INDOOR WIDEBAND PROPAGATION DATA

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DESCRIPTION OF THE ROOM

An open plan office room that used soft partitions to delineate work areas was measured using a wide bandwidth (200 MHz null to null) slipped correlator channel probe at a frequency of 1500 MHz [Pappazian, 1992a]. The open plan office room was located on the third floor in a building of modern construction.

The building was large, however the measurements were taken in a square area measuring 25 by 25 meters that was bounded by outside walls on 3 of the four sides. Two of the outside walls had regularly spaced, tall, narrow windows. Along the remaining side, not bounded by an outside wall, were offices with full height sheetrock walls. The interior of this area was filled with a maze of 2 m high soft office partitions. The suspended ceiling height was approximately 3.3 m. Beyond the suspended ceiling was an attic and the building's gabled roof steel decking.

PATH GEOMETRY

The stationary receiver "base station" antenna was placed in a corner bounded by two outside walls at a height of 2.1 m. A corner location was selected to allow the maximum diagonal path
to be measured. The mobile transmitter antenna was mounted on a cart 1.6 m high. The cart was walked at a steady pace up and down the 8 office isles. The transmit and receive antennas were obstructed in six of the eight isles (paths 2,3,4,5,7,8) by the office partitions. The remaining 2 paths (paths 1,6) were not.

SPATIAL SAMPLING RESOLUTION

The transmitter cart was moved at an average velocity of .37 m/s. This number was computed by averaging the velocities of the eight paths. The number of complex impulse response measurements/wavelength, N, is computed by the equation

N = (1/velocity)*wavelength*sampling frequency

where velocity is in m/s, wavelength is in m, and sampling frequency is in impulse response measurements/s. For this measurement, the wavelength is .2 m, the sampling frequency is approximately 10 impulse response measurements/s, and N is 5.4 impulse response measurements/wavelength.

MEASUREMENT PARAMETERS

Broadband vertically polarized discone antennas were used at the transmitter and receiver. The antennas had an omnidirectional azimuth pattern with approximately 2.5 dB in gain. The elevation pattern had a 3 dB beamwidth of approximately +/-30 degrees. A PN code 127 chips long BPSK modulated the carrier at 100 Mchips/s. To obtain an estimate of the complex impulse response, the received signal was split into I and Q channels and correlated with a copy of the transmitted PN word. The correlation filter had a 3 dB bandwidth of 15 KHz which corresponds to a time constant of 66.7 us. The slip correlator increased the correlated chip time from 20 ns to 1700.8 us. The word time was increased from 1.27 us to 108 ms. A digital audio tape (DAT) recorder with two channels sampling at 48.0 kHz was used to store the I and Q channel data. This sampling rate allows about 81.6 samples/correlated chip or about 5184 samples per word.

DATA REDUCTION

Samples are considered independent if they are separated by at least 2 correlation filter time constants. Using this criteria, there are 12.8 independent samples/correlated chip. The acquired data was reduced to 13.6 samples/correlated chip by keeping every 6th sample and discarding the remainder leaving approximately 864 independent samples/word. The amplitude, phase, and delay of the 128 most powerful samples are used to describe the channel's impulse response. For the unobstructed paths with little dispersion the 128 points will respresent the entire dynamic range of the measurement. For the obstructed line of sight measurements with high dispersion the 128 points will not always respresent the entire dynamic range of the measurement. The noise parameter included with each impulse response record can be used to stuff the missing data points.

SYSTEMATIC MEASUREMENT ERROR

Independent 5 MHz quartz frequency standards were used for frequency references at the transmitter and receiver. After frequency synchronization, I and Q components rotated 360 degrees every 10 seconds. If the time to record one impulse is .108 s, it can be shown that there is a systematic 3.6 degree phase error from the start to the end of the impulse due to frequency synchronization.

Amplitude imbalance between I and Q channels may cause a systematic phase error. The amplitude imbalance between I and Q channels was calibrated in a "back to back" configuration. As the I and Q channels rotated, amplifiers in the I and Q channels were adjusted for equal peak amplitudes.

There is a steady increase in the arrival time of the first multipath component. This is due to the increasing transmitter and receiver distance as the cart is moved down the measurement path.

REFERENCING THE DATA SET

Simulations or reports that use this measurement data should reference the NTIA report (NTIA Report 93-292, January 1993) that describes the measurements. In addition the ITS data cataloging number (ITSIR001) and release date should be referenced.

FILE FORMAT

To insure compatibility across all computers, these files have been written in ASCII format. The files have been "zipped" with a public domain compression program and can be "unzipped" with the executable that accompanies the data. Each file represents one measurement path in the office and is labelled ITSIR001.00f where f is the path number 1 through 8.

Following is a key to terminology used and an example file. The example file contains only a few $\tau_k, \beta_k, \theta_k$ for brevity.

TERMINOLOGY

PATH	measurement path cart travelled
IRM	impulse response measurement
MPC	multipath component
TX/RX LOC	transmitter/receiver location (m)
FREQ	carrier frequency (MHz)
TX PWR	power (dBm)
TX/RX LOSS	loss including variable attenuator, cables (dB)

TX/RX ANT	antenna nominal azimuthal gain (dB)
TX/RX ANT DESCR	model number, type, polarization, beamwidths, etc
SPARE	for future use
NOISE	noise floor of original samples (average of 3 lowest)
CHIP RATE	PN word chip rate (Mchips/s)
CHIPS/WORD	Number of chips per PN word
IRM MANY	Number of impulse response measurements in file
MPC MANY	Number of measurement samples in impulse response record
τ_k	Delay of k-th sample (0 to 1270 ns)
β_k	Amplitude of k-th sample (0 to 32000×10^{-4} volts)
θ_k	Phase of multipath component (-3.14 to 3.14 radians)

EXAMPLE FILE

Institute for Telecommunications Sciences
325 Broadway, Boulder, Co 80303
Data Release: 05/30/93
Reference: NTIA Report 93-292
TESTNAME: Soft Partitioned Office
PATH START 1
TX LOC +00.00,+00.00
FREQ 1500.00
TX PWR +17.6
TX LOSS +19
TX ANT +2.5
TX ANT DESCR model# discone pol:vert az:360 el:60
RX LOSS +10
RX ANT +2.5
RX ANT DESCR model# discone pol:vert az:360 el:60
SPARE
SPARE
SPARE
SPARE
CHIP RATE 100
CHIPS/WORD 7
IRM MANY 2
IRM START 1
RX LOC +11.11,+11.11
NOISE 20011
SPARE
SPARE
MPC MANY 128
111.0,23470,+1.46
114.2,28410,+1.96
...
247.9,02130,-0.83
IRM END
IRM START 2
RX LOC +22.22,+22.22
NOISE 2022
SPARE
SPARE
SMP MANY 128
080.9, 1682,-0.81
114.2,22841,+1.96
...
247.9,10213,-0.83
IRM END

PATH END

REFERENCES

[Papazian, 1992a], P.B.Papazian, R.J.Achatz, "Wideband Propagation Measurements for Wireless Indoor Communication", IEEE 802 Submissions, IEEE P802.11-92/83, pp.1-28

[Papazian, 1992b], P.B.Papazian, et al., "Wideband Propagation Measurements for Wireless Indoor Communication", NTIA Report 93-292, January 1993