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Office of Engineering and Technology
Laboratory Division

U-NII-4-TO-DSRC EMC TEST AND MEASUREMENT PLAN

PHASE I: FCC LABORATORY TESTS

ET Docket No. 13-49

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I. INTRODUCTION

The Commission released a Public Notice[1] on June 1, 2016 to update and refresh the record in the "Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band" Proceeding.[2] A draft test plan was included as an attachment to the Public Notice that described a general approach for performing laboratory tests intended to collect empirical data that can be used in a technical evaluation of the electromagnetic compatibility (EMC) between proposed 5.9 GHz U-NII-4 transmitters and Dedicated Short Range Communications (DSRC) [3] Basic Safety Message (BSM) reception.[4]

At the time of the Public Notice release, there was not adequate technical detail available with respect to DSRC or U-NII-4 prototype devices, or the interference mitigation proposals to facilitate the development of a detailed test plan. The comments and reply comments submitted to the record, and the prototype devices provided to the FCC laboratory in response to the Public Notice have provided the technical information needed to support the development of the detailed test plan offered herein.

II. TEST SCOPE

This test program is designed to acquire the data necessary to inform further technical analysis of the potential for spectrum sharing between DSRC public safety operations and proposed U-NII-4 devices intended for wireless local area network (WLAN) operations. Other prospective unlicensed operations, e.g., unlicensed wide area network (WAN) applications, are not considered within this effort.

The DSRC system has two primary modes of operation: a broadcast mode and a peer-to-peer mode. A typical DSRC device includes two independent radios: one dedicated to reception and transmission on the channel dedicated to public safety broadcasts (i.e., channel 172), and a separate radio utilized for peer-to-peer communications on the control and general service channels. Although different types of traffic safety-related messages may be broadcast on the public safety channel, the BSM is considered to be representative of the size and frequency of most DSRC safety messages. The basic frame format among broadcast safety-related DSRC messages is similar, but the associated packet lengths will differ. While it is recognized that the packet length may be a factor when assessing network performance in a potential interference interaction, it is also not practical to test all possible packet lengths in combination with the myriad of other variable parameters within the time constraints placed on this effort. Thus, the testing described herein will primarily utilize the BSM frame structure with a packet length of 300 bytes, transmitted every 100 ms, to represent the DSRC message traffic. However, if time permits, some informed (i.e., spot-check) testing will be considered assuming a BSM frame structure and a packet length of 1500 bytes.

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[1] *The Commission Seeks to Update and Refresh the Record in The "Unlicensed National Information Infrastructure (U-NII) Devices in The 5 GHz Band" Proceeding*, ET Docket No. 13-49, Public Notice, 31 FCC Rcd 6130 (2016) (Public Notice).

See Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, ET Docket No. 13-49, Notice of Proposed Rulemaking, 28 FCC Rcd 1769, 1797-98, paras. 92-93 (2013).[3] DSRC uses short-range wireless communication links to facilitate information transfer between appropriately equipped vehicles and appropriately equipped roadside systems ("vehicle to infrastructure" or "V2I") and between appropriately equipped vehicles ("vehicle to vehicle" or "V2V").

[3] DSRC uses short-range wireless communication links to facilitate information transfer between appropriately equipped vehicles and appropriately equipped roadside systems ("vehicle to infrastructure" or "V2I") and between appropriately equipped vehicles ("vehicle to vehicle" or "V2V").

[4] The EMC between DSRC transmitters and proposed U-NII-4 receivers is not considered because the FCC does not recognize interference to unlicensed devices (47 CFR § 15.5(b)).

The devices under consideration in this test effort, both DSRC and U-NII-4, are part of a family of wireless network radios that are required to conform to the IEEE-802.11 standards applicable to local and metropolitan area networks. The operation of such devices can be very complex due to the incorporation of dynamically-selectable transmission parameters (e.g., power, modulation, coding rate, etc.) that are dependent on existing channel conditions and data throughput requirements. For example, the IEEE 802.11ac standard, under which U-NII-4 devices are assumed to be designed, provides for the use of multiple spatial streams, with multiple modulation-coding scheme (MCS) combinations available for each stream. For this test effort only a single spatial stream will be considered, but there are still up to ten individual MCS combinations available for that single spatial stream. Additionally, the IEEE 802.11-2012 standard governing DSRC devices defines eight supported MCS combinations.

An empirical examination of each possible U-NII-4 MCS combination to each possible DSRC MCS combination is not feasible within the established time constraints. Therefore, the number of such combinations to be considered has been culled by applying practical considerations as follows.

The U-NII-4 prototype devices incorporate ten possible MCS combinations, utilizing five available modulation schemes (BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM) and three different coding rates. The higher-order modulation schemes (16-QAM, 64-QAM, and 256-QAM) typically require excellent-to-ideal channel conditions to enable. Since the potential interference interactions under examination (i.e., U-NII-4-to-DSRC) involve operational environments that will not typically be conducive to excellent channel conditions (e.g., outdoor operation in fairly severe multi-path conditions), these available higher-order modulation schemes are unlikely to be employed. Therefore, the U-NII-4 MCS combinations for consideration are reduced to two of the three available BPSK and QPSK modulation schemes. In particular, for the interference testing described herein, BPSK modulation with a ½ coding rate and QPSK modulation using a ¾ coding rate will be utilized to represent U-NII-4 transmissions.

The BSM is intentionally a short message so as to best optimize reception range and potential network loading conditions, and as such, does not require the higher data rates provided by the available higher-order modulation schemes (e.g., 16-QAM and 64-QAM). Rather, BSMs are transmitted using QPSK modulation with a ½ coding rate.[5] Therefore, the MCS combination to be used in establishing the DSRC BSM broadcasts for the interference tests described herein will be the QPSK modulation with a ½ coding rate.

III. TEST SAMPLES

The following U-NII-4 prototype devices have been submitted to the FCC in response to the Public Notice.

- KEA Tech DSRC/802.11 Detectors w/RSMA stub antennas (two devices – one access point and one client)
- Cisco WS-a-00510 STA detector (one device)
- Cisco WS-a-00637 A0 detector (one device)
- Qualcomm/Triad Magnetics 10-Y9345-203 REVA Cascade SR108 Wi-Fi device (2x2) (two identical devices)
- Broadcom OXTK9N U-NII-4 prototype devices with circuit patch antennas (two identical devices)
- CAV Technologies roadside reflector (one device)

[5] SAE J2945/1_201603, Dedicated Short Range Communication (DSRC) Common Performance Requirements, SAE International, March 30, 2016.

Responding parties have also provided the following DSRC devices to support the testing.

- Savari AG2412-B prototype DSRC transceivers (On-Board Units) w/ magnetic mount antennas (four identical devices)
- KEA Tech DSRC Preamble generator with stub antenna (one device)
- Cisco DSRC transmitter w/swivel dipole antenna (one device)

IV. TESTS AND MEASUREMENTS

This document provides additional detail regarding the Phase 1 testing as described in the Public Notice. The tests and measurements to be performed as a part of this phase are further divided into three individual components as described below.

A. 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. These parameters will be measured for each of the U-NII-4 and DSRC transmitters submitted for this effort. The RF characterization measurements will utilize industry standard calibrated RF test equipment, such as digital spectrum analyzers and/or vector signal analyzers, to empirically determine the values associated with the identified EMC parameters.

The resulting data will be used to compare with the applicable IEEE 802.11 transmission mask[6] to confirm compliance and/or quantify any deviation, and is also expected to benefit a technical understanding of the co-channel and adjacent-channel interactions to be examined in the subsequent interference susceptibility tests.

U-NII-4 devices will likely implement variable transmission bandwidths of 20 MHz, 40 MHz, 80 MHz, and 160 MHz. Similar RF characterization measurements will also be performed for U-NII-4 signal bandwidths of 40 MHz and 80 MHz, but the U-NII-4 prototype devices provided to the laboratory to date do not implement the 160-MHz bandwidth option.

In addition, relevant EMC-related receiver parameters, such as the minimum input sensitivity, will be measured for each of the DSRC receivers submitted for the test effort for use in subsequent tests and analyses. The measurement of minimum input sensitivity will be performed as a part of the baseline testing that precedes the benchtop interference susceptibility tests discussed below. The data collected from these measurements will be compared to the specified minimum input sensitivity levels.[7]

B. Benchtop Interference Susceptibility Tests

This portion of the test effort will focus on quantifying the potential impact to the reception of DSRC BSM broadcasts introduced by unmitigated co-channel and adjacent-channel U-NII-4 transmissions.

It is recognized that the interference mitigation approaches that have been proposed to enhance compatible operation between U-NII-4 transmissions and DSRC BSM reception are intended to preclude co-channel interference interactions; however, an examination of such interactions will aid in understanding the "worst case" interference potential.

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[6] IEEE Standard 802.11-2012 at 1607-1609.

[7] IEEE Standard 802.11-2012 at 1612.

The data collected from the adjacent-channel tests will permit examination of an underlying premise associated with at least one of the interference mitigation approaches that have been proposed, i.e., whether EMC can be realized between U-NII-4 and DSRC while operating in immediately adjacent channels. If this premise is proven incorrect, then the data will reveal the amount of frequency/channel separation necessary to achieve EMC.

The basic approach to these tests will involve introducing a U-NII-4 signal to a nominal DSRC broadcast link while observing and recording the effect on typical network performance indicators as the introduced U-NII-4 device output power is incrementally increased.

1. Test Metrics

The following network performance indicators will serve as the fundamental metrics for these interference susceptibility tests:

- Packet Error Rate (PER),
- Data Throughput,
- Network Latency or Delay, and
- Packet Delay Variation (aka, Jitter).

These performance metrics will be monitored and recorded throughout the tests utilizing a commercial network analysis performance tool.

2. DSRC Baseline Testing

These tests are intended to determine baseline values for the identified test metrics. A simple DSRC broadcast link will be established using each DSRC test sample and a steady state transfer of basic safety messages achieved under "no interference" conditions. These tests will be performed in an antenna port conducted test set-up, so as to enable greater control over transmission channel conditions and to reduce measurement uncertainty. Figure 1 provides a simplified block diagram of the anticipated test arrangement. It is noted that since this test effort involves testing of prototype devices, some elements of the baseline testing must be performed at the completion of each test run to ensure that the device performance characteristics remain constant throughout the test.

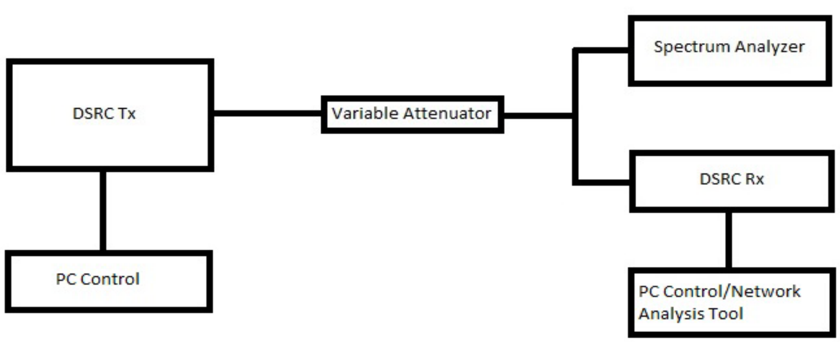

Figure 1. Baseline Tests Simplified Block Diagram

As a part of this baseline testing, a standard test for confirming compliance to the IEEE-802.11 minimum receiver input sensitivity specification will be performed. This test involves reducing the desired signal input level (referenced to the EUT antenna port) until a PER of 10% is observed. The corresponding signal level is defined as the minimum input sensitivity. This level will then be compared to the appropriate specifications in the IEEE-802.11-2012 standard. It is noted that the IEEE-802.11 standard specification represents a minimum level and that receivers can be built with improved receiver input sensitivity relative to what is specified and still maintain compliance to the standard.

The maximum permissible EIRP level for DSRC transmission varies over the seven designated channels by more than 20 dB.[8] In addition, in practice, the implemented power levels are often less than the FCC-permissible levels. Rather than attempting to design and perform unique tests for each possible DSRC transmit EIRP level, the tests described herein will instead be performed for three specific DSRC link margin conditions based on received power instead of transmit power conditions. Specifically, the interference susceptibility tests will be performed assuming DSRC reception at the minimum sensitivity level (representative of edge-of-coverage, or "worst case" signal conditions), the minimum sensitivity level + 15 dB, (representative of nominal signal conditions), and the minimum sensitivity level + 25 dB (representative of ideal signal conditions).

3. Test Channels

The existing DSRC channel plan divides the usable DSRC spectrum into seven 10-MHz wide communications channels and one 5-MHz guard channel. The seven DSRC channels are further segregated into a control, two Public Safety, and four general service channels.[9] The U-NII-4 proposal specifies the use of 20-MHz wide channels with the option of expansion to 40 MHz, 80 MHz, and 160 MHz channel bandwidths. Because of the differing channel bandwidths, the DSRC and proposed U-NII-4 channel plans are not in alignment (see Figure 2).

In an effort to avoid test redundancy, only one U-NII-4 20-MHz channel will be utilized in performing the benchtop interference tests, under the presumption that the U-NII-4 transmission characteristics and thus the ensuing test results will be consistent over the other available channels. These tests will be performed initially with the U-NII-4 prototype transmitting on proposed new channel 177 (center frequency = 5885 MHz). Utilizing this channel for the interference testing will provide data with respect to:

- Co-channel interactions with BSM traffic on DSRC channels 176 and 178,
- First adjacent-channel interactions with BSM traffic on DSRC channels 174 and 180,
- Second adjacent-channel interactions with BSM traffic on DSRC channels 172 and 182,
- Third adjacent-channel interactions with BSM traffic on DSRC channel 184.

The data collected from these measurements can also be used to examine other potential channel interaction arrangements.

For similar reasons, when these tests are repeated using 40 MHz and 80 MHz U-NII-4/Wi-Fi signal bandwidths, proposed U-NII-4 channels 175 and 171, respectively, will be utilized.

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[8] *See* 47 CFR § 90.377(b).

[9] .*Id*.

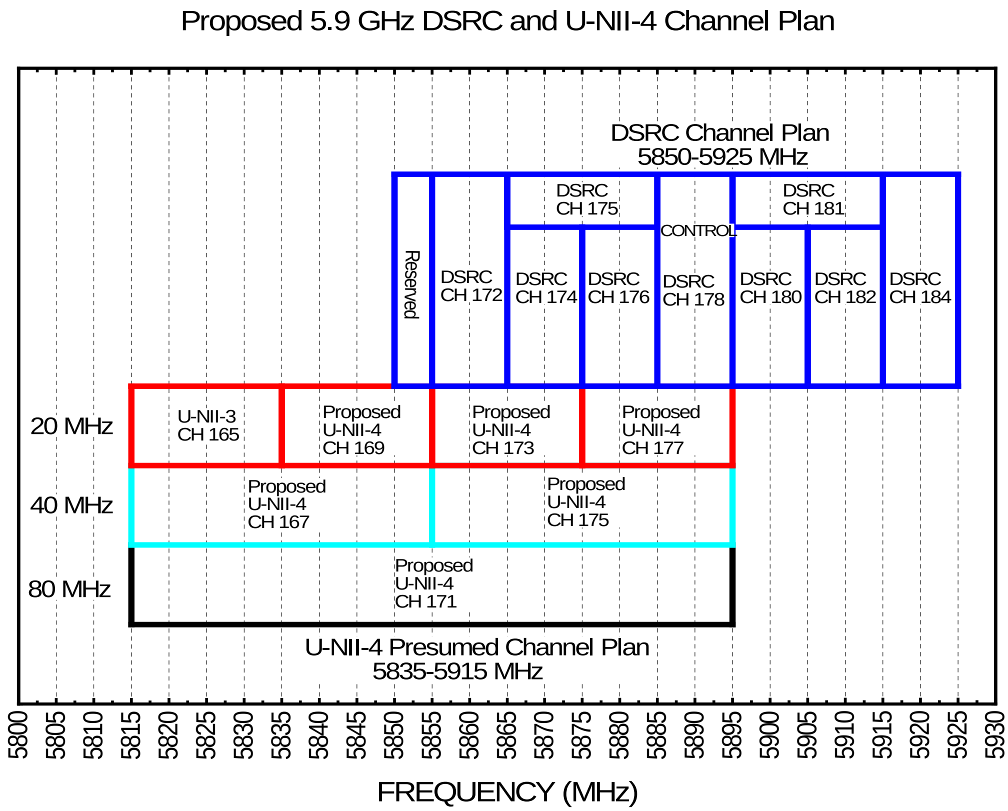

Figure 2: DSRC and Proposed U-NII-4 (802.11ac) Channel Plans

4. Network Loading Conditions

The first instance of the interference susceptibility testing will consider the potential impact to DSRC in a one-on-one type of interference interaction (i.e., without consideration of network loading). A subsequent set of data will also be collected to consider the potential impact under loaded channel conditions. In these tests, simultaneous DSRC BSM packets will be generated using several DSRC transmitters, so as to simulate channel loading conditions.

5. Test Approach

The measurement approach to performing the benchtop interference tests is described below. A simplified block diagram of the measurement configuration is provided in Figure 3.

- A simple DSRC link will be established via coaxial connection, initially with the transmit power adjusted to produce the minimum input sensitivity level at the DSRC antenna input port.
- BSM broadcast traffic will be generated and received on DSRC channel 178.
- A 20-MHz U-NII-4 signal, will then be introduced to the DSRC link via a directional coupler, initially at a low power level.
- The U-NII-4 signal power level will be incrementally increased.
- At each interference power increment, each of the identified performance parameters will be measured and recorded for each DSRC receive channel of interest for comparison to baseline (i.e., no interference) values.

- The DSRC broadcast link will be reset to realize a desired input power level equal to the minimum input sensitivity level plus an additional 15 dB and the entire procedure repeated.
- The procedure will again be repeated with the DSRC communications link reset to realize an input power level equal to the minimum input sensitivity level plus an additional 25 dB.
- The complete procedure will then be repeated for each of the three presumed link margin conditions, utilizing a U-NII-4/Wi-Fi signal bandwidth of 40-MHz centered at 5875 MHz (proposed U-NII-4 channel 175), and then again for an 80-MHz signal bandwidth centered at 5855 MHz (proposed U-NII-4 channel 171).

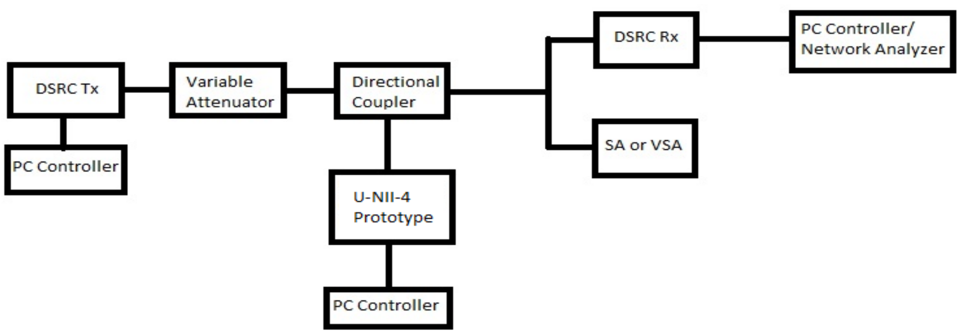

Figure 3. Simplified Block Diagram of Interference Susceptibility Test Configuration

Every attempt will be made to perform these tests using each of the provided U-NII-4 prototype devices to generate the undesired signal. However, past experience has demonstrated that it can be difficult to exert full test control over such complex devices even when mature devices are the test subjects. Therefore, it is expected that such difficulties are also likely with respect to the prototype devices examined as a part of this test program. As such, this susceptibility test will also be performed to produce at least one data set using a commercial IEEE 802.11 signal studio, hosted on a vector signal generator, to simulate the undesired signal, thus permitting greater test control over the relevant test parameters.

C. Interference Mitigation Tests

Responses to the Public Notice provided three distinct proposed strategies for mitigating interference to the DSRC BSM operations from proposed U-NII-4 transmissions. One of these proposed approaches is specific to outdoor, point-to-point, wide-area network (WAN) communications, but since this effort is specific to WLAN operation, and because this particular proposed mitigation strategy is primarily premised on scenario-specific considerations, it is considered to be beyond the scope of this test program.

The remaining two mitigation proposals have been termed the "*re-channelization*" and the "*detect-and-vacate*" approaches and are specific to mitigating the interference potential introduced by WLAN operations. Both of these approaches include strategies to preclude co-channel interactions between U-NII-4 transmissions and DSRC receivers as the primary means of interference mitigation.

1. Re-channelization Mitigation Strategy

This proposed strategy 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 retain exclusivity with respect to DSRC operations. In particular, the strategy 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, but details as to how these three channels will be configured to support the control channel (currently on channel 178), the higher-power dedicated Public Safety channel intended for use by emergency service providers (currently on channel 184), and the newly introduced (under the proposal) dedicated Public Safety channel for V2V operations have not been made apparent.

Under this proposal, the lower 45 MHz of the DSRC spectrum (i.e., DSRC channels 172, 174, 176, 178, and the 5-MHz guard channel) would be made available for shared use by DSRC and U-NII-4; however, there are subtle differences among the advocates of this proposal as to how the remaining lower DSRC spectrum would be structured to facilitate such sharing. There appears to be consensus agreement among the re-channelization advocates that the four 10-MHz DSRC channels should be reconfigured as two 20-MHz channels so as to mutually enable the use of existing clear channel access employing carrier-sense (CCA-CS) methodology already incorporated in the 802.11ac standard. This could also permit the implementation of a priority access scheme utilizing modified Enhanced Distributed Channel Access (EDCA) technologies that can be used to assign higher priority to DSRC message traffic related to public safety applications.[10]

However, some advocates of this methodology assert that the three DSRC-exclusive channels to be retained in the upper 30 MHz of the DSRC band are adequate to handle all safety-related DSRC messaging, and thus DSRC message traffic in the shared portion of the band should not be given any special dispensation, but should instead be handled according to the same routing methods applied to any other 802.11 message traffic.[11]

2. Detect and Vacate Mitigation Strategy

The "detect and vacate" approach (often referred to as "detect and avoid"), would require that U-NII-4 devices implement a capability for detecting and identifying any DSRC message traffic present in the lower five DSRC channels (DSRC channels 172, 174, 176, 178, and 180) and to immediately vacate all of the DSRC channels and the upper 25 MHz of the U-NII-3 frequency band (i.e., 5825-5925 MHz) upon a positive detection and identification. As with the re-channelization proposal, all U-NII-4 operations are intended to utilize DSRC spectrum below 5895 MHz, leaving the upper three DSRC channels unencumbered.[12]

This approach does not rely on a reconfiguration of the existing DSRC channel plan. Rather, this strategy is predicated upon the use of a detection capability to determine the presence of DSRC messages through

[10] Broadcom Ltd. July 22, 2016 Reply Comments.

[11] National Cable & Telecommunications Association July 22, 2016 Reply Comments.

[12] Cisco Systems, Inc., July 22, 2016 Further Reply Comments at Exhibit 1.

a combination of energy sensing and demodulation of the DSRC signal to enable identification of unique training symbols embedded in the DSRC physical layer convergence protocol (PLCP) preamble. Although this is similar to the CCA-CS approach discussed above, the particular implementation proposes to utilize 10-MHz preamble detectors so as to maintain the existing 10-MHz DSRC channelization (i.e., would not require the lower four DSRC channels to be reconfigured into 20 MHz DSRC channels). The proposed minimum signal power detection threshold for DSRC message traffic is -85 dBm/10-MHz in DSRC channels 172, 174, 176, and 178 (lower 40 MHz) and -65 dBm in channel 180 (via digital image detection).[13] The -85 dBm/10-MHz detection threshold corresponds to the IEEE 802.11-specified minimum receiver input sensitivity level.

When the detection threshold is realized, and the preamble training symbols are recognized as DSRC, then a "DSRC Channels Busy" true condition applies and will remain true for at least [10 seconds]. Under this condition the U-NII-4 device will terminate transmissions within the 100-MHz portion of spectrum from 5825-5925 MHz. This methodology is referred to as DSRC Clear Channel Assessment (DCCA), and is intended to be independent of, and concurrent to, traditional CCA operation as specified in the 802.11ac standard. Under this strategy, both CCA and DCCA must concurrently indicate channel idle and DSRC Channels Not Busy, respectively, for a minimum of [1 ms] before a U-NII-4 device is permitted to transmit. In addition, it is also proposed that all U-NII-4 transmissions be restricted to a period of 3 ms or less to further minimize the potential for interference to DSRC radios.[14]

3. Validation/Verification Tests

The following tests will be performed to collect the data necessary to assess each of the two proposed strategies intended to mitigate potential interference from U-NII-4 transmissions to DSRC reception of priority messages (i.e., BSMs).

The U-NII-4 prototype devices submitted for testing do not actually implement the prioritization scheme advocated by the re-channelization proponents. Thus, direct testing to ascertain its viability is not practical. However, the data acquired from the benchtop interference susceptibility tests can be used to assess a fundamental premise of this strategy – the presumption that adjacent-channel compatibility can be realized between U-NII-4 transmissions and DSRC BSM reception. In addition, a set of tests will be performed in an effort to assess the CCA capabilities implemented in the U-NII-4 prototype devices with respect to 10-MHz DSRC channel bandwidths, and where possible, 20-MHz DSRC channel bandwidths (some of the DSRC devices provided permit DSRC communications on 20-MHz service channels).

The "detect and vacate" approach will be tested in various measurement configurations. A set of measurements will be performed in an antenna-port conducted test to determine the probability of detection with respect to DSRC BSMs at various detection threshold levels, under ideal channel conditions and then with additive white Gaussian noise (AWGN) injected into the channel. See Figure 4 for a simplified block diagram of the general test set-up. This will be followed by a radiated test performed within a semi-anechoic chamber (SAC) to introduce limited multipath reflections. Figure 5 provides a block diagram representation of the test configuration. Finally, another radiated test will be performed on an outdoor area test site (OATS) so that the effect of both ambient noise and multipath reflections can be observed. See Figure 6 for a block diagram of the test configuration anticipated for use in these tests.

The following is the general procedure that will be applied to these tests:

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[13] *Id*.

[14] *Id*.

- Establish DSRC links on each of DSRC channels 172, 174, 176, 178, and 180 (this will be performed first as a conducted test and then as a radiated test in the SAC and then on the OATS).
- Introduce a U-NII-4 prototype with detect and vacate capability into the circuit.
- Attenuate the DSRC signal power level in equal steps while recording the results of the detection algorithm (DSRC Channels Busy flag).
- When the DSRC signal power is attenuated such that the detection level is close to the specified threshold value, the tests will be repeated to accumulate at least 50 samples at each power step to accommodate a statistical data analysis.
- Once the minimum detection threshold level has been determined on a conducted basis, additive white Gaussian noise (AWGN) will be injected into the channel under examination, initially at a level equivalent to the receiver thermal noise level (i.e., INR = 0 dB) and the test repeated.
- The injected AWGN will then be increased and the detection tests repeated.
- Upon successful detection, it will be verified that the U-NII-4 device actually vacates the DSRC band and the channel vacate time will be measured. This measurement will also require multiple samples to produce a statistically significant data set.
- The radiated tests performed in the SAC will utilize a similar approach in that the DSRC output power levels will be step-wise attenuated while the U-NII-4 device exercises its detection capability at a fixed separation distance (≤ 3m).
- The radiated tests performed on the OATS will deviate slightly from the basic procedure in that the DSRC signal level present at the U-NII-4 detector antenna will be attenuated by increasing the physical distance between the devices.

Where possible, the complement of this scenario will also be similarly tested in a conducted set-up. These tests will attempt to determine the minimum U-NII-4 signal levels that can be detected by a DSRC device utilizing CCA-ED technologies. Figure 7 provides a block diagram representation of the anticipated set-up for these tests.

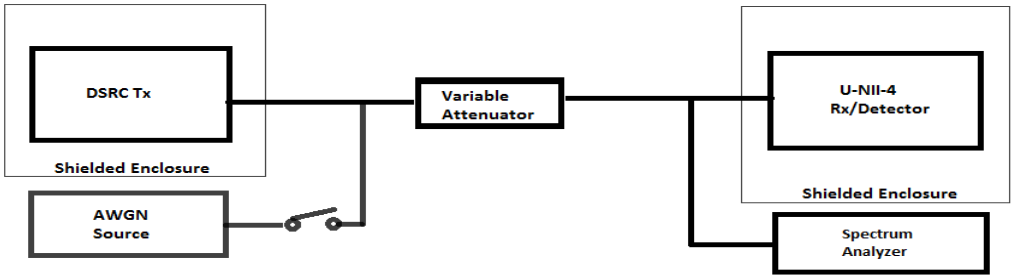

Figure 4. DSRC Detection Threshold Conducted Test Configuration.

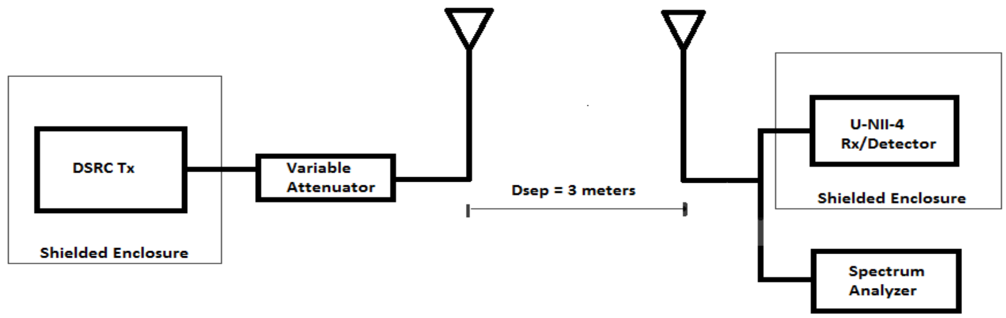

Figure 5. DSRC Detection Threshold Radiated (SAC) Test Configuration.

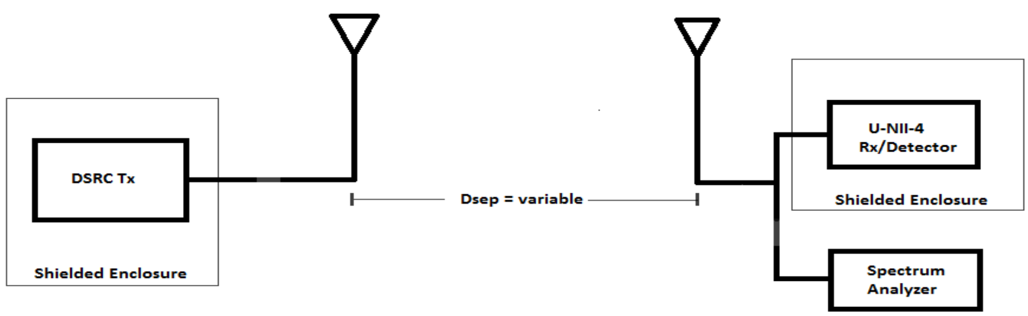

Figure 6. DSRC Detection Threshold Radiated (OATS) Test Configuration.

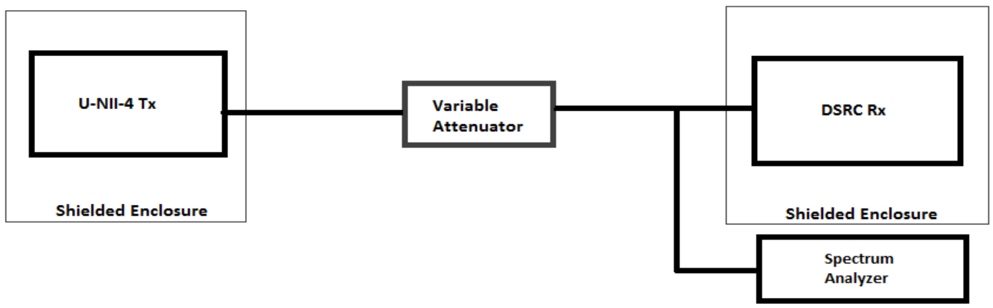

Figure 7. U-NII-4 Detection Threshold Conducted Test Configuration.

V. ANTICIPATED OUTPUT DATA AND FORMAT

The data produced by this measurement program and intended to inform the ongoing discussion regarding the potential for shared spectrum operations between DSRC and proposed U-NII-4 applications will be formatted as described below.

The data accumulated from the RF Characterization measurements will consist of frequency vs. amplitude (power) plots with applicable 802.11 mask overlays for each DSRC and prototype U-NII-4 transmitter submitted for testing. These plots will depict the transmitter OBW, fundamental power, and out-of-band emission characteristics. In addition, the data collected with respect to pertinent receiver characteristics will be reported in tabular format.

The data accumulated from the benchtop interference susceptibility tests will be presented in a graphical format (i.e., plots) depicting the selected performance indicators (i.e., packet error rate, data throughput, network latency, and jitter) as a function of interference power for each assumed link margin condition. Histograms will also likely be generated to depict the timing associated with the successful transmission and reception of BSMs under various interference conditions.

The data accumulated from the interference mitigation tests will be presented in a tabular format.

VI. PROGRAM STIPULATIONS/CAVEATS

The plans and procedures discussed herein presume the ability to exercise full control over the test device parameters of interest. However, complex transceivers used in network applications often do not offer this level of user control. In this particular measurement effort, the devices provided for testing are primarily prototypes, which can increase the complexity of the measurement effort due to such factors as inadequate RF shielding. If and when such complications are encountered, some reconsideration of components of this test plan may be necessary, which may also impact the test schedule.

Any deviations or modifications to this plan, necessitated by the above considerations or by other unforeseen circumstances, will be fully detailed and explained in the final test report.