

UNITED STATES DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

RADIO CHANNEL CAPACITY LIMITATIONS

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U.S. DEPARTMENT OF COMMERCE
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**UNITED STATES DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS**

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The research conducted at the Institute for Telecommunication Sciences and reported in this paper was supported by the Electromagnetic Compatibility Analysis Center, North Severn, Annapolis, MD 21402, as one of the ECAC Propagation Development Tasks, MIPR No. FY7620 -77-00078.

PREFACE

The research conducted at the Institute for Telecommunication Sciences and reported in this paper was supported by the Electromagnetic Compatibility Analysis Center, North Severn, Annapolis, MD 21402, as one of the ECAC Propagation Development Tasks, MIPR No. FY7620 -77-00078.

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LIST OF SYMBOLS AND ACRONYMS

| | |
|----------|--------------------------------------------------------------------------------|
| AM | Amplitude modulation |
| ASK | Amplitude shift keying |
| b | Bits as in bits per second, b/s |
| B | Ideal baseband filter bandwidth in Hertz effective noise bandwidth in Hertz |
| B_a | Available bandwidth of allocated bandwidth |
| B_c | Coherent bandwidth |
| B_T | Total bandwidth occupied by a signal or sequence of symbols |
| C | Channel capacity in bits/s |
| cm | Centimeters |
| D | Distortion factor |
| dB | Decibels |
| DPSK | Differential phase shift keying |
| e | Naperian Base (2.71828...) |
| E_b | Energy per bit |
| ECAC | Electromagnetic Compatibility Analysis Center |
| $E(R_c)$ | Error exponent |
| f_c | Carrier frequency |
| FM | Frequency modulation |
| FSK | Frequency shift keying |
| GHz | 10^9 cycles/s |
| H | Information bits per symbol ($\log_2 m$) |
| Hz | 10^0 cycles/s |
| ITS | Institute for Telecommunication Sciences |
| k | Boltzmann's constant, 1.38×10^{-23} joules per degree Kelvin |

| | |
|-------|-----------------------------------------------------------|
| k | Constant proportionality factor |
| kHz | 10^3 cycles/s |
| km | Kilometers |
| L | Level of diversity |
| LOS | Line of sight |
| m | Number of distinguishable signals |
| ms | Milliseconds or 10^{-3} seconds |
| MHz | 10^6 cycles/s |
| n | Number of frequency channels |
| N_o | Noise power spectral density, watts per Hertz, W/Hz |
| ns | Nanoseconds or 10^{-9} second |
| OT | Office of Telecommunications |
| PCM | Pulse code modulation |
| P_e | Probability of symbol error or bit error in binary system |
| P_k | Received power at delay time τ_k in watts |
| PM | Phase modulation |
| PN | Pseudo random |
| PSK | Phase shift keying |
| R | Information or data rate in bits/s |
| RAKE | Spread spectrum system used to reduce multipath effects |
| R/B | Packing ratio in bits/s/Hz |
| rms | Root mean square |
| S | Average received signal power in watts |
| S_d | rms delay spread in units of time |
| T | Time in seconds required to send one information bit |
| T | Temperature in degrees Kelvin |
| T_s | Signal duration |

| | |
|------------|--------------------------------------------------|
| W | Watts |
| x | Fade distribution |
| Δf | Frequency separation in Hertz |
| λ | Wavelength |
| μs | Microseconds or 10^{-6} seconds |
| ρ | Correlation coefficient |
| τ | Time in seconds required to send a symbol |
| τ_a | Minimum delay of signal arrival in units of time |
| τ_k | Arbitrary delay increment in units of time |
| τ_m | Maximum delay of signal arrival in units of time |
| τ_o | Mean path delay in units of time |
| \sum | Summation |