.)
4. Providing infra-structure in Eastern European countries

The DECT specification will have 10 parts. Part 9 is a Public Access Profile, specifying permitted subsets of the overall specification. Part 10 specifies cryptographic algorithms and will not be publicly available.

There are three levels of DECT conformance:
CI Base — a Physical and minimal MAC subset
CI Profile — equipment that conforms to a published profile. The only one so far is PAP; there may be more.
CI Profile Plus — Conforms with a published profile, plus additional features.

A System Description Document, which now exists in draft form, provides additional information.

Data rates at the MAC service boundary are:
— unprotected data — 736 k bit/s
— protected data — 488 k bit/s

There are a total of 10 channels available, giving a total capability of about 5 Mbit/s when all channels are used in a multiple radio implementation. The modulation used is GMSK.

The chairman asked Rick to present an evening tutorial on DECT at the next IEEE 802 plenary meeting in November.

Discussion ensued. Major points made were:

1. Members expressed doubt that a 500 k bit/s data rate was achievable over an indoor RF channel using GMSK. Rick stated that the BER numbers were approximately 10^{-2} to 10^{-3} for unprotected data, 10^{-8} for protected data.

2. The signaling rate is 1.152 Mbit/s in environments with a delay spread of a few hundred ns.

The chairman asked Rick to determine if and when the interim report would be available to the public at large, and not just to ETSI members. The chairman agreed to add any information provided to the next mailing.

8.2.2.2 802.11/91-71. Rick reported on the ETSI ad-hoc group on cordless data networking. It was established in February 1991, and to date has held two meetings. It has 27 participants: 14 manufacturers, 5 operators, and 2 regulators. They have established an almost-SI volume unit of data occupancy: Mbit/(s ha floor). This translates as megabits per second per hectare (100 m x 100 m) per floor. [A hectare is about 2.5 U.S. acres — sec.]

One member pointed out the apparent inconsistency between the ETSI rates and a total rate of 2 Mbit/s. Rick stated that ETSI desires to cooperate with IEEE 802.11, and that CEPT and ETSI RES need to have a discussion on this matter.

The Working Group broke for lunch at 12:05 PM, scheduled to reconvene at 1:30 PM.

Tuesday, July 9, 1991, Afternoon

The chairman called the meeting to order at 1:40 PM.

8.2.3 CEPT report was presented by Vic Hayes.

Vic reported that as IEEE 802.11 chairman [and a European — sec.] he had been invited to participate in CEPT — the Conference of European Postal and Telecommunication administrations. They have developed a draft recommendation for frequency requests for Radio Local Area Networks (RLANs), to be forwarded to local (i.e., national) administrations. This recommendation was delayed because of objection by ETSI, which said that the recommendation was premature. They hope to get the following recommendation approved by December 1991.

Recommended:

1. 2445 – 2475 MHz be used on a non-interference and non-protected basis for RLANs using spread spectrum technology (ERC category (a): data rate < 2 Mbit/s) with a maximum power of -17 dBW/MHz EIRP for systems using direct sequence techniques, and 0 dBW/MHz EIRP measured in a 100 kHz bandwidth for systems using frequency hopping techniques.

2. 5785 – 5815 MHz be used on a non-interference and non-protected basis for RLANs using spread spectrum technology (ERC category (a): data rate < 2 Mbit/s) with a maximum power of -17 dBW/MHz EIRP for systems using direct sequence techniques, and 0 dBW/MHz EIRP measured in a 100 kHz bandwidth for systems using frequency hopping techniques.

3. 24.11 – 24.14 GHz be used on a non-interference and non-protected basis for RLANs using spread spectrum technology (ERC category (a): data rate < 2 Mbit/s) with a maximum power of -17 dBW/MHz EIRP for systems using direct sequence techniques, and 0 dBW/MHz EIRP measured in a 100 kHz bandwidth for systems using frequency hopping techniques.

4. 17.1 – 17.3 GHz be used on a non-interference and non-protected basis for RLANs (ERC category (c): data rate of 2 – 30 Mbit/s).with a maximum power of -28 dBW/MHz EIRP.

5. initially the bansd 61.0 – 61.5 GHz be used for RLANs (ERC category (b): data rate > 30 Mbit/s).with a maximum power of -28 dBW/MHz EIRP.

6. ETSI is requested to develop the relevant standards.

8.2.4 ANSI T1P1 liaison report was presented by Rif Dayem.

T1P1 has an inter-disciplinary charter, and is addressing PCS-like Personal Wireless Communication. Rif is serving as full-duplex liaison between the two committees, T1P1 and 802.11. T1P1 meets three times per year, and is an even "younger" group than 802.11.

8.2.5 ECMA liaison report was presented by Vic Hayes.

Vic presented 802.11's liaison letter to ECMA. He was asked to chair an ad hoc group within TC32 for WLAN. That group has met once, and proposed to make a joint ECMA/ETSI committee to coordinate or synchronize with 802.11.

ETSI determined that an ETSI-only subcommittee would be more manageable [by ETSI — sec.], but did not create such a subcommittee. So ETSI still has just an ad hoc RLAN group.

ECMA TC32 postponed further activity on this, while awaiting further input from ETSI.

8.2.6 802.11/91-81, Research on Wireless LAN systems in Japan was presented by Hideaki Haruyama.

The name IEICJ, given in a prior report, should have been IEICE, for Institute of Electronics Information and Computer Engineering.

(See the paper for details of the presentation. The following is only a partial summary.)

The objective is the establishment of a WLAN system with flexible access capabilities.

Frequency allocation in Japan is controlled by the MPT (Ministry of Posts and Telecommunications). Under the MPT is a Telecommunication Technology Council, which has a Frequency Sharing Committee, which was told in June to allocate a frequency band suitable for WLAN.

Another committee is RCR, which has a wireless LAN system committee, which has the charter to write the Japanese standards for WLANs. They are considering a sub- 3 GHz band and an 18 GHz band. They cannot allocate a band of more than 20 MHz below 3 GHz. A Motorola-like [i.e, WIN[a]-like — sec.] system may be possible in Japan with small modifications.

The committee wanted more bandwidth below 3 GHz to be able to send 10 Mbit/s. RCR has been asked whether a larger band, above 3 GHz but below 18 GHz, could be made available.

Another working group member commented that MITI also has a group looking at WLANs, for rates up to 20 Mbit/s. A detailed report is not available at this time.

6. Establishment of architecture (cont.)

6.1 Market requirements (cont.)

6.1.2 802.11/91-61 was put on the table. Vic Hayes and others summarized the genesis of this document. The first page, other than the last two items, came from a discussion of Target Environments. The remainder of the document was a poll based on earlier work in IEEE 802.4L.

The apparent inconsistency between some of the first-page votes was raised.

It was pointed out that the medium imposes such a massive set of problems that we should start with an "empty cup" when it comes to MAC approaches.

Many people spoke to the potential need for multi-faceted solutions. The need for rapid progress, enabling a short time-to-market, was also emphasized.

The working group discussed ways in which it could develop a set of requirements in a productive manner.

The Working Group took a break at 3 PM, to reconvene at 3:30 PM. The meeting restarted about 3:45 PM.

6.2 "Vocational" and derivative requirements

An attempt to split requirements into various "vocational" uses was made. The resulting list was:
— retail
— industrial automation/manufacturing
— office
— education
— warehousing
— medical
— financial institutions

The chairman led the group in a multi-partite, almost hierarchical brainstorming session to list the "vocational" uses, the derivative applications, their platforms, their constituent services, the implied MAC characteristics, and the resultant traffic modeling statistics.

The chairman then coerced volunteers to lead the various "vocational" groups, and then asked the rest of the Working Group members to assign themselves to the appropriate "vocational" group. The "vocational" groups were told to meet the following morning, from 8:30 AM until 10 AM, and the IEEE 802.11 Working Group was to meet as a committee of the whole at 10:30 AM, after the morning break.

The meeting adjourned for the day at 5:50 PM.

Thursday, July 11, 1991, Morning

[This was the morning of the solar eclipse, which occurred between 6:30 and 8:30 AM, and reached a maximum of 92% occultation at 7:30 AM when viewed from Kaua`i. There were occasional clouds, but the view from the hotel was very good. Most members had "sun peeps", which were made of aluminized mylar, to permit direct viewing of the eclipse while protecting their eyes. — sec.]

6.2 "Vocational" and derivative requirements (cont.)

The various ad hoc "vocational" requirements groups met between 8:30 and 10 AM, and then took a break until 10:30 AM, the scheduled time for the full IEEE 802.11 meeting to begin.

The chairman called the IEEE 802.11 Working Group to order at 10:35 AM. He then queried the working group about attendance at future meetings:

1) How many of those present expected to attend the September interim meeting — 20;
2) How many of those attending that meeting would be staying in the Palo Alto Hyatt for the meeting — 12;
3) How many of those present expected to attend the November Plenary meeting — 32.

The chairman requested that a good copy of those overheads which were presented during the plenary, but were not contained in the distributed papers, be submitted to the acting Secretary. [None were submitted to me; perhaps they were submitted to the "keepers of the pigeon holes" — sec.]

The chairman also asked those who plan submissions to the next meeting to contact him so that he could construct an appropriate agenda.

2.1 Approval of the minutes of the Worcester meeting. The minutes of the Worcester, MA interim meeting were reviewed. One correction was noted: On page 9, 14th paragraph, starting "Chandos É", replace the name "Dave Bagby" with "Dale Buchholz".

Dick Allen ***moved adoption of the minutes as corrected***; Chandos Rypinski seconded. Discussion indicated that many members felt the motion was premature, because the minutes were not distributed in a timely manner, allowing those not present a chance to review the minutes.

Bill Stevens ***moved to postpone the motion until the next meeting***; Tom Phinney seconded. This was clarified to be the next Plenary meeting in November. **Carried** 13-5-4.

6. Establishment of architecture (cont.)

6.2 "Vocational" and derivative requirements (cont.)

The various ad hoc "vocational" groups reported on their applications and resultant traffic.

[The following was taken mostly from the presented overheads. Refer to them, appendix 2, for a more complete summary — sec.]

6.2.1 Office, reported by Ken Biba. [This was the largest ad hoc group — sec.]

Applications were:
- File access/sharing
- Printer / FAX sharing
- E-mail: text, voice, image, graphics, video
- File transfer
- Terminal emulation / modem sharing / X-terminals
- "Collaborative" computing groups

Platforms/configurations ranged from servers to palmtop computers.

Network size was 2 – 200 nodes, with a mean of about 12. Node density could be as high as 1000/ha [where ha = hectare = $(100\ m)^2$, about 2.5 U.S. acres — sec.]

The MAC service requirements for file sharing, program sharing and printer sharing were:
- MSDU size: bimodal, 50% 80 octets, 50% 600 octets
- Desired burst throughput: maximal, limited only by media speed
- Delay: mean: 1 ms, variance: 10 ms
- Privacy, integrity, etc.: privacy as good as UTTP (unshielded telephone-grade twisted pair)
- Occupancy: << 10% (e.g., very bursty)
- Fairness
- Lost packet: < 0.1%
- Outage: < 0.1%
- Residual BER (from MAC): $< 10^{-12}$

The MAC service requirements for file transfer and E-mail were:
- MSDU size: bimodal, 20% 80 octets, 80% 600 octets
- Desired burst throughput: maximal, limited only by media speed
- Delay: mean: 10 ms, variance: 10 ms
- Privacy, integrity, etc.: privacy as good as UTTP (unshielded telephone-grade twisted pair)
- Occupancy: 100% [e.g., continuous but episodic — sec.]
- Fairness
- Lost packet: < 0.1%
- Outage: < 0.1%
- Residual BER (from MAC): $< 10^{-12}$

The MAC service requirements for terminal sharing were:
- MSDU size: bimodal, 80% 80 octets, 20% 600 octets

Desired burst throughput: maximal, limited only by media speed
Delay: mean: 1 ms, variance: 10 ms
Privacy, integrity, etc.: privacy as good as UTTP (unshielded telephone-grade twisted pair)
Occupancy: << 10% (e.g., very bursty)
Fairness
Lost packet: $< 0.1\%$
Outage: $< 0.1\%$
Residual BER (from MAC): $< 10^{-12}$

The MAC service requirements for voice were:
MSDU size: 32 octets
Desired (near-isochronous) throughput: 64 k bit/s
Delay: maximum: 30 ms, variance < 4 ms
Privacy, integrity, etc.: privacy as good as UTTP (unshielded telephone-grade twisted pair)
Occupancy: 100%
Fairness
Lost packet: 1%
Outage: $< 0.1\%$
Residual BER (from MAC): $< 10^{-3}$

The MAC service requirements for voice were:
MSDU size: 600 octets
Desired (near-isochronous) throughput: 0.8 – 200 Mbit/s, mean = 2 – 3 Mbit/s
Delay: maximum: 30 ms, variance < 4 ms
Privacy, integrity, etc.: privacy as good as UTTP (unshielded telephone-grade twisted pair)
Occupancy: 100%
Fairness
Lost packet: 1%
Outage: $< 0.1\%$
Residual BER (from MAC): $< 10^{-6}$

The Working Group suggested that a CAD application also be evaluated.

6.2.2 Warehousing, reported by Marvin Sojka

Warehousing overlaps other "vocational" uses. Offices in warehouses are like other offices. Manufacturing Automation and Process Control aspects of warehousing are like other Manufacturing Automation / Process Control uses. In addition to these, warehouses have some distinctive aspects:

1. Areas of relatively-low user density, so it is possible to have more access points than users.

2. Greater mobility — speeds of at least 30 km/hr or 20 miles/hr will require active changing of access points [dare we say "hand off"? — sec.]

3. Voice, which replaces or complements traditional voice (now almost entirely walkie-talkie). The emphasis is on local communication, not PSTN (Public Switched Telephone Network) access.

4. In some cases, a willingness to reduce raw data rates to extend the reach of the wireless system.

5. A harsh environment, in which it may be hard to wire access points.

Applications are similar to those in the office environment. Mobile communications in warehousing is relatively simple today, but functionality would grow if higher data rates were available. 1 – 2 Mbit/s seems adequate.

Package handling and racking systems are similar, but include a good deal of down-loading and up-reading. This may also be true of AGVs (automated guided vehicles).

6.2.3 Retail, reported by Bob Buaas (slides marked Don Johnson)

The retail group intends to use the 802.11 BBS to establish a database. Many of the other groups will probably do likewise.

Retail includes two main application domains: POS (point of sale) and hand-held (for pricing and receiving).

Hand-held stations require a sub-second response time. They can be moving while transmitting, and may change access points while waiting for a reply to a previous request. They power-up only while transmitting. Their critical need is low response delay; they have only very small throughput requirements.

POS (point of sale) applications include:

- Data collection
- Price lookup
- Credit card check, both of a local "hot card" file and via WAN
- Program load
- Financial point-of-sale transactions (e.g., debit card)

	Department store	Discount checkout	Supermarket checkout (UPC-code scanner)
peak transaction rate for N items	1/3 min for 2.5 items	1/min for 7 items	1/3 min for 50 items
number of enquiries/responses per transaction [== N+1 — sec.]	3.5	8	51
network area	0.25 – 2 ha	clustered	clustered
number of terminals	60 / ha	20	20
user response delay			
desired within	1 s	1 s	50 ms
required within	5 s	5 s	200 ms
Message size per transaction (in octets)			
sent by POS terminal	120	120	25
sent to POS terminal	50	50	50
total	170	170	75

POS stations are movable but not mobile — they need not work while being moved — but a move must not necessitate any user reconfiguration

Summarizing all of the above tables:

A department store requires 26.4 bit/s/terminal = 1.6 k bit/s/ha.

Supermarket checkout requires 167 bit/s/terminal = 3.3 k bit/s/ha

Download to a diskless terminal requires 512 k octets/min = 68 k bit/s + overhead. With multicast (e.g., 802.1E), a total system load requires only 68 k bit/s. 60 POS terminals loaded individually require 60 x 68 k bit/s = 4+ M bit/s when a multicast protocol is not used.

Most POS terminals have an associated telephone, used primarily for in-store intercom. This gives rise to a small voice requirement. There may also be an in-store announcement channel [e.g., "Attention K-Mart shoppers" —

sec.] requiring voice. And some stores may add a few graphics displays whose controllers are on the WLAN.

6.2.4 Education, reported by Bill Stevens (See report in doc: 91-89)

Education encompasses three substantially-different environments:

1. Classroom, which resembles an office LAN with two exceptions:
   — high density: 30 – 40 / small room; 100 – 500 / lecture hall
   — exceedingly bursty due to synchronization of activity shifts in the class (e.g., everyone access files on a new topic simultaneously)

2. Extended Campus Mobility, while mobile or stationary, anywhere on campus
   — information access — the electronic library
   — E-mail, including faculty/student conferencing

3. Field Study (also known as "the field trip")
   — information access via a mobile database server in an accompanying van
   — real-time collaboration (with others in the group) — may include voice, image and video
   — data collection, including bulk transfer to a central repository

6.2.5 Industrial Automation and Manufacturing, reported by Bob Crowder

Scenarios [the following are renumbered for consistency - sec.]
1) service areas and remote sites (often offices)
2) service and mobile equipment (e.g., crane, tug boat)
3) production (assembly)-line carriers (e.g., AGV)
4) mobile test equipment on assembly lines (e.g., rides along line with object being assembled)
5) monitoring and controlling dispersed or inaccessible process equipment (e.g., a storage tank "farm")
6) manual survey of an extended area (e.g., inventory)
7) a mobile terminal requiring access to an existing LAN [e.g., roving operator to control room — sec]
8) CAM (Computer Aided Manufacturing) download (e.g., program download to a robot or numerically controlled manufacturing device)

The service requirements for scenario number 1 are:
— moderate amounts of data, voice (to PSTN), and slow scan video
— highly reliable
— minimal security [e.g., 802.10-like confidentiality, integrity, data origin authentication, access control — sec.]
— moderate delay, but jitter is unimportant
— stationary, not mobile
— slow scan video at 19.6 k bit/s is adequate
— database accesses are 1/5 min, but short request bursts as rapidly as 1/s can occur due to humans "short-cutting" through known database or display linkages
— input loads are based on type of windowing: DOS, MS-Windows, or X-Windows
— may require an extended system reach (range) and may need to function in a high-noise environment.

Bob requested that others in his ad hoc "vocational" group submit service requirements for their scenarios to him by the third week of August.

Ken Biba volunteered to maintain the list of "vocational application" ad hoc groups.

The meeting broke for lunch at 12:15 PM, to reconvene at 1:30 PM.

Thursday, July 11, 1991, Afternoon

The meeting restarted shortly after 1:30 PM.

11. Tentative meeting schedule

The tentative meeting schedule was updated. The January 1992 meeting will be held 13 – 16 January in the Raleigh, NC area, hosted by Jim Neeley of IBM. The May 1992 meeting will be held 11 – 14 May in the New York area. The September 1992 meeting will be held 14 – 17 September in the Chicago, IL area. Tom Phinney will look into hosting the January 1993 meeting in Phoenix, AZ. The updated schedule is as follows:

Date	Month	Year	Place	type	Location	Host
9-12	September	1991	Palo Alto, CA	Interim	Hyatt	Apple
11-15	November	1991	Fort Lauderdale, FL	Plenary	Crown Sterling Suites	
13-16	January	1992	Raleigh, NC	Interim	TBD	IBM
9-13	March	1992	Irvine, CA	Plenary	Irvine Marriott Hotel	
11-14	May	1992	New York area	Interim	TBD	AT&T
6-10	July	1992	Bloomington, MN	Plenary	Radisson Plaza South	
14-17	September	1992	Chicago area	Interim	TBD	Motorola
9-13	November	1992	La Jolla, CA	Plenary	Hyatt Regency Hotel	
TBD	January	1993	Westcoast	Interim	TBD	Open
8-12	March	1993	?New Orleans/Hilton Head?	Plenary	TBD	
TBD	May	1993	Baltimore area	Interim	TBD	Ship Star
12-16	July	1993	Denver, CO?/Kauai, HI?	Plenary	Sheraton Denver Tech Center	
TBD	September	1993	TBD	Interim	TBD	Open
9-13	Nov	1993	?Ft. Laudedale, FL	Plenary	Crown Sterling Suites	

The dates on the current progress schedule for IEEE 802.11 were updated. They now are:

Requirements closure	Nov 91
Architecture established	Mar 92
Draft 1 MAC/PHY standard	Nov 92
Draft 2 MAC/PHY standard	Mar 93
TCCC MAC/PHY standard	Jul 93
TCCC Conformance standard	Nov 93

The status (progress and accomplishments) report was prepared for the IEEE 802.0 Executive Committee and the Friday Summary:

1. Finalized a letter to be sent to various RF-spectrum-allocating regulatory agencies, worldwide
2. Reviewed an already-working commercially-available product.
3. Further refined models of the characteristics of the wireless medium.
4. Received presentations on a number of potential WLAN MAC variations
5. Developed a questionnaire to obtain WLAN requirements
6. Established a new schedule for work completion, and established a BBS for WLAN activities
7. Developed an initial, top-down analysis of user applications.

11.1 Confirmation of September meeting The meeting will be held 9 (8:30 am) – 12 (5:00 pm) September, 1992, at the Hyatt Regency hotel in Palo Alto, CA.

11.2 Objectives for the Palo Alto, CA meeting

- To prepare requirements for a Wireless LAN

- To establish the architecture for Wireless LAN

11.3 Last mailing date for the Palo Alto, CA meeting is 12 August 1991.

11.4 Need for other intermediate meetings There will not be a pre-plenary intermediate meeting in November.

11.5 Confirmation of November meeting IEEE 802.11 will ask to hold an evening tutorial on DECT during the November plenary meeting of IEEE P802. In November, 802.11 will need a room for 100 people. [the high-tide mark for attendance at the Kaua`i plenary was 76 — sec.] Presenters who bring copies to the November meeting should bring 100 copies. In addition to its main room, 802.11 will request a breakout room for 20 people for 2 days.

11.6 Confirmation of January meeting The January 1992 meeting will be held 13 – 16 January, 1992 in the Raleigh, NC area.

12. Review of document list

12.1 Approval of output documents The letter to administrations was approved, for forwarding to the 802.0 Executive Committee.

12.2 Destination of input documents For those papers that were submitted that have copyrights, the chairman requires a written copyright release from the principal author for each such submitted paper.

6. Establishment of architecture (cont.)

6.2 "Vocational" and derivative requirements (cont.)

6.2.6 Meetings, reported by Rick Albrow

Four different types of meetings were identified:

A. Conference (such as IEEE 802)

B. Conference room
   - B1. Business or Board meeting, with a structured agenda
   - B2. Technical meeting, more ad hoc than B1

C. Sales meeting
   - C1. on-site meeting
   - C2. off-site meeting

D. Spontaneous meeting (e.g., a hallway meeting)

A Conference meeting is typically a large structured group (e.g., seating, chairman, secretary) with the following requirements:

— large transfers of text and graphics, and image data in some applications (e.g., a WLAN replacement for the "pigeon hole" system of document distribution)

— communications back to home office

— the following application services
  - file distribution and retrieval
  - database access, both intra-conference and off-site
  - E-mail
  - file sharing
  - print server
  - image distribution (real-time image?)
  - access to WANs
  - no voice need seen at present [but see comments — sec.]
  - electronic "conferencing"
  - voting

— platforms
  - personal computers: luggables and portables, laptops, notebooks This is truly a multi-vendor environment, with a wide range of capabilities.
  - PC-based servers: print, file, communications.

— connection types
  - point-to-point: delegate/delegate and delegate/chair
  - point-to-multipoint delegate/delegates and chair/delegates
  - point-to-servers

— transient population, but very limited mobility

— security: 802.10-like confidentiality and data origin authentication

— acknowledged (local) broadcast, with a high peak/mean traffic ratio

— communication between separate work-groups [e.g., multicast]

The need for an access point was questioned. APs are not necessarily required for a small room, but are useful in large rooms or to provide inter-room communications.

Comments indicated that a voice capability, simulating a chairman-controlled wireless microphone, would be useful. A voice capability could also assist simultaneous translations.

6.2.7 Financial, reported by "Nat" Natarajan

The "vocational" users are banks and stock or commodity trading floors. They can be viewed as a special class of offices. Their specific requirements are:

— emphasis on interactive / transaction processing

— require a quick response to requests

— security: 802.10-like confidentiality, integrity and data origin authentication are mandatory.

— small packet sizes of about 50 octets: buyer, seller, quantity, price

— peak request rate: 1/10 s or 1/15 s per user

— high transaction rate per user

— low to moderate throughput

— mobility at pedestrian speed

— small weight, power, size

— small cost desirable

— rugged

Ensuing discussion brought out the following additional requirement aspects:

— high terminal density, where the distance between adjacent transceivers can be quite small (< 30 cm)

— power consumption is important. Devices must operate continuously for 8 hours; traders don't take breaks.

— logging of all voice and data traffic is required today

— a mobile station may need to be in a circumscribed location (the proper trading pit) for a specific application operation

— links to a back-end system are required. The Chicago Board of Trade (CBOT) permits up to 20 s delay in reporting to the back-end system, but all transactions must be time-stamped.

— digital signatures and non-repudiation are also important security services.

10. Miscellaneous

None

13. Other Business

Questions have been raised about actions taken at interim meetings. The chairman addressed this issue by noting that any meeting which constituted a quorum could take such actions. The IEEE 802 rules state that those members present at a Working Group meeting held concurrently with the P802 Plenary meeting always constitute a quorum. For other Working Group meetings (i.e., interim meetings), 50% of the voting members must be present to constitute the quorum.

At 3 PM, with participation dwindling rapidly, Tom Phinney ***moved that the meeting be adjourned***. Dick Allen seconded. **Carried** 11-0-0.

Appendix 1

Attendance list

Mr MENACHEM ABRAHAM	CHIPCOM Corporation	508 460 8900
Mr. SVEN OLOF AKERLUND	ELLEMTEL	+46 8 727 30 44
Mr. RICK ALBROW	Symbionics	+44 223 421025
Mr. RICHARD C. ALLEN	Apple Computer Inc	408 974 2880
Mr. PER-OLA ANDERSSON	Swedish Telecom	+46 8 7131833
Mr. CHARLES ANDREWS	3Com Corporation	408 764 5510
Mr. MICHAEL A. ATTILI	M/A-COM Corporate Research and Development	617 272 3000 X2816
Mr. DAVE BAGBY	Sun Microsystems labs Inc	415 336 1631
Mr. CHANDAN BANERJEE	NYNEX Corporation	914 287 5543
Mr. BRIAN D. BARRERA	Comdisco Systems Inc.	415 358 3625
Mr. STEVE BELL	National Semiconductor	408 721 7899
Mr. CHUCK BERMAN	SynOptics Communications Inc.	408 764 1269
Miss. HELEN E. BEVIS	BT Development and Procurement	+44 473 645206
Mr. KEN BIBA	Ken Biba & Xircom	415 665 1812
Mr. THOMAS D. BRITTON	DataCard Corporation	508 568 1411
Mr. ROBERT A. BUAAS	The Buaas Corpotation	714 968 0070
Mr. DALE BUCHHOLZ	Motorola Inc.	708 632 5146
Mr.JIM BUCKINGHAM	Symon Systems Monitor Inc.	214 343 9177
Mr. SHIN BYUNG-CHEOL	KAIST dept of EE	+82 42 829 3404
Mr. HIDEAKI CHIBA	Fujitsu Program Laboratories limited	045 212 4871
Mr. ROBERT S. CROWDER	Ship Star Associates Inc	302 738 7782
Mr. LUCIAN DANG	Rockwell International	714 833 4352
Dr. RIFAAT A. DAYEM	Altamont Research	408 736 7107
Mr. GEORGE DUANE	BICC Communications	508 832 8650
Dr. GLENN C. DUNLAP	Wandell & Goltermann	+19195420478
Dr. PAUL EASTMAN	Fairchild Data Corporation	602 949 1155
Mr. RICHARD FORMEISTER	Fairchild Data Corporation	602 949 1155
Mr. PETER FORROW	Racal Research Ltd	+44 734 868601
Mr. PATRICK GREEN	Advanced Micro Devices	408 749 2825
Mr. MORGENS HANSEN	CASE Communications	+44 923 58842
Dr. ANDY HARTER	Olivetti Research Limited	0223 343333
Mr. HIDEAKI HARUYAMA	Toshiba	+81 44 548 5350
Mr. VICTOR HAYES	NCR Systems Engineering B.V	+31 3402 76528
Mr. HAMID R. HEIDARY	C-COR ELECTRONICS INC	814 238 22461
Dr. BOB HEILE	WINDATA Inc.	508 393 3330
Mr. PETER HOOVER	Ratheon Co. 1-1-1438	
Mr. SCOTT HRASTAR	Hitachi Telecom Inc.	404 446 8820
Mr. TATSUKI ICHIHASHI	Mitsubishi Electric Corp	+81 467 44 1101
Dr.Eng. TOMOAKI ISHIFUJI	HITACHI Central Research Laboratory	+81 423 23 1111
Mr. S.W. JANSHEGO	Mitre Network Engineering	617 271 8280
Mr. DONALD C. JOHNSON	NCR Corporation WHQ 5E	513 445 1452
Mr. MARK JOHNSTON	Microtest	602 971 6464
Mr. RANDALL JONES	COMPAQ Computer Corp	214 985 4828
Mr. JARI KARTTUNEN	Omnitele	+358 31 599 503
Dr. DAVID B. LEESON	California Microwave	408 720 6215
Mr. DANIEL E. LEWIS	Telxon	216 867 3700
Mr. ISABEL Y. LIN	Toshiba	714 583 3854
Mr. RONALD MAHANY	Norand Corporation	319 369 3552

Mr. NECHEMIA MANDEL	Tadiran Ltd	9723 557 4251
Mr. MASSIMO MASCOLI	SIP/STET PSSI/RS-TM	+39 6 3688 6439
Mr. YASUSHI MATSUMOTO	NTT data Communications Systems Corporation	+81 44 548 4544
Mr. T. MITSUTOMI	Sharp	714 261 6224
Dr. K.S. NATARAJAN	IBM T.J. Watson Research Center	914 784 7844
Mr. MINORU MINI NIMURA	Epson Technology Center	408 986 0115
Mr. PAUL NIKOLICH	Racal Interlan	508 263 9929
Mr. LLOYD OLLIVER	3Com Corporation	408 764 6931
Mr. SHINJI ONO	NEC Corporation	+81 3 3798 6395
Dr. JOHN O'SULLIVAN	CSIRO Div of Radio Physics	+61 2 868 0397
Mr. ROGER PANDANDA	Fujitsu America Inc	214 997 7635
Mr. THOMAS L. PHINNEY	Honeywell	602 863 5989
Mr. JOHN PORTER	Olivettie Research LTD	0223 343000
Mr. KEN RATTRAY	AT&T Bell Laboratories	908 949 1099
Prof. ROBERT D. ROOD	GTE Government Systems	508 880 4289
Mr. CHRIS ROUSSEL		404 840 9200
Mr. CHANDOS RYPINSKI	LACE Inc.	707 765 9627
Mr. SAID SAADEH	Compaq Computer Corporation Program Manager	214 985 4238
Mr. CURTIS JOHN SCHMIDEK	National Semiconductor	408 721 7321
Mr. JAMES E. SCHUESSLER	ISG Group VLSI Business Center Unit	408 721 6802
Mr. CHENG-CHUNG SHIH	Level one	916 985 3670
Mr. RON SIDELL	Genetech Inc	415 266 1000
Mr. RICHARD SILLMAN	Sun Microsystems Laboratories Inc	415 336 3670
Mr. MARVIN SOJKA	Norand corporation	319 369 3564
Mr. LOUIS STANKAITIS	ANIXTER	708 677 2600
Mr. WILLIAM STEVENS	Apple Computer Inc	408 974 6307
Mr. KENTA TAKUMI	NEC Corporation	+81 3 3798 6395
Mr. CHARLES THURWACHTER	Square D Compnay	708 397 2600
Mr. CARLOS A. TOMASZEWSKI	NetVantage	213 314 3550
Mr. HIROSHI TOMIZAWA	Stanford University ERL Building room #447	915 723 9388
Mr. DAVID TSAO	Adman Inc.	908 888 7878
Mr. KOICHI KENT TSUNO	Sumitomo Elektric U.S.A. Inc	408 737 8517
Mr. BRUCE TUCH	NCR Systems Engineering B.V.	+31 3402 76527
Mr. KAZUO UNEMOTO	Nippo Telegraphi and telephone Corporation	+81 468 3554
Mr. IMAD UYOUB	National Semiconductor	408 721 2857
Mr. JACK S. VEENSTRA	AT&T Bell Labaratories	908 949 5747
Mr. RADHA VENKATARARAM	INTEL Folsom Microcomputers Division	916 351 5032
Mr. NADER VIJEH	Advanced Micro Devices	408 749 4693
Mr. DICK WALVIS	Stanford Telecom	408 748 1010
Mr. ROY WANT	Xerox	415 494 4784
Mr. R.E. (DICK) WEADON	Southwestern Bell Techn Resources Inc	314 529 7517
Mr. STEVEN WEISS	DCA	408 432 9111
Dr. ALAN YOUNG	Vimiera& Pembroke Roads	02 868 0469
Mr. HONG YU	Casat Technology Inc	603 880 1833
Mr. ZOHAR ZISAPEL	RAD Data communications ltd	+972 3 494511

Applications

Application Services

- File access/sharing
- Program access/sharing
- Printer/Facsimile sharing
- E-mail: text, voice, image, graphics, video
- File transfer
- Terminal emulation (including X)/modem sharing
- Database access
- "Collaborative" computing/groupware
- File paging
- Image manipulation
- Distributed computation
- Data entry
- Environmental control
- Real-time voice (POTS)
- Real-time video (TV)

Assume implicit support for all relevant 802 standards

- Interworking with other LANs: 802.3, 802.4, 802.5, 802.6, FDDI
- Support for required services: 802.1, 802.2, 802.10

Implicit Market Requirements

- Support for extant and anticipated LAN software
- Novell, TCP/IP/NFS, AppleTalk, LAN Manager, etc.

Platforms/Configurations

Anticipated Node Types

- Desktop PC
- Workstations
- Portables
- "Handheld": Notebooks -> palmtops
- Bridges/gateways
- Servers
- Network peripherals with built-in network attachments
- Telephones
- TVs

How Many Are They

- $1 < X < 200$
- Average x about 12
- Caution: this is a historical number that future applications may change

How Are They Distributed

- < 1000 nodes/hectare presuming about 1 node/person

MAC Service Requirements

	File Access	File Transfer	Terminal Emulation
MSDU Size	50% 80 octet 50% 600 octet	20% 80 Octet 80% 600 octet	80% 80 octet 20% 600 octet
Burst Thruput	Media speed	Media Speed	Media Speed
Delay	1 msec	< 10 msec	1 msec
Delay Variation	< 10 msec	< 10 msec	< 10 msec
Privacy	Yes	Yes	Yes
Integrity	Yes	Yes	Yes
Occupancy	<< 10%	100%	<< 10%
Fairness	Yes	Yes	Yes
Lost Packet	< .1%	< .1%	< .1%
Outages	< .1%	< .1%	< .1%
Residual BER	10^-12	10^-12	10^-12

MAC Service Requirements

	Voice	Video
MSDU Size	32 octet fixed	600 octet fixed
Burst Thruput	64 Kb/s	.8 Mb/s < x < 135 Mb/s average about 2-3 Mb/s
Delay	< 30 msec	< 30 msec
Delay Variance	4 msec	4 msec
Privacy	Yes	Yes
Integrity	Yes	Yes
Occupancy	100%	100%
Fairness	Yes	Yes
Lost Packet	< .1%	< .1%
Outages	< .1%	< .1%
Residual BER	< 10^-3	< 10^-6

Warehousing

Marvin Sojka

Like:

1. Office environment
   - offices in Warehousing
   - Same user Applications
2. Manufacturing Automation
   - Process Control / Automation / Real-time Control

Differences or Uniqueness

1. Areas of ^relative Low User Density
   - Possible to have more access points than users in Areas.
   - [redacted]
2. Mobility, [redacted].
   - A. Speeds up to at least 20mph
   - B. Active changing of Acess Points
3. Voice - [redacted]
   - Replace ^Traditional Voice Radio or complement.
   - Emaphis is not for connection to Public telephone
4. ~~Some~~ Trade Radio Reach over [redacted] Raw Data Rate in Some Areas
5. Harsh Enviroment.

Retail POS D. Johnson

Applications
Data Collection
Price Look-Up
Credit Check (Hot Card file + WAN)
Program Load

	Dept Store	Discount C-Out	Supermarket C Out (Scanner)
Peak Trans Rate	1/3min	1/min	1/3min
Average Items	2.5	7	50
#Exg-R/Tr	3.5	8	51
Size Range (Chars)	1/4 - 2	NA	NA
#Terminals/hr	60	20	20
User Response Time Rqmt	1-5s	1-3s	50ms - 200ms
Message Size In	120 bytes	120	25
Out	50	50	50
Total	170	170	75

Mobility Move w/o changing parameters manually
No need to communicate while in motion

Don Johnson

~~Download~~

Summary for POS

Dept. Store — 26.4 b/s / Terminal
1.6 kb/s / ha

Supermarket CO — 167 b/s / T
3.3 kb/s / Ha

Download 512k bytes

1 minute load - 68 Kb/s + Respon O'head

68 kb/s + total with Broadcast

60X68⁺ = 4⁺ mb/s without broadcast

Don Johnson

INDUSTRIAL AUTO / MFG.

SCENARIOS

S1. SERVICE to REMOTE SITES (often OFFICES) OK

S2. SERVICE to MOBILE EQUIPMENT eg. CRANE, TUG MM

S3. PRODUCTION (ASSEMBLY) LINE CARRIER (PATH) CS

S3A MOBILE TEST EQUIP on ASSEMBLY LINE CT

S4. MONITOR (& CONTROL) DISPERSE or INACCESSIBLE PROCESS EQUIP (usually FIXED) eg. TANK FARM RJC TLP

S5. MANUAL SURVEY of EXTENDED AREAS eg INVENTORY RON M.

S6. MOBILE TERMINAL with ACCESS to EXISTING LA

S7 MFG DOWNLOAD TLP

BOB CROWDER
RON MAHANY
PAUL EASTMAN
RICH FORRISTER
TOM PHINNEY

BOB BUAAS

CHUCK THURNACHER

S1. SERVICE REMOTE SITES OFFICES

SERVICE = MODERATE DATA + VOICE & VIDEO (SLOW SCAN)
= FILE SHARING, DB ACCESS = V.SAN

HIGHLY RELIABLE, MIN SECURITY + PRIVACY
DELAY MODERATE, JITTER - NOT IMPORT.
MOBILE = NO

SLOW SCAN VIDEO <= 19.6 KBS

DBASE ACCESS - AVG = 1/5 MIN
BUT CAN HAVE 1/SEC "SHORT CUTS"

PCS ~~[illegible]~~ 1 KB REQ, 4 KB RESP
WINDOWS = SAME

??? X WINDOWS ~~[illegible]~~ TERMINAL (SERVER) 32B-5/SEC
16 - 500 KB RESP

EXTENDED DISTANCE
[illegible]

1 of 2 R. ALBROW

MEETINGS, MEETINGS, MEETINGS.

TYPES

a) CONFERENCE RA

b) CONFERENCE Room – 'Business Mtg' RA
'Technical Mtg' RA

c) SALES MTG – On-site CA
Off-site CA

d) HALLWAY MTG CA

THE CONFERENCE

Large Group 20 – 500

CHAIR + SEC + DELEGATES

STRUCTURED ARRANGEMENT

LARGE TRANSFERS OF TEXT + GRAPHICS
IMAGE in some applications

connection to own office

2 of 2 R. ALBROW

SERVICES

File distribution, File retrieval
Data Base Access - intra conference / off-site
E-Mail " "
File sharing
Print server
Image distribution. Real time image?
Access to WANs
'CONFERENCING' VOTING ~~VOICE~~

PLATFORMS

All PCs : Portables, Laptops, Notebooks
Multi-Vendor. Wide range of capabilities

SERVERS - Print, File, Comms [all PC based]

CONNECTION TYPES

Pt → Multipoint
Pt → Pt. inter-delegate : delegate → chair
Pt → Server

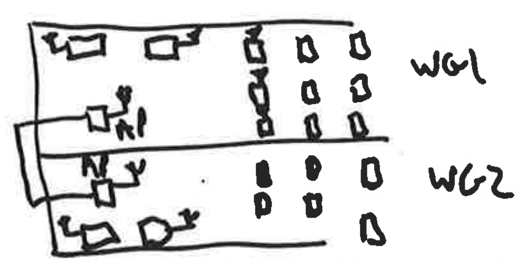
Transient Population but no mobility
Security & Authentication

'Acknowledged Broadcast' High Pk-to-Mean ratio

Communication between Work Groups [selective broadcast]

NETWORK TOPOLOGY

Need for an Access Point?



MAC SERVICE REQUIREMENTS.

NATARAJAN 1 of 2

FINANCIAL INSTITUTIONS

{ BANKS, STOCK/COMMODITY TRADING FLOORS

→ Special class of OFFICES

- Interactive / Transaction processing

- QUICK RESPONSE (YES/NO)
- SECURITY / AUTHENTICATION MANDATORY
- Small packet sizes (50 octets)

<Buyer, Seller, Qty, Price>

- Peak Request once every 10~15 secs
- High Transaction rate

Low to moderate throughput

NATARAJAN 2 of 2

- Mobility (pedestrian speed)

- Low weight
  - " Power
  - " Size
  - ? Cost
  - Rugged

} Smaller the better

Collaborative Computing (Ad-hoc)

→ Inputs Welcome from one and all ←

- Fairness to users