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)

SAFECOM

ITS Institute for Telecommunication Sciences
Boulder, Colorado

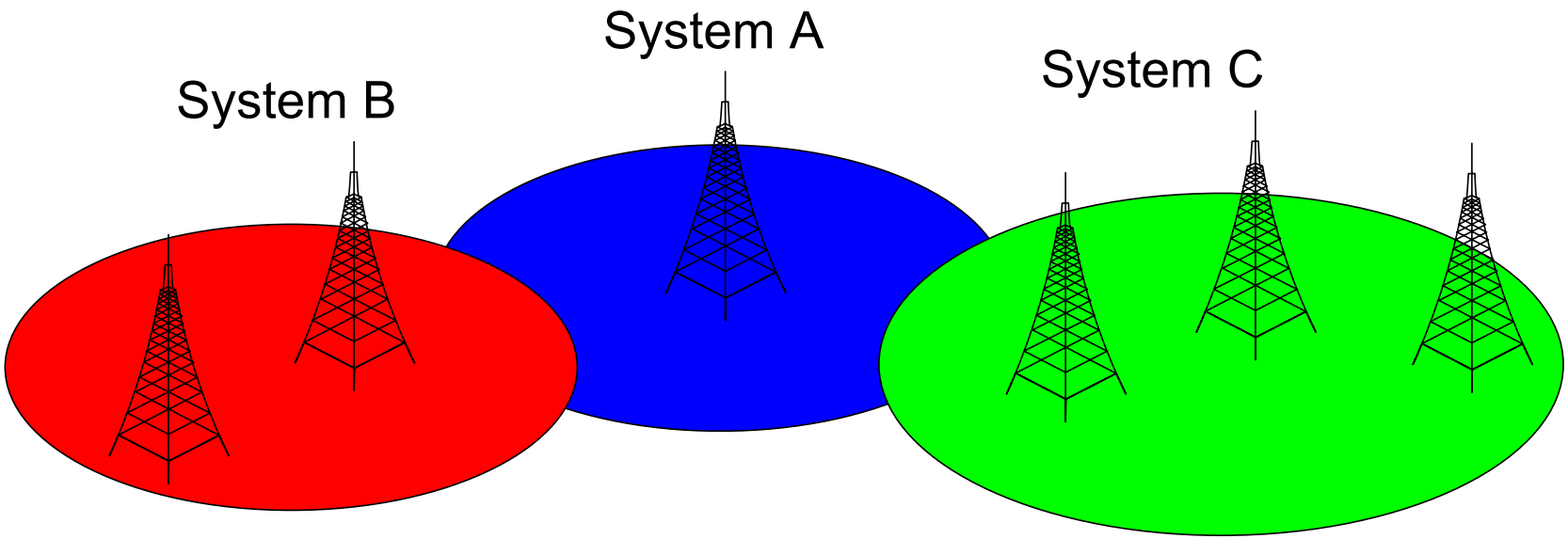
Project 25 Digital LMR

- 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...

Project 25 Digital LMR

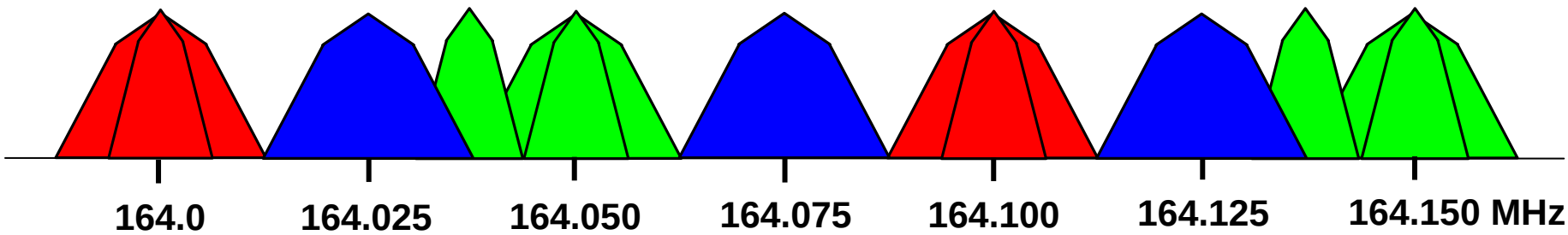
- Issues of non-interoperability and non-conformance pester Project 25
- Congress mandates a P25 compliance program; manufacturers say it should include:
  - Interoperability testing (functional testing between manufacturers and models)
  - Conformance testing (to required message format and protocol standards)
  - Performance testing

Three federal systems



System B goes narrowband

System C goes narrowband



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

P25 Receiver Measurements

- 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

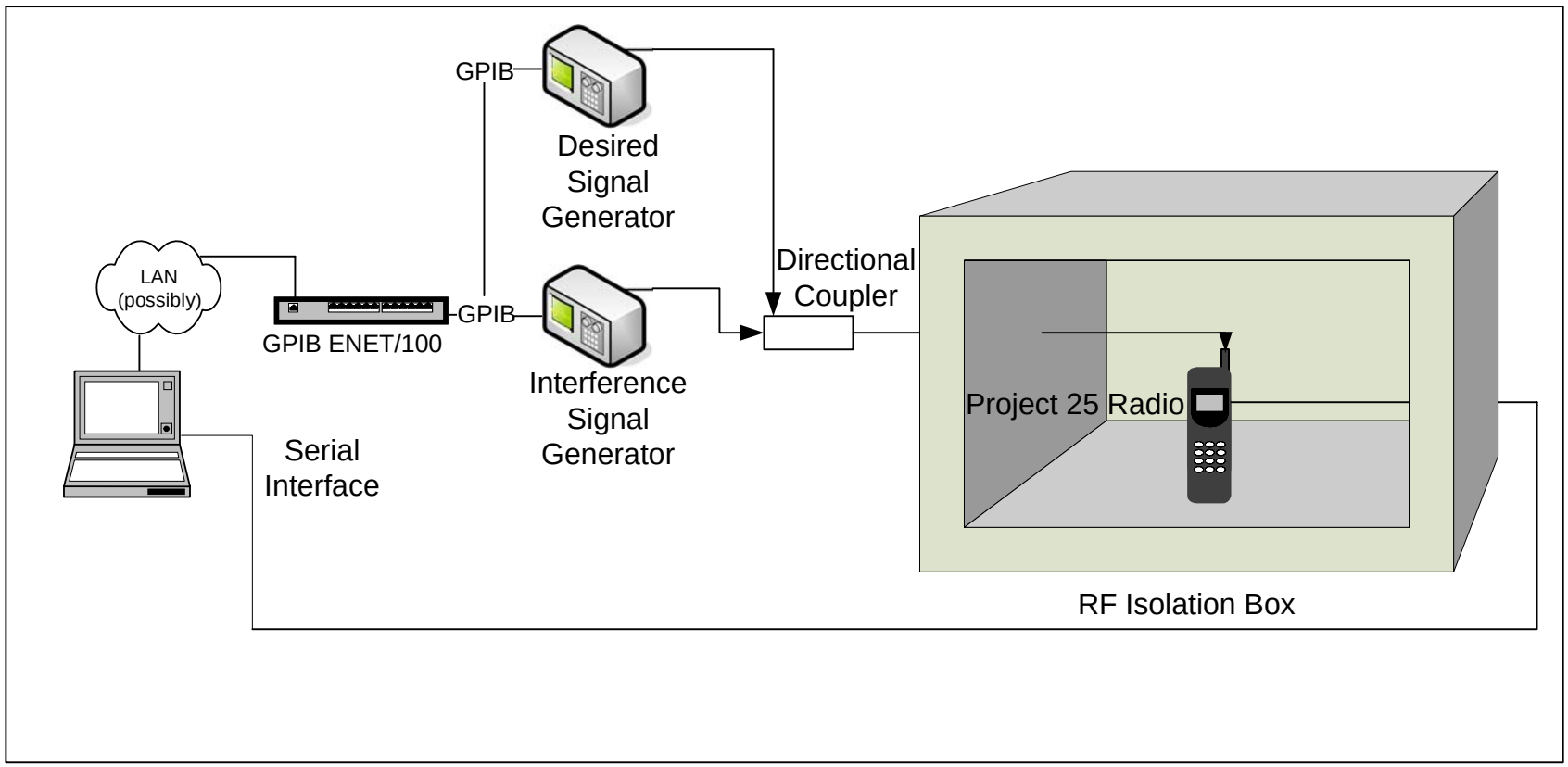
P25 Transmitter Measurements

- 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

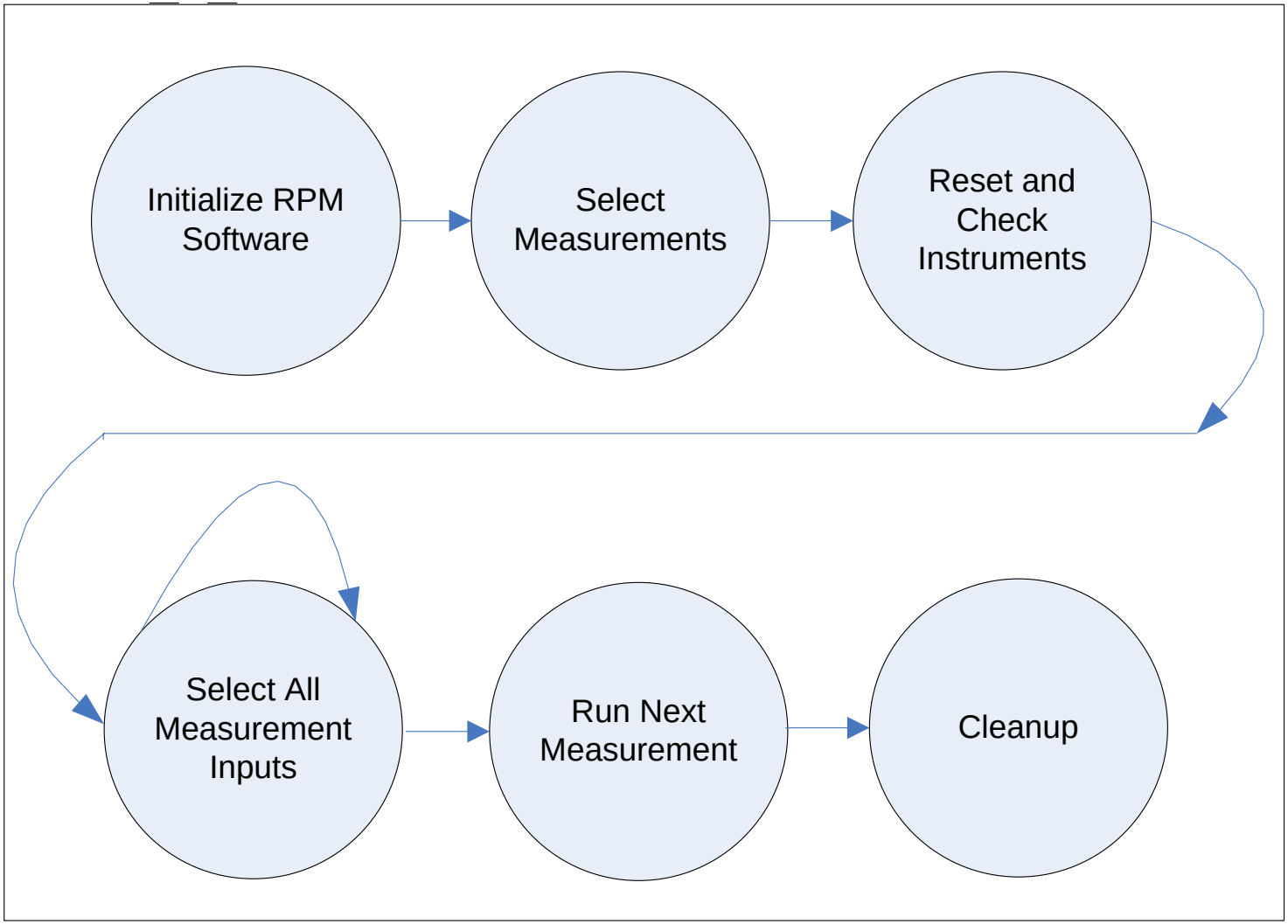
Test Suite

- RF Shielded Enclosure
- Desired Signal Source
- Undesired Signal Source
- Combiner
- Automated Test Computer

Spurious Response Equip Diagram



Software Flowchart



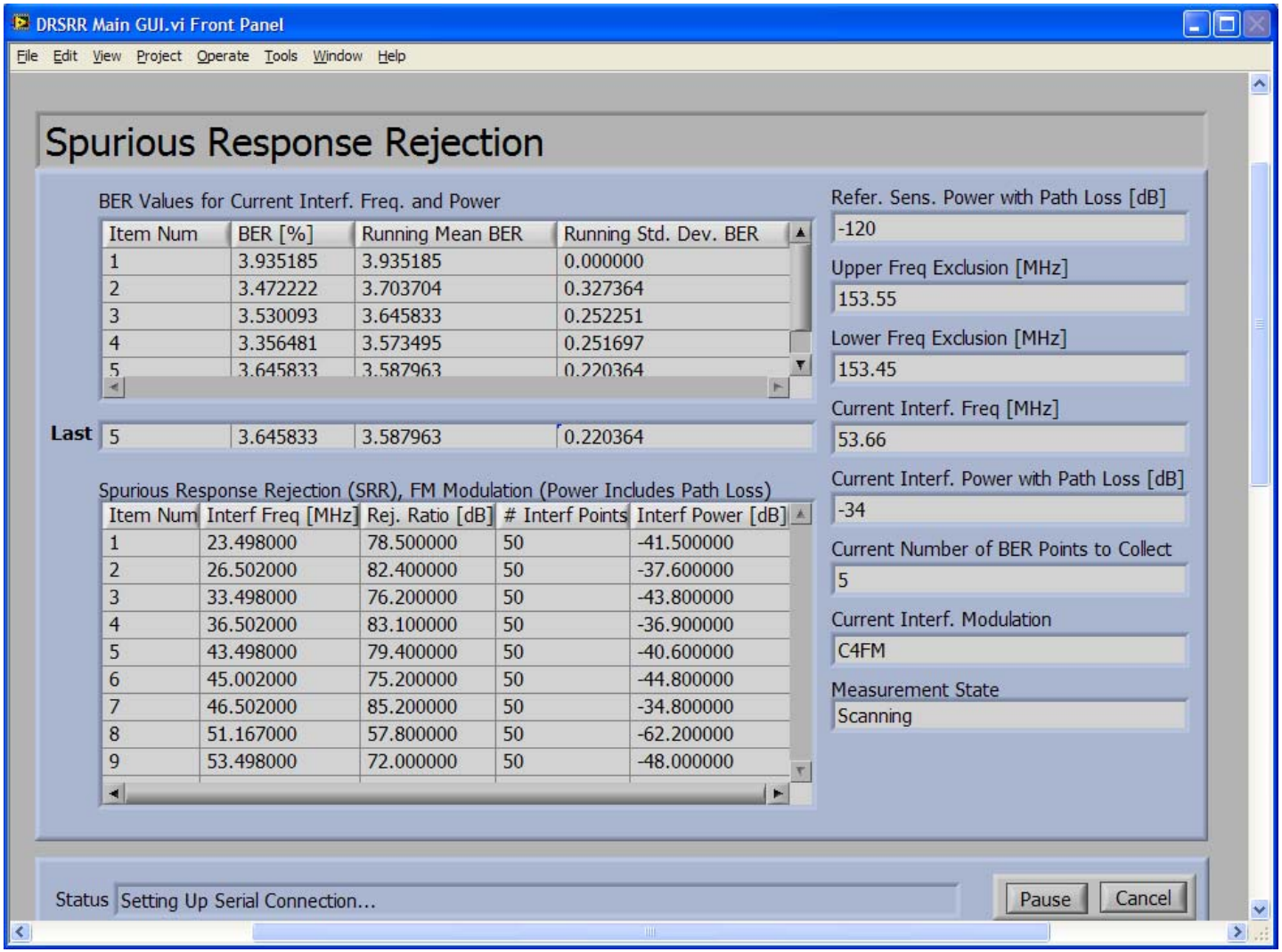
Software Requirements

- 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

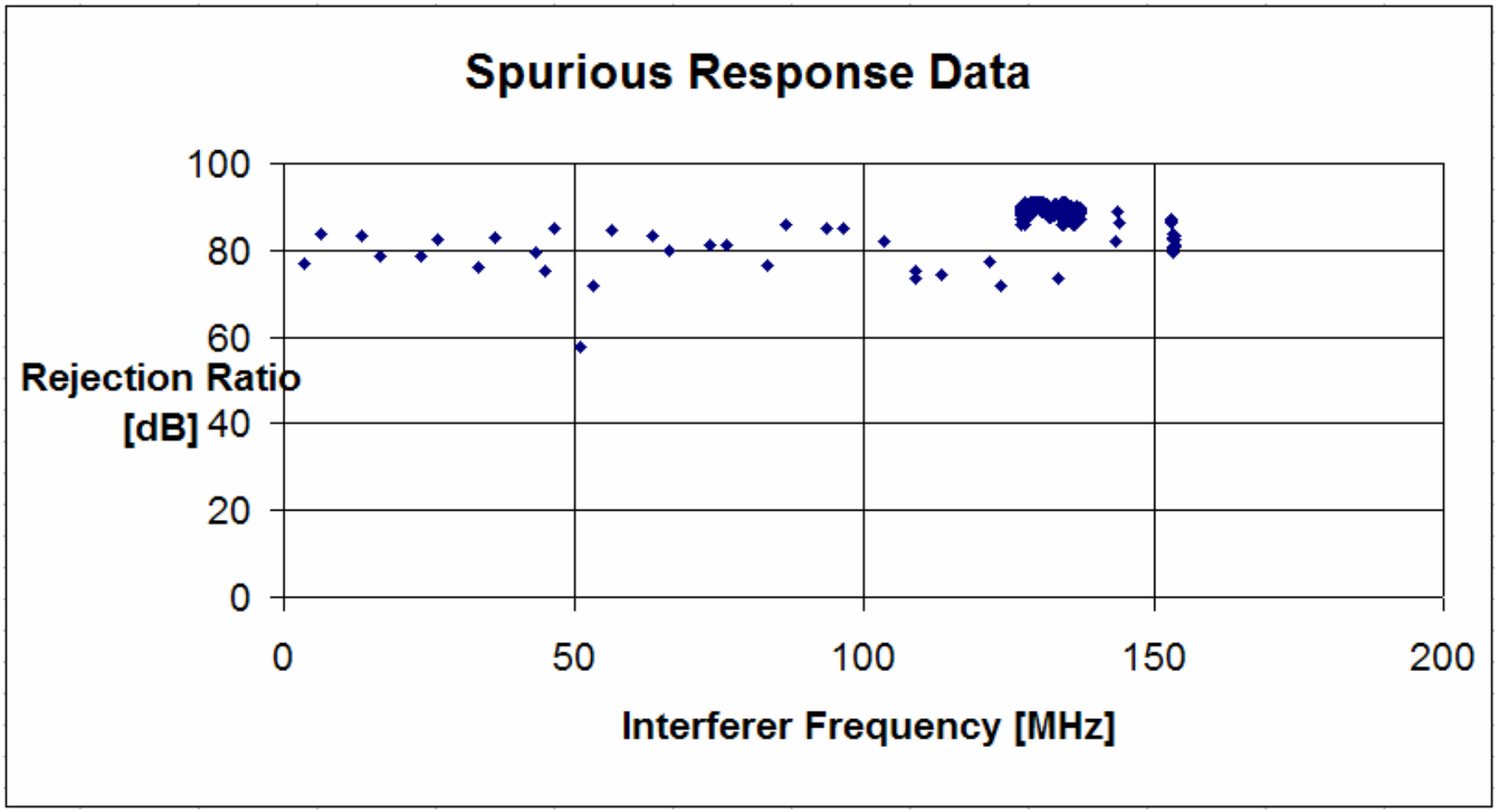
Spurious Response Algorithm

- 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



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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)