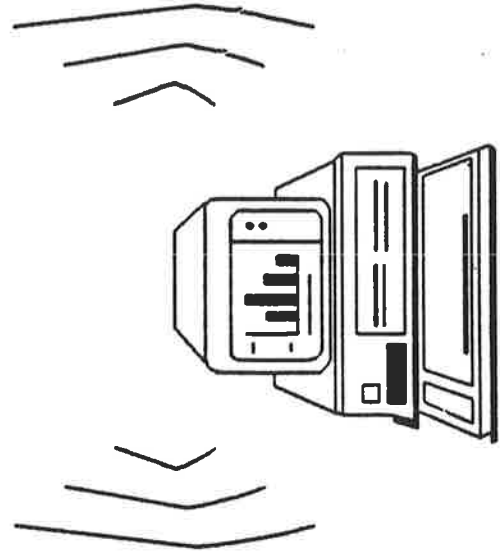
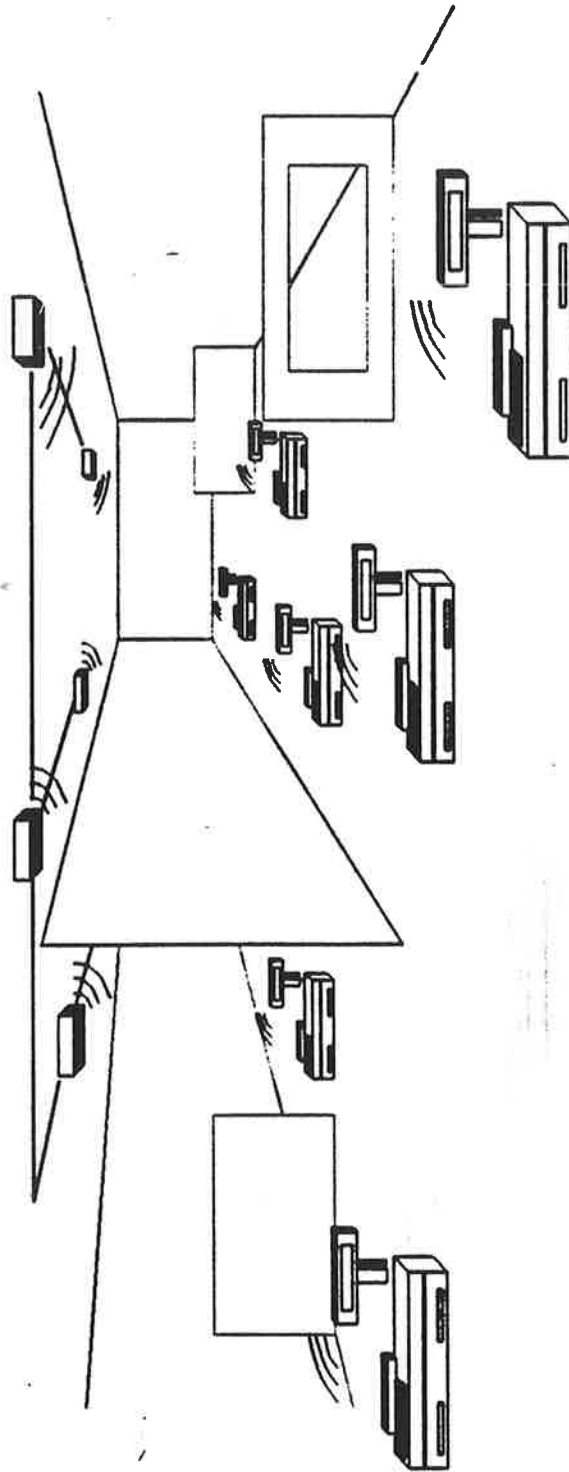




WaveLAN



WIRELESS COMMUNICATIONS FACILITY-WIDE RADIO-LAN



I. CLAN REQUIREMENTS

Except for the benefits of cordless operation, the end user should observe the least possible difference with standard installed wired based LAN products.

- IEEE 802 LAN standards charter for 1-20 Mbps
THE ISM BANDS HAVE THE AVAILABLE SPECTRUM BANDWIDTH FOR HIGH DATA RATES.
- SHARED BANDWIDTH DATA PACKET COMMUNICATIONS.
- INITIAL ZERO INFRASTRUCTURE SET UP MUST BE POSSIBLE.

II. PHYSICAL LAYER

THE PROTOCOL

SPREAD SPECTRUM CDMA:

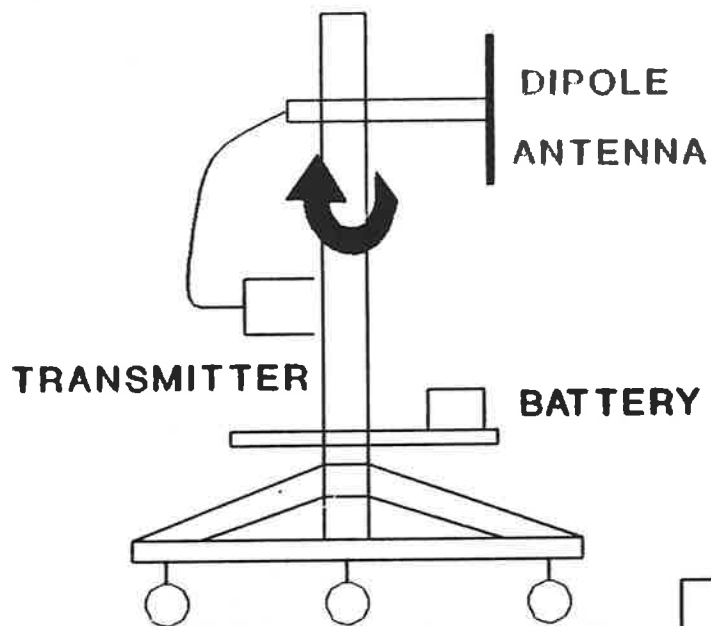
- SHOWS PROMISE FOR VOICE, FIXED BANDWIDTH/USER, APPLICATIONS IN HOMOGENEOUS "CELLULAR" ENVIRONMENTS.
- COST PREMIUM MUST BE PAID TO IMPLEMENT (LARGE PROCESSING GAIN SYSTEMS)
- DOES NOT HAVE THE STRUCTURE OF ACCEPTED LAN PROTOCOLS.

SUMMARY OF IMPORTANT PARAMETERS

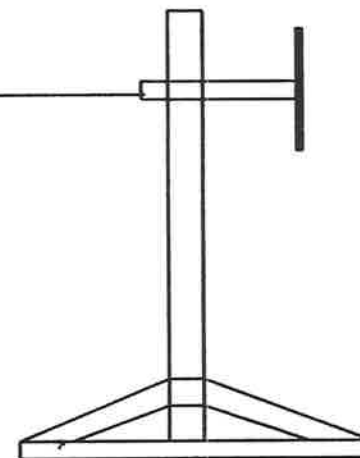
| PARAMETER PHYSICAL LAYER | PROTOCOL/PHYSICAL CONSIDERATION |
|---|--------------------------------------|
| -Dynamic Range For radio this can be > 80 dB. (100 Million in Power!) | Capture Effect. |
| -Secondary User (FCC ISM Band). Modulation Criteria Bandwidth Criteria | Interference present. Data Rate. |
| -Delay Spread. | Data Rate. |
| -Physical Layer is Stochastic (Fading, Shadowing) | Stochastic BER. |
| -"Open" Physical Layer. | Difficult to control conformance. |

PROPAGATION MEASUREMENT

ROTATING TRANSMIT STATION



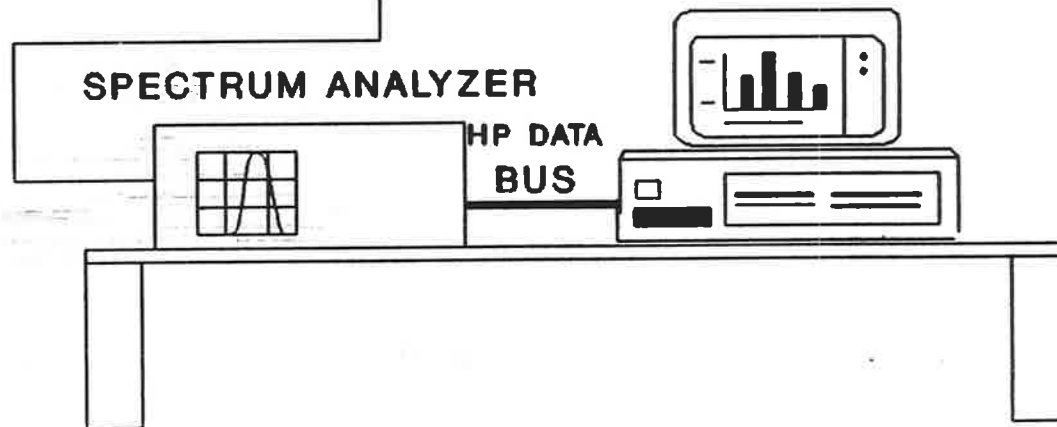
RECEIVE BASE STATION



NCR COMPUTER

SPECTRUM ANALYZER

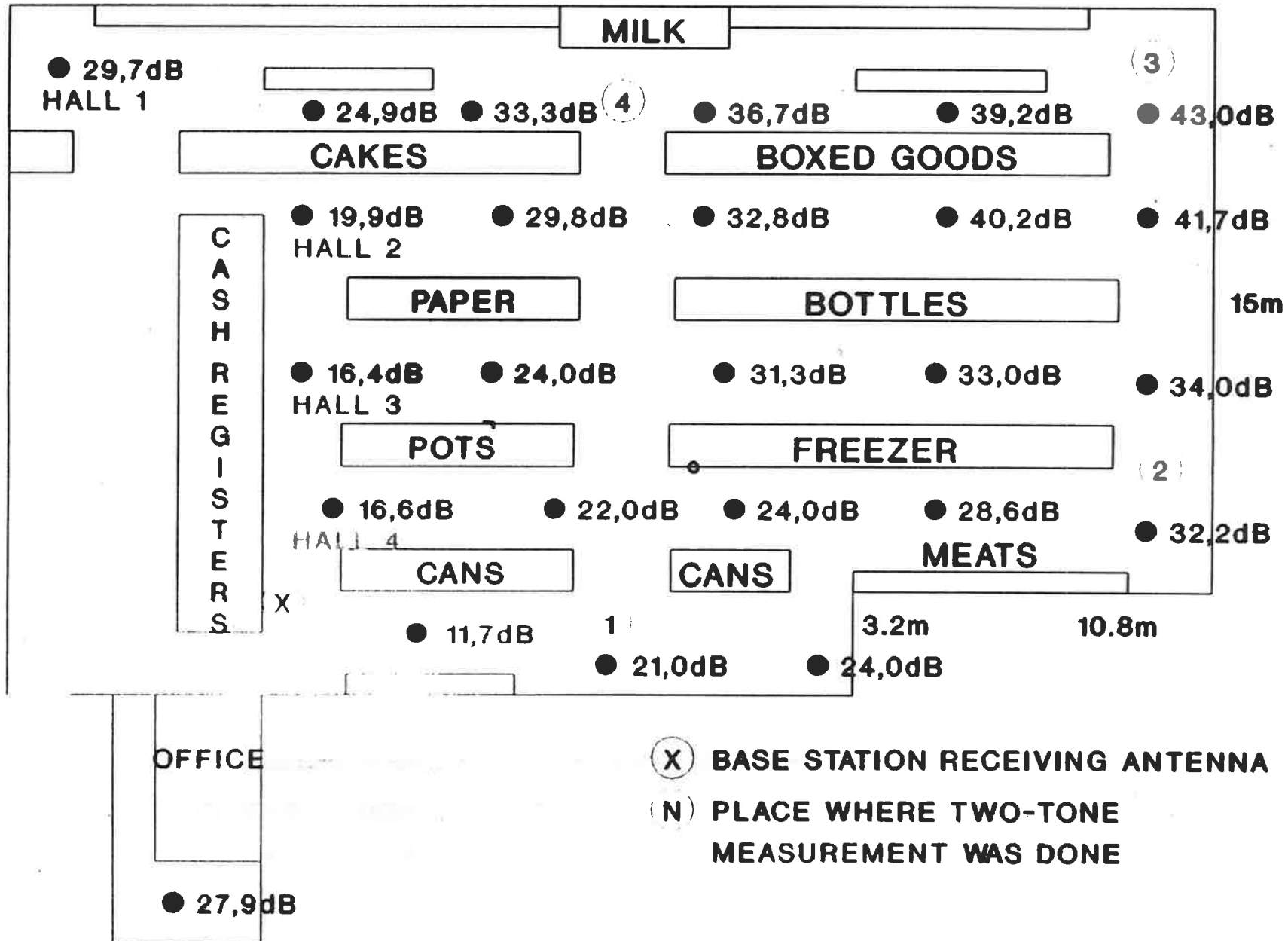
HP DATA
BUS



SUPERMARKET

40m

18m



NCR SE DEPARTMENT C.P.D.

ATTENUATION WITH
RESPECT TO
POWER RECEIVED
AT 1 meter

SLEEVE DIPOLE
HEIGHT : 1m

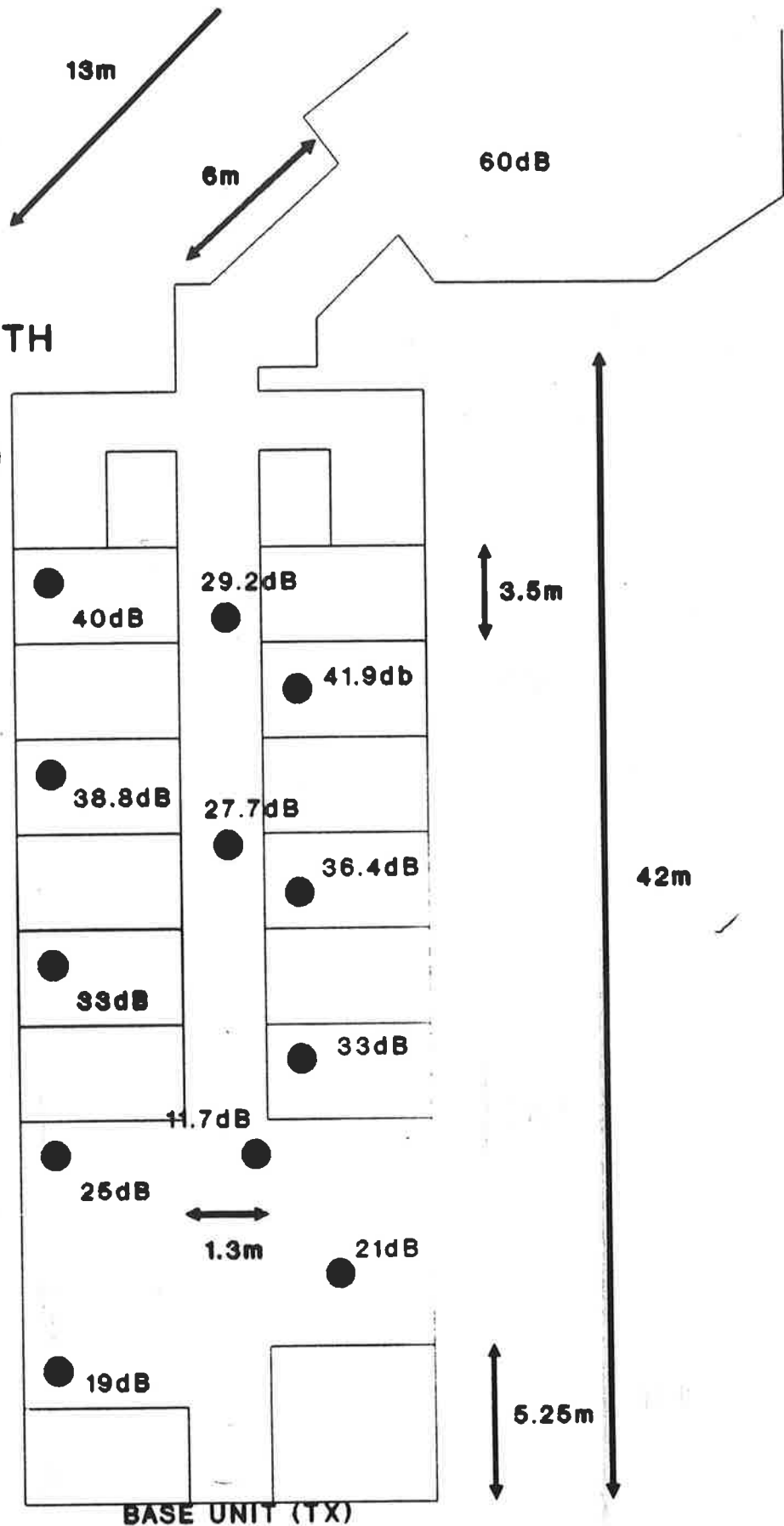
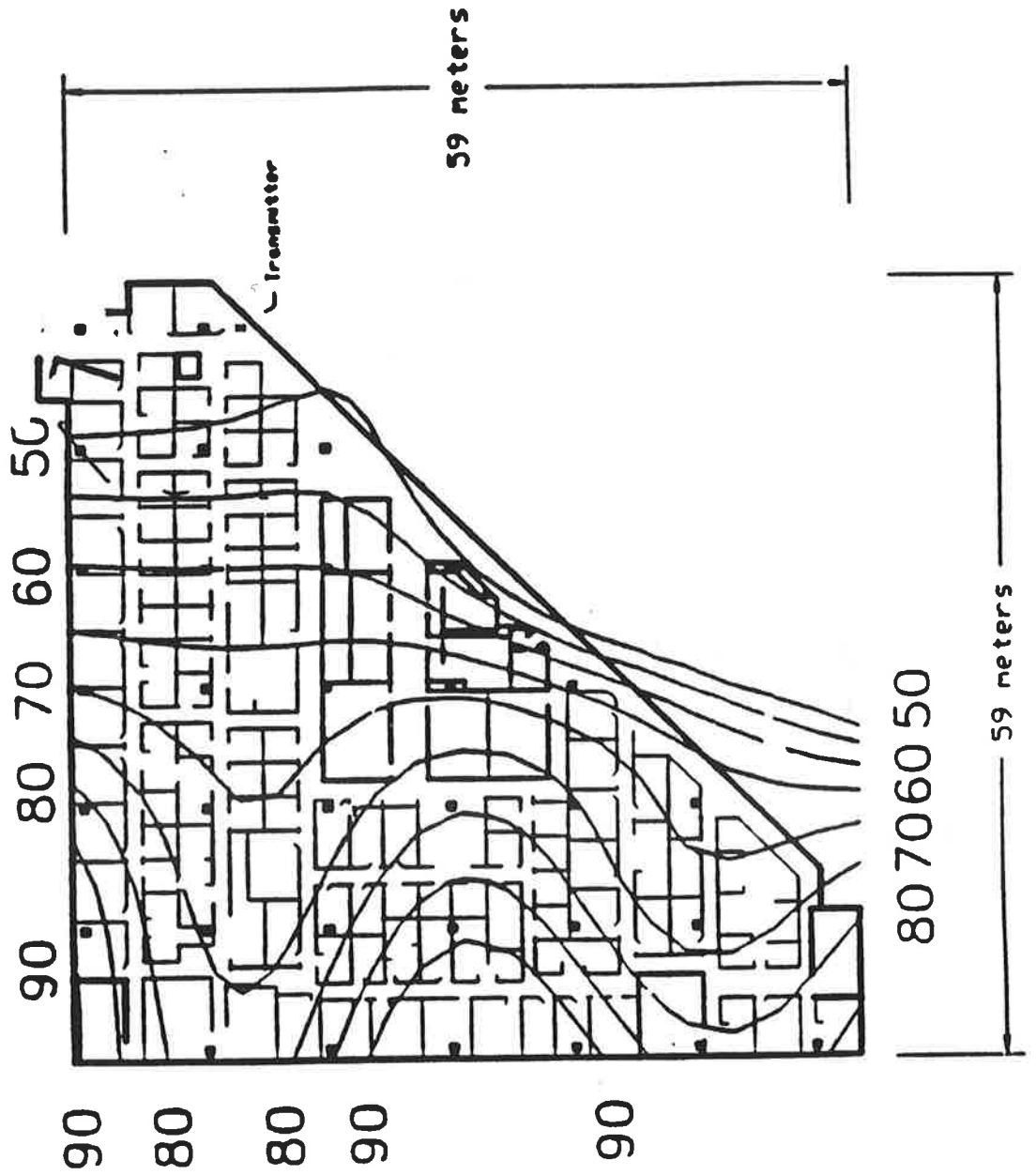


FIG. 1

BASE UNIT (TX)

| | n | σ (dB) | # Locations |
|----------------------------|------|---------------|-------------|
| All Buildings : | | | |
| All Locations | 3.14 | 16.3 | 646 |
| Same Floor | 2.76 | 12.9 | 501 |
| Through 1 Floor | 4.19 | 5.1 | 144 |
| Through 2 Floors | 5.04 | 6.5 | 60 |
| Through 3 Floors | 5.22 | 6.7 | 58 |
| Grocery Store | 1.81 | 5.2 | 89 |
| Retail Store | 2.18 | 8.7 | 137 |
| Office Building 1 : | | | |
| Entire Building | 3.54 | 12.8 | 320 |
| Same Floor | 3.27 | 11.2 | 238 |
| W. Wing 5th Floor | 2.68 | 8.1 | 104 |
| Central Wing 5th | 4.01 | 4.3 | 118 |
| W. Wing 4th Flo | 3.18 | 4.4 | 120 |
| Office Building 2 : | | | |
| Entire Building | 4.33 | 13.3 | 100 |
| Same Floor | 3.25 | 5.2 | 37 |

Table 1 The minimum mean square error path loss exponent and standard deviation for 914 MHz CW propagation for various combinations of measured data.



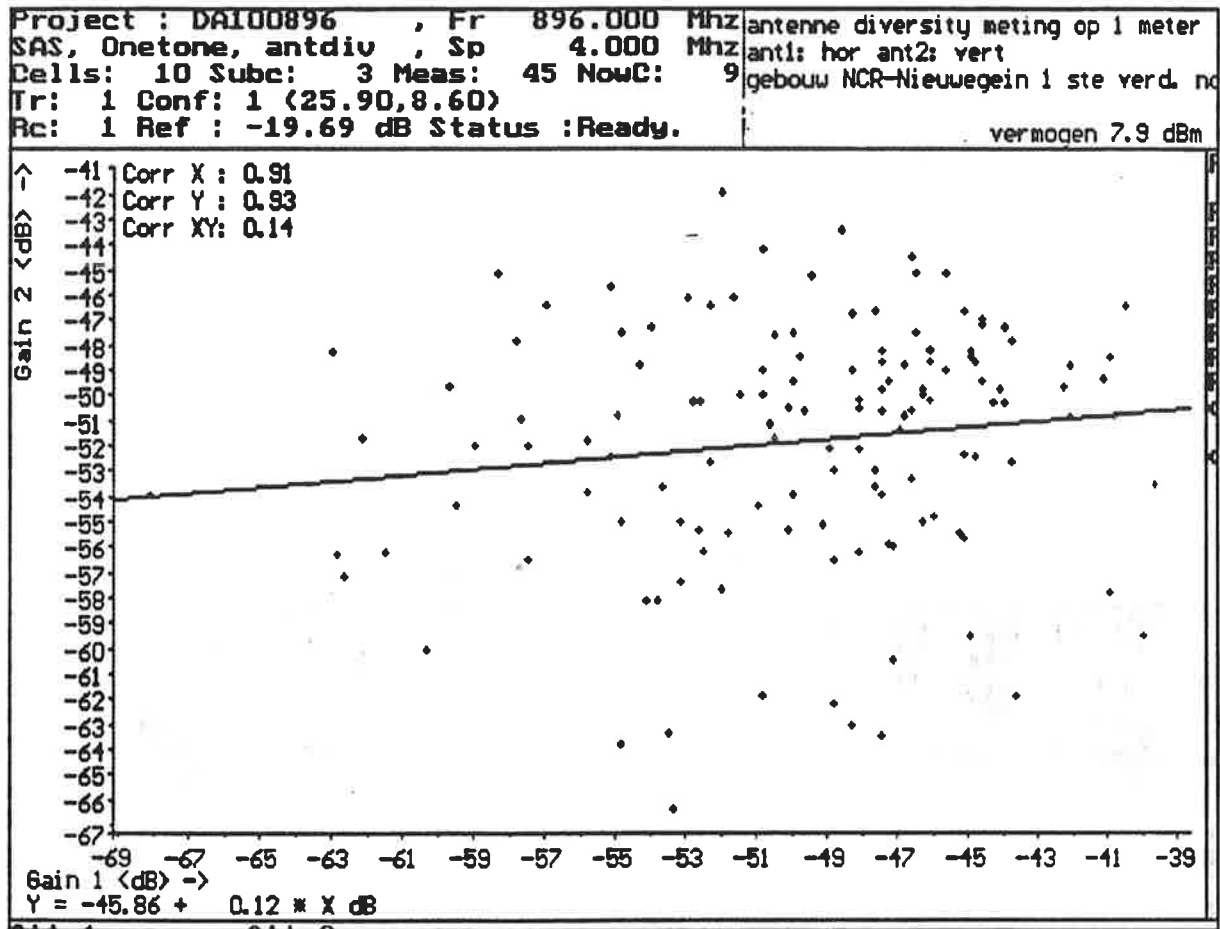


Figure 1. Horizontal vs Vertical Correlation with Cross Correlation Coupling of +3 dB (TX/RX distance of 28 m).

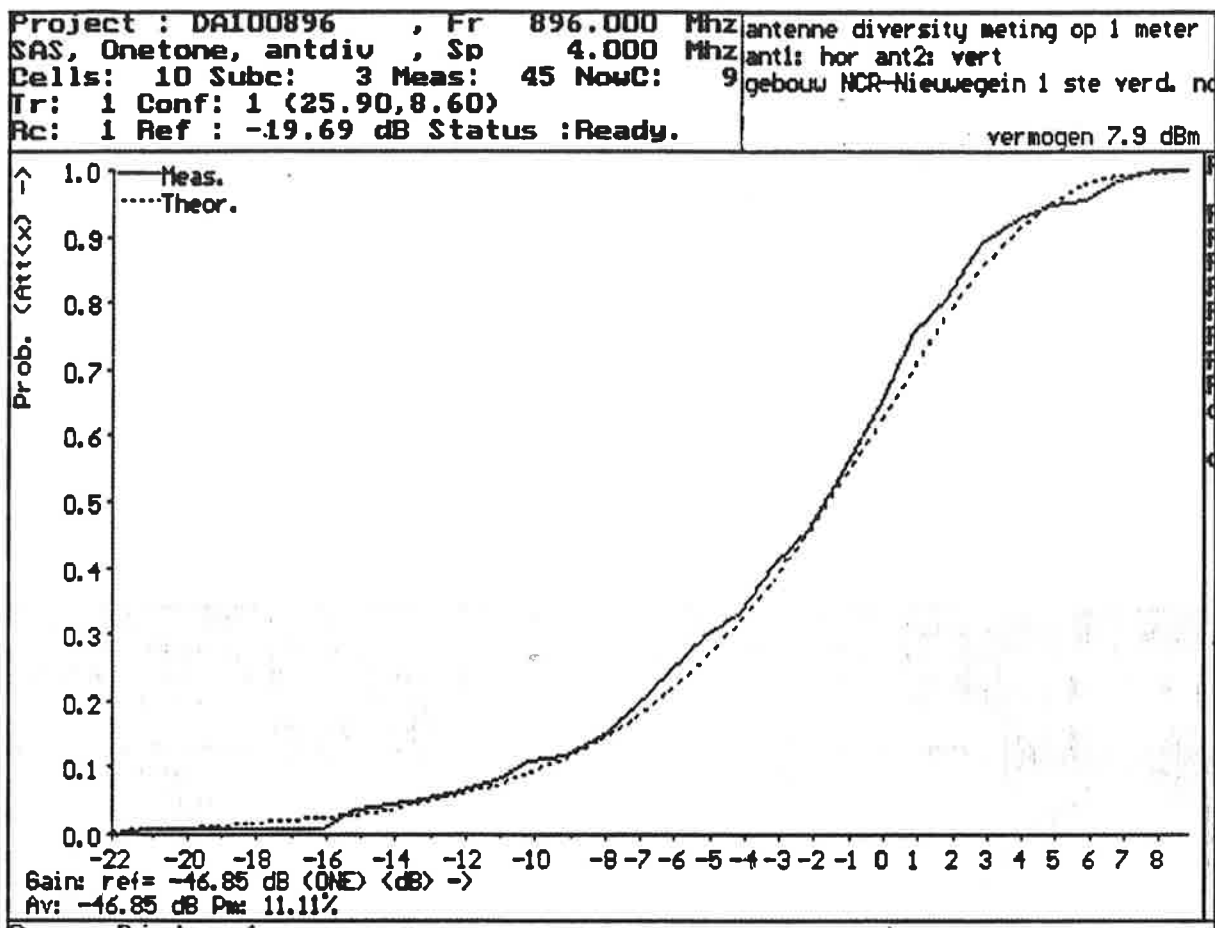


Figure 2. Cumulative Distribution of Vertical Antenna, with respect to cell average power, in a location with -3.7 dB Cross Polarization Coupling (TX/RX distance of 37 meters).

THE DISCRETE CHANNEL MODEL

THE TIME INVARIANT IMPULSE RESPONSE:

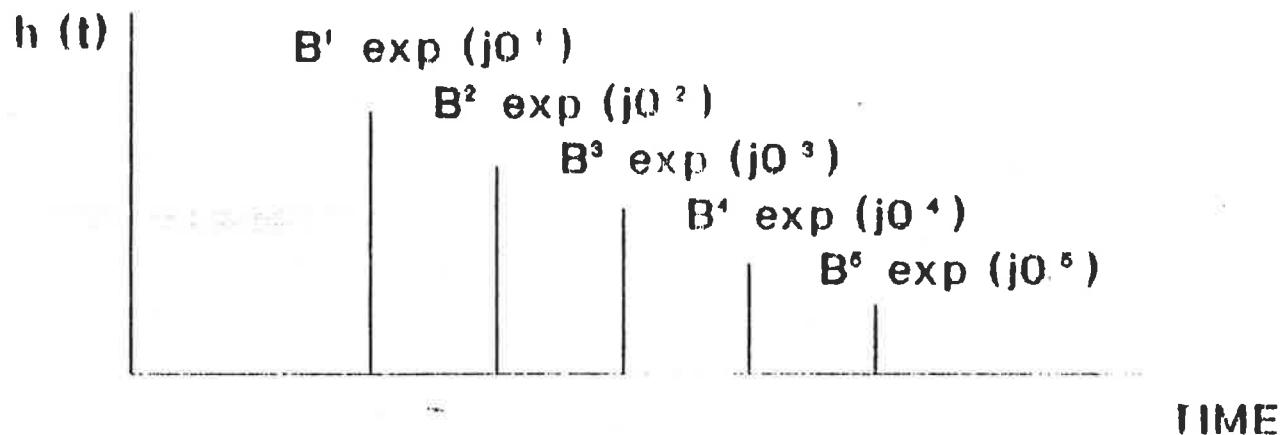
$$h(t) = \sum_m b_m \delta(t - t_m) \exp(j\theta_m)$$

WHERE:

B IS THE PATH CONSTANT (RAYLEIGH STATISTICS)

θ_m IS THE PATH PHASE (UNIFORM PROBABILITY 0-2PI)

t_m IS THE m TH DELAYED RAY'S ARRIVAL TIME



THE MODULATION

- SPREAD SPECTRUM IS AN FCC REQUIREMENT LIMITING TRANSMIT POWER DENSITY.
- THE APPLICATION SPACE IS NOT MILITARY: POTENTIAL INTERFERENCE IS STATIONARY IN NATURE. MAXIMIZATION OF PROCESSING GAIN DOES NOT TRANSLATE INTO A MORE ROBUST SYSTEM.
- SS HAS KNOWN ROBUST MULTIPATH PROPERTIES.
- TOLERANT TO IMPULSIVE NOISE.

Network

System: Novell SFT Netware version 2.15.

Configuration: Server PC with Intel 80386 processor/16 MHz. Six stations with Intel 80286 processor/8 MHz.

Benchmarks: Novell Perform 3 test and PC Magazine LABS Network Speed Under Load Test rev. 2.

| WaveLAN | Arcnet | Token Ring | Ethernet | StarLAN | |
|---------|--------|------------|----------|---------|---|
| 2 | 2.5 | 4 | 10 | 1 | MEDIUM DATA RATE Mbps |
| 1 | 1.1 | 2.5 | 3.6 | .8 | SYSTEM THROUGHPUT' (PERFORM 3) |
| 580 s | 400 s | 320 s | 300 s | 700 s | FILE TRANSFER TIME (PC MAGAZINE) |

MULTIPLE ELECTROMAGNETICALLY OVERLAPPING LANs

| #CLANs | #WS | S | S.#CLANs |
|--------|-----|----------|----------|
| 1 | 1 | .50 Mbps | .5 Mbps |
| 1 | 3 | .70 Mbps | .7 Mbps |
| 1 | 6 | 1 Mbps | 1 Mbps |
| 2 | 3 | .44 Mbps | .9 Mbps |
| 3 | 3 | .30 Mbps | .9 Mbps |

Where:

S gives the individual LAN system throughput (Novel Perform 3 test).

#CLANs the total number of overlapping LANs.

#WS the number of workstations/LAN.

S.#CLANs gives the total system throughput of all the overlapping CLANs.

VII.

CONCLUSION

- . THE NEED FOR HIGH SPEED WIRELESS LAN IS CLEAR.
- . THE ISM BAND HAS GIVEN US GREAT OPPORTUNITY TO SOLVE THE USER PROBLEM TODAY.
- . AN "OPEN SYSTEM" IS NEEDED TO SATISFY CUSTOMER NEEDS....LETS DO IT!!!