ITS WIDEBAND MEASUREMENT AND PREDICTION EFFORTS

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ABSTRACT

The radio local area network (RLAN) requires a wideband channel to pass data at high rates in a multipath environment. This report describes how results from the Institute for Telecommunication Sciences (ITS) wideband measurement and prediction efforts can be applied to the indoor RLAN channel. Examples of indoor channel measurements and output from the ITS urban propagation prediction software are shown.

INTRODUCTION

Local area networks (LANs) need to operate at high data rates to be effective in cpu-to-cpu communications. These high data rates are possible when cable is used as the communications medium. Robust levels of reliability and performance are virtually guaranteed if the IEEE 802 physical layer standards are followed for any of the cable types. The IEEE 802.11 Standards Committee is defining specifications for a RLAN, which would provide the same connectivity over an indoor radio channel. This is a challenging task since the channel will be subjected to interference and diverse propagation conditions that are dependent upon the frequency band, building architecture, and building activity.

Two propagation effects, shadowing and multipath, dominate radio channel behavior. Shadowing attenuates the signal and is compensated by adjusting other factors in the link budget. Multipath causes frequency selective fading and intersymbol interference. The signal power loss due to frequency selective fading can be mitigated by other link budget factors by providing antenna diversity, or by spreading the signal using a wideband modulation method. The intersymbol interference can be mitigated by equalizing the channel, pulse shaping, lowering the data rate, or other methods.

To predict the performance of techniques such as channel spreading and equalization on an RLAN link, a wideband channel model is needed. Wideband measurements are also needed to support the model. This paper describes the ITS wideband measurement and prediction efforts. Some preliminary results of each are presented for illustrative purposes.

ITS WIDEBAND CHANNEL MEASUREMENT PROGRAM

A wideband channel can be completely described by its time varying impulse response. The impulse response of a communications channel is measured with a channel probe. As part of its wideband measurement and prediction efforts, ITS has built a wideband pseudo noise (PN) channel probe. The probe's PN word is 127 chips long and runs at a rate from 100 to 500 megachips/second. The PN word length and the chip rate limit the maximum measurable delay times within the impulse response to 254 to 1270 ns depending on the chip rate. This delay range is ideal for measuring the channel of many RLAN environments, such as large conference rooms, factory floors, and soft partitioned offices.

When measuring the impulse response of a communications channel, it is common to average several closely spaced measurements to eliminate dependance on small changes in time or location. The result of the averaged measurements is called the average power delay profile. The standard deviation of the average power delay profile is then calculated. This common measure of delay spread is called the rms delay spread and is used to determine the bit error rate for a given modulation type, pulse shape, and signal-to-noise ratio.

In addition to the average power delay profile and rms delay spread, ITS is interested in producing data sets that contain instantaneous impulse responses and delay spreads. These data sets could then be used to support channel prediction models and software channel simulators. Probability distributions of delay spread could also be derived from these data for other prediction purposes.

ITS WIDEBAND CHANNEL PREDICTION EFFORTS

The Institute for Telecommunication Sciences has developed a channel model that is capable of predicting signal levels in urban areas [1]. Work is currently underway to add diffraction to this model so signal levels around building corners can be predicted. These models were developed to support personal communications services (PCS) research. To support indoor PCS as well as RLAN applications, this model will be enhanced to predict indoor signal levels. Plans for incorporating the wideband channel measurement data into a software channel simulator are also being made.

PRELIMINARY RESULTS OF INDOOR WIDEBAND CHANNEL MEASUREMENT

As part of the wideband channel measurement program, ITS engineers have conducted indoor channel measurements of a long, narrow hallway at the U.S. Department of Commerce Laboratories in Boulder, Colorado. Measurements were made at 100, 200, and 500 megachips/sec with the transmitter cart moving at a slow walk. Example instantaneous impulse response and delay spread plots are shown.

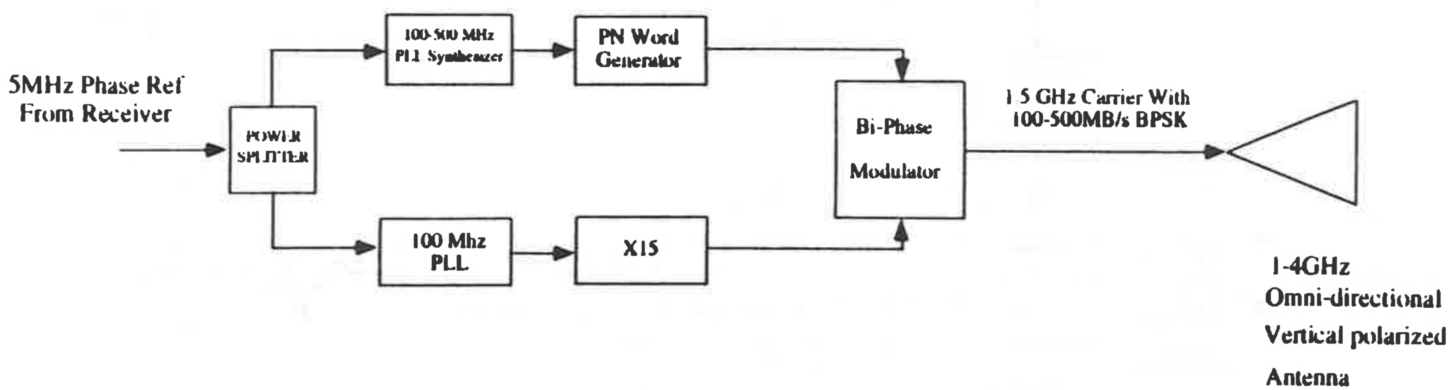
EXAMPLE OUTPUT OF ITS WIDEBAND CHANNEL PREDICTOR SOFTWARE

Also shown is the output of the wideband urban propagation predictor. The output shows signal power as a function of three dimensional location. The transmitter can be located at any point along the left side of the urban canyon grid (see parameter: distance from the wall). Transmitter and receiver antennas can have differing heights and engineering parameters.

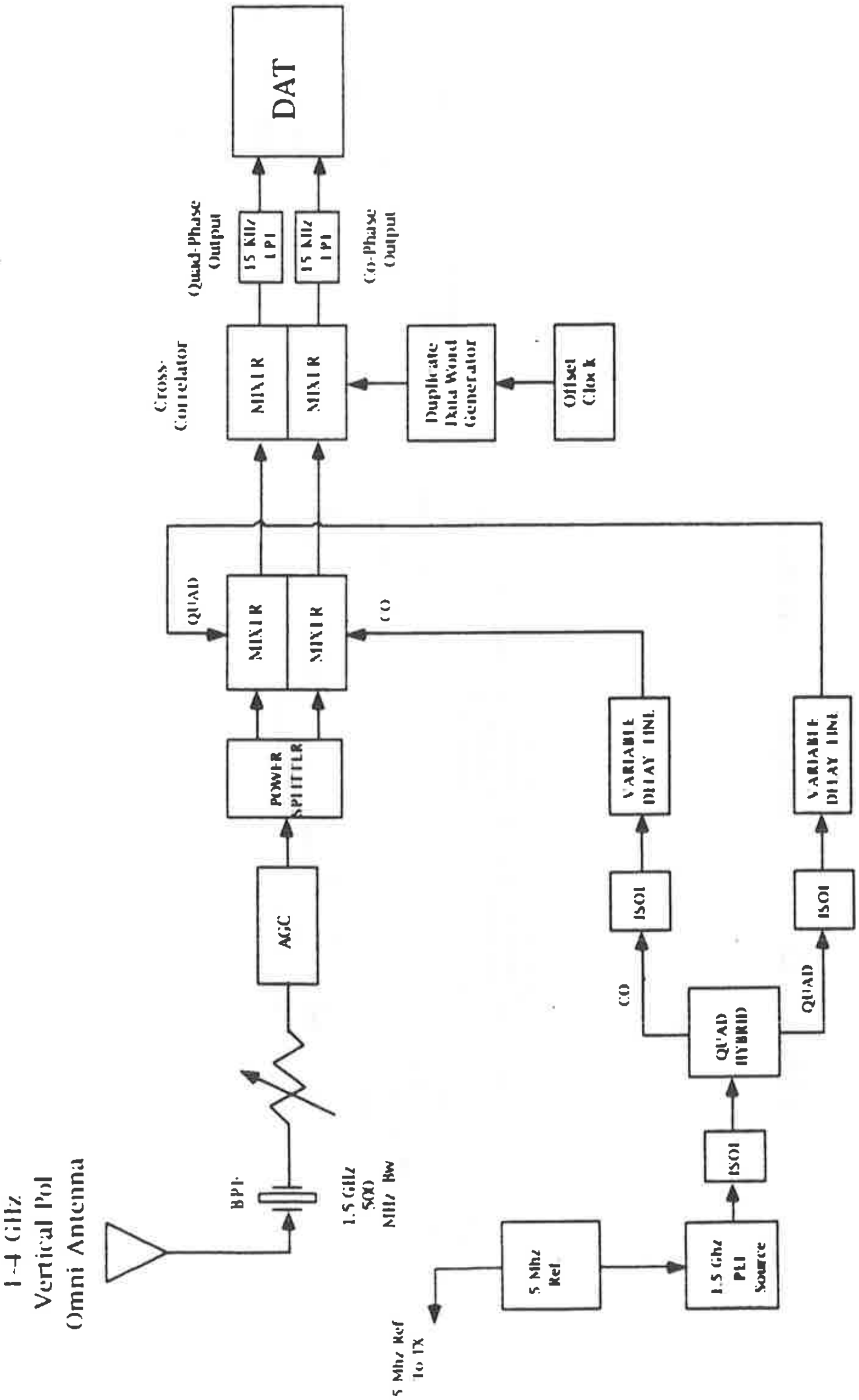
REFERENCES

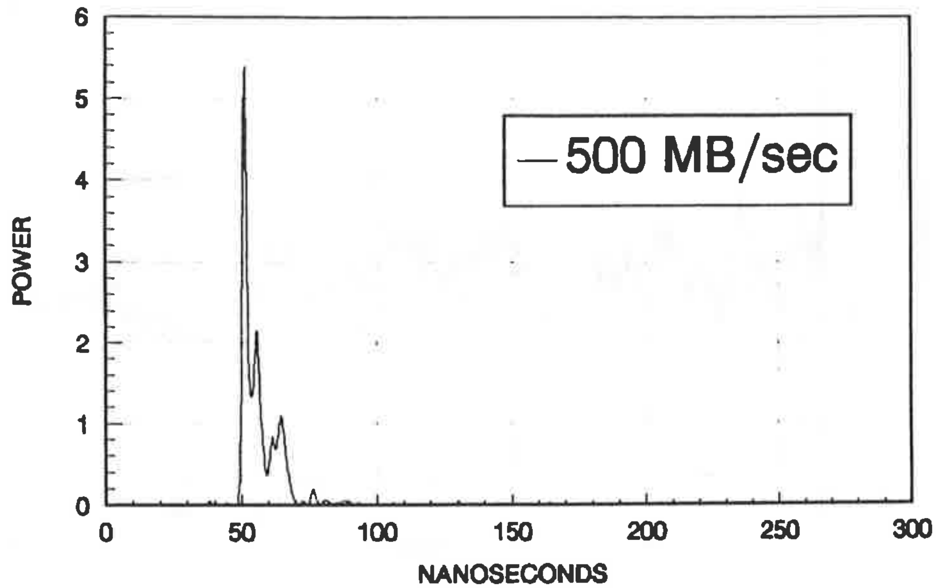
[1] K.C. Allen, "A Model of Millimeter-Wave Propagation for Personal Communication Networks in Urban Settings," NTIA Report 91-275.

Wideband Delay Spread System Transmitter

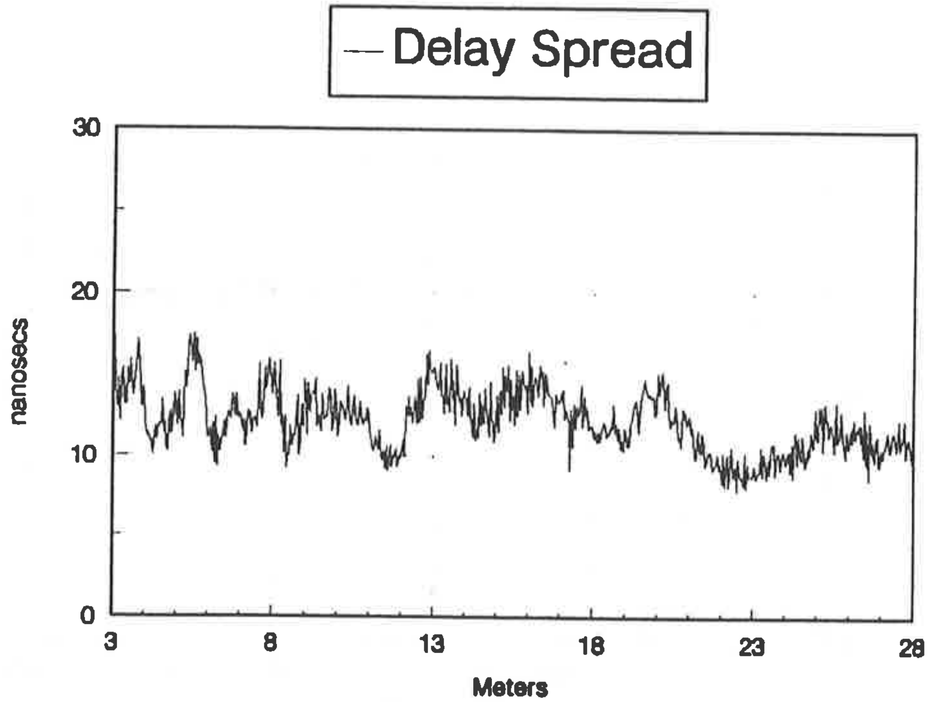


WIDEBAND DELAY SYSTEM RECEIVER





Channel Impulse Response 1
Maximum Resolution 4ns
Maximum Delay 254 ns



Channel Delay Measurement
Wing 4 Hallway
500 MB/sec

rayout.05

PARAMETER	TRANSMITTER	RECEIVER
Height Above Street (m)	10.00	1.80
Beam Width (deg)	180.00	180.00
Gain (dB)	.00	.00
Elevation Angle (deg)	.00	.00
Azimuthal Angle (deg)	.00	.00
Power (dBm)	.00	
Frequency (GHz)	.90	
Distance from Wall (m)	12.00	
Street Width (m)	24.00	
Max # Wall Reflections	3	
Street Reflection Loss	1.00 dB	
Wall Reflection Loss	3.00 dB