Extensible Software for Automated Testing of Public Safety P25 Land Mobile Radios

Presented by:
Eric D. Nelson and Julie Kub
Institute for Telecommunication Sciences
Public Safety Land Mobile Radio (LMR)
About Project 25

- Formed in 1989 by APCO in conjunction with the Telecommunications Industry association (TIA)
- Response to FCC mandate to narrow bands from 25 kHz to 12.5 kHz and 6.25 kHz BW
- Not the only digital LMR technology, but it’s the only open standard in the United States
- Attempt to overcome shortcomings of Project 16 analog trunking standard
- But it’s not without its own problems…
Issues of non-interoperability and non-conformance pester Project 25.

Congress mandates a P25 compliance program; manufacturers say it should include:

- Interoperability testing (functional testing between manufacturers and models)
- Conformance testing (to required message format and protocol standards)
- Performance testing
Three federal systems

System B goes narrowband
System C goes narrowband

164.0  164.025  164.050  164.075  164.100  164.125  164.150 MHz
Common Air Interface Testing

- Subscriber unit performance testing in accordance with TIA-102.CAAA
  - ITS developing reference implementation of P25 Radio Performance Measurements (RPM)
  - Consists of a series of automated procedures to test both transmitter and receiver performance
  - ITS will seek acceptance from manufacturers on RPM implementation—then to be used to accredit labs
  - Accredited laboratories will test radios and produce reports. Manufacturers will publish results.
  - Testing slated to begin this year
2.1.4 Reference Sensitivity
2.1.5 Faded Reference Sensitivity
2.1.6 Signal Delay Spread Capability
2.1.7 Adjacent Channel Rejection
2.1.8 Co-Channel Rejection
2.1.9 Spurious Response Rejection
2.1.10 Intermodulation Rejection
2.1.11 Signal Displacement Bandwidth
2.1.17 Late Entry Unsquelch Delay
2.1.18 Receiver Throughput Delay
P25 Transmitter Measurements

- 2.2.5 Modulation Emission Spectrum
- 2.2.8 Unwanted Emissions: Adjacent Channel Power Ratio
- 2.2.9 Intermodulation Attenuation
- 2.2.12 TX Power & Encoder Attack Time
- 2.2.14 Transmitter Throughput Delay
- 2.2.15 Frequency Deviation for C4FM
- 2.2.16 Modulation Fidelity
- 2.2.18 Transient Frequency Behavior
Test Suite

- RF Shielded Enclosure
- Desired Signal Source
- Undesired Signal Source
- Combiner
- Automated Test Computer
Spurious Response Equip Diagram
Software Flowchart

1. Initialize RPM Software
2. Select Measurements
3. Reset and Check Instruments
4. Select All Measurement Inputs
5. Run Next Measurement
6. Cleanup
Software Requirements

- Documentation: requirements, design documents, test plans, and bug-tracking
- Database storage of instrument commands, measurement parameters, and results
- Code Templates for creating new instrument drivers and new measurements
- Object oriented design, event loops, and state machines for clarity, code-reuse, and modularity
- Core RPM structure easily extensible
Spurious Response Algorithm

- Find Reference Sensitivity power (Pref) with desired signal generator at carrier freq., add 3 dBm.
- Set the interferer signal generator to: Pref + SRR + 6 dBm
- Loop through interf. freq.: 0.22 MHz – 1 GHz, 10 kHz step, exclude carrier freq. +- 50 kHz
- If BER > 5%, step interf. freq. from -0.05kHz to +0.05kHz, 1 kHz steps, find max BER freq.
- Set to max BER freq., find interf. power (Pspur) for BER = 5%, find spurious rej. = Pspur - Pref
Sample Meas. – Spurious Response
Spurious Response Results

Spurious Response Data

Rejection Ratio [dB]

Interferer Frequency [MHz]
Sponsor Acknowledgements

- Department of Homeland Security’s SAFECOM Program
- Federal Partnership for Interoperable Communications
- Department of Justice CommTech Program
- NIST’s Office of Law Enforcement Standards (OLES)
ITS Staff Acknowledgements

- Eric Nelson, RPM Project Leader
- Julie Kub, RPM Software Leader
- Irena Stange, William Ingram, John Tyler, Raian Kaiser, Automated Test Engineering
- John Vanderau, RF Engineering
- Dr. Robert Stafford, RF Metrology
- Joel Dumke, Engineering Intern
- Ken Tilley, Technical Writer
Contact Information:

Eric D. Nelson and Julie E. Kub
Electronics Engineers

Institute for Telecommunication Sciences
National Telecommunications and Information Administration
US Department of Commerce

NTIA/ITS, 325 Broadway, Boulder, CO 80305
enelson@its.bldrdoc.gov (Eric), jkub@its.bldrdoc.gov (Julie)