CROSSPOLARIZATION COUPLING MEASURED
FOR 800 MHZ RADIO TRANSMISSION IN AND
AROUND HOUSES AND LARGE BUILDINGS

D. C. COX*
R. R. MURRAY*
H. W. ARNOLD*
A. W. NORRIS**
M. F. WAZOWICZ**

I. INTRODUCTION

Signal impairments that decrease radio link quality for portable radiotelephones result from multipath propagation and from random orientation of the radiotelephone antenna. The low signal levels caused by random orientation can be mitigated by using diversity in reception or in adaptive retransmission. The random orientation effects are also reduced by crosspolarization coupling that can occur at scatterers or reflectors causing multiple propagation paths.

II. THE MEASUREMENTS

The 816 MHz residential measurements are described in detail in References 1 and 2. The residential measurements were made from an instrumentation van parked at different fixed locations. A 27-foot-high erectable collinear array antenna with an 18° vertical beamwidth was mounted on the van. Signal levels were received and recorded in the van from a portable signal source moved in and around eight houses. The signal source antenna was a half-wavelength coaxial sleeve dipole attached to the portable unit.

Measurements were also made within two large buildings using the same signal source. The instrumentation receiver and an antenna were mounted on a cart and moved to locations in corridors within the two buildings. The receiving antenna was a vertical half-wavelength coaxial sleeve dipole and was raised to within one foot of the ceiling at each location.

The Crawford Hill Laboratory is a two-story building housing approximately 150 people. The building has two main corridors intersecting in a "T" shape, with rooms on both sides of each corridor. Inside walls are built of wood and wallboard; outside walls are largely glass. Ceilings and floors are reinforced concrete.

*Bell Communications Research, Holmdel, NJ, USA
**AT&T Bell Laboratories, Holmdel, NJ, USA
The Holmdel Laboratory houses approximately 6,000 people, has 5 above-ground floors, and is made up of 4 buildings separated by a large central open area. The complex is enclosed with metallized glass walls. Corridors run in one direction through each building, with rooms on both sides. Some interior walls are metal; others are wallboard. Ceilings and floors are reinforced concrete.

Crosspolarization coupling is defined as $20 \log \left( \frac{E_x}{E_t} \right)$, where $E_t$ is the average or median field magnitude of the polarization aligned with the transmitted polarization and $E_x$ is the average (or median) field magnitude of the polarization orthogonal (crossed) to $E_t$. An indication of the crosspolarization coupling can be obtained by orienting the signal-source dipole antenna vertically and scanning a 4 foot square area to determine the signal median. The scan can be repeated with the dipole oriented horizontally. If the multipath propagation were uniformly distributed in azimuth around the measurement location and were confined to a horizontal plane, horizontally polarized multipath would produce a median received signal level in a scanned horizontal dipole that was 3 dB less than the median that would be produced by the same multipath in a scanned loop oriented with its plane horizontal. Equal median received signal levels for end-on and broadside horizontal scans of the source dipole would be consistent with multipath having a uniform azimuthal distribution. A better estimate of the crosspolarized signal median under these conditions can be obtained by averaging these two medians. The definition used here for crosspolarization coupling (XPOL) includes the 3dB antenna factor and is:

$$\text{XPOL} = \frac{1}{2} \left[ \frac{L_h (\text{broadside})}{L_h (\text{end-on})} \right] - L_v + 3\text{dB}.$$  \hspace{1cm} (1)

### III. RESULTS

Figure 1 shows measurements of XPOL versus copolarized signal level taken in and around the eight houses. The reference level for the copolarized signal for these data was measured over a 14.2 foot free-space path. Significant crosspolarization coupling XPOL (approaching 0 dB) exists at most locations, both inside and outside the houses tested. The locations with low XPOL usually had shorter and less-obstructed paths between the portable signal source and the van-mounted receiving antenna.

Figure 2 shows measurements of XPOL versus copolarized signal level taken within the large buildings. The reference level for the copolarized signal for these measurements was a 1.85 foot free-space path between the sleeve dipole transmitting and receiving antennas. In these buildings both median and mean XPOL values were significantly greater than zero; the median XPOL observed at Holmdel was +1.8 dB. This suggests that significant propagation paths may exist outside the horizontal plane. This seems reasonable, since most of the data were taken with transmitter and receiver on different floors.
IV. CONCLUSIONS

This paper summarizes measurements of crosspolarization coupling at 816 MHz on short paths into and around houses and within two large buildings. Nearly complete coupling was seen for all paths except for a few residential paths having high copolarized signal levels. Because of this nearly complete coupling, random orientation of radiotelephones will not cause significant degradation of signal quality for radio links implemented with or without diversity. 3, 4

REFERENCES


