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A Land Mobile Radio Coverage Area Prediction Model For New Zealand.

by

G. B. Rowe.

A Thesis submitted in fulfilment of the requirements of the degree of Doctor of Philosophy.

Department of Electrical and Electronic Engineering.

University of Auckland.

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This thesis describes research undertaken as an initial step in the development of a nationwide land mobile coverage area prediction model for New Zealand. The most suitable approach is shown to be a computer-based method which includes corrections for both environmental and terrain features. Extensive field trials performed in Auckland at 76 and 465 MHz to develop a propagation data base are described. Measurements have been made in a variety of environments over unobstructed, obstructed and mixed land-sea paths. An analysis of these measurements indicates that, subject to the availability of suitable topographic and environmental data bases and with the exception of two special cases, a plane earth based prediction method is suitable for incorporation in a nationwide land mobile coverage area prediction model for New Zealand. Recommendations are made for the implementation and further development of this model.
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GLOSSARY.

a The largest linear dimension of an antenna.

$\text{ae}$ The effective earth radius.

A Surface wave attenuation factor.

$\text{Ae}$ Diffraction loss relative to free space.

$\text{AgC}$ An antenna's effective aperture.

$\text{AOGC}$ An amplitude pattern of an antenna.

AAC Auckland City Council.

AE A path loss.

AFS Free space propagation loss.

AGC Automatic gain control.

AM A path loss.

APE Amplitude modulation.

BBC British Broadcasting Corporation.

A clutter factor.

C The Rayleigh Criterion.

$\theta$ A clutter factor.

CBD Central Business District.

CCIR International Radio Consultative Committee.

CPU Central Processor Unit.

d Path length.

D The divergence coefficient.

d$_1$, d$_2$ Distances to the horizon.

$\text{dbI}$ Decibels relative to isotropic.

$\text{dbm}$ Decibels relative to 1mW.

$\Delta$ A phase difference.

$\Delta n$ A quantitative measure of terrain irregularity.

$\Delta \phi$ A phase difference.

$\Delta r$ A path difference.

DSIR Department of Scientific and Industrial Research.

E, $E_f$ rms field strength.

$E(\theta)$ Amplitude pattern of an antenna above a plane reflector.

$\varepsilon$ Dielectric constant of the ground.

$\varepsilon'$ The complex permittivity.

$\varepsilon_r$ Relative permittivity.

erfc Complementary error function.

f Frequency.

$F_B$ Propagation loss over a smooth earth.

FOC Federal Communications Commission.

$F_{EP}$ Propagation loss over a profile containing a number of knife edges, calculated using the Epstein-Peterson method.

FR Frequency modulation.

$F_R$ Loss over obstructed path.

G Antenna gain in dB.

g Refractive index gradient.

$G_b$, $G_b$ Base (transmitting) station antenna gain.

$G_m$, $G_m$ Mobile (receiving) antenna gain.

$\gamma$ An angle of incidence.

h Surface irregularity height.

hc Obstacle clearance height.

$h_0$ Minimum effective antenna height.

$h_1$, $h_2$ Antenna heights.
$h_b, h_m$ Heights of the transmitting (base) and receiving (mobile) antennas.

$h_r, h_r'$ Effective antenna heights for the transmitter and the receiver.

$I/O$ Input/Output.

$JRC$ Joint Radio Committee of the Nationalised Power Industries.

$K$ The effective earth radius factor.

$L$ Land usage factor.

$L_{bf}$ Basic free space loss in dB.

$\lambda$ The wavelength.

$MODEM$ Modulator and demodulator unit.

$n$ Atmospheric refractive index.

$n_0$ Surface value of atmospheric refractive index.

$N_s$ Surface value of the refractivity.

$NZMS$ New Zealand Map Service.

$\nu$ The Fresnel diffraction parameter.

$P$ Total pressure in millibars.

$p$ Partial pressure of water vapour in millibars.

$P_{Q}$ Power flux per unit area.

$P_0$ Power received.

$P_t$ Transmitter output power.

$P_{sr}$ Operationally required probability of successful communication.

$P_s$ Probability of successful communication.

$p(x)$ Probability density function of the normal random variable $x$.

$\phi'$ A phase lag.

$\psi$ A grazing angle.

$\phi$ A diffraction angle.

$R$ Reflection coefficient of the ground.

$R_{r}$ Predetection signal-to-unwanted signal ratio.

$R_r'$ The value of $R$ required for user-determined acceptable performance.

$R'$ Modified earth reflection coefficient (taking the divergence into account.)

$r$ Ray radius.

$R_e$ Crest radius.

$r_{n}$ Effective ray radius.

$r_n$ Radius of the $n^{th}$ Fresnel zone.

$s$ The percentage of the total area in a unit of 2 sq. km occupied by buildings and vegetation.

$\sigma$ Index of curvature.

$rms$ Root mean square.

$S/N$ Signal to noise ratio.

$\sigma'$ Conductivity of the earth.

$T$ Standard deviation of the path loss.

$TASO$ Absolute temperature in degrees Kelvin.

$\Theta$ Television Allocation Study Organization.

$\theta$ Angle of Incidence.

$\theta_0$ The diffraction angle.

$U$ The degree of urbanisation factor.

$UHF$ Ultra High Frequency.

$VHF$ Very High Frequency.

$x$ A normal random variable describing the local mean received power.

$\bar{x}$ The mean of $x$.

$X_0$ User specified threshold of $x$.

$z$ An intermediate term used in the calculation of the earth's reflection coefficient.