The Office of Engineering and Technology held an open house to review the U-NII-4 to DSRC phase 1 test plan on October 21, 2016 at its Laboratory located in Columbia, MD. The test plan consists of three major components as listed below:

**RF Characterization Measurements.** This portion of the test and measurement program will focus on determining values associated with traditional EMC-related transmission parameters such as occupied bandwidth (OBW), channel power, and out-of-band emission (OOBE) characteristics.

**Benchtop Interference Susceptibility Tests.** This portion of the test effort will focus on quantifying the potential impact to DSRC basic safety message (BSM) reception from unmitigated co-channel and adjacent-channel transmissions from the prototype devices.

**Interference Mitigation Tests.** This portion of the testing will evaluate the different distinct strategies that have been proposed for mitigating interference to the DSRC BSM operations from proposed U-NII-4 transmissions.

A copy of the materials presented and list of those in attendance is attached.
AGENDA

U-NII-4 PROTOTYPE DEVICE TESTING OPEN HOUSE

FCC Laboratory, Columbia, MD
October 21, 2016
10:00 AM to 12:00 PM

1. Introduction – Rashmi Doshi

2. U-NII-4-to-DSRC EMC Test and Measurement Plan Overview – Steve Jones

3. Open Discussion – Rashmi Doshi

4. Test Demonstrations
   a. RF Characterization Measurements – Dusmantha Tennakoon
   b. Benchtop Interference Susceptibility Tests – Steve Jones
   c. Interference Mitigation Tests – Reza Biazaran
# DSRC- UNII-4 Open House Attendee List

*(Friday October 21, 2016, Laboratory Division, FCC)*

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<th>Name</th>
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<tr>
<td>Michael Schagrin</td>
<td>Global Automakers (ctr)</td>
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<td>John Kuzin</td>
<td>Qualcomm</td>
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<td>Justin McNew</td>
<td>JMC Rota Inc.</td>
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<td>Brian Gallagher</td>
<td>DENSO Inc.</td>
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<td>Ms. Megumi Suzuki</td>
<td>Subaru</td>
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<td>Bill Graff</td>
<td>TUV Rheinland of North America</td>
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<td>Danielle Pineres</td>
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<td>Andy Scott</td>
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<td>Paul Caritj</td>
<td>Harris, Wiltshire &amp; Grannis LLP</td>
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<td>Austin Bonner</td>
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<td>Michael Cammisa</td>
<td>Association of Global Automakers</td>
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<td>Steve VanSickle</td>
<td>CAMP</td>
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<td>Ehsan Moradi-Pari</td>
<td>Honda R&amp;D Americas, Inc.</td>
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<td>John Kenney</td>
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<td>Mary Brown</td>
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<td>Will Otero</td>
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<td>Bud Zaouk</td>
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<td>Neeraj Dalal</td>
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<td>Ken Leonard</td>
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<td>Kevin Gay</td>
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<td>Tom Schaffnit</td>
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<td>Jason Conley</td>
<td>OmniAir Consortium</td>
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Friday October 21, 2016, Laboratory Division, FCC

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<td>Rajesh Gangadhar</td>
<td>Charter Communications</td>
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<td>Praveen Srivastava</td>
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<td>Audrey Connors</td>
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<td>Hariharan Krishnan</td>
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<td>Radhika Bhat</td>
<td>Mintz Law firm</td>
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<td>Michael Lewis</td>
<td>DLA Piper LLP</td>
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<td>Kev Miller</td>
<td>Squire Patton</td>
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Agenda

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- Open Discussion – Rashmi Doshi
- Test Demonstrations
  - RF Characterization Measurements – Dusmantha Tennakoon
  - Benchtop Interference Susceptibility Tests – Steve Jones
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October 21, 2016
Introduction

- Public Notice (PN) FCC-16-68 released on June 1, 2016.
- PN included an initial general test plan.
- Comments and Reply Comments to the PN and prototype devices submitted for testing have provided information in the development of a more detailed test plan.
- The following slides give an overview of the plan for performing tests and measurements to obtain the requisite data to evaluate sharing proposals.
Test Scope

Information provided to the record alludes to potential sharing between unlicensed local area network (LAN) applications and DSRC operations.

This plan is specific to assessing compatibility between these types of operations.

- Other possible DSRC interference sources, including non-standard unlicensed operations, are not considered within the scope of this effort.
A DSRC radio contains two discrete radios, one dedicated to broadcast and reception of public safety messages, and the second for use in peer-to-peer communications.

To maintain a manageable test scope, only basic safety message (BSM) traffic is being considered in this effort.

- BSM considered to be representative of most DSRC safety messaging in terms of packet structure and length.
- Ongoing discussion of what constitutes safety-related messaging, but general agreement that BSM’s represent fundamental safety aspect of DSRC.
Test Scope (3/4)

Modulation-Coding Schemes (MCS)

- DSRC and proposed U-NII-4 devices operate under the IEEE 802.11 standard and have ability to dynamically assign one of many available MCS combinations depending on prevailing channel conditions.
- Practical considerations applied to reduce the number of MCS combinations for the current test effort
- DSRC BSM’s use MCS 1 (QPSK with ½ coding) and this will be the combination employed in testing.
- U-NII-4 devices not likely to utilize higher order modulation schemes in a DSRC environment, so consideration will be limited to MCS 0 and 2 (BPSK with ½ coding and QPSK with ¾ coding, respectively).
Multiple Input Multiple Output (MIMO)

- The IEEE 802.11ac standard provides for MIMO operations that are likely to be employed by proposed U-NII-4 devices.
- However, due to time constraints, only a single spatial stream will be considered for the proposed U-NII-4 devices.
Test Samples

Several parties for 5.9 GHz expansion have provided prototype U-NII-4 devices for testing in response to the Public Notice.

Some parties have also provided DSRC devices to support the test effort, but these are not all fully-capable devices (e.g., some are only preamble generators).

We are working with DOT to acquire additional representative DSRC radios to support the test effort.

A detailed list of the test sample devices currently in our possession is provided in the test plan.

- 8 U-NII-4 prototype devices
- 6 DSRC devices
Phase I Testing:
FCC Laboratory Tests

Phase I testing has been divided into three discrete components:

– RF Characterization Measurements
– Benchtop Interference Susceptibility Tests
– Interference Mitigation Tests

Each of these components is discussed in the subsequent slides.
Component 1: RF Characterization Measurements

Measurement Objectives
- To quantify and determine parameter consistency among the various test samples.
- To aid in obtaining an understanding of the operational capabilities of the sample devices.
- To identify any potential bugs or glitches prior to use in subsequent testing.

Characterization Measurements to be Performed with U-NII-4 Prototype Devices
- Measure occupied bandwidth (OBW) and emission spectra (fundamental and out-of-band/spurious emissions)
  - Measurements for each supported modulation scheme.
  - Measurements for 20, 40, and 80 MHz channel bandwidths
    - Prototypes provided do not support 160 MHz channel BW
  - Only one spatial stream examined per device.
Component 1: RF Characterization Measurements (2/2)

- Characterization Measurements to be Performed for DSRC Transmitters
  - Measure OBW and emission spectra for 10 MHz DSRC channel bandwidth.

- Characterization Measurements to be Performed for DSRC Receivers
  - Measure minimum receiver sensitivity.
    - Quantify receiver sensitivity applying a standard methodology (i.e., received signal level associated with a 10% PER).

- Compare measured emission spectra (U-NII-4 and DSRC) to applicable IEEE 802.11 emission mask.
Component 2: Benchtop Interference Susceptibility Tests

Test Objective
- To produce data regarding potential impact to reception of DSRC BSM’s introduced by unmitigated (i.e., native CCA-CS only) co-channel and adjacent-channel U-NII-4 transmissions.

Approach
- Basic approach is to introduce a U-NII-4 (undesired) signal to a functioning DSRC broadcast link while observing and recording the effect on typical network performance indicators as the undesired signal is incrementally increased.
Component 2: Benchtop Interference Susceptibility Tests

Test Metrics

- The following network performance parameters will serve as the fundamental metrics for the interference susceptibility tests:
  - Packet Error Rate (PER)
  - Data Throughput
  - Network Latency or Delay
  - Packet Delay Variation (aka, Jitter)

- These parameters will be monitored and recorded during testing utilizing a commercial network analysis software tool.
Baseline Testing

- Establish a conducted DSRC communications link, in which priority messages (BSMs) are broadcast and received.
- Attenuate the DSRC transmitted signal power level to attain a predetermined link margin at the receiver.
- Measure and record baseline values for the identified test metrics under a “no interference” condition.
- Repeat the baseline measurements for additional link margin assumptions.
Test Channels

- The figure below depicts the DSRC channel plan overlaid with the proposed U-NII-4/Wi-Fi channel plan.

![Proposed 5.9 GHz WiFi-DSRC Channel Plan](image-url)
Proposed channel 177 (CF=5885 MHz) will be used for testing DSRC BSM susceptibility to a 20-MHz U-NII-4 signal.

- Channel 177 selected so as to facilitate examination of:
  - co-channel interactions with DSRC channels 176 and 178,
  - first adjacent-channel interactions with DSRC channels 174 and 180,
  - second adjacent-channel interactions with DSRC channels 172 and 182, and
  - Third adjacent-channel interactions with DSRC channel 184.
Similarly, susceptibility tests performed for 40 and 80 MHz channel BWs will utilize proposed U-NII-4 channels 175 (CF=5875 MHz) and 171 (CF=5855 MHz), respectively.

Will utilize a commercial signal suite hosted on a vector signal generator (no CCA) to simulate a U-NII-4 signal to produce one data set that can be used for comparative purposes.
Network Loading Conditions

- Previous tests assume one-on-one potential interference interactions (i.e., ignores influence of network loading).
- The susceptibility tests will be repeated with multiple DSRC devices used to generate simultaneous BSM packets to simulate network loading conditions.

  • The amount of network loading that can be achieved will be determined by the available number of DSRC devices.
Interference Mitigation Tests

Interference Mitigation Proposals

- Three distinct mitigation strategies proposed for enhancing compatibility between proposed U-NII-4 transmissions and DSRC BSM reception.
- One of these proposals is specific to WAN applications and is considered beyond the scope of this effort.

The two mitigation proposals under consideration are:

- The “re-channelization” approach
- The “detect and vacate” proposal.
- Both are intended to preclude co-channel interactions with DSRC receivers.
Interference Mitigation Proposals: “Re-channelization” Approach

Relies on re-channelizing the DSRC frequency band such that all DSRC priority and control messaging is performed on the upper three 10-MHz channels (i.e., DSRC channels 180, 182, and 184), that would continue to be exclusive to DSRC operations.

Proposes to move the channel currently dedicated to Public-Safety V2V messaging (i.e., channel 172) onto one of the three upper channels above 5895 MHz.

The lower 45 MHz of the DSRC spectrum (i.e., DSRC channels 172, 174, 176, 178, and the guard band) would be made available for shared use by DSRC and U-NII-4.

- Reconfigure lower four 10-MHz DSRC channels into two 20-MHz channels to enable use of existing 802.11ac CCA-CS techniques.
- Proposes use of a priority channel access scheme using Enhanced Distributed Channel Access (EDCA).
Interference Mitigation Proposals: “Detect and Vacate” Approach

PN and some commenters also refer to this approach as “Detect and Avoid”.

Proposes detecting and identifying DSRC message traffic present in the lower five DSRC channels (DSRC channels 172, 174, 176, 178, and 180) and to immediately vacate transmission in the 5825-5925 MHz band upon a positive detection.

- Proposed detection threshold of -85 dBm/10-MHz on DSRC channels 172, 174, 176, and 178 (lower 40 MHz) and -65 dBm/10-MHz in channel 180 (via digital image reflection).
- Identification of DSRC signal through demodulation and recognition of unique preamble training symbols.
Component 3: Interference Mitigation Tests

Re-channelization Mitigation Proposal

- Since this approach, particularly the proposed message prioritization scheme using EDCA, is not implemented in the current U-NII-4 prototype devices, direct testing is not practical.
  - If the devices can be upgraded, we will revisit this test
- However, data acquired in previous (Component 2) tests can be used to assess some aspects of the proposal.

Detect and Vacate Proposal

- Initial conducted tests will be performed to determine detection reliability at threshold levels and the time required to vacate the band.
Detect and Vacate Proposal (continued)

- Conducted tests will be repeated with AWGN introduced into channel while observing effect on detection reliability at the threshold level.
- Subsequent tests will be performed using over-the-air (OTA) signals (i.e., radiated test configuration).
- General approach to these tests is to attenuate DSRC signal level at U-NII-4 device while recording the detection success rate over enough trials to obtain a statistically significant representative data sample.
Additional Information

The PN and the detailed test plan are accessible at:

https://www.fcc.gov/oet/unii-4banddevice

Updates and additional test schedules will be published on the website
Questions?