FCC Technical Exhibit A
E-Predict Field Test
Validate Algorithms

By Claude Caci
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Introduction

The Public Safety and Criminal Justice division of Lockheed Martin Integrated Systems and Solutions (ISS) is executing a research project to develop a software tool to verify a Public Safety customer's contract requirements for a communication radio system have been met. Lockheed Martin is in a partnership with Virginia Tech University to do research on this subject. Both organizations will participate in this effort. Lockheed Martin will assume full responsibility for transmission group equipment and operations. Software verification will eliminate the schedule and expense of field test verification. This software is a new approach to the quality (accuracy) of wireless signal coverage prediction. The components of this task are: (1) develop algorithms and a software for improved RF coverage prediction that requires less costly up front field-testing, and (2) Prove algorithms and software do improve RF coverage prediction. A periods of field testing is required over a range of conditions to provide the proof. A number of commercial radio network design tools automate the task of designing land mobile radio (LMR) networks. These tools are good for initial design but lack precision and confidence needed to support design decisions. Commercial radio propagation tools do not take into account precision geographic and climatological data. Because of this they cannot accurately compute signal coverage in a geographic tile. Additionally, commercial models use estimation algorithms which produce estimation coverage maps. To meet a customer's RF coverage requirements, the designer must offer acceptable proof of compliance. COTS estimation models are not accurate and so they require field testing to show compliance. Some level of field testing will always be required but the E-Predict tool will be successful if it can eliminate a good portion of field testing.

Verification Methodology

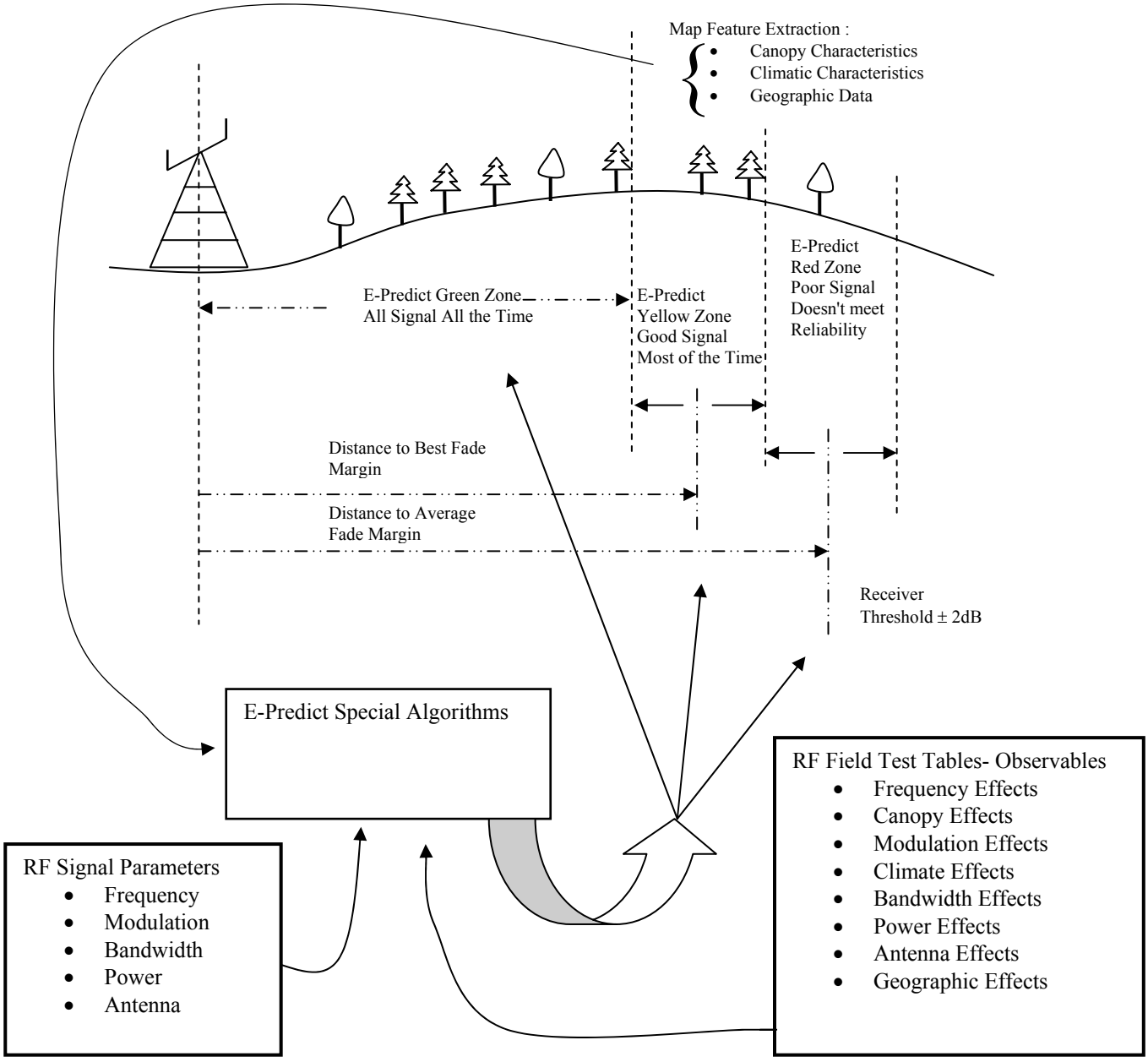
Prediction models are needed during plan and design phase. E-Predict can be used in the design phase to eliminate some of the up front testing needed to provide input for the prediction model. E-Predict is based on detailed knowledge of the geography and climatic conditions. Detailed geographic knowledge and special algorithms will convert a COTS estimation model to a verified map model.

The special algorithms require an R&D test effort to collect information necessary to complete the algorithms. There is no proof that the special algorithms developed in the 2003 IRAD effort will work unless there is an RF field test effort to complete the algorithms and prove they work. The efficacy of these algorithms depends on a rigorous field test effort.

Field Test Outline

This research is predicated on the premise that computer generated data tables incorporating test data and other parameters can be applied by an advanced algorithm to

unknown terrain so the unknown terrain can be accurately known without field test. The figure below shows how geography factors into E-Predict. A COTS receive signal level prediction tool has already produced coverage estimation. Lockheed's E-Predict tool will use this estimation as the basis for a conversion into a certified signal quality map. A certified map is one that does not need field testing in specific tiles designated as certified. Tiles designated uncertain will need to be tested to show they meet customer requirements. It is imperative that tiles designated as certified be within the parameters set within E-Predict. Lockheed's field test will provide the data for the research and development program to produce the E-Predict tool.



The RF Field Test Tables are the critical component of E-Predict. These tables contain the data fusion algorithm between RF signal parameters and the map data. The E-Predict special algorithms are also a product of R&D field tests. In the course of LMR radio propagation investigation ITU published a report detailing the effects of land cover on radio signal propagation, field strength and coverage. The ITU report confirmed our research direction. This direction is towards field tests. Field tests will produce tables of measured data. This data is then compared to detailed ground cover. Where there is a match, then confirmation of accuracy is possible. A unit of geography, a tile can be confirmed in the Green zone. Where the match is close, within specified tolerance units (also determined by field test) the tile is graded yellow. When data indicates no compliance with requirements, the tile is graded red.

Test Procedure

Field test requires a transmit station and a mobile receiving unit. The transmit station is setup to model an actual base station. An antenna is raised to specific height that is determined by the engineer. The antenna pattern is also determined by the engineer. A calibrated signal source is setup to feed a power amplifier. It is critical the calibrated signal source be checked for signal purity and level as it goes into the power amplifier for two reasons, it will affect test results and need to comply with FCC license requirements. The output signal must also be confirmed so we can stipulate that we are in compliance with FCC license. The graphic below shows the emitter setup.

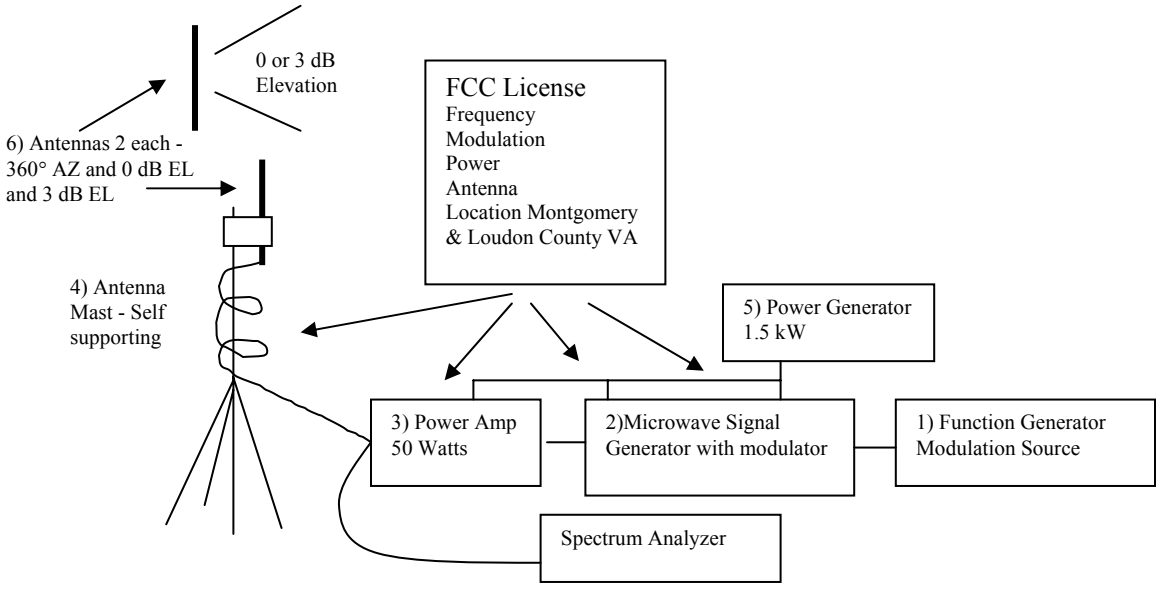


Figure A
Emitter Configuration

First Step

To model public safety frequencies, it will be necessary to use frequencies in or near public safety bands. If it is not possible to get frequencies close to actual operating frequency, the accuracy of the E-Predict tool will deteriorate.

Plans call for testing to be performed in Montgomery County Virginia between the dates of 26 April 2004 through date of 31 March 2005. There is coordination between Montgomery County Public Safety Authority and Lockheed Martin with Virginia Tech University. This program will support public safety land mobile radio networks. Montgomery County will receive a radio propagation report for the county prepared by Lockheed Martin and Virginia Tech University. The emission signal will alternate between CW and APCO-25 at various dates. For example one day at CW and one day at APCO-25. The purpose is to compare propagation between the two signals

Plans call for testing to be performed in Loudon County Virginia between the dates of 10 May 2004 through date of 31 March 2005. There is coordination between Loudon County Public Safety Authority and Lockheed Martin with Virginia Tech University. This program will support public safety land mobile radio networks. Loudon County will receive a radio propagation report for the county prepared by Lockheed Martin and Virginia Tech University. The emission signal will alternate between CW and APCO-25 at various dates. For example one day at CW and one day at APCO-25. The purpose is to compare propagation between the two signals

Second Step

Design test and procure test equipment shown in Figure A. The objective of the test equipment is to connect E-Predict algorithms to physical phenomena. Once a connection can be made and confirmed, then the information can be used to modify the E-Predict algorithms to improve accuracy. The following are steps the test procedure need to perform at Tompkins County. The primary objective of this test is to record the effects of steep terrain and large bodies of water with respect to multipath and indirect line of sight.

- Emit a signal of proper frequency, modulation and power in a controlled manner at the proper elevation to cover a geographic area with specific terrain and land cover features.
- Check the emitter signal and amplification equipment to make sure the signal is at the proper frequency, power and linear in amplitude and free from distortion.
- Measure accurately output power into the antenna and the near field strength for amplitude and linearity.
- Calibrate the receiving equipment group through the entire sensitivity range or a minimum of 60 dB of dynamic range with the lowest range at -120 dBm.

- Verify linearity throughout the sensitivity range (step test)
- Drive a specified route collecting data to compare with E-Predict.
- Stationary receiver setup and observe fading as conditions warrant. Determine cause of fading. Match field conditions to E-Predict conditions.
- Collect multipath data at locations where it is observed and where it is predicted by software tool. Match prediction with actual. Reconcile any differences.

The following are steps the test procedure need to perform at Montgomery and Loudon County, with Virginia Tech. The primary objective of this test is to record collect land cover effects on refraction and absorption. Figure A shows a common emitter setup that will function at Montgomery County. The canopy is long thought to upset polarization and we need proof if this is so. Cross polarization prediction is a key component of the software tool.

Figure B shows a common mobile unit setup that will function for Montgomery County. The same spectrum analyzer in Figure A is in Figure B, it is common to both.

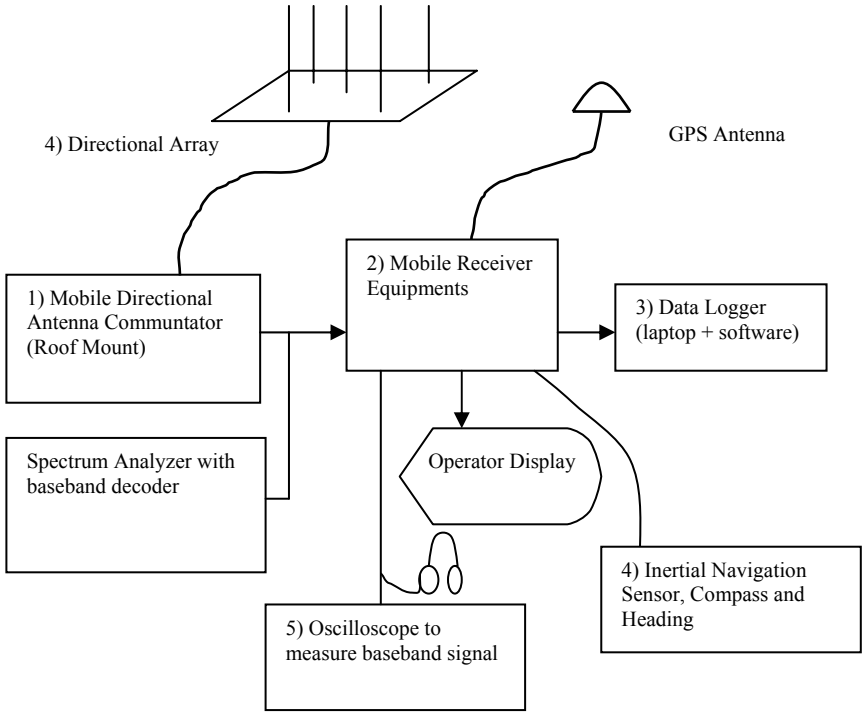


Figure B
Mobile Logging Receiver Equipment Group

The emitter signal will be collected by the mobile logging receiver group along with other data. This operation would last a day at a time. The signal will alternate between an APCO-25 signal and a CW signal. A data base will be created from these tests. The data base will be analyzed and used to develop precise propagation algorithms. In the course of collecting information a county wide report will be developed for each of the two test counties. This report will be freely offered to the public safety authorities to help them better understand land mobile radio propagation in their area.

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