EFFECTS OF NOISE ON VHF SATELLITE COMMUNICATIONS

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INTRODUCTION

• MOTIVATION FOR MEASURING MAN-MADE NOISE AT VHF (137 MHz)
• PREDICT LINK MARGIN FOR SATELLITE BROADCAST OF DIGITAL WEATHER SATELLITE IMAGES
• PUBLISHED NOISE DATA
  MAN-MADE - 25+ YR. OLD MEASUREMENTS
• MAN-MADE NOISE = T(TECHNOLOGY)
• VHF MEASUREMENT RESULTS
• UHF MEASUREMENT RESULTS
• SUMMARY
CNR at the Earth Station = EIRP - $L_b$ - NOISE
Basic Transmission loss $L_b = L_{\text{free space}} + \text{Attn}$
NOISE = ?
RADIO NOISE

• NATURAL RADIO NOISE
  – Atmospheric (distant lightning)
  – Galactic
  – Sun
  – Rain
  – Cosmic Background

• MAN-MADE RADIO NOISE
  – Business
  – Residential
  – Rural
  – Quiet Rural
A: Estimated median business-area man-made noise
B: Galactic noise
C: Galactic noise (toward galactic center with infinitely narrow bandwidth)
D: Quiet sun (1/2 degree beamwidth directed at sun)
E: Sky noise due to oxygen and water vapor (very narrow beam antenna); upper curve 0° elevation angle; lower curve, 90° elevation angle
F: Black body (cosmic background), 2.7 K

Median Values of $F_a$
Percent of Time $F_a$ is Exceeded
Cumulative distribution of CNR for a business noise environment with the low-end receiving system.
Cumulative distribution of CNR in a residential noise environment with the low-end receiving system.
NOISE

POWER LINE

COMPUTER PART & RF DEVICES

AUTOMOBILE

CELLULAR

ISSUES:
CURRENT NOISE LEVELS & TRENDS
SPECTRAL CHARACTER OF NOISE

 EFFECTIVENESS OF COMMUNICATIONS SYSTEM
MEASUREMENTS

- CUSTOM RECEIVER 2.9 dB NOISE FIGURE AND ABOUT 80 dB DYNAMIC RANGE
- MEASURED FIRST ORDER STATISTICS FOR LONG PERIODS OF TIME (E.G., DAYS)
- - 30,000 ENVELOPE SAMPLES/MIN
- BUSINESS, RESIDENTIAL, AND RURAL ENVIRONMENTS
- DEVELOPED STATISTICAL NOISE MODELS FOR SIMULATION
Automotive at Clear Creek Canyon
Electrical network near Leyden
Denver West Office Park near residential area
Denver West Office Park near highway
Denver West Office Park
RAD residence
INSTITUTE FOR TELECOMMUNICATION SCIENCES
International Symposium on Advanced Radio Technologies, Sep 8-10, 1999

RAD residence

Hour of 11/17/96

dB above $kT_0$
Class B noise measurements near from a noisy rural power line West of Denver on 11/12/96 at 2:02 p.m., average power = 22.6 dB/kT₀b.
Class B noise measurements in Denver West Park on 11/27/96 at 11:15 to 11:45 a.m., average power = 14.7 dB/kT_o b. A constant narrowband noise source yields the characteristic Nakagami-Rice behavior for lower powers.
Predicted within-the hour variations in mean noise power for four environments, based on CCIR methods.
Power averaged from measurements at six urban sites.
Power averaged from measurements at six urban sites.
ISM BAND EMISSION MEASURED IN DOWNTOWN DENVER (2460 MHz)
• **SIGNIFICANT CHANGES IN MAN-MADE NOISE AT 137 MHz**

• **MEAN POWER LEVELS OVERALL ARE LESS**

• **TIME VARIABILITY CHANGED**

• **SIGNIFICANT VARIATION WITHIN ENVIRONMENT CLASSIFICATIONS - PARTICULARLY BUSINESS**
  
  – Automotive emissions reduced
  
  – Power lines appear to be variable and can have significant emissions - density of power line has increased
  
  – Many *new* sources of man-made noise (computers, switching devices, efficient electric motors, microwave ovens, etc.)

• **MORE VHF AND UHF MEASUREMENTS NEEDED**