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

by

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of the degree of Doctor of Philosophy.

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ABSTRACT.

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 465MHz 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. |
| a_e | The effective earth radius. |
| A | Surface wave attenuation factor. Diffraction loss relative to free space. |
| A_e | An antenna's effective aperture. |
| $A(\theta)$ | An amplitude pattern of an antenna. |
| ACC | Auckland City Council. |
| AE | A path loss. |
| AFS | Free space propagation loss. |
| AGC | Automatic gain control. |
| AM | A path loss. Amplitude modulation. |
| APE | Plane earth propagation loss. |
| BBC | British Broadcasting Corporation. A clutter factor. |
| C | The Rayleigh Criterion. |
| β | 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. |
| dBi | Decibels relative to isotropic. |
| dBm | Decibels relative to 1mW. |
| Δ | A phase difference. |
| Δh | A quantitative measure of terrain irregularity. |
| $\Delta\phi$ | A phase difference. |
| Δr | 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. |
| ϵ | Dielectric constant of the ground. |
| ϵ' | The complex permittivity. |
| ϵ_r | Relative permittivity. |
| erfc | Complementary error function. |
| f | Frequency. |
| FB | Propagation loss over a smooth earth. |
| FCC | Federal Communications Commission. |
| FEP | Propagation loss over a profile containing a number of knife edges, calculated using the Epstein-Peterson method. |
| FM | Frequency modulation. |
| FR | 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. |
| γ | An angle of incidence. |
| h | Surface irregularity height. |
| h_c | 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_t, 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. |
| λ | The wavelength. |
| MODEM | Modulator and demodulator unit. |
| n | Atmospheric refractive index. An integer. |
| n_0 | Surface value of atmospheric refractive index. |
| N_s | Surface value of the refractivity. |
| NZMS | New Zealand Map Service. |
| v | The Fresnel diffraction parameter. |
| P | Total pressure in millibars. |
| p | Partial pressure of water vapour in millibars. |
| P_a | Power flux per unit area. |
| P_0 | Power received. |
| P_r | Received power. |
| 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. |
| ϕ | A phase lag. |
| ψ | A grazing angle. A diffraction angle. |
| R | Reflection coefficient of the ground. 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. Crest radius. |
| r_e | Effective ray radius. |
| r_n | Radius of the n^{th} Fresnel zone. |
| ρ | The percentage of the total area in a unit of 2 sq. km occupied by buildings and vegetation. |
| ρ | Index of curvature. |
| rms | Root mean square. |
| S/N | Signal to noise ratio. |
| σ | Conductivity of the earth. Standard deviation of the path loss. |
| T | Absolute temperature in degrees Kelvin. |
| TASO | Television Allocation Study Organization. |
| θ | Angle of incidence. |
| θ_D | 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. |