Minutes of the IEEE p802.4L Task Group

Norcross, Georgia
May 14-18, 1990

Chairman. Vic Hayes

Secretary & Editor. Michael Masleid, Chuck Thurwachter, Tom Phinney.

Attendance

Mr. VICTOR HAYES	NCR Systems Engineering B.V	+31 3402 76528
Mr. MICHAEL MASLEID	Inland Steel Co. MS2-465	219 399 2454
Mr. DONALD C. JOHNSON	NCR Corporation WHQ 5E	513 445 1452
Mr. PAUL PIRILLO	NCR E&M Atlanta	404 623 7505
Mr. JONATHAN CHEAH	HUGHES Network Systems	619 453 7007
Mr. KIWI SMIT	NCR Systems Engineering B.V.	+31 3402 76479
Mr. OLIN S. GILES	Sensormatic Electronics Corporation	305 427 9700
Mr. CHANDOS RYPINSKI	LACE Inc.	415 435 0642

Monday PM, 90.05.14

Vic Hayes opened the meeting at 1:09 PM. 6 people were in attendance.

Arrangements: Refreshments at the meeting and cost of overhead will be billed to the room. The meeting room will cost $100.00 per day if less than 8 guests registered, however, the hotel management may not enforce the charge.

Announcements:

- Vic Hayes indicates intention to propose a Radio LAN task group under CSMA/CD (in IEEE p802.3). (It is thought that this will be for 1 Mbit/s data rate but that is an open issue). Masleid suggests that a possible goal is to keep the distribution system common between 802.3 and 802.4
- Jonathan Cheah indicated that Stan Kay may not continue to attend the Task Force but that HNS intents to continue involvement.
- Vic will not be in on time Sunday July 8,1990. Therefore someone is needed to chair the meeting. Don Johnson to chair the meeting on Sunday.

The **minutes of the Irvine meeting** were reviewed. The following corrections were made:

Page 2; the definition of coherence time is to be replaced by:

Coherence time is defined as follows:

Given a time-variant (wide-sense stationary) channel impulse response of

$c(\tau;t) = \alpha(\tau;t)\, e^{-j2\pi f_c \tau}$,

where τ is the delay and $\alpha(\tau;t)$ is the attenuation of the signal components at delay τ at time instant t.

Let $C(f;t) = \int_{-\infty}^{\infty} c(\tau;t)\, e^{-j2\pi f\tau}\, d\tau$ be the Fourier transform of this impulse response.

$\phi_c(f_1,f_2;\Delta t) = 1/2\ E\ [(C^*(f_1;t)\ C(f_2;t+\Delta t)] = \phi_c(\Delta f;\Delta t)$,

where E is expectation, is called the spaced-frequency spaced-time correlation function.
Holding gives
~~If you hold~~ Δf to 0 ~~you have~~ the spaced-time correlation function. The period of time over which the magnitude of this function is essentially non-zero is the coherence time of the channel.

Discussion started on the usefulness of the Coherence time and how it should be defined. Is Coherence time the Doppler frequency change in the time domain? Doppler is frequency domain , or is it changed to time domain through the Fourier transform? We will return to this discussion later.

- the sentence "... provided all of the raw data needed for such ..." be chanced to "... provide sufficient raw data for such characterization".

With those amendments the minutes of the Irvine meeting were adopted.

Matters arising from the minutes.

The discussion continued in attempts to find the definition of Coherence time.

Is Coherence time the inverse FFT of the Doppler frequency. (But what does this add if the definition of Doppler frequency is the FFT of the coherence time!??)

It is the time that the channel doesn't change or "At a particular frequency, it is the amount of time before the response at that frequency changes".

Rappaport showed change in impulse response with position but this observation can be tied to fast fading. He also measured channel stability with time (for him stationary) local spatial correlation.

Is Coherence time the time that the channel remains the same in terms of the modems ability to maintain lock? On amplitude and phase? Or is the length of time that the channel impulse response has not changed beyond recognition.

The meeting was adjourned at 6:23 pm without having reached a conclusion on coherence time. No afternoon breaks were taken during this meeting.

Tuesday, 1990.5.15

Vic Hayes called the meeting to order on 8:22 AM. A round of introductions was given for the benefit of Olin Giles, Sensormatic based Deerfield Beach, Florida, that is between W Palm Beach and Ft. Lauderdale. Olin attended this meeting to seek support for his company's position for additional regulation between his shoplift-detection-devices and other users of the band, especially the newly allowed consumer devices.

The discussion on the significance of coherence time was initiated by Don Johnson. Don maintained that Rappaport's measurement represented by the "Local Spatial Correlation" had in effect described the channel sufficiently. Jonathan Cheah suggested that Spatial Correlation as a parameter had different significance and did not provide any insight into coherence time.

Mike presented the updated analysis on the Oshawa data to demonstrate the time-variant nature of the channel. He stated that in the measurement set up, the transmitter and the receiver had a frequency offset of 8 kHz and an undetermined I and Q phase and amplitude imbalance refer to *Addenda 1, 2 and 3*). He explained that the previous erroneous conclusions of rapid signal fades were a result of these imbalances and phase rotation. A new analysis of phase-domain impulse response of the channel was presented (*Addendum 3*).

Jonathon Cheah provided a graphical explanation of coherence time relationship with respect to a phase-domain response representation. Kiwi Smit suggested that there was an inconsistency with Mike's method of analysis, where the auto correlation was shown to be a rectangular pulse from the measured data. Refer to *Addendum 4*.

Mike presented the details of his analytical method. The Oshawa measurement was run with 8 samples per chip at 5 nsec/sample. Mike performed the auto correlation by running the code backwards and convolved with a 5 nsec Rnjh peak pulse of the code. (Think of the code as a sampled function, a string of 255 Dirac pulses spaced 40 ns apart, with the correct signs. Correlate the signal with this sampled code) The resultant auto correlation was a rectangular pulse of 40 nsec time width and 1/8 of the amplitude of the standard auto correlation peak (*Addendum 4*). Jonathan Cheah derived from Mike's results a prediction that an estimated coherence time can be extracted. He suggested perhaps Mike can filter out the 8 kHz frequency offset and the I and Q imbalances and determine the Doppler shift frequency distribution. The coherence time could then be defined as the reciprocal of the Doppler frequency spread at 3 sigma point. Refer to *Addendum 3* for the results.

Don Johnson questioned the relationship between Doppler frequency and coherence time and the narrow band nature of the definition. Jonathon Cheah explained the importance of the coherence time with respect to the design of modem and he was concerned with the modems ability to remain locked.

Vic Hayes requested a more clear cut representation of the coherence time. Jonathon Cheah proposed that the coherence time should be viewed from the Doppler shift perspective. The time variation in the channel observed could be viewed as a Doppler frequency distribution in the channel. The effective delta t span of the non-zero amplitude of the spaced-time spaced-frequency correlation function defined in the previous minute was effectively the coherence time which was the reciprocal of the Doppler frequency spread. It was the duration between two non frequency-selective fades. Mike and Don Johnson agreed upon the view that the maximum time-delay auto correlation of a channel impulse response was the coherence time.

Jonathan Cheah moved that, because a preamble length of 100 symbols or more is required for practical phase coherent acquisition of the carrier, therefore coherent phase detection should not be considered a viable implementation method. Don Johnson seconded, carried 5,0,0. This motion is captured in Doc.: IEEE p802.4L/90-17 section 2.1.

Vic Hayes recapped the discussions on coherence time in IBIS format (refer to Doc.: IEEE p802.4L/90-17, section 5.1.1, 5.1.2 and 5.1.3).

The temporary document list was reviewed (refer to the end of these minutes). We decided to first introduce IBIS and then have Olin present his proposal.

Vic Hayes presented temporary documents N.4L/5 and 6 and proposed to adopt IBIS as the way to document the discussions in the Task group. IBIS is Issue Based Information Systems and represents a method of documenting discussions. It is something of an outline form that captures under items, what people or company positions are/were on those items, and what the argument/reasons were for the decisions made. (and indecisions) The advantage of using this method is that discussions can be captured in a uniform way and the rejected positions are kept in the Information Base. More information is available in doc.: IEEE p802.4L/90-17.

Vic also introduced temporary document N.4L/4, a list of questions related to the main business of the task group. CCITT uses this method as the authorization of the various projects trusted to the various groups. With the introduction of IBIS as the way of documenting the discussions, we would have a direct relation to the questions and the information base. By marking all submissions with the addressed question number, we would also have an easy way to find documentation as well to prepare the agenda. Further discussions will be held on Wednesday.

Olin Giles started his presentation on the use the 902-928 MHz band by field disturbance devices by Sensormatic (doc.: IEEE p802.4L/90-20) and the impact that FCC rule making has on their business.

Sensormatic, Deerfield Beach Florida, has as primary business to stop shoplifting, some industrial security. The method is by little tags on clothes. By the way, 80% of the alarms are due to clerks failing to remove tags, (largely because of the high turnover rate in clerks). In the US the 902-928 MHz band is used, 2450 MHz in Germanic, lower in Spain. The pedestal, the shape and color themselves are a deterrent.

Send microwave into a gain antenna from power pack. Another frequency of 100 kHz modulated with say 400, 500, 700 audio is sent from the bar across the top. The latter signal mixes inside the tag, which is an antenna and a diode. The 915 MHz transmitted signal mixes with the E field, makes 915.1 and 914.9.

In the USA shoplifting cost 30 B$ per year to the consumer. This is typically 3 to 5% per store.

FCC allows widespread use of new wireless devices at 902-928 MHz through new Part 15 Report and Order. It is anticipated that this threatens Sensormatic's core business. They estimate over 30,000 microwave systems in U.S and consequently expect sever interference and malfunction. Just imagine that cordless VCRs, speakers, microphones, and so on will be all over the band. The power level is chosen for exactly 30 meters span on video. They are limited to about .75 mW, and are allowed everywhere. The last of the 915 MHz microwave ovens seem to be dead, they utilize now the 2450 MHz band.

Sensormatic is proposing to move their devices to the lower 3 MHz of the band an request the other users to give up 3 MHz.

This now goes into a discussion of how to coexist. Vic Hayes records the discussions in IBIS format as written in Doc.: IEEE p802.4L/90-17 section 8.1.

It will be most valuable to find the power level at which the proposed 802.4L modulation will cause desensitization of the field disturbance (FD) devices (anti-shoplifting devices). This is documented as Issue 8.1.0.1. Olin will do measurements on this issue and issues 8.1.0.2 and 3. With this discussion terminated, Olin leaves the meeting.

The meeting is adjourned at about 5:30 PM.

Wednesday, 1990.5.16

Vic Hayes called the meeting back to order at 8:30 AM. Chandos Rypinski joined the task group.

The discussion is on the proposal for organization of work. A way of keeping track of what subjects need to be discussed, and where contributions are needed. (temp doc N.4L/4, now Doc.: IEEE p802.4L/90-16).

The minutes ~~respectively~~ and the long term running directions document will be reduced to a record of issues, the pro's and con's of the issues, and current decisions if any. (temp doc N.4L/5, now Doc.: IEEE p802.4L/90-17).

The meeting agreed with the proposed documentation method (IBIS). Especially the fact that rejected position will be kept on record was a welcome feature. The questions list was reviewed and completed and changed as is now given in Doc.: IEEE p802.4L/90-16.

We reviewed the various matters in Doc.: IEEE p802.4L/90-17 and updated where necessary. In the distribution system section the following definitions for the channels were adopted

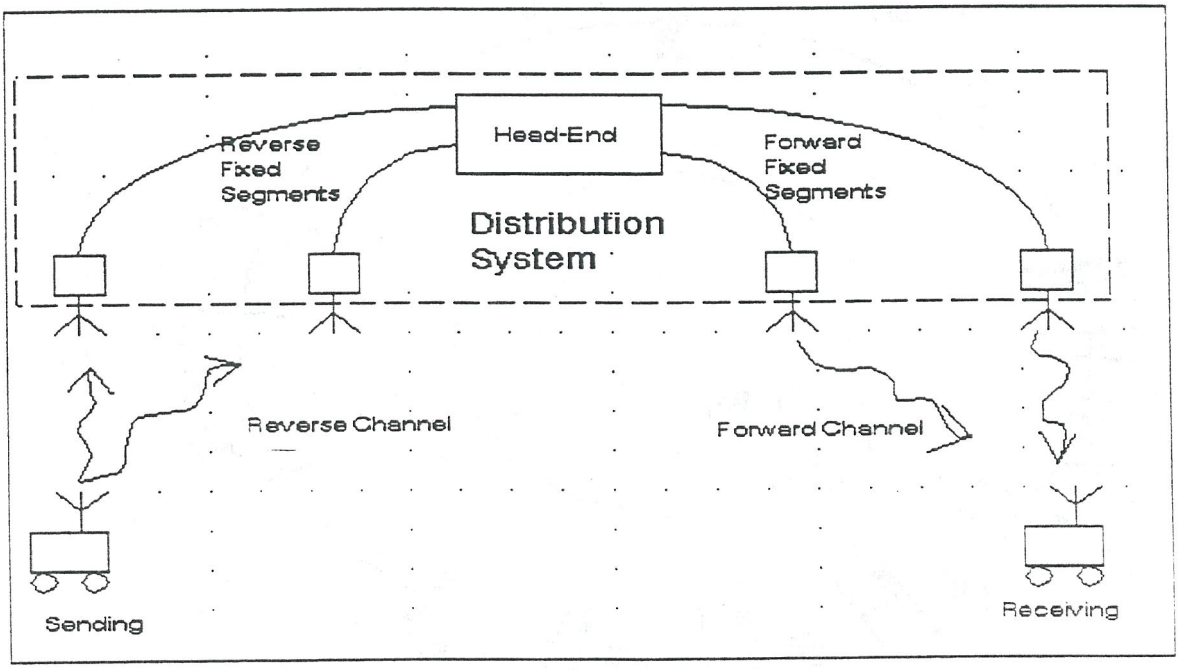
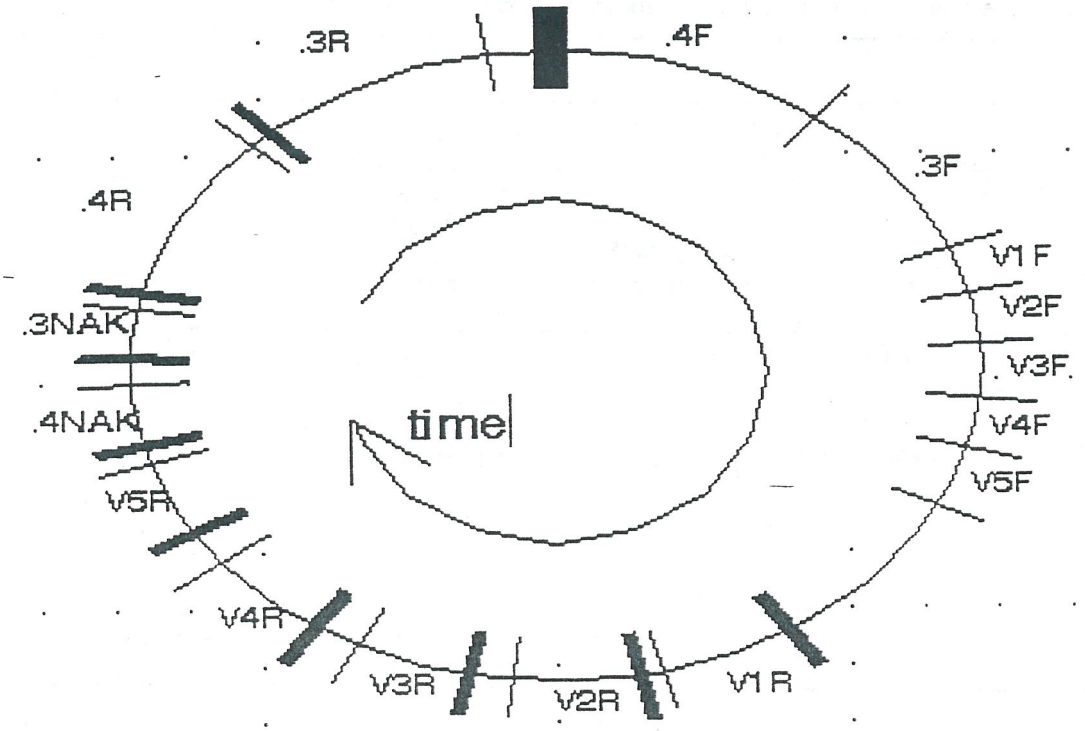


Figure 1

Having drawn this picture, Michael went ahead with drawing a scheme for the transmission of the various Data Units that could possibly be contained in the system. He included Token Bus, CSMA/CD and voice channels as shown in figure 2.

With this scheme one could support an architecture as shown in figure 3; i.e. two delimited bit string oriented services (Token-Bus and CSMA/CD) and a constant bit string oriented service as required for voice and video.



Legend:

.4F	Token Bus block from distribution system
.3F	CSMA/CD block from distribution system
V1F	Voice channel 1 block from distribution system
.4R	Token Bus block to distribution system
.3R	CSMA/CD block to distribution system
V1R	Voice channel 1 block to distribution system
.4NAK	Token Bus NAK to distribution system
.3NAK	CSMA/CD NAK to distribution system

Figure 2

Each cycle of the time is a slot. Beginning at the top of the circle, the distribution system starts with the transmission of a combined "chunk" consisting of a preamble followed by "chunks of the various protocols. At the end of the distribution system transmission, each assigned user finds a subslot for his use. Note that the fat lines are the preambles.

The NAK subslots are meant for asking retransmission of a 802.4 chunk or reports a collision for the 802.3 chunk.

The number of subslots is a matter of management. When there are no voice channels required, the distribution system could assign all time to the Delimited Bit string Oriented services. The whole slot could even be allocated to one of the two Delimited Bit string Oriented services.

In ISDN environments the D-channel is allocated to the transfer of connection control information (call control information). As the D-channels are point-to-point links to the central control, we would limit the capacity in the single channel case we are dealing with. Therefore the call control is ~~lead over~~ one of the two Delimited Bit string Oriented services.

~~Persist~~ carried on

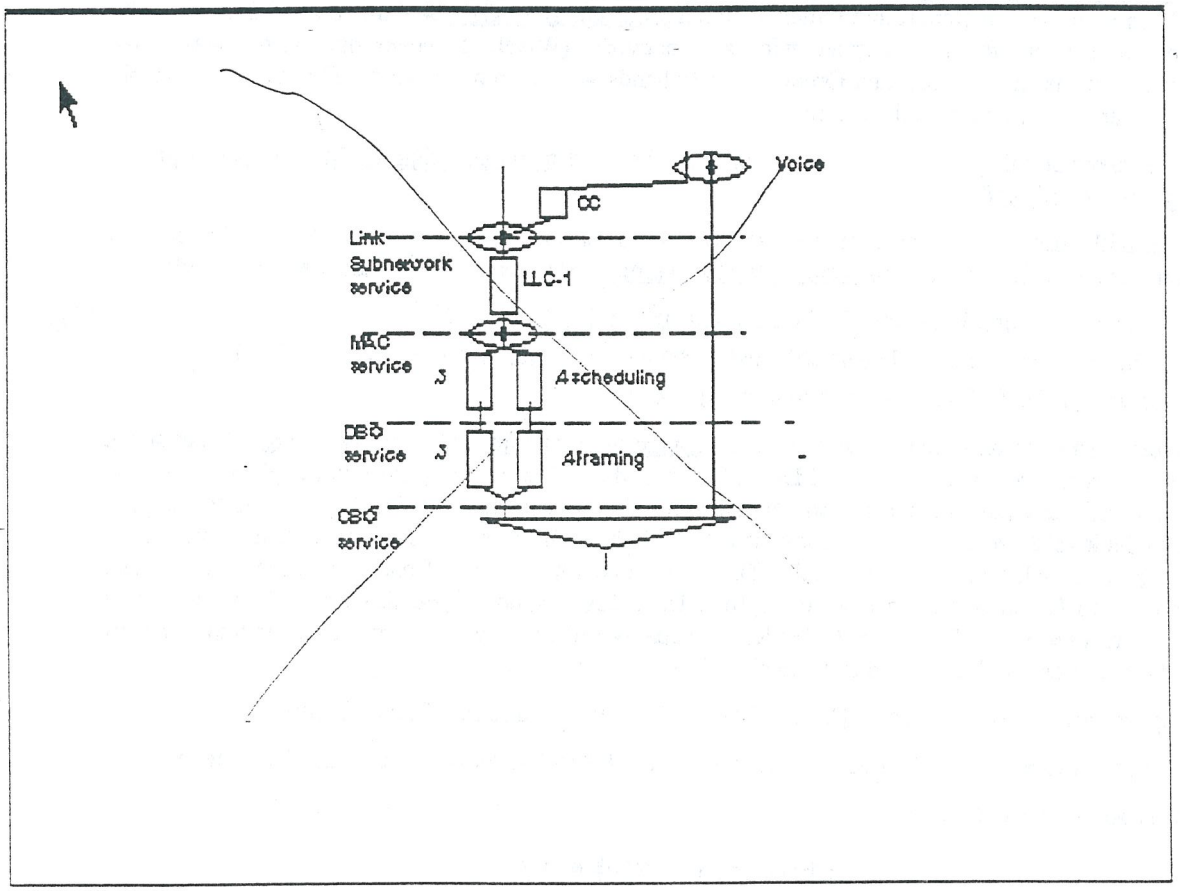


Figure 3

Two submissions from Larry van der Jagt (N.4L/8 and N.4L/9), made available by Michael Masleid, were noted. Michael could not give a presentation of the material. However, he did start a discussion of frequency locked transmitters in head end distribution systems which was addressed in temporary document N.4L/8.

Each transmitter independent, required phasing and delay in order to make it work. Precedent is that FCC does not consider the aggregate to be a phased array. Based on coherence time of multiple oscillator distribution, the use of DQPSK or the transmission of a frequency reference in the distribution system was thought not to be useful. The chip time offset of 1/(11 MHz) = .09 μs equalling 27 m was found too small to solve the space-time mapping. A filter of the sort given in *Addendum 9* can recover transmit frequency submultiples (1/21) from distribution system. Cost is equal to oscillator cost. As the distribution system required a carrier anyway, the cost at the transmitter side is not an issue.

The FCC has issued a new Report and Order in which spectrum at 18 GHz was made available for LAN. The bands were meant for a high speed wide area network. (WAN), however the system was never implemented. In the same Report and Order, 10 MHz bands were also mentioned. This may be a viable resource for our standard work in the future.

Chan and Johnathan will prepare a draft text that may be used to request that 10 MHz of spectrum be reserved for use by RLAN's.

Doc.: IEEE p802.4L/90-17 section 2 on the various modulation methods was reviewed and enhanced. A discussion started on the definition of Amplitude Modulation (AM). ~~Two possibilities were provided:~~

- If any information is encoded in the amplitude then it is AM.
- If the signal can be described as a(t)*cos(p(t)*t) with a(t) real, then it is AM modulated.

No decision was made. (NOTE: What should be captured?)

A debate between Chan and Jonathan started on the source of Minimum Shift Keying (MSK); Chan stated that MSK was conceived in 1956 by Mell Dolts, Collins, when Chan was a grunt level engineer. How do you measure the frequency of a short chunk of sine wave. Now, it seemed that 90 degrees was the amount required to distinguish, so the two frequency differed by half the bit rate. Looking at it another way it is a projection of amplitudes on and I and Q axis. These were two sinusoid out of phase (in quadrature). MSK was attributed to D. Buda, but he is a crook, Mell Dolts actually developed this about 10 years earlier (1955). It was used in the DEW line OQPSK. Parsupathy (10 or 15 years) wrote a paper that correctly attributed the references..715 is the minimum shift. If longer than a symbol

The Europeans are pushing "tamed FM". The phase shift has to go through a Gaussian filter.

Adjustable power levels were discussed. Refer to Doc.: IEEE p802.4L/90-17 section 2.2.1 for the result.

Wednesday adjourned at 5:22 pm

Thursday, 1990.5.17

The Thursday meeting more or less began at 8:30 to 8:40 AM

We started with adding the following two items to Doc.: IEEE p802.4L/90-16:

- item for petition to the FCC for spectrum allocation and
- item for features needed to support other protocols (item 13!) of the 802.X sort.

Chandos Rypinski gave a report of the structure of US and International regulations.

Interim Working Party (IWP) 13 of Study Group (SG) 8 of CCIR is the important group for our task group. CCIR SG 8 is mobile services (international). Most important aspect is Band allocation, since mobile ship and such must be globally significant. This extended to other things, such as satellites, communication to ships, and in wilderness, such as Canadian far north. Satellites are inherently international things. Why is a RLAN mobile. Well, SG 8 is inherently mobile but, SG 8 as a whole may be doing other things.

The real class is short distance communications, (IWP 13 charter is future public land (with a d) mobile telephone systems. Future systems expected to be hand held, as apposed to in car. Scale used to be bus, room, and cell). Allow that future systems should work equally well on both sides of the Atlantic. It was desired that common frequency be used (of course impossible) then at least close frequencies. US position is that no international group will make FCC decisions. In Europe, GSM in high 900 MHz band, doing a technology leapfrog of the US. It is intended to meet a vehicular need providing 260 to 300 kbit/s delivered in two 64 kbit/s channels, a 16 kbit/s channel for call control and data and 3 kbit/s for forward error correction, in time division multiplexing. The reverse path is tricky because the mobiles must lay consecutive in time space. GSM is the current thing in Europe, Digital cellular in US. Neither is within the purview of IWP 13. Little work from the US is expected on this subject. The US delegation, mostly Motorola, regard an international standard as a source of excessive supply of imported electronics. Chan is Member of US committee (US Delegation to IWP 13 of SG 8, Future Public Land Mobile Radio Systems) and is an international delegate.

The structure of committees is as follows:

CCIR is an assembly of administrations

for the US the US State Department is the representative

the US state department has mandated the FCC

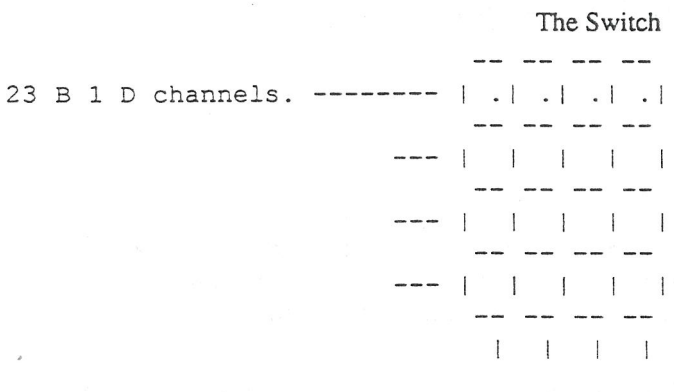
to formulate the position of the US as a whole, the Prepatory Meetings are used.

At those meetings US papers are presented and discussed. When the Preparatory meeting agrees the paper get approved for submission to the CCIR. The Preparatory meetings also nominate the Delegates to CCIR.

The output of the CCIR are Reports and Recommendation. They are published in the famous colored books at the end of a four year study period. The previous study period (1986-1990) has just been closed, the new one can start. It is expected that in the future, however, the output is letter balloted and published as soon as they are available.

Papers in the area of mobile communication show a requirement for 5 to 50 thousand ERLANG (one ERLANG is one hour of continuous voice transmission per hour clock time in buildings or quarters. Contending protocols are: Mixed ISDN and 802 packet versus BISDN or Broadband ISDN, based on ATM or Asynchronous Transfer Mode. An ATM cell carries a 5 octet label and a 48 octet payload, first 4 octet payload is end to end overhead.

The customer access is based on T1. In the network the transport and switching takes place in ATM cells:



125 microsecond

The point of ATM is that the end to end delay is not likely to be more than ~~25 millisecond~~ added to the propagation delay, so ATM cell, rather than FRAME is the unit that is transferred.

Though the structure of ATM is not relevant, a payload size of 48 octets may be wise, with overhead not to exceed 64 octets. It is proving to be the case that packets should be short to facilitate fairness algorithms. Longer tend to require arbitrary and long buffer queues in the network. It is best if the queues form at the point of origin, to indicate congestion.

The WARC92, World Administration Radio Conference 1992 has some questions to answer on frequency allocation related local area networks.

Because of the short distance involved, no one sees why there should be internationally agreed frequency space for radio LAN.

As far as the terminal protocols in OSI are concerned, ANSI X3S3 is the US decision making committee for the lower 4 layers of OSI. ANSI has delegated some of the work to CBEMA (Communication and Business Equipment Manufacturers Association). This ends Chandos discussion.

Vic Hayes provided some information from the European scene. The two main bodies are:

CEPT Conference of European Postal and Telecommunications, the CEPT members are the carriers. Some meetings are also for industry, however, these tend to be for information dissemination only.

ETSI European Telecommunications Standards Institute. ETSI has been incorporated by CEPT with the aim to make standards on Telecommunications based on a wide support. Here industry can become a member. The output of ETSI ore ETS (European Telecommunication standards. These are then considered by the administrations and the European committee to become a NET (with regulatory power). ETSI allocates the standards making job to project groups.

Frequency Management for Radio has so far been a part of the CEPT territory. This is challenged by the European Commission to become more open to industry. They have started ERC European radio communication, so there will be a new committee that consists of the administrations (high level civil servants. Reporting to this board are groups among which FM group (frequency management). Another group will be European Radio Office where industry can be heard. Once a year they will make a seminar where industry can air there opinions. So far Vic Hayes' presentation.

WIN is wired in building network, ~~implied radio though~~, a term used by Rockwell.

Next item is Forward Error Correction. Kiwi Smit introduced Doc.: IEEE p802.4L/90-13 (there is an error in the formula in the paper in section 2.2 should be: $u(n)=(y_S(n)+y_i(n))*(y_S(n-1)+y_i(n-1))$. The version sent by mail will bu updated.

Kiwi stated that the distortion in the Channel could be caused by one of the following:

Multipath
AWGN
Man made noise
narrow band interferers
Transceiver

Treating these as separate and independent for now, the main source in the retail environment is expected to be the narrow band interferers The analysis leads to the conclusion that the least worst case scenario leads to abrupt change from 0 to 1/8 to 1/4 to 1/2 error rate for some omega, and other omega it is an abrupt change form 0 to 1/2 BER.

If the channel is limited by single line interferers FEC does not improve the channel. If, however, the single line interferres are otherwise removed by legislation or an adaptive filter of some sort, than FEC may further improve the channel.

If the signal is say voice modulated, it is still narrow band, that is if the modulation is long compared to signal time.

NCR anticipates that this condition obtains in the retail market place due to the presence of theft detection devices.

Jonathan submitted two foils with a reaction to Kiwi's paper (provided as *Addendum 8*) A long discussion started. At the end, Johnathan agrees in principle, but he states that with RAKE you can do better than theoretical best against AWGN. So when a system without FEC does not work, a system with does not work either. When a system without FEC works, a system with works better. Further discussions will be held on Friday.

The meeting was adjourned at 6:38 pm; Chan had to leave.

Friday, 1990.5.18

Began at about 8:30

Don Johnson introduced Doc.: IEEE p802.4L/90-14. This is the result of an action item from th last meeting. It was agreed that the contents is according the expectation provided two columns are added marked Local Spatial Correlation and coherence time.

Continue discussion of FEC option with compatibility at the head end. Refer to *Addendum 10* for the block diagram of the head-end system.

A message in the radio channel will have a header, data unit, and trailer. The header has a preamble, network id, many control and identification fields, and FEC bits. The trailer has a CRC that covers all bits (including FEC) in the message. The complete discussion is captured in Doc.: IEEE p802.4L/90-17 section 2.4.

Johnathan moved, second by Masleid that the position, "FEC should be avoided if possible" should be changed from a preferred position to a questioned position. After a long discussion, Masleid moved for an amendment, second by Jonathan, to read the motion as:

The position, "FEC should be avoided if possible" should be changed from a preferred position to a argument supporting the "No" position on the issue "should forward error correct be used". The motion carried (2 - 1 - 2) and the resulting motion carried also (3 - 2 - 0).

The next meeting will be from July 8 (Sunday) till July 12 (Thursday) at the Sheraton Denver Tech Center Hotel, Denver Colorado.

The following meeting has been scheduled for September 10-14 in Oshawa. 10-14 preferred, noon to noon. Probably in the Oshawa GM plant, delegates need car.

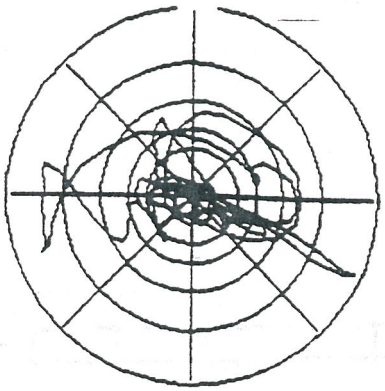
We decided also that the first meeting of the November meeting in Kauai is on Sunday PM.

List of temporary documents

Temp.	Source	Title	Document number
N.4L/1	Hayes	Document list	
N.4L/2	Hayes	Agenda	
N.4L/3	Hayes	Attendance list	
N.4L/4	Hayes	RLAN Standard, List of Questions	IEEE p802.4L/90-16
N.4L/5	Hayes	RLAN Standard, Issues and Positions	IEEE p802.4L/90-17
N.4L/6	Hayes	What is IBIS	IEEE p802.4L/90-17
N.4L/7	Hayes	Draft for section 20	
N.4L/7	Van der Jagt	Analysis of the Impact of propagation from multiple antennae on complex conjugate demodulators	IEEE p802.4L/90-18
N.4L/8	Van der Jagt	Description of a set of codes for CDMA	IEEE p802.4L/90-19
N.4L/9	Giles	Use of 902-928 MHz by field disturbance devices of Sensormatic	IEEE p802.4L/90-20
N.4L/10	Cheah	Response to FEC potential in case of narrow band interferers	Add. 8

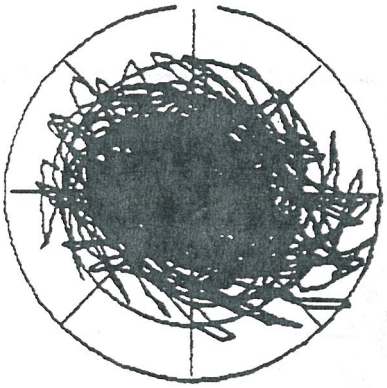
List of Addenda

Addendum 1	Phase diagrams, Oshawa measurements
Addendum 2	Error in Quadrature
Addendum 3	Phase diagrams, Oshawa measurements (2)
Addendum 4	Phase diagrams, effect of operation done by Mike
Addendum 5	Oshawa measurements test rig
Addendum 6	Operation done by Mike on measurement results
Addendum 7	Local Spatial Correlation
Addendum 8	Response to Doc.: IEEE p802.4L/90-13, Jonathan
Addendum 9	Filter
Addendum 10	Block diagram head-end system



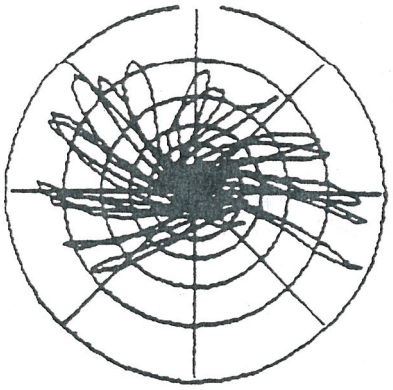
begin at: 1040

MSEQ019 Phase Plane
Q
I Impulse Response
1μs - 25 chips



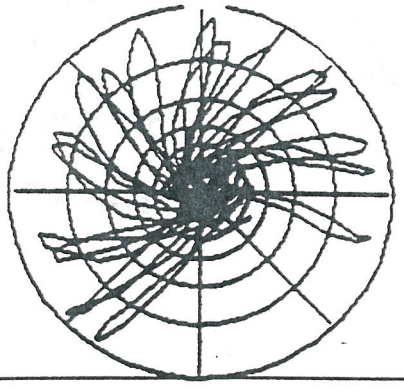
begin at: 51

17 Impulse Responses
each 1μ sec - 25 chips



begin at: 234

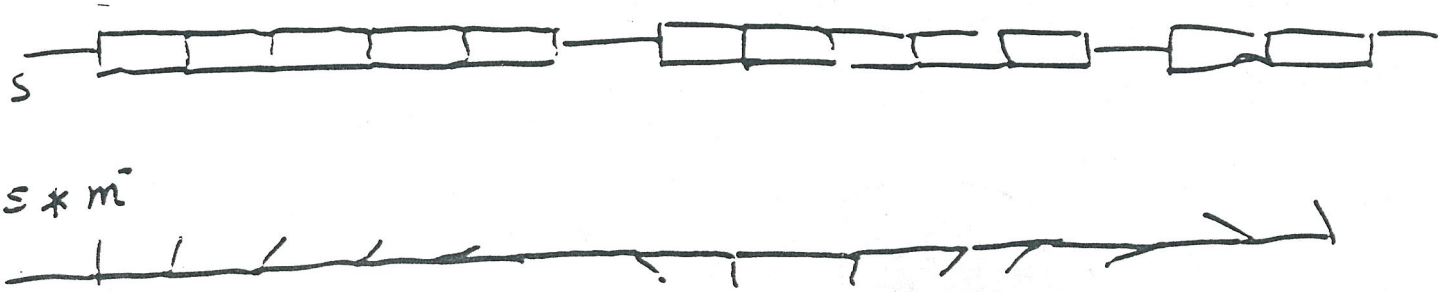
17 partial impulse response showing a free standing pulse, 1 chip long (40ns
Clearly, the channels are not ballanced

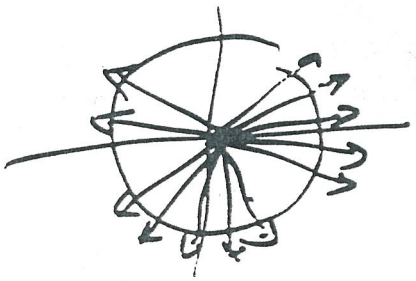


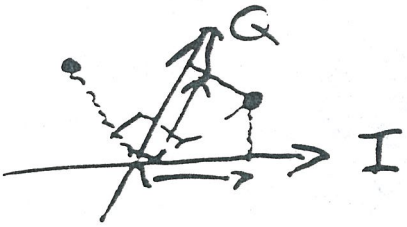
begin at: 239

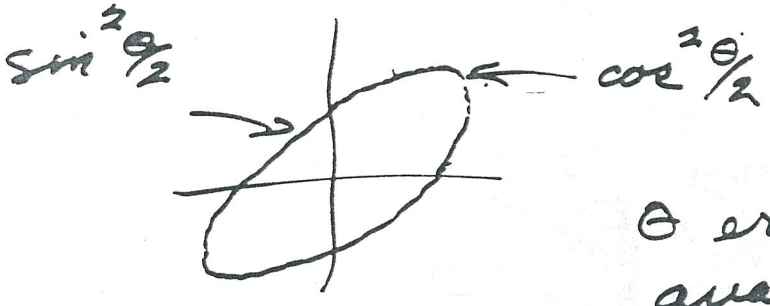
Same plot as before but Q corrected for 0.75 amplitude, -20° phas error

Add 2



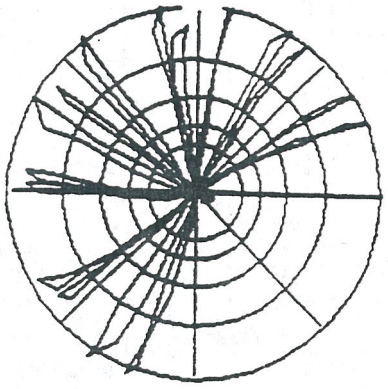






θ error in quadrature

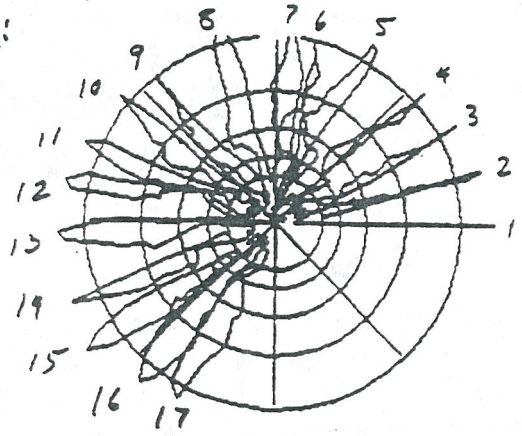
corrected for:
ballance .75
tilt -20°



begin at: 246

MSEQ019 Phase Plane
Conjugate Product of first impulse response with each subsequent response.
Single 1 chip impulse
(Samples 295-304)

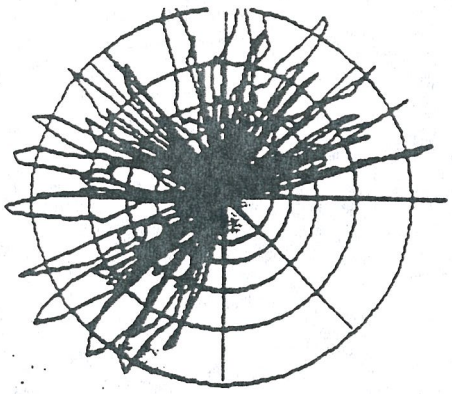
corrected for:
ballance.75
tilt -20°



begin at: 238

5 chips worth of Conjugate product showing very slow change in channel (17 'fatter' than 2)

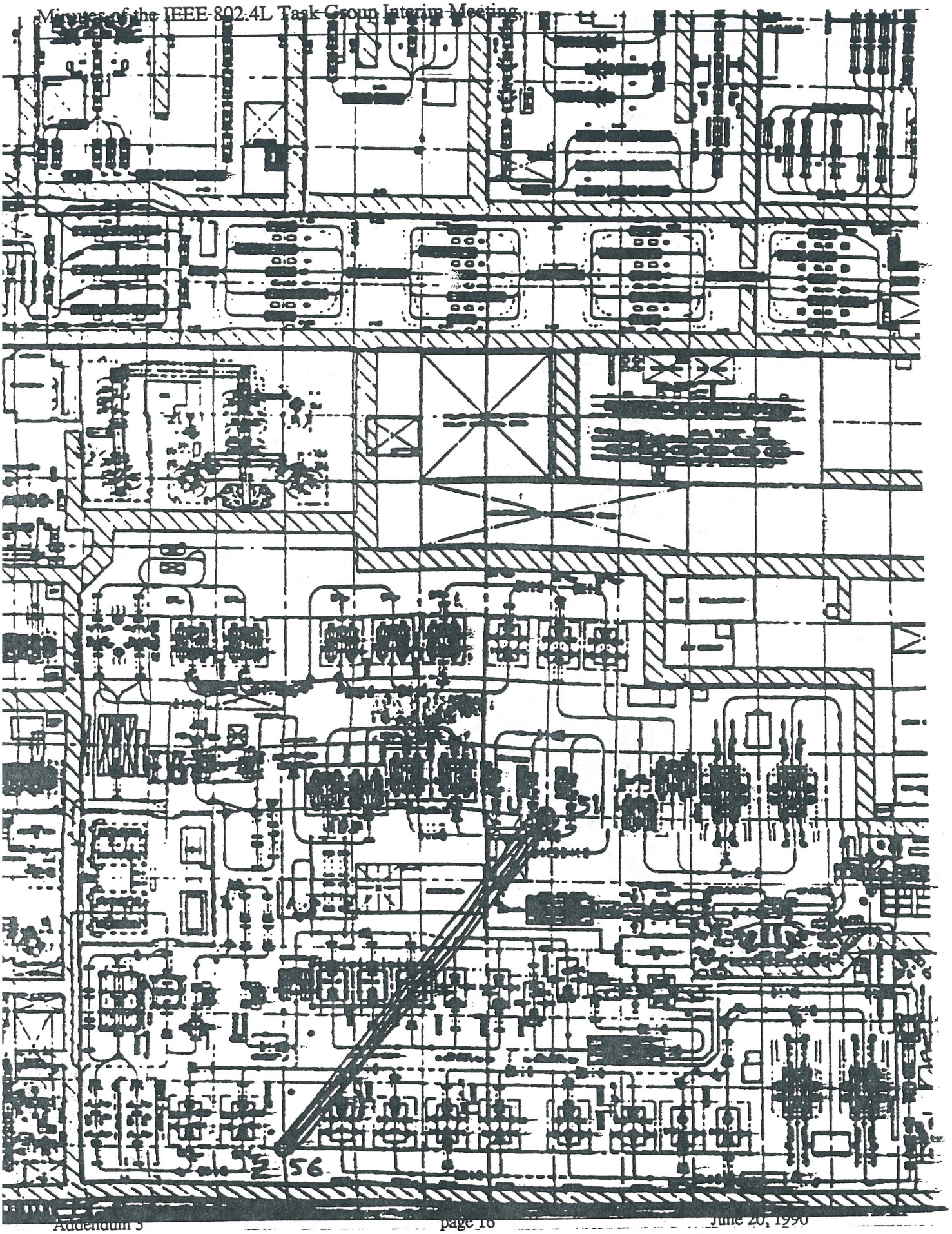
corrected for:
ballance.75
tilt -20°

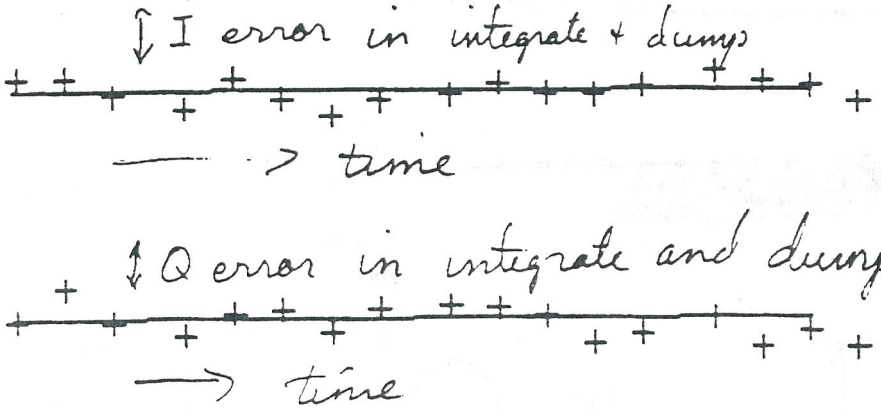


begin at: 68

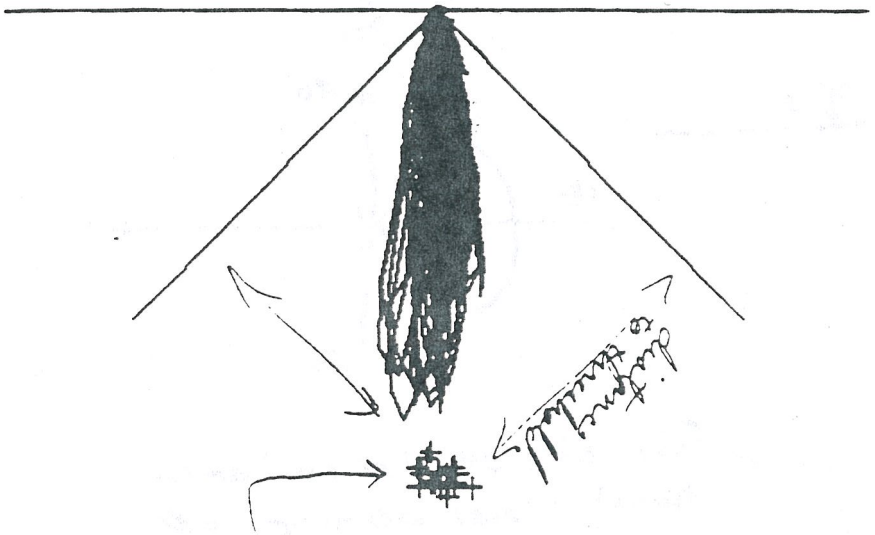
25 chips of conjugate product

TRANSMITTER AT U51
Reciever at Z56
NOT LINE OF SIGHT


56



This is new stuff

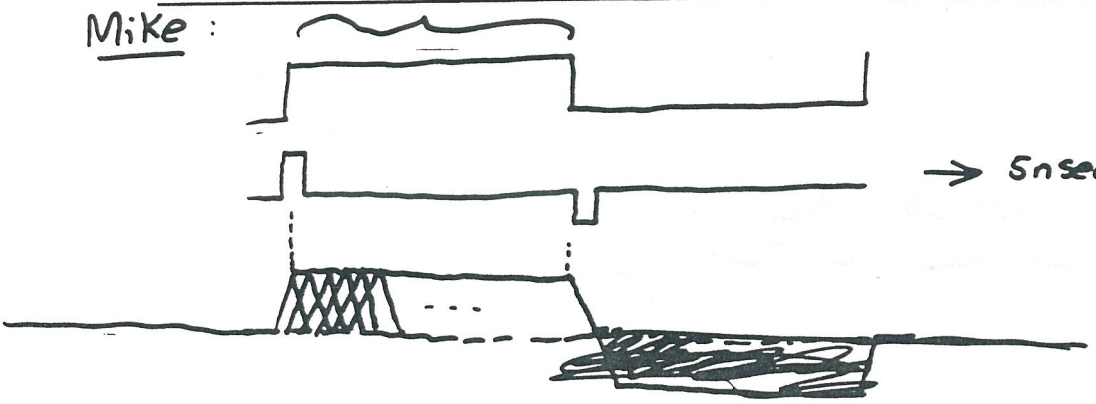


17 phase conjugates of MSEQ 019 Compensated for .75 ballance -20° tilt -14.282° precession per symbol time

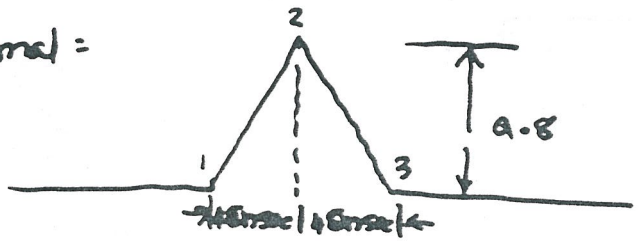
output of integrate and dump indicates very good signal to noise ratio

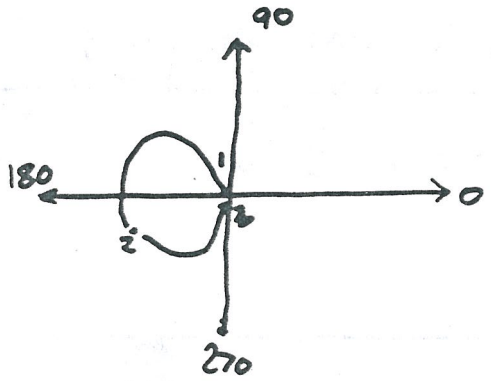
40 nsec = 8 x 5 nsec

Mike :

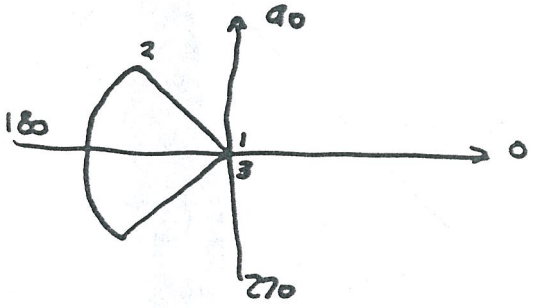


normal :

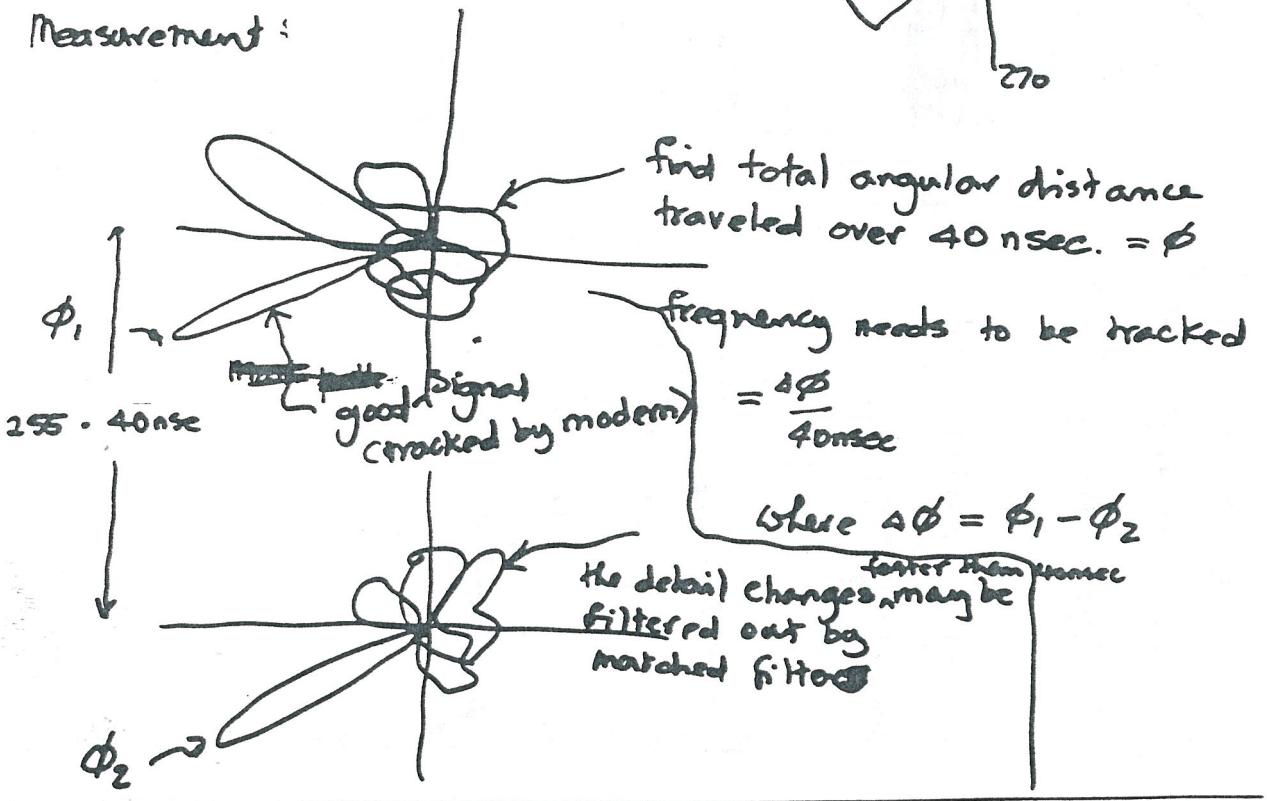


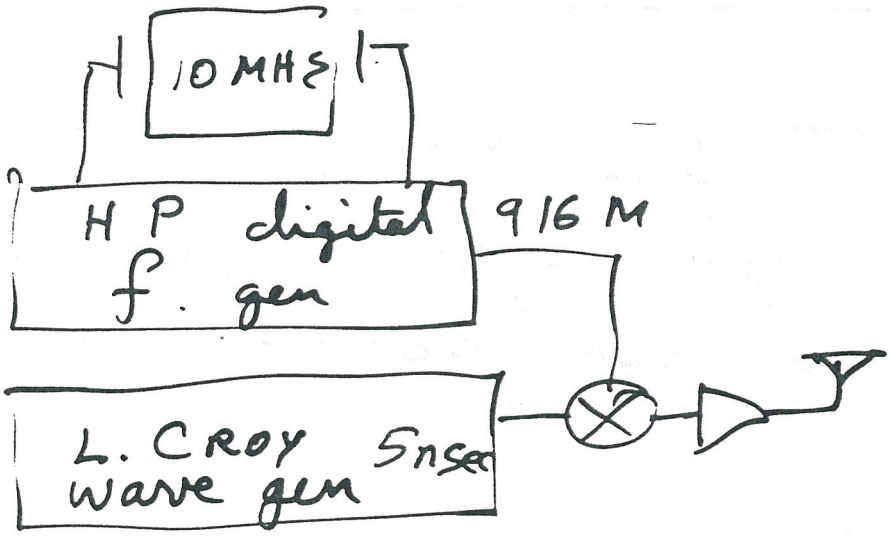


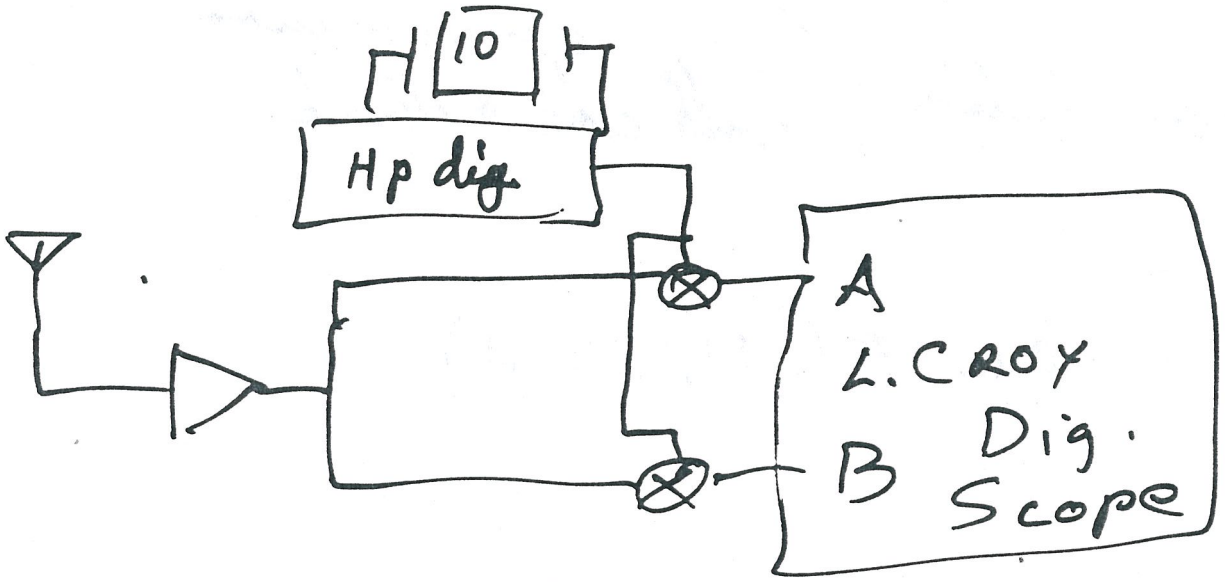
mike :

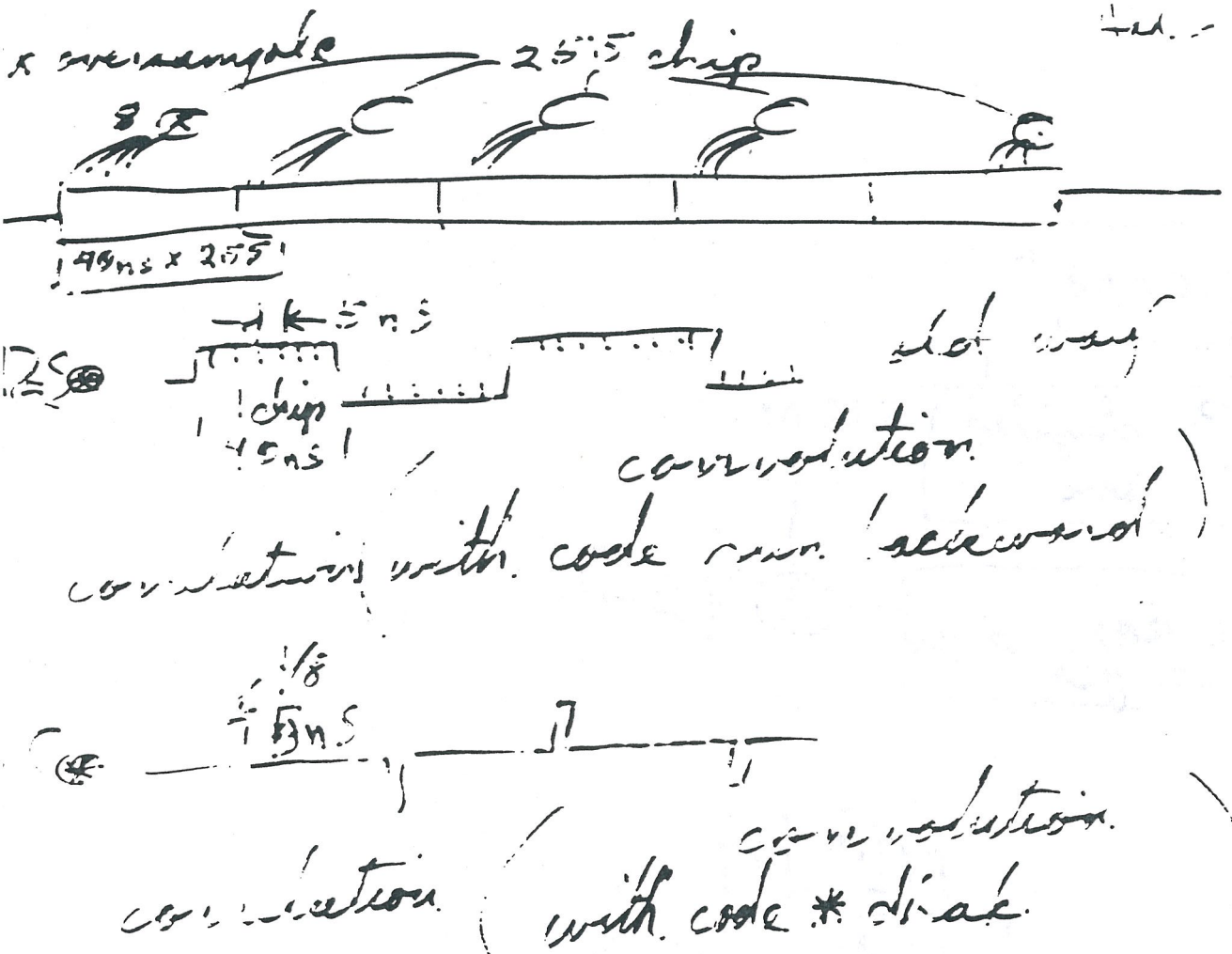


Measurement :




10 MHz
HP digital
f. gen
916 M
L. CROY
wave gen

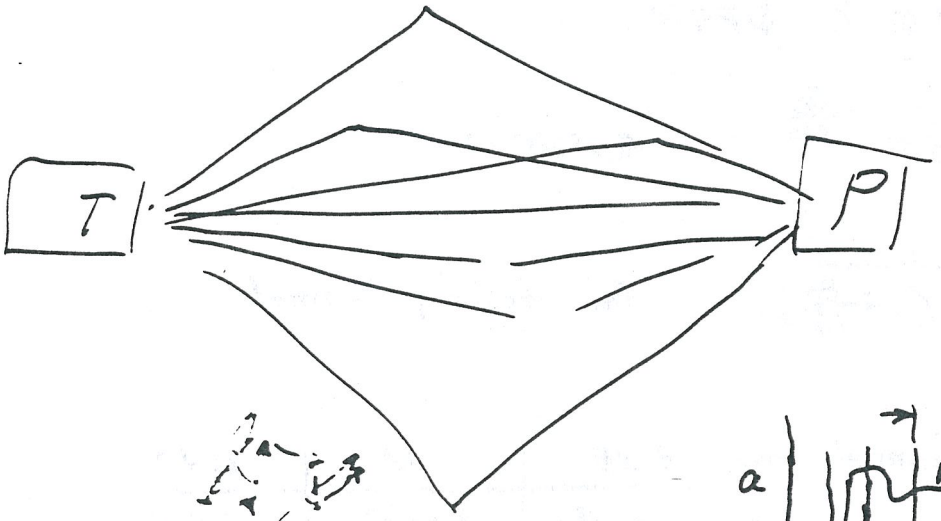

10
Hp dig.
A
L. CROY
Dig.
B
Scope



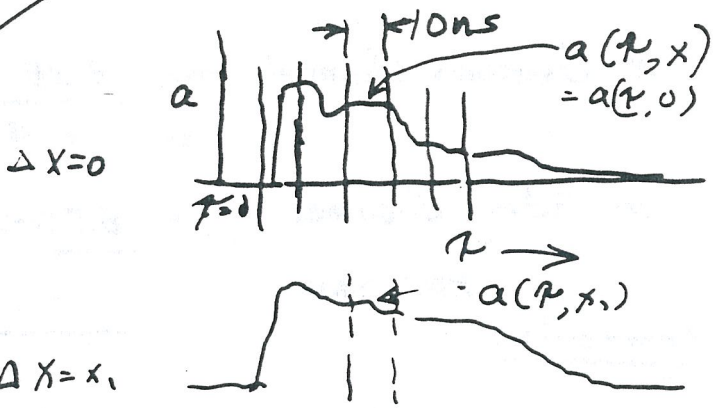
CLD = Mod * (1,1,1,1,1,1,1,1)

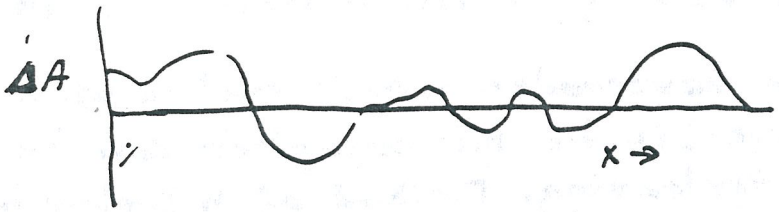
Local Spatial Correlation (LSC)

$$LSC(\tau, \Delta x) = \frac{E[\Delta A(t,x)(\Delta A(t, x+\Delta x)]}{E[\Delta A(\tau, x)^2]}$$

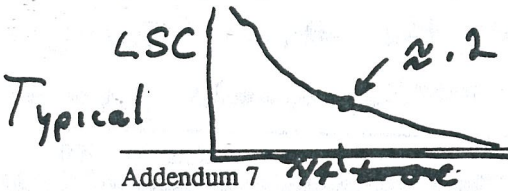


$$A(\tau, x) = 20 \log a(\tau, x)$$





LSC(τ, x) = Autocorrelation of ΔA



Jamming in Spread Spectrum: (response to doc/90-13) J. Cheah

$$\frac{Eb}{Nj} = \frac{Sav/R}{Jav/W}$$

Sav — Average Signal power into receiver

R — Data rate

Jav — Average Jamming power into receiver

W — Total signal bandwidth

For $\frac{Eb}{Io} = 8dB$

then $\frac{Sav}{Jav} = -2.4dB.$

The BER probability for DPSK

$$P\left(\frac{Eb}{No}\right) = \frac{1}{2}e^{-\frac{Eb}{No}}$$ for AWGN

$$P\left(\frac{Eb}{No}\right) = \frac{1}{2\left(1+\frac{Eb}{No}\right)}$$ for fading channel

	8 dB	6 dB	4 dB
IN Gaussian Channel for =	9 E-4	9.3 E-3	4 E-2
IN fading Channel =	6.8 E-2	1 E-1	3.5 E-1
KIWI SMIT =	—	1.25 E-1	2.5 E-1

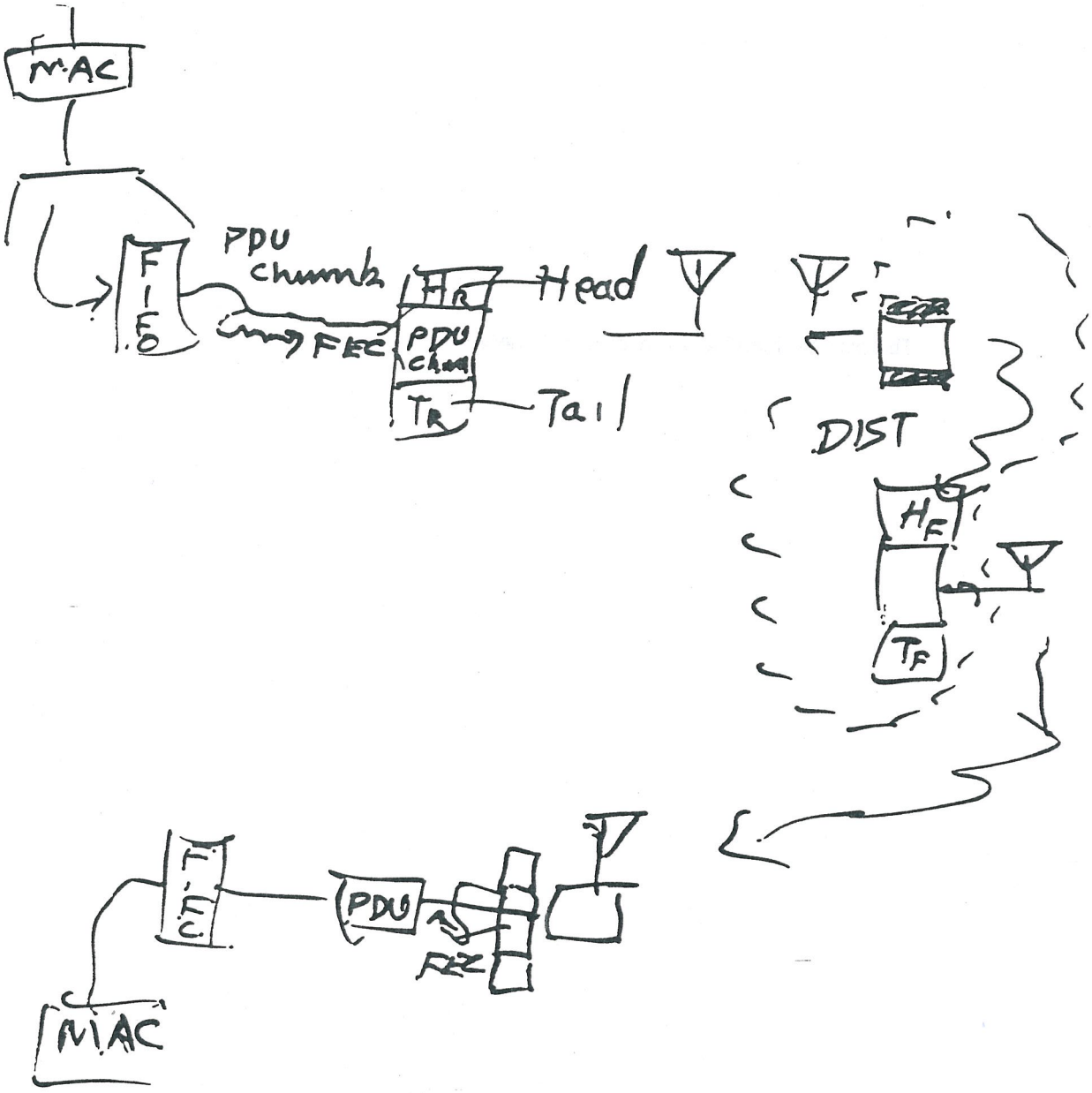
Comments:

1. DPSK will not be working at low SNR/bit < 10dB for RLan.
2. Jamming at the despreader output that causes independent probabilistic bit corruption can be mitigated by interleaving. Method of interleaving is to compliment FEC type.
3. FEC in this case, given that the Eb/No / Eb/Io is (means or) not low enough that nothing works, would provide a net gain. (Sav > 10dB)

4. It can be argued that the cost of FEC may be not justified by the gain FEC provides. However, it does not means FEC does not provide gain.

5 To achieve BER of 10^{-8}, (for DPSK) in a Gaussian environment is $\frac{E_b}{N_o} = 12.5$ dB in a Rayleigh environment $\frac{E_b}{N_o} = 77$ dB
Therefore it is important to know what environment we want 802.4L to work in. (This applies if the time duration of fade is small compared to packet length)

add this drawing -


MAC
FIFO
PDU chunk
FEC
PDU chunk
HR
TR
Head
Tail
DIST
HF
TF
FIFO
PDU
FEC
MAC

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